Lexical Representation and Processing in Bodo−Assamese Bilinguals

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By

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Statement

I hereby declare that the matter embodied in this thesis, entitled **"Lexical Representation and Processing in Bodo−Assamese Bilinguals"**, is the result of research carried out by me at the Department of Humanities and Social Sciences, Indian Institute of Technology Guwahati, India under the supervision of Dr. Bidisha Som, Associate Professor, Department of Humanities and Social Sciences.

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Certificate

This is to certify that Sugandha Kaur has prepared the thesis entitled **"Lexical Representation and Processing in Bodo−Assamese Bilinguals"** for the degree of Doctor of Philosophy at the Department of Humanities and Social Sciences, Indian Institute of Technology Guwahati, India. The work has been carried out under my supervision and in strict conformity with the rules laid down for the purpose. It is the result of her investigation and has not been submitted either in whole or in part to any other university/institution for a research degree.

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Dr. Bidisha Som
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ABSTRACT

Contact between people speaking different languages has been a common phenomenon since ancient times. As globalization has increased awareness of the extent of language contact and linguistic diversity, questions concerning bilingualism have taken on an increasing importance from both practical and scholarly points of view (Wei & Moyer, 2008). Psycholinguistics has greatly enriched the field of bilingualism research by providing insights into the bilingual mind, in order to better understand the cognitive basis of bilingualism and the logic of experimental and formal approaches to language science. Psycholinguistic research in the field of bilingual lexical processing has suggested that information from the non-target language is spontaneously accessed when bilinguals read, listen, or speak in a given language. Although there has been extensive research in this area, the available evidence is not always consistent and the answers to some of the questions are still subject to controversy. Grosjean (1998a) suggested that variation in experimental manipulations may influence the pattern of results and be responsible for differences in outcomes.

The present study, therefore, intended to bridge this gap by examining the nature of bilingual lexical representation and processing in a previously unexamined different-script language pair (Bodo−Assamese). We examined two major areas of research activity in experimental psycholinguistics—comprehension and production. The overall goal of the study was to investigate how Bodo−Assamese bilinguals represent and process their two languages during word recognition as well as production, as a function of their second language age of acquisition and proficiency. More specifically, it focused on the empirical investigations of the storage and retrieval of cognates and non-cognates in a bilingual mind. In order to look at proficiency separately from age of acquisition, we tested three groups of bilinguals who differed on their second language age of acquisition and proficiency—Early High Proficient, Late High Proficient and Late Low Proficient.

The study further investigated whether language-specific differences, such as script can modulate cross-language activation, the locus of language selection, and the manner of language/lexical selection during bilingual word recognition as well as production.

To address these issues, several behavioural experiments were designed which include twenty word recognition experiments from three different tasks (visual lexical decision, semantic categorization, and translation recognition) and twelve production experiments from five different tasks (word naming, word translation, simple picture naming, picture-word interference, and primed picture naming). The overall results of the experiments suggest that Bodo–Assamese bilinguals activate both the first language and the second language in parallel, even when direct linguistic input is presented in one language only. The results are interpreted within the context of current models of bilingual language representation and processing.

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Sugandha Kaur

December 2016

To my family,

for making it possible

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ABBREVIATIONS

L1	First and native language
L2	Second language
AoA	Age of acquisition
CFE	Cognate facilitation effect
CPH	Critical period hypothesis
BNT	Boston Naming Test
LDT	Lexical decision task
PWI	Picture word interference
Target Language (also "response language")	The language to use in a specific setting
Non-target language (also "non-response language")	The language not in use in a specific setting
RHM	Revised Hierarchical Model
DCF	Distributed Conceptual Feature
BIA (+)	Bilingual Interactive Activation (Plus)
SOPHIA	Semantic, Orthographic, Phonological, Interactive
BIMOLA	Bilingual Model of Lexical Access
RT	Reaction time
SOA	Stimulus onset asynchrony

1

INTRODUCTION: THEORETICAL BACKGROUND

The first chapter begins with an introduction for the significance of the problem, contextualizes the study, and provides an overview to the basic components. It also discusses the major goals of this investigation and the general strategy of the study.

Main Contents

1.1 Introduction

Life as a bilingual: The case of a Bodo−Assamese bilingual

Nizwmshree Basumatary lives in Guwahati. Her native language is Bodo and she learnt Assamese as a second language at the age of around 5 years. She never leant Assamese formally. Although she is highly proficient in both, Bodo and Assamese, her Bodo is much stronger. In addition to that, she studied English in college and university but has very few opportunities to hear or speak it. She uses Bodo with her parents and siblings and uses Assamese with her friends and colleagues. She is a teacher and her job demands a good deal of Assamese. Based on requirement, Nizwmshree is able to use both the languages, without any one of the language infringing on the use of the other. Interestingly, she has the dexterity to code-switch during interaction with similar speakers, which depicts that both languages are being processed simultaneously.

Language is one of the fundamental topics in human science. It is one of the things that characterize us as humans. But language comes so naturally to us that we often fail to appreciate it as a miraculous and special gift. Technically, we define language as a set of spoken, written, or signed words and the way we combine them to communicate meaning. However, when we see and hear languages, what connections do we use? The question becomes more intriguing when we take the case of bilinguals. The majority of the people in the world are able to speak two or more languages. So, how do the two languages of bilingual individuals interact in everyday communication? If an individual possesses knowledge of multiple languages, the ways in which each of those languages represents and stores meaning, and the relationship between languages lead to interesting questions regarding the interaction between language, memory and perception. It is, therefore, important to understand whether these dual representations in bilinguals interact or affect one another, which is inherently interesting in understanding how the human brain works.

In the last decade, the study of bilingualism has been an engaging topic in psycholinguistic research. Any study on the psycholinguistic processes in bilinguals generally revolves around two core areas: the *representation* and *processing* of both the languages used by bilingual speakers. A fundamental characteristic of bilingualism is the fact that a given concept has at least two different lexical representations in the two languages. The most direct link between such two lexical representations in two given languages is called translation equivalence. For instance, for an Assamese−English bilingual (a bilingual whose native language is Assamese and second language is English) the concept of a barking pet can be referred to either by the Assamese word 'কুকুৰ' [kukur] or by the English word 'dog'. In the past six decades, psycholinguistic research into bilingualism has been dominated by two related questions concerning representation and processing:

1) What is the structure of representation of two different lexical identities in the mind of the bilingual speaker?

2) What is the scheme of interaction between two unique lexical systems during processing of language?

It has been observed that studies concerning the first question above have tried to largely decipher whether the psyche of the bilingual encompasses two different language-centric lexicons (one each for the two languages used by the bilingual) or if the two languages spoken by the bilingual share a common lexicon. Similiarly, research concerning the aforestated second question aims to understand if language activation/access in bilinguals is inherently selective or non-selective. As per the selective access view, a bilingual can selectively activate one of their languages, whereas as per the non-selective access view, both languages of a bilingual get activated simultaneously.

Many studies have been carried out over the last six decades in an attempt to determine the type of connections between the lexical forms of words between the two languages of the bilingual, including how these forms are linked to the corresponding, shared semantic representations within the common conceptual system. However, the available evidence is not always consistent and the answers to some of these questions are still subject to controversy. The presented work in this thesis follows the same line of research, but it intended to bridge this gap by exploring the nature of bilingual lexical representation and processing, focusing, in particular, on the processes of bilingual language comprehension and production in a previously unexamined different-script language pair, i.e., Bodo−Assamese. The study aims to delve into the bilingual's cognition aspect in order to gain an insight into the interaction between different languages in his/her mind. The study was largely based on the premise of languages mutually affecting each other, the premise against which models relating to bilingual language representation and processing were to be evaluated. What follows in this thesis are data and interpretations on how Bodo−Assamese bilinguals mentally organize their languages, and how these languages interact. The following section provides a brief overview of this chapter.

1.2 Chapter Overview

This introductory chapter seeks to provide a framework for the subsequent chapters by identifying the key concepts prevailing in the area of bilingualism. The first major concept in this chapter is the notion of bilingualism and a discussion on some of the inconsistencies pertaining to definition and classification of bilinguals will be presented. The next section will describe psycholinguistics of bilingualism with respect to the major theoretical viewpoints on models of word recognition and production which had been propounded with a view to explain representation of lexicals in bilinguals and associated processing. These sections provided the basis for the identification of the rationale for the present study which will be briefly discussed in the next section. The section that follows outlines the goals, research questions, and hypotheses of the present research and the next section will briefly present an overview of methodology. An outline of the thesis content concludes the present chapter, with a more precise introduction to the topics discussed in each of the five chapters that follow.

1.3 Definition of Bilingualism

What does it really mean to be bilingual and become bilingual? There are many different ways to define bilingualism, but essentially bilingualism refers to knowledge of two languages. Researchers have long been on logger-heads to suitably define the term ‘bilingualism’. However, so far, a general consensus has proved elusive. Table 1.1 summarizes some of the more common definitions found in the literature.

Table 1.1 Definition of Bilingualism

Author	Definition
Aucamp, (1926)	“Bilingualism is the condition in which two living languages exist side by side in a country, each spoken by one national group, representing a fairly large proportion of the people.”
Bloomfield (1933)	“Bilingualism resulted from the addition of a perfectly learned foreign language to one’s own, undiminished native tongue.”
Weinreich (1953)	“Bilingualism is the alternate use of two languages.”
Haugen (1953)	“Bilingualism began with the ability to produce complete and meaningful utterances in the second language.”
Macnamara (1967)	“A bilingual is someone with some proficiency in any one of the skills of reading, writing, speaking and understanding a second language.”
Grosjean (1992)	“Bilingualism is the regular use of two (or more) languages, and bilinguals are those people who need and use two (or more) languages in their everyday lives.”
Valdes and Figueroa (1994)	“Bilingualism is the condition of knowing two languages rather than one.”

On perusal of the definitions enunciated above, it can be opined that while earlier definitions were narower in scope and seemed to consider bilinguism as being equally proficient in both languages, later definitions were more extensive and have allowed for variability in competency across both languages. Further, they provide the scope for the inclusion of the developmental processes involved in second language acquisition into the gamut of the term bilingualism. Grosjean (1994) had based his classification of bilinguals on the basis of degreee of daily usage of languages. His study tends to differentiate between bilinguals using two or more languages on a day-to-day basis from the ones who do not use the languages despite knowing them (i.e., dormant bilinguals).

Overall, it appears that the documented realm of bilingualism is replete with instances of ambiguities and inconsistencies as far as usage of terminologies are concerned. Perusal of the same provides an abundant clarity that the definition of the term ‘bilingual’ as people only equally proficient in the usage of two languages will not be used for the present study. Instead, the following definition shall more holistically capture the aims, objectives and spirit of the study being undertaken: “Bilingualism is the regular use of two (or more) languages, and bilinguals are those people who need and use two (or more) languages in their everyday lives” (Grosjean, 1992, p. 51).

1.4 Classifying Bilinguals

Most bilinguals around the world know and use their languages in varying proportions. And depending on their situation and how they acquired each language, they can be classified into different categories. Some of the major typologies that researchers use depending on linguistic, cognitive, developmental, and social dimension are summarized in Table 1.2 (Butler & Hakuta, 2004). Holistically, bilingual classification embraces different dimensions both in the individual and social strata. These dimensions, however, do not generally operate in isolation. Rather, they are intertwined, thereby creating obstructions in demarcating well defined boundaries between them. The complexity of understanding the processing mechanism of bilinguals is further aggravated by the contextual usage of languages.

Table 1.2 Typology of Bilinguals (Adapted from Butler & Hakuta, 2004, p. 116−117)

Typology	Point of focus (Dimension)	Characteristics of SLA	Possible outcomes	Related issues and educational implications
Balanced Dominant (Peal & Lambert, 1962)	Relationship between proficiencies in two languages	Functional differences; related to age factor	Differences in proficiencies in L1 and L2: achieving equal level of proficiency in L2 with L1 (balanced); L2 proficiency varies but not the same as L1 (dominant)	Conceptualizing and assessing one's language proficiency; Cummin's threshold hypothesis and interdependent hypothesis; semilingualism
Compound Coordinate Subordinate (Weinreich, 1953)	Organization of linguistic codes and meaning unit(s)	Functional differences; differences in form-meaning mapping	Differences in semantic representation and information processing for L1 and L2	Difficulties with operationalizing distinctions and testing differences
Early Simultaneous Sequential Late (Genesee, Hamers, & Lambert, 1978)	Age of acquisition	Maturational differences; schooling differences	Attainment of L2 proficiency varies by age of acquisition; L1 proficiency is not addressed	Neurolinguistic differences; critical period hypothesis

Incipient Receptive Productive	Functional ability	Functional and motivational differences	Different proficiencies in L1 and L2 in different domains	
Additive Subtractive (Lambert, 1974; 1975)	Effect of L2 learning on the retention of L1	L2 as enrichment with or without loss of L1; status of a language in a given context	L2 as enrichment without loss of L1 (additive); L1 is replaced by L2 (subtractive)	Social status of individual groups and the social value of their L1 greatly influences the retention of L1; support for literacy in L1 and L2 literacy development
Elite Folk (Fishman, 1977); Circumstantial Elective (Valdés & Figueroa, 1994)	Language status and learning environment; literacy support of L1	Differences in language status and value of bilingualism	No or little additive value of L1 as a language minority status (folk); additive value of L2 (elite)	Support for literacy in L1 and L2 literacy development
Bicultural L1 monocultural L2 accultural Deculturated (Hamers & Blanc, 2000)	Cultural identity	Differences in acculturation process	Cultural identity shaped by two cultures (bicultural); identity in one culture, loss of L1 culture	High bilingual competence does not necessarily coincide with dual identity

At this juncture, it is pertinent to mention that bilingualism need not be stable and/or static, rather it is succeptible to change over time. A spoken proficiency in primary language may subside in favour of a secondary (or even acquired) language due to protracted usage of the latter. This means a bilingual's languages may wax and wane over years and different stages will affect the psycholinguistic processes differently. Research investigating the nature of bilingual language representation and processing has usually studied the effects of second language (L2) age of acquisition (AoA) and proficiency separately. For this reason, in the present study, the effects of both factors will be examined in parallel, by manipulating not only the L2 proficiency level of the participants, but also the age at which L2 was first acquired. Using these and a set of other parameters (all of which have already been shown to have some effect on bilinguals' cognitive and psycholinguistic processes), a deliberate effort has been made to classify the bilinguals into three groups (see Chapter 3).

1.5 Psycholinguistics and Bilingualism

Psycholinguistics as a field of study has grown through various stages of development from 'linguistic period' to the 'cognitive science period' as can be seen from the works of Morris, (1938), Wundt (1907), Miller (1964), Fodor (1966), Lenneberg (1967), Luria (1970, 1976, 1979) that brought language studies out of romanticist evaluation to be explained in terms of psychological examination and, in recent times, in terms of brain function. However, studies on bilingualism has seen an immense growth in last twenty or so years, not only among psycholinguists but also psychologists, neuropsychologists, applied linguists among others. This increase in the cognitive study of bilinguals have perhaps been fuelled by a growing understanding that bilingualism, and not monolingualism, is fast becoming the norm world over. As two of the leading researchers in the field have summarised: "…bilingualism is a common human condition and that it may influence cognition, were presumably instrumental in putting bilingualism on the agendas of many researchers of cognition and language in recent years" (De Groot and Kroll, 1997, p. 2). The three major strands of psycholinguistic research on bilingualism refer to the *comprehension, production*, and *acquisition* of language. That is, (1) How do people use their knowledge of language, and how do they understand what they hear or read? (2) How do they produce messages that others can understand in turn? (3) How language is acquired and represented in the mind? Psycholinguistic research on bilingualism over the past six decades has focused on two interrelated fields, i.e., representation and processing of the bilinguals two languages. Whereas 'representation' indicates the structure and deals with organizing the varied components of languages in bilinguals, 'processing', on the other hand, is concerned with the activation of the varied components of languages in bilinguals and their mutually inclusive and exclusive interactions.

One way of conceptualizing our general knowledge of words is in terms of a mental lexicon, a term researchers use to refer to our mental dictionary. Lemmas are the building blocks of a mental lexicon. Levelt (1989, p. 6) defines a lemma as the ''non-phonological part of an item's lexical information, including semantic, syntactic, and some aspects of morphological information". The mental lexicon in bilinguals may be better understood as the individual's intrinsic representation of knoweldge (which invariably is specific to a language) about the surface forms. The process by which a word is activated within the lexicon is termed lexical access. As put forward by (De Groot, 2011):

> In comprehension studies, used in a narrow sense the term refers to the stage during word recognition in which, following a match between an input word and a representation in the mental lexicon, all the information stored with this representation, including its syntactical and morphological specifications and its meaning, becomes available for further processing. In a broader sense it is also used to cover the earlier stage in which an input word is matched onto its lexical representation. In production studies "lexical access" is used to refer to all the processing that occurs between the conceptualization of a specific lexical concept and the moment the corresponding lexical element (or lemma) is selected for actual production. (p. 454)

In Chapter 4, the term word recognition and lexical access will be used interchangeably, referring to the complete process in both cases. In Chapter 5, on speech production, the term lexical access will be used to refer to all the processing that occurs between the intention to produce a word (the "conceptualization" of a word) and the moment its lexical element is selected for production.

1.5.1 Models of Bilingual Language Representation and Processing

When it comes to aims of research on bilingualism, development of models on how the language of the bilingual individual is acquired, represented and processed has been of primary interest irrespective of the methodology of reasearch—be it descriptive, theoretical or experimental. Multifarious models have evolved over time depicting the representation of words in dual languages and the inherent interconnectivity between them. In models pertaining to lexical representation and processing, it has been observed that a clear demarcation is made between form representations and their inherent meaning. Further, in discussion of language processing models in bilingualism, a striking area of differentiation that emerges is that between language comprehension and its production. Most available models are specific to either of them and cannot be applied interchangeably. The following section gives a brief overview of some of the major bilingual word recognition and production models developed within the theoretical framework of cognitive psychology.

1.5.1.1 Models of word recognition

The most common view of bilingual lexical memory is that it is 'hierarchical' in the sense that it consists of at least two layers of memory representation (or 'nodes')—a general level (i.e., the conceptual level) and the language-specific mental lexicons. In the following sections we discuss briefly three hierarchical models.

The Word Association and Concept Mediation Models. In 1984, Potter et al. proposed two hierarchical models, namely, the *Word Association Model* and the *Concept Mediation Model*, with respect to retrieval of word knowledge in the lexicon of the bilingual. These models have been around under different names much longer (see Weinreich, 1953). According to the Word Association Model, lexicons are connected directly by means of word connections. According to Concept Mediation Model, the lexicons are related only via their connections with the conceptual information, which is common for both languages (see Figure 1.1).

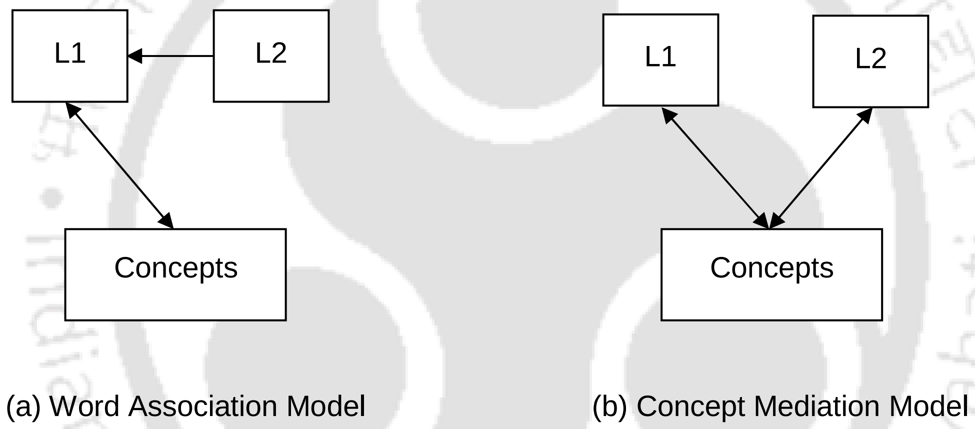


Figure 1.1 (a) The Word Association Model and (b) the Concept Mediation Model (adapted from Potter et al., 1984).

Initially, the various psycholinguistic models did not account for the possibility that bilingual memory may be a function of second language proficiency and translation direction. To account for this, Kroll & Sholl (1992) and (Kroll & Stewart (1994) introduced a third version of the hierarchical model by incorporating both the word association and the concept mediation models into the same model (see next section).

The Revised Hierarchical Model (RHM). The *Revised Hierarchical Model* by Kroll & Stewart (1994) is one of the most well-known models of bilingual lexical representation. The model is similar to the earlier hierarchical models in terms of basic structure—it proposes two independent lexicons, one for each language, and an integrated conceptual system. However, the model also captures the inter-language connections between lexical and conceptual representations as learners become more proficient in their second language. Two core assumptions of the model are (1) links to the conceptual system are stronger in case of L1 lexical items, whereas in case of L2 lexical items, lexical links between word forms are stronger (see Figure 1.2), and (2) high proficient bilinguals can map an L2 word to the conceptual system directly, whereas low proficient bilinguals initially map an L2 word onto its L1 translation, and then access the conceptual system via the lexical and conceptual representation of the L1.

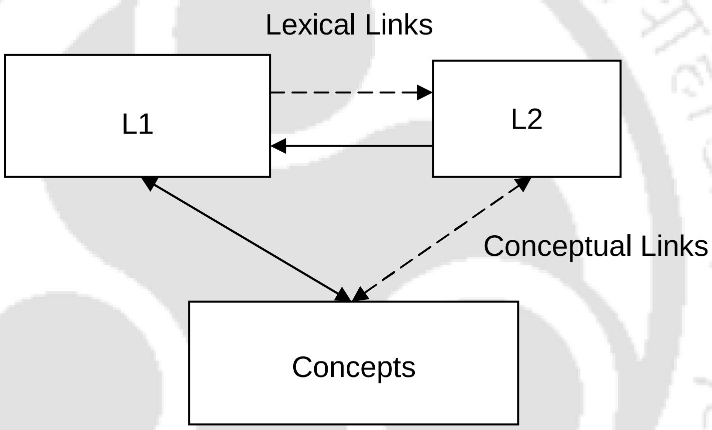


Figure 1.2 The Revised Hierarchical Model (adapted from Kroll & Stewart, 1994).

In the following section, we will discuss two models which differ from the hierarchical models in that these models assume bilingual memory structures with distributed meaning representations. In these models, the meaning of a word is spread out over a number of more elementary meaning units that each stores one elementary part of a word's meaning (e.g., De Groot, 1992a, 1992b; Taylor, 1976) and the word form representations are also distributed over a number of more elementary features, this time form features (e.g., Kroll & De Groot, 1997; Van Hell & De Groot, 1998a).

The Distributed Conceptual Feature Model (DCF). The *Distributed Conceptual Feature Model* was proposed by De Groot and colleagues (De Groot, 1992a, 1992b, 1993; De Groot et al., 1994; Van Hell &De Groot, 1998a, 1998b). As per the assumptions of this model, a shared conceptual system exists for both L1 and L2, but the conceptual representation is in the form of distributed features. Moreover, the degree of overlap between L1 and L2 representations is primarily dependent on word type (see Figure 1.3). For example, translation is easier when the words from two different languages share many semantic features, as opposed to when they share limited semantic features.

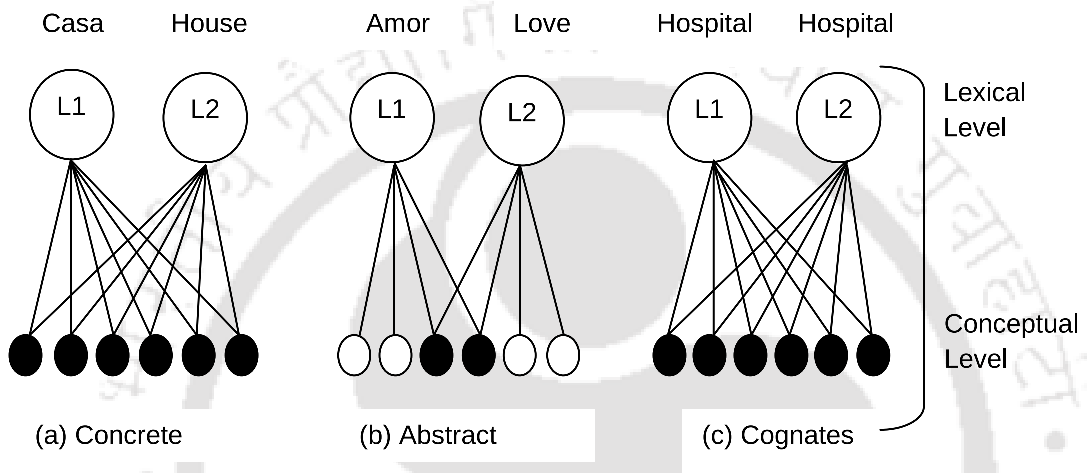


Figure 1.3 The Distributed Conceptual Feature Model of bilingual memory representations for different word types (adapted from De Groot, 1992a).

The interconnectedness of words across languages is well captured in this model. However, it is limited in the sense that only findings at the word level are explained by it, whereas other general findings, such as the role of translation direction or the role of proficiency cannot be explained by this model. The next section discusses a model by Finkbeiner et al. (2004) who have proposed interesting modifications to De Groot's Distributed Conceptual Feature Model.

The Sense Model. To account for the bilingual translation priming asymmetry observed in previous studies, Finkbeiner et al. (2004) proposed the *Sense Model* which gives an alternative to the DCF model. Instead of focusing on the varying number of meaning and form elements different translation pairs may share, the authors focused on clusters of meaning elements that each constitute a word sense (De Groot, 2011). According to this model, each member of a pair of translations has language-specific senses in addition to the one or more senses that it shares with the other member of the translation pair and the ratio of the primed senses to the unprimed senses determine priming. Thus, as per the predictions of the model, not only the overlap in the semantic senses activated by the prime and target determines translation priming, but it also depends on the ratio of the primed to unprimed senses associated with the target. Moreover, the model explains the asymmetry in translation priming by proposing that a bilingual speaker would normally know more senses in their L1 words as they are more proficient in their L1 as compared to L2 words. This results in significant priming in L1−L2 than from L2−L1 (see Figure 1.4).

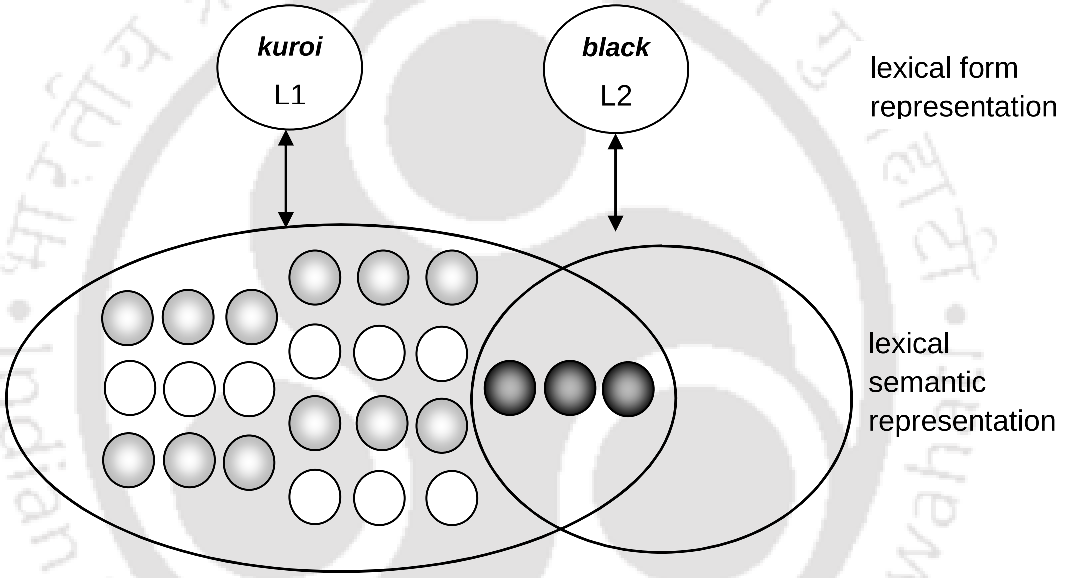


Figure 1.4 A schematic representation of the Sense Model (adapted from Finkbeiner et al., 2004).

In the present decade interesting trends have emerged for the description of bilingual lexical organization by the application of the connectionist framework. A main feature of connectionist models is the way they represent information. Connectionist models are divided into local representation models and distributed representation models. In the next section few local connectionist models for word recognition are briefly reviewed.

The Bilingual Interactive Activation (Plus) Model(s) (BIA and BIA+). The *Bilingual Interactive Activation* (BIA) model of lexical access developed by Dijkstra et al. (1999); Grainger (1993); Grainger & Dijkstra (1992); Van Heuven, Dijkstra, & Grainger (1998) is a connectionist computational model of bilingual visual word recognition in bilinguals and it is based on McClelland & Rumelhart's (1981) *Interactive Activation* model (IA) of monolingual visual word recognition (see Figure 1.5).

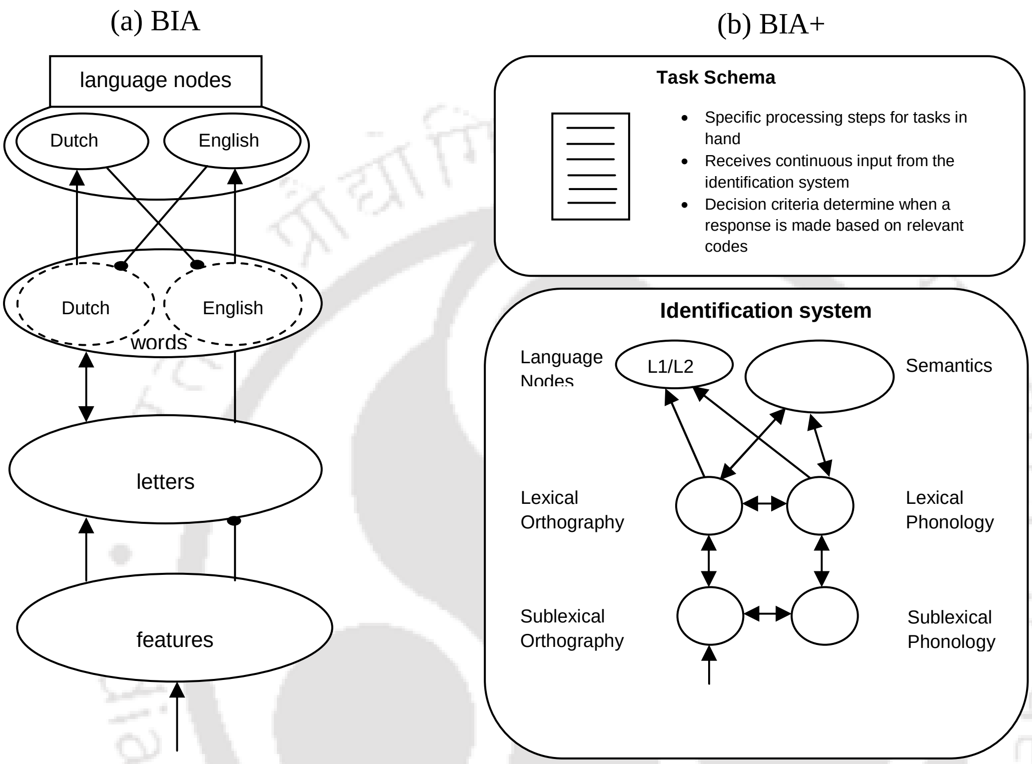


Figure 1.5 Visual representation of (a) BIA and (b) BIA+ (adapted from Dijkstra & Van Heuven, 1998; Dijkstra & Van Heuven, 2002).

The model consists of hierarchical arrangement of four levels of representation units, namely, features, letters, words, and language nodes respectively. However, BIA differs from the early hierarchical models in that the lexical items of the first and the second language are stored in an integrated lexicon and the items of both the languages get activated in a non-selective manner. Specification of language membership is further provided by the level of language nodes. Although BIA predicts that regardless of the language in use, several lexical items are activated and compete for selection, the role of contextual influences on these processes has been ignored. The original BIA model was therefore, updated to BIA+ in which a task/decision schema is added onto the word identification system. According to the model, contextual effects (both linguistic and non-linguistic) have an influence on the access of lexical items in bilinguals (Dijkstra & Van Heuven, 2002).

The above discussed models of word recognition were limited in many respects—they did not deal with the phonological element. Therefore, to account for the effects of phonology and acknowledging the central role of meaning in language processing, another extended model of BIA was subsequently proposed by the authors that, in addition to the various types of nodes that represent orthography and language, also includes nodes that represent phonology and semantics (Van Heuven & Dijkstra, 2001). The next section discusses the model's components, general structure, and connections between the various types of representations.

The Semantic, Orthographic, Phonological Interactive Model (SOPHIA). *Semantic, Orthographic, Phonological Interactive Activation Model* by Van Heuven & Dijkstra (2001), is a localist connectionist model. The model is similar to the word identification system of BIA+ in that, it includes orthography, phonology, and semantics. However, the task/decision schema is absent in this model (see Figure 1.6). After being tested on numerous findings from monolingual language processing studies, in recent years, the model has been applied to bilingual studies as well (Thomas & Van Heuven, 2005).

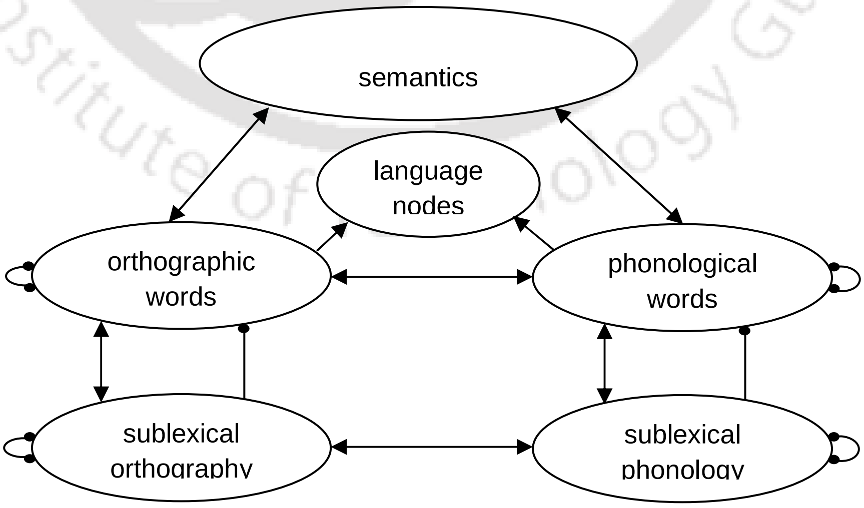


Figure 1.6 Visual representation of SOPHIA (adapted from Van Heuven & Dijkstra, 2001).

The Bilingual Model of Lexical Access (BIMOLA). The *Bilingual Model of Lexical Access* (Grosjean, 1988, 1997a, 2008; Léwy & Grosjean, 2001) is a computational model of lexical access which has been strongly inspired by the interactive activation framework (TRACE, in particular). It has the task of accounting for processing in the bilingual's different language modes. Two core assumptions of the model are (1) bilinguals have two independent yet interconnected language networks which consist of features, phonemes, words, etc., and (2) the mode of the language (whether monolingual or bilingual) determines the activation level of the two language networks (see Figure 1.7).

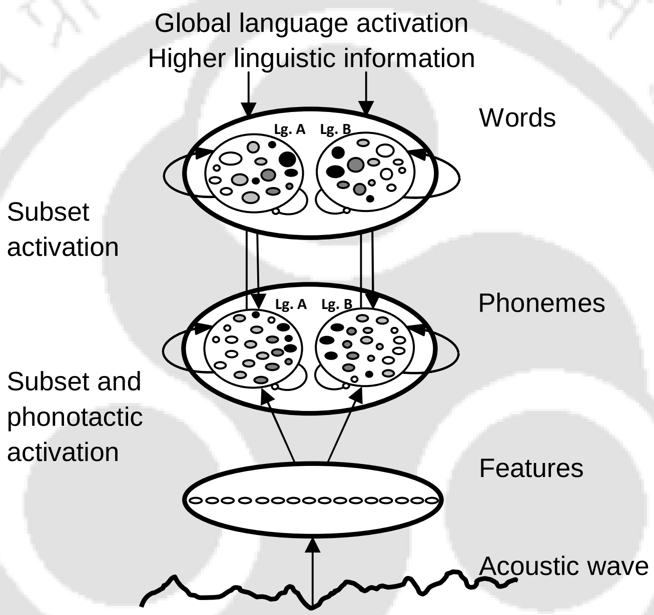


Figure 1.7 Visual representation of BIMOLA (adapted from Grosjean, 2008).

1.5.1.2 Models of Speech Production

Similar to words recognition models, models of lexical access in bilingual speech production are generally categorized into two theoretical camps: selective/language-specific/discrete vs. non-selective/language-non-specific/cascaded. As shown in Table 1.3, selectivity can be defined in terms of the flow of activation and the manner of lexical selection (Hoshino, 2006).

Table 1.3 Models of Lexical Access in Bilingual Production (Adapted From Hoshino, 2006, p. 13)

Activation	Lexical Selection	Language Selection
Selective: No cross-language activation	Language-specific: Only candidates in the intended language are considered	Conceptual
Nonselective: Cross-language activation	Language-specific: Only candidates in the intended language are considered	Conceptual
	Language-nonspecific: Candidates in both languages are considered	Lemma level Phonological level Articulation

As per the assumptions of the selective view, lexical access in bilingual word production is fundamentally a selective process. With respect to language, selection occurs at the conceptual level, activating lemmas only in the intended language. To illustrate, the selective model of bilingual word production by Poulisse and Bongaerts (1994) and Hermans (2000) is shown in Figure1.8 (adapted from Hoshino, 2006).

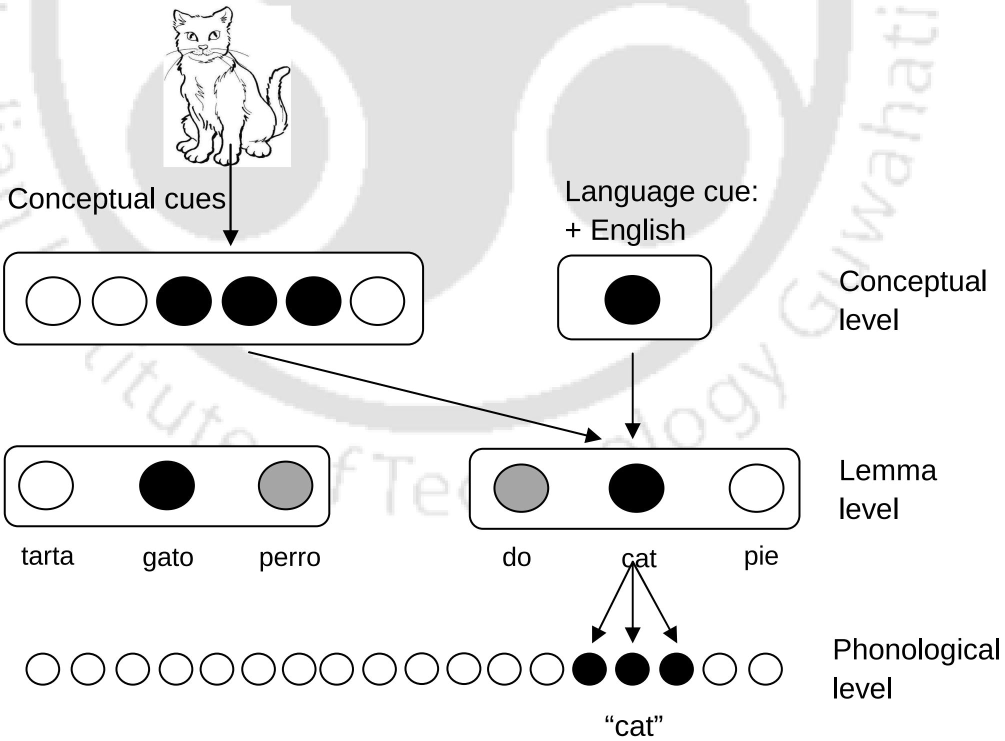


Figure 1.8 A model of selective lexical activation with language-specific selection (adapted from Poulisse & Bongaerts, 1994; Hermans, 2000).

On the other hand, as per the assumptions of the non-selective view, lexical access in bilingual word production is fundamentally a non-selective process. In this case, language selection does not occur at the conceptual level and thus, lemmas from both languages get activated simultaneously. Although, research on bilingual word production, in terms of lexical activation mainly supports the non-selective view, the manner of lexical selection is still under debate. The manner of lexical selection has been further divided into two theoretical camps: language-specific selection and language-non-specific selection. According to the language-specific view, when a bilingual intends to speak in a language, lexical candidates from both languages become active (see Figure 1.9). However, lexical candidates from the non-response language do not interfere in the process of selection, and thus, only the candidates in the response language are finally considered for selection (e.g., Costa, Miozzo, & Caramazza, 1999).

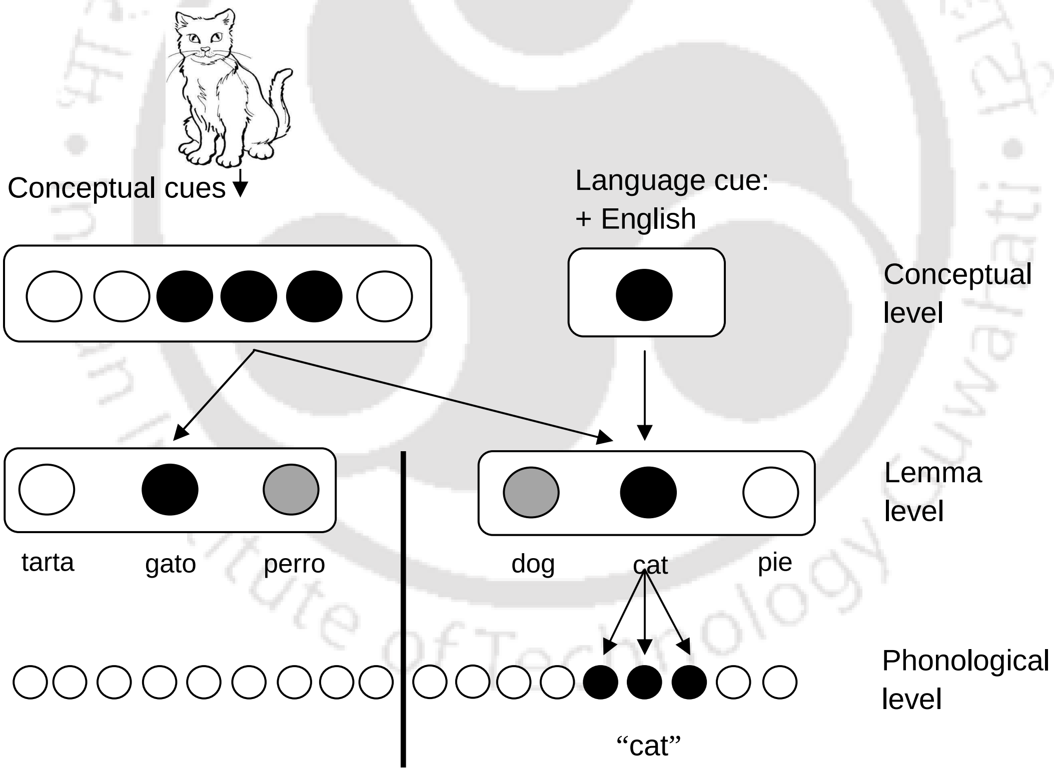


Figure 1.9 A model of non-selective lexical activation with language-specific selection (adapted from Poulisse & Bongaerts, 1994; Hermans, 2000).

In contrast to the language-specific view, the language-non-specific view assumes that, in addition to lexical candidates in both the response and non-response languages being simultaneously active, lexical candidates from both languages also compete for selection (e.g., Herman, Bongaerts, De Bot, & Schreuder, 1998). Thus, influence of the non-response language is evident in the selection process which has to go through further processes like inhibition of the non-response language or higher level activation of the response language, in order for the intended language to be spoken (see Figure 1.10).

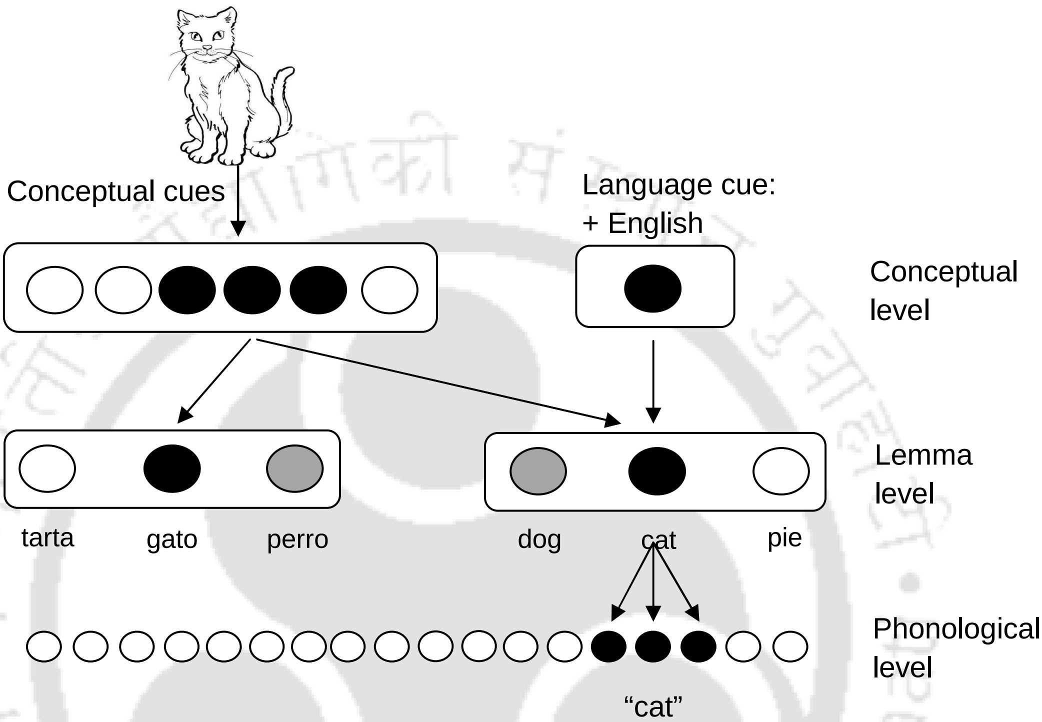


Figure 1.10 A model of non-selective lexical activation with language-non-specific selection (adapted from Poulisse & Bongaerts, 1994; Hermans, 2000).

Furthermore, in recent literature, there has been a debate concerning the manner of language selection and the evidence that supports each alternative model. Some studies suggest that, alternative candidates from both languages are active at the lemma level but only candidates from the intended language are encoded phonologically (e.g., Herman et al., 1998). On this view, language selection occurs at the lemma level. Others demonstrate that alternative candidates from both languages are active all the way to the phonological level and language is selected at the phonological level (e.g., Colomé, 2001; Costa, Caramazza, & Sebastián-Gallés, 2000; Kroll et al., in preparation). The previous discussion thus makes it clear that psycholinguistic models on bilingualism primarily focus on two issues: (1) the activation level of the contributing languages, and (2) selective or non-selective access to the lexicon. Based on these observations, Grosjean (1998a) proposed the Language Mode Hypothesis which is a situational continuum on the basis of which different language modes are induced.

1.5.1.3 The Language Mode Hypothesis

Grosjean (2001, p. 3) defines *Language Mode* as "the state of activation of the bilingual's languages and language processing mechanisms at a given point in time". The language mode hypothesis assumes the language mode of the bilingual to be a continuum having three different modes, namely, monolingual, intermediate and bilingual, depending on the level of activation of the bilingual's two languages (see Figure 1.11).

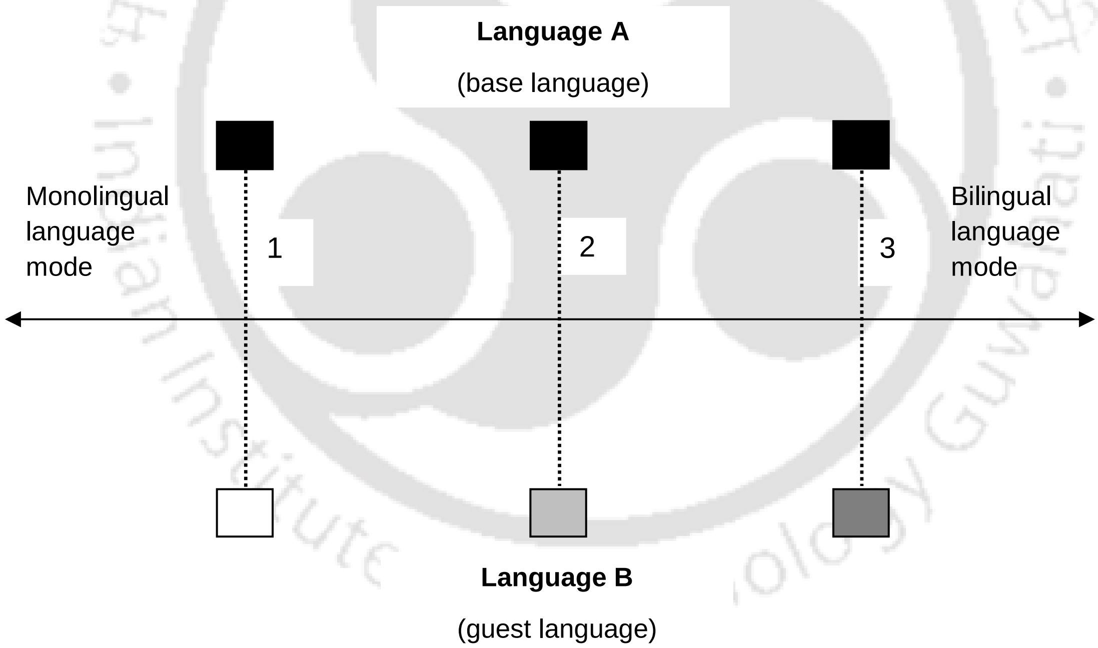


Figure 1.11 Visual representation of the language mode continuum (adapted from Grosjean, 1998a).

According to the hypothesis, two primary concepts are involved, (1) choosing the main language at a given point in time, in which the interaction occurs, i.e., the base language, and (2) the comparative activation of the language not in use, i.e., the guest language. Throughout the continuum, the degree of activation of the base or target language is always maximum, whereas, level of activation of the guest or non-target language varies, but it is never switched off completely. Furthermore, Grosjean enumerated that a bilingual's position on the language mode continuum may be influenced by a number of variables, namely, (1) the situation of the interlocutor(s), (2) the situation, form and content of the message, (3) the function of the language act, and (4) specific research factors (Grosjean, 2001).

1.6 Rationale for the Present Study

India has been a multilingual, multiethnic and multicultural country ever since its known history. The bilingual situation in India is quite unique because (1) unlike many other countries, where learning a second language becomes primarily a socio-political need, bilingualism in India is mostly through social contact, the only exception being English (Mishra & Singh, 2010), (2) unlike western countries, where sequential bilingualism is typical, simultaneous or neighbourhood bilingualism is common in India, and (3) unlike western countries, where bilinguals learn their second language mostly through formal education, bilinguals in India acquire a second language informally, most of the time (English being an exception). Because of its uniqueness, researchers have investigated bilingualism in India since long (Hodson, 1936). However, bilingualism in India has been studied mostly from an educational (Mohanty, 1994) or sociolinguistic perspective (Pattanayak, 1981) and there have been very few sustained attempts to study the cognitive or psycholinguistic aspects of bilingualism in Indian context, where both L1 and L2 are indigenous languages (see Chapter 2). Whereas research in Indian bilingualism from the perspective of cognitive mechanisms and implications are few and far between, similar study in North-East Indian languages is virtually non-existent. The results from few neuroimaging and eye-tracking studies have not led to unique understanding of the psychological processing in bilinguals of India.

The North-East of India presents a remarkable diversity in terms of ethnicity, linguistic and socio-cultural practices. It is the home for more than 166 separate tribes speaking a wide range of languages. A perfect linguistic heterogeneity is found in all the states of North-East India which makes the ethnic situation of this region unique. Bilingualism or multilingualism in North-East India is common in both rural and urban areas, even among the unlettered. More than 75% of the tribal people in NE India are bilinguals, their second language being mostly either, Assamese, Hindi or Bengali. Unfortunately the question of studying these bilingual/multilingual populations is given little emphasis by scholars. Although some sociolinguistic studies on the bilinguals of North-East India have been conducted (see Chapter 2), they have not motivated empirical workers in the field. As a result, there has been no work on the cognitive or psycholinguistic aspects of bilingual population of this region.

The present study, therefore, tried to make a benign beginning in this direction by taking into account the Bodo−Assamese bilinguals of Guwahati, Assam (see Chapter 3 for details). The study focuses on different kinds of representations in bilingual memory, using the priming method as a promising tool to investigate cross-linguistic interactions. In our study, bilingual theories based on a wide range of relatively recent studies were presented, and it is with respect to these theories and previous findings on bilingualism, that we developed our research questions. As we have seen, different models of bilingualism make different assumptions regarding these questions. Testing the hypotheses of these models was the leitmotiv throughout this thesis. The data collected during the course of the study along with the results derived from its systematic analysis aspires to find a practical utility in education, specially that for bilinguals.

1.7 Goals, Research Questions and Hypotheses

The overall aim of the study was to explore how Bodo−Assamese bilinguals represent, comprehend, and produce words in their two languages. In order to achieve that, the study explores important issues like lexical representation and processing, as well as examines the factors which influence them. The specific research questions addressed are as follows:

1) Is lexical access selective or non-selective?
2) Are cognates represented and processed differently from non-cognates? If yes, is the difference task-specific?
3) To what extent is the co-activation of languages modulated by differences in age of acquisition and proficiency in the second language?
4) Does a language-specific difference, such as script, modulate cross-language activation, the locus of language selection, and the manner of language/lexical selection during bilingual word recognition and production?
5) Is lexical processing asymmetrical?

Considering the fact that there is a strong support from existing literature (Jared & Kroll, 2001; Van Heuven et al., 1998, Woutersen, 1997, Marian, Spivey, & Hirsch, 2003; Costa & Caramazza, 1999; Hermans et al., 1998) for non-selective access in bilingual language processing, we predicted that lexical representations from the first language will be accessed during processing of words from the second language and vice versa in case of Bodo-Assamese bilinguals. We further predict that non-selective access would result in cognates being processed differently than the non-cognates, in that, cognates will be responded to faster than non-cognates and the difference would be more evident in tasks having a phonological component.

With respect to the AoA and proficiency factor, a number of studies claim that bilinguals who differ in their second language AoA and proficiency have different architectures as well as distinct processing mechanisms. Based on previous findings (Silverberg & Samuel, 2004; Sunderman & Priya, 2011) and the predictions of the RHM, we predicted that similar differences will be found in this study. In order to look at proficiency separately from AoA, we tested three groups of bilinguals and we predicted that proficiency, more than AoA, will be a deciding factor for the locus of selection. Hence the Early High Proficient bilinguals and Late High Proficient bilinguals are expected to show similar results in various processing tasks.

Existing studies provide proof of cognate facilitation in different script bilinguals (Gollan et al., 1997; Bowers, Mimouni, & Arguin, 2000; Kim & Davis, 2003; Voga & Grainger, 2007; Fotovatnia & Taleb, 2012; Hoshino & Kroll, 2008, Nakayama et al., 2013) Many of these studies confirm that phonological similarity "survives script difference and different-script bilinguals can utilize phonological similarity between a prime and a target in making lexical decision tasks" (Higashitani, 2015; p. 30). Considering these findings and in keeping with the non-selective view we predicted that even though Bodo and Assamese do not share the script, significant cross language activation will be seen in processing, also aided by the fact that the languages share phonological similarity, which in turn can be contributed to the geographical contiguity.

Evidence for the processing asymmetry is well attested in previous research and concerns the revised hierarchical model's predictions that ensue from the assumed asymmetries in the strengths of the connections between the lexical and conceptual nodes within a single developmental stage (De Groot, 2011). Considering these findings, we predicted that reaction times will be faster in the backward direction than in the forward direction and that the magnitude of priming effect will be larger in the forward direction than in the backward direction.

To address these questions, a series of word recognition and production experiments compared the performance of three groups of Bodo-Assamese bilinguals in their first and second language. In total, thirty two experiments were conducted using eight different tasks to obtain converging evidence on the role of different variables in bilingual word recognition as well as production. Most studies in the areas of lexical representation and processing in bilinguals have been performed with bilinguals whose two languages share the same script (Roman script). Here it is important to mention that the L1 and L2 under study belong to different language families, do not share the script. On the other hand, owing to living side by side each other through centuries, they have come to share many linguistic features, namely, lexical and phonological features. A critical manipulation in the present experiments is whether the written lexical form is perceptually present or absent. Moreover, based on the observations with existing empirical studies, the thesis was designed in order to contribute to the understanding of cognate facilitation effect. The logic of the experiments with cognate materials was to determine whether there is cognate facilitation even when two languages differ in scripts (i.e., when cognate status is based on shared phonology only). In addition to that, both age of acquisition and proficiency have been taken into account, in order to discern how these two factors interact to affect L1 and L2 processing in two dissimilar languages. The experiments aim to shed some light on these issues while investigating the primary objectives mentioned above.

1.8 Overview of Methodology

Keeping with the research aim in general and specific research questions, we adopted standard *experimental* methods to look at the influence of different variables on cognitive and behavioral performance. The study was conducted in two phases: Phase One – *The Pilot Study* and Phase Two – *The Main Study*. The main phase of the experiments was preceded by a Pilot Study to check the feasibility of the methods. The outcomes of the pilot phase are provided in Chapter 3. Phase Two was built on the outcomes of Phase One and involved quantitative analysis on a large number of individuals. The outcomes of the main phase are provided in Chapter 4 and 5.

1.9 Thesis Structure

This thesis is an attempt to answer questions regarding a number of conflicting views on bilingual lexical representation and processing. The thesis is in six chapters. Chapter 1 begins by creating a backdrop into the study of bilingualism in general and psycholinguistic aspects of bilingualism, in particular. An extensive literature review, briefly pointing out the empirical findings in bilingual psycholinguistic research is provided in Chapter 2. Chapter 3 deals with the research methodology, derived from the overall aim of the study, wherein reasons for choosing a particular research approach, sample selection, data collection methods and analysis techniques have been enunciated. The data collected during field survey has been enunciated and the findings derived thereof have been discussed threadbare in Chapter 4 and 5 respectively. Chapter 4 and 5 are companion chapters with a common goal, addressing it from the perspective of either bilingual language comprehension or production. These two empirical chapters solely rely on behavioral measures to investigate how a word's lexical representation in the first or the second language accesses its/their meaning. The thesis concludes by discussing in Chapter 6, the main findings of the study with reference to the overall research questions and highlights future directions for research.

1.10 Chapter Summary

The present chapter provided an overview of the research—the basic issues behind the thesis, a broad overview of the current models of lexical representation and processing, followed by the rationale for the study. We briefly pointed out the goals, research questions and hypotheses and provided an overview of methodology. The following chapter will first provide an overview of the background literature to this study, and then a more specific focus on the bilingual lexical representation and processing literature. It will review bilingual word recognition and production studies in different paradigms.

2

LITERATURE REVIEW

This chapter aims to place the current study in the contextual paradigm of topical researches conducted previously. Further, on the basis of theme or variable based relevancy, it also aims to present a critical analysis of empirical literature, therefore justifying the role of the study in addressing observed gaps or problems in the existing topical literature.

Main Contents

2.1 Introduction

The preceding chapter had attempted to introduce the research and provide an overview of the thesis structure in general. The current chapter consists of literature review concerning certain domains of bilingual lexical representation and processing which are considered controversial yet meriting mention in the discussion of bilingual word recognition and production. There is a large and contentious research in these two areas and summarizing of conflicting data emanating from the multitude researches over so many years will invariably be beyond the scope of the present study, primarily because of the sheer amount of such data being existent.

The present study, therefore, limits its review to findings and theoretical analyses that are crucial to the thesis. These studies have addressed the issue of bilingual lexical representation and processing using different paradigms in both word recognition and production, and results emanating from the various experimentations strongly suggest that the contradicting results owe its genesis to various factors. The said issues shall figure in subsequent discussions pertaining to theoretical models proposed vis-à-vis bilingual lexical representation and processing and we will be speaking in terms of evidence in favor of (or against) these bilingual theories.

2.2 Chapter Overview

This chapter reviews the evidence on two important areas: bilingual lexical representation and processing. It brings together the results of many of the studies and presents the theories and views on that motivated these studies and emerged from them, but it also explains the research methods and tasks that were used to address these theories and views in specific experiments. Considering the significant quantum of research conducted over the last three decades, the current research shall invariably incline towards being selective and more focused only on the more pertinent studies and theoretical claims. And finally, the chapter concludes with the chapter summary.

2.3 Research on Representation

As mentioned in Chapter 1, the primary question which has dominated bilingual psycholinguistic research in terms of representation is whether the lexical systems of the bilinguals is stored in a single mental lexicon or in two separate mental lexicons? In order to examine this, the most frequently used method has been the priming paradigm (see Chapter 3). The logic of using this paradigm was to explore whether cross-language words facilitate each other during word recognition or production. Some researchers opined that in an integrated single lexicon, words from the two languages are likely to interact and affect each other more in lexical access, whereas the same is not expected in case of words from two languages stored in two separate lexicons. The presence of cross-language priming effect would therefore provide evidence for an integrated lexicon, whereas its absence would be consistent with two separate lexicons.

Traditionally bilinguals were considered to have two separate language-specific mental lexicons in their mind. Probably, the first evidence on this comes from the cross-language priming study of Kirsner et al. (1980) in which they tested Hindi−English bilinguals by employing a blocked lexical decision task. The primary aim of this study was to examine both within-language and between-language priming and to achieve that the experiment included two blocks. After the completion of the first block, the participants conducted the second block which consisted of the following items: (1) words that appeared in the first block, (2) translations of words that appeared in the first block, and (3) new items. The results of the experiments showed a reliable priming effect for within-language condition, but no between-language priming effect. The finding of this study is thus consistent with the view that bilingual lexical systems are separate. Similar to this finding, several subsequent studies using the priming approach failed to observe between-language priming (Kirsner et al., 1984, Experiment 1, Scarborough, Gerard, and Cortese, 1984).

However, evidence from some studies reinforced the idea that the two languages of a bilingual are represented in two separate mental lexicons. The first evidence that supports the idea that there are no separate lexicons comes from the study by Cristonffanini, Kirsner, and Milech (1986) in which the critical stimuli were cognate and non-cognate translations. The results of the study showed priming effect only for cognates which was similar to within-language repetition priming. The second evidence comes from the study by Gerard and Scarborough (1989) in a two block design experiment which included three types of words: cognates, non-cognates, and homographs. The findings of this study showed that only cognates and homographs benefited from exposure in the first block. Unlike lexical representations, there is general consensus in the literature that concepts are represented within one common unified conceptual store because concepts do not differ much across languages.

There are many models in the literature that postulates separate lexicons for L1 and L2 and assumes that these lexicons do not influence each other in functioning. Moreover, in some other models, the two separate lexicons are localized in different parts of the brain (Krashen, 1973; Evans, Workman, Mayer, & Crowley, 2002; Gomez-Tortosa, Martin, Gaviria, Charbel, & Ausman, 1995). However, such models have been defended by Paradis (1980, 1997), who proposed a three-store hypothesis for word recognition. In this model, a distinction is made between word forms, word meanings and conceptual features. Paradis assumed that word forms and word meanings are language-specific, whereas conceptual features are shared between languages. Furthermore, some earlier hierarchical models of word recognition such as word association model, concept mediation model, and revised hierarchical model postulated separate independent lexicons for the two languages of a bilingual but similar to Paradis, they defended the functional autonomy of L1 and L2 word recognition (see Chapter 1). The first computational model of word recognition that included an integrated lexicon for L1 and L2 was the Bilingual Interactive Activation (BIA) model proposed by Dijkstra and colleagues (Dijkstra & van Heuven, 1998; Dijkstra, vanHeuven, & Grainger, 1998; van Heuven, Dijkstra, & Grainger, 1998) (see Chapter 1).

2.4 Research on Processing

As mentioned before, a fundamental question in research concerning bilingual language processing is whether bilingual individuals activate or access lexical representations selectively or non-selectively. Another controversial issue in the bilingual lexical processing literature is the existence of a well-known *asymmetry* which assumes that forward processing (L1−L2) and backward processing (L2−L1) explore different processing mechanisms.

2.4.1 Lexical Access: Selective or Non-selective?

In the past, some early behavioral studies favoured the selective access (Gerard & Scarborough, 1989; MacNamara & Kushnir, 1971) and the dominant conception was that bilinguals keep their knowledge of their two languages separated, and could access one language selectively in line with the task being performed (e.g., De Groot, 1992a, 1993; Kroll, 1993; Kroll & De Groot, 1997; Paradis, 1997). Most of the evidence supporting language selective lexical access comes from studies which included language-switching tasks (Grainger & Beauvillain, 1987). But since 1980s, a significant number of researches have been undertaken and findings generated to conclusively establish and support the non-selective access in which both L1 and L2 meanings are activated simultaneously at first. Only later is the unitary language selected. Evidence for the non-selective hypothesis comes from a number of different paradigms such as neighbourhood effects in word recognition (Jared & Kroll, 2001; Van Heuven et al., 1998), various forms of priming with lexical decision (Woutersen, 1997), eye-tracking studies and brain-imaging studies (Marian, Spivey, & Hirsch, 2003), and picture-word interference task (Costa & Caramazza, 1999; Hermans et al., 1998). These findings suggest that information from one language can influence lexical processing of another language in the bilinguals.

There are many models in the literature in support of both selective and non-selective access. One of the leading models explaining representation and processing of languages in bilinguals in the Revised Hierarchical Model (RHM) which proposes that bilinguals have a mechanism of language control (selective access). The RHM provided support for selective access to any one of the lexicon, since it made a distinction between the L1 and L2 lexicons. However, in recent years, evidence against language selective access have been presented, which appears to refute the predictions of the model and thereby triggers much debate and controversy for it. Based on recent evidence on non-selective access in bilingual word recognition, Brysbaert and Duyck (2010), therefore, proposed to abandon the RHM and suggested that connectionist models such as BIA+ (Dijkstra and Van Heuven, 2002) can account for the recent evidence more accurately.

If bilingual lexical access is assumed to be language non-selective, cross-language interaction is expected to happen at different levels. In other words, there could be different levels of overlaps (orthography, phonology, or semantics) of lexical representations across two languages, which can affect bilingual language performance. Overlap at orthographic level can result in interlingual homographs, e.g., *spot* is a word in both English and Dutch, but it means *mockery* in Dutch. Phonologically overlapped lexical items across languages are sometimes referred to as interlingual homophones, e.g., the English word *cow* is pronounced like the Dutch word kou (meaning *cold* in English), (see Lemhöfer & Dijkstra, 2004, for more examples). Semantic overlap can happen when the two lexical items in the two languages are translation equivalents, e.g., apple and 苹果 ($ping^2guo^3$). The interactions mentioned before are based on overlap at one level only (either at orthographic, phonological, or semantic level) (Yujie, 2011).

There are also cases of multiple levels of overlap, which needs to be investigated in order to understand the bilingual mental lexicon. One special type among such words is *cognates*, which traditionally refer to words that have a common etymology. For example, English *starve* and Dutch *sterven* derive from the same Proto-Germanic root, **sterbaną* 'die'. However, in psycholinguistic studies, the definition for cognates is broader (Voga & Grainger, 2007). In same-script languages, it refers to translation equivalents which are similar not only phonologically but also orthographically (e.g., the English–Spanish cognate translation equivalents, palace−palacio), and in different-script languages, it refers to translation equivalents which are similar only phonologically (e.g., the Bodo–Assamese cognate translation equivalents, सियाल [siyal]−শিয়াল [xiyal] 'fox'). In contrast to cognates, *non-cognates* refer to translation equivalents that are not similar either phonologically or orthographically in both same-script and different-script languages (e.g., the English−Spanish non-cognate translation equivalents apple−manzana, and the Bodo−Assamese non-cognate translation equivalents मोख्रा [mwkhra]−বান্দৰ [bandor] 'monkey' respectively). Cognates have thus overlap at multiple levels whereas non-cognates have overlap only at the conceptual/semantic level. This raises an important question whether cognates and non-cognates are represented and processed similarly (Yujie, 2011)? In the following section, we review evidence for the special status of cognates.

2.4.1.1 The Cognate Facilitation Effect

In order to determine language selectivity in bilinguals, a pivotal investigation has been using words that are similar across languages. In both bilingual word recognition and production research, a substantial part has been dedicated to investigate how cognates and non-cognates are represented and processed. Previous research shows that regardless of what languages or bilingual populations are used, cognate words are likely to be recognized faster than non-cognate words, and this may influence the results. This general finding in the psycholinguistic literature is known as *the cognate facilitation effect* (CFE) which indicates the activation of lexical items in both languages, simultaneously.

In a number of experimental situations, cognates have been found to behave differently, as compared to non-cognates. For example, in lexical decision tasks, cognate words are recognized easily than non-cognates (Dijkstra, Grainger, & Van Heuven, 1999; Lemhöfer & Dijkstra, 2004; Lemhöfer, Dijkstra, & Michel, 2004). In word translation tasks, cognate words are translated more quickly than non-cognate words (De Groot, 1992a; Sánchez-Casas, Davis, & García-Albea, 1992). Moreover, in various priming paradigms, stronger priming effects are generally observed for cognates than non-cognates. To cite an example, in priming studies where a large number of trials intervene between the prime and the target (called long-lag priming), only cognates have been found to show facilitation (Cristoffanini, Kirsner, & Milech, 1986; Lalor & Kirsner, 2001). However, Bowers, Mimouni, and Arguin (2000) suggested that to obtain long-lag priming effect, orthography plays a critical role. In their experiment with French−Arabic cognates of same script (i.e., cognate homographs) and different script, they observed long-lag priming effect only for cognate homographs. Their finding was supported by other studies employing a similar paradigm (Gerard & Scarborough, 1989; and Kerkman, 1984).

Numerous studies have also showcased that cognates are responded to more quickly in a second language (L2) lexical decision task, compared to matched non-cognate control words (e.g., Caramazza & Brones, 1979). Interestingly, Van Hell and Dijkstra (2002) showed that cognate status even affects lexical decision in subjects' first language (L1). Thus, Dutch-English-French trilinguals responded faster to L1/L2 cognates (e.g., *droom*, meaning *dream*) than to L1 control words (*tuin*, meaning *garden*). There was also an effect for L1/L3 cognates (e.g., *muur*, *mur* in French, meaning *wall*) but only in a group that was highly proficient in L3.

Lemhöfer et al. (2004) showed that cognate effects even accumulate across languages: Dutch-English-German trilinguals performing an L3 lexical decision task responded fastest when the word was a cognate in all three languages (e.g., *echo−echo−Echo*), slower when the word was a cognate between Dutch and German but not English (e.g., *kunst−art−Kunst*) and slowest for German control words (e.g., *Zelt–tent* in both Dutch and English).

Another relevant evidence has been obtained in studies employing the masked priming paradigm (Forster and Davis, 1984). The key assumption is that upon presentation of a masked prime, the prime's orthographic, phonological and semantic representations begin to be activated. As a consequence, when the target is orthographically, phonologically, or semantically related to the prime, responses to the target are often facilitated compared to when the prime and target are unrelated. A robust priming was obtained between orthographically similar cognates in some critical studies in which participants made lexical decisions to the targets (e.g., Davis, C., Sánchez-Casas, R., García-Albea, J. E., Guasch, M., Molero, M., & Ferré, P., 2010; De Groot & Nas,1991; Duñabeitia, Perea, & Carreiras, 2010; Sánchez-Casas, et al., 1992). However, non-cognate translation equivalents typically show much less (or no) priming in the bilingual speakers (De Groot & Nas, 1991; Sanchez-Casas et al. 1992), and monolinguals presented with cognates fail to show any priming (Garcia-Albea, Sanchez-Casas, Bradley, & Forster, 1985). Similar cognate priming advantage has also been observed for different-script bilinguals whose cognate translation equivalents are not orthographically similar and thus have only phonological and conceptual similarities (e.g., Gollan, Forster, & Frost, 1997; Voga & Grainger, 2007; but see Kim & Davis, 2003; Nakayama et al., 2013; Higashitani, 2015). Support for the cognate facilitation effect also comes from other studies using tasks such as semantic categorization (Sánchez-Casas et al., 1992; Lemhöfer et al., 2004), word translation (De Groot, 1992a). These key finding can be interpreted in favour of the language non-selective access.

Furthermore, some studies suggest that the general claim that bilingual speakers non-selectively activate their two languages needs some qualification (Kroll, Bobb,

& Wodniekca, 2006). For example, cognate facilitation was not observed in some other studies as—word naming (Schwartz, Kroll, & Diaz, 2007); masked priming lexical decision task (Kim & Davis, 2003; Bowers et al., 2000). Taken at face value, these results of the previous studies suggest that while there are separate lexical representations for non-cognate translation equivalents in each language, cognate translations share the same lexical representations. Moreover, recent findings have made plausible the hypothesis that cognate relations are explicitly coded within the orthographic system by suggesting that written words in different languages are processed within a common orthographic system (e.g. Grainger & Dijkstra, 1992; for reviews of this issue, see Kroll & De Groot, 1997; Smith, 1997). In general, the bilingual literature on cognate processing supports the non-selective view.

Different theories have been proposed to explain the cognate facilitation effect. There are mainly three important positions that can be identified: (1) the *morphological account* (Cristoffanini et al., 1986; Davis et al., 2010; García-Albea, Sánchez-Casas, & Igoa, 1998; Kirsner, Lalor, & Hird, 1993; Lalor & Kirsner, 2001; Sánchez-Casas et al., 1992; Sánchez-Casas & García-Albea, 2005); (2) the *form overlap* or *phonological account* (Dijkstra et al., 1999; French & Jacquet, 2004; Gollan et al., 1997; Thomas, 1997; Voga & Grainger, 2007); and finally (3) the *link account* (Kroll & Stewart, 1994).

According to the morphological account, cognate facilitation effect reflects an underlying structural difference in how cognate and non-cognate translation equivalents are represented in the bilingual lexicon. This account has, most often, been invoked to explain data from bilinguals whose two languages use the same script. As noted, cognate translation equivalents for same-script (e.g., Spanish–English) bilinguals are similar, both phonologically and orthographically, in addition to being virtually identical conceptually (e.g., rico−rich). This set of similarities between cognate translation equivalents is presumed to result in their representations being organized in much the same way that the representations for within-language morphologically related words (e.g., rich and richer) are presumed to be organized. That is, because of the strong overlap in their form-to-meaning correspondences, cognate translation equivalents, like morphologically related words in both languages, are postulated to be represented in a unified fashion through a common root word (e.g., rich, richer, rico and rica). Due to the integrated nature of these representations, significant priming effects will emerge for cognates more readily than for non-cognates, because non-cognates would not be represented in this fashion. The morphological account maintains, therefore, that the representation of cognate translation equivalents is fundamentally different from the representation of non-cognate translation equivalents. That is, the cognate priming advantage (i.e., robust cognate priming effects vs. smaller non-cognate priming effects) is presumed not to be due to simply the sum of lexical and conceptual similarities between cognate primes and targets, but is instead interpreted to reflect a qualitatively different type of mental representation for cognates and non-cognates.

Another theoretical account for the cognate facilitation effect has been proposed by the form overlap or phonological account, which proposes that cognates are only different from non-cognates in that they share form overlaps with their translation equivalents and cognate facilitation is the result of the additional form overlap between cognates. This line of explanation for the cognate facilitation effect comes from the connectionist models (both distributed and localist) (Dijkstra et al., 1999; French & Jacquet, 2004; Thomas, 1997; Voga & Grainger, 2007). The distributed model, as represented by the DCF model assumes that, the reason for the cognate facilitation effect lies in the fact that cognates share many overlapping features in L1 and L2 (shared meaning as well as form) and therefore, they will not only show a large overlap in their form related lexical representations, but also in their conceptual representations. The Localist model, which is represented by the BIA+ model (Dijkstra & Van Heuven, 1998, 2002) explains cognate advantage in a way slightly different from distributed model. In BIA+ model, the activation of orthography and phonology are language non-selective. For example, the English word *tomato* can activate its orthographic neighbors in English, as well as in Dutch, for a Dutch−English bilingual. Therefore, the word *tomaat* (tomato in Dutch) can be activated with the presentation of *tomato*. This orthographic activation can feed forward to the conceptual level of the words. In the case of cognate word *tomato*, the shared semantics of *tomato* and *tomaat* is co-activated and it sends feedback to orthographic representation, thus strengthening both *tomato* and *tomaat* (see Dijkstra, Miwa, Brummelhuis, Sappelli, & Baayen, 2010, for a detailed discussion).

Thus, the difference between the two camps in the form overlap account lies in that the localist model, which assumes non-selective activation of both languages, predicts lateral inhibition at each level of representation, while no such mechanism is clearly stated in distributed model. Thus localist model predicts that identical cognates and similar cognates are different in that identical cognates receive no lateral inhibition at the orthographic level while similar cognates do. Except for the above differences, both models believe that form overlap is the cause of cognate advantage and the degree of overlaps influences the processing of cognates.

Finally, theoretical explanation for the link view of cognate facilitation comes from a well-known model of bilingual mental lexicon, RHM (Kroll & Stewart, 1994) which suggests that the stronger link between cognates is the cause of larger cognate priming effect. Although RHM did not address the issue of cognates directly, as a model on translations across languages, its theoretical positions on translations should apply to cognates too, which belong a type of translation equivalent. As mentioned in Chapter 1, RHM assumes that there is an associative link between the translation equivalents at the lexical level and there is at the same time a common meaning/concept linking the two. The connection between L2 word and the concept is less strong than that between L1 word and the concept, but it grows stronger as the bilingual becomes more proficient with the L2 language which causes cognate facilitation because the lexical link between cognates is stronger than non-cognates. However, while RHM provides plausible explanation for the translation asymmetry, it faces some challenges. Gollan et al.'s (1997) study apparently failed to get any L2−L1 priming effect, even with cognates. Jiang (1999) also failed to find L2−L1 priming effect with longer processing time. To sum up, the stronger link explanation of the RHM is able to predict cognate facilitation effect, but this explanation lacks specifications on what variables determine the strength of the link, except for proficiency levels and dominance.

To put in a nutshell, the three theoretical explanations on cognate facilitation effect have different ways of interpretation and predictions. The morphological account attributes the facilitation to the underlying representational difference between cognates and non-cognates. The form overlap account from connectionist models argues that cognate facilitation arises because besides shared semantics, cognates have additional shared form overlaps. If cognate facilitation arises out of form overlaps, cognate facilitation should disappear when the influence of form overlaps is taken out. Further, if form overlap does not affect processing, cognate facilitation will not exist either. Finally, the link account attributes the facilitation effect to stronger link at the lexical level and thus predicts cognate facilitation regardless of task. To sum up, extensive research in the field of bilingual lexical processing has demonstrated that the two languages of a bilingual can interact at various levels. Moreover, the way bilinguals can vary as a result of their age of acquisition and proficiency can also influence the co-activation of languages. In the following section, we address this issue of whether differences in second language age of acquisition and proficiency can affect the representation and processing of languages in bilinguals.

2.4.1.2 The Influence of Age of Acquisition and Proficiency

It is a well attested fact that second language learners differ substantially as a function of their age of acquisition and level of proficiency. Historically, the focus of second language research has been on age of acquisition (AoA). Research on this confound has shown that children and adults differ in terms of their experience of learning a second language. While young children are generally believed to be better at learning a second language (L2) almost as easily as their first language (L1), adult L2 learners must work much harder and often do not attain native-like proficiency (De Groot, 2011). To explain this age-dependent difference on language learning, many researchers have posited the existence of a critical period during development. The *Critical Period Hypothesis* (CPH), first proposed by Lenneberg

(1967) and adopted to explain age-dependent differences in L2 learning by Johnson and Newport (1989) states that after a certain age, the ability to acquire an L2 is greatly diminished or lost. Birdsong (1999) succinctly defined the term as:

> There is a limited developmental period during which it is possible to acquire a language, be it L1 or L2, to normal native like levels. Once this window of opportunity is passed, however, the ability to learn languages declines. (p. 1)

The issue of how the cutoff for early and late AoA is determined has also been a much debatable issue. Past studies have used a variety of ages to categorize late AoA groups, ranging from 6 to 16 years of age (Kim, Relkin, Lee, & Hirch, 1997). Indeed, some researchers suggest that results in support of a critical period are simply confounded with other predictive factors, such as amount of L2 education, chronological age, and L2 language exposure (Flege, Yeni-Komshian, & Liu, 1999). This implies that dividing subjects into two groups of early and late acquisition may not be appropriate, and treating AoA as a continuous variable may allow for a more complete and accurate description of the effects of AoA on L2 processing. As put forward by De Groot (2011):

> To anticipate, the results of these studies suggest that the human ability to learn language remains intact throughout life as long as it is fed by early linguistic experience. If it is not nourished in this way, the proficient use of languages learned later in life seems beyond reach. (p. 59)

Over the years, numerous studies which have made use of different tasks and paradigms have demonstrated differences in processing as a function of second language age of acquisition. For example, Kim et al., (1997), Weber-Fox & Neville (1999) and Wuillemin & Richardson (1994) have shown contrasts between early and late bilinguals. Similarly, in 2002, Izura and Ellis found that second language words which were learned at an early stage had a processing advantage over words which were learned at a later stage. In other words, the majority of the studies in the past have investigated bilinguals differing in their second language age of acquisition.

This raises another important question as to what extent the representation and processing of the bilingual's two languages modulated by differences in second language proficiency?

Studies investigating the role of proficiency in bilingual lexical representation and processing have examined bilinguals with different levels of proficiency in their second language. Several studies investigating the degree of co-activation and interaction between the two languages of a bilingual have observed that variation in second language proficiency differentially affects cross-language interactions at various levels. For example, studies employing cross-language semantic priming and translation priming paradigms have observed that differences in proficiency affect semantic and translation priming effects (Frenck and Pynte, 1987). The findings of these studies are in line with the assumptions of the Revised Hierarchical model. In contrast, studies employing cross-language masked phonological priming paradigm have observed that differences in second language proficiency does not affect phonological priming effect (Duyck, Diependaele, Drieghe,and Brysbaert, 2004).

Moreover, the fact that age of acquisition and proficiency are highly intertwined complicates the situation even more. For example, the influence of both factors has been observed in Silverberg and Samuel's (2004) study. In their study, they tested Spanish−English bilinguals differing in their second language age of acquisition and proficiency in a semantic priming task. The results showed that significant semantic priming effects were evident only in case of early high proficient bilinguals, whereas, late proficient bilinguals, regardless of their second language proficiency failed to produce any priming effects.

The issue of how the representation and processing of bilingual's two languages differ as a result of their second language age of acquisition and proficiency has been described by several theories and models. However, most of these theories and models deal with high proficient bilinguals. The Revised Hierarchical Model is among the few developmental models that provided an interesting perspective on how the bilingual memory organization can change as function of increasing proficiency (see Chapter 1).

To summarize, the age at which a second language is acquired as well as the level of proficiency acquired in a second language can raise many interesting questions regarding the representation and processing of multiple languages in the brain. In the next section, we focus on the role of script in bilingual word recognition and production and review several behavioural studies concentrating on cross-linguistic influences in same-script and different-script bilinguals.

2.4.1.3 The Role of Script

Studies addressing the role of script in either bilingual word recognition or production generally assume that script is nothing but a normal orthographic difference which bypasses redundant search of both lexicons and helps in guiding the lexical search to the lexicon appropriate for the task. However, this assumption is not supported by enough experimental evidence. Although numerous studies have examined lexical processing in same-script bilinguals, the number of published studies examining these questions in different-script bilinguals is few.

A long line of research addressing same-script bilinguals has provided clear evidence for non-selective access (e.g., Altenberg and Cairns, 1983; Dijkstra, Van Jaarsveld, & Ten Brinke, 1998; Nas, 1983). One of the early studies providing partial attention to different-script bilinguals was by Kirsner, Smith, Lockhart, King, & Jain (1984). The findings of the study showed that simulus presented in same-script and different-script bilinguals has the same effect. Contrary to the findings of Kirsner et al. (1984), Tzelgov, Henik, Sneg, & Baruch (1996) found that when bilinguals do not share script, the stimulus will lead to activation only in the intended language. However, recent research examining the influence of script on language processing suggests that in different-script bilinguals, script cannot serve as a cue to allow early selection of one of the languages (Guo & Peng, 2006; Hoshino & Kroll, 2008) but it can modulate the extent of activation across the two languages (Guo & Peng, 2005; Hoshino & Kroll, 2009).

The influence of script is evident even in speech production in which the written lexical form is not overtly present. Evidence from recent studies suggests that in both comprehension and production, all lexical codes are active to some degree. For instance, the activation of orthography has been observed in many spoken word recognition studies where the written word was not present itself (e.g., Chéreau, Gaskell, & Dumay, 2007; Donnenwerth-Nolan, Tanenhaus, & Seidenberg, 1981; Ziegler et al., 2003). Similarly, the activation of phonology has also been witnessed in presence of written word form (e.g., Tan & Perfetti, 1999; Van Orden, 1987). To cite an example, in word naming tasks, participants take longer to read homographs as opposed to control words, suggesting bi-directional connections between orthographic and phonological representations in which the phonological representations for a homograph compete against each other (Gottlob, Goldinger, Stone, & Van Orden, 1999).

Models of visual word recognition assume that script can influence the activation of lexicons. In other words, for same-script bilinguals, a visually presented stimulus from one language can activate words from both languages irrespective of whether or not the stimulus contains language-specific orthographic cues. However, for different-script bilinguals, a visually presented stimulus from one language cannot activate words from both languages, unless the stimulus is a homophone of a word in the non-target languages.

Similar to bilingual word recognition models, models of bilingual production assume that the structural differences across languages found in case of different-script bilinguals may serve as a language cue to direct lexical access and thereby facilitating language selection. Evidence for the language cue hypothesis comes from a translation Stroop study (Miller & Kroll, 2002). The translation Stroop task is formally similar to picture-word interference but instead of a picture as the initiating event, a word is presented for translation. The task is to translate the word as quickly as possible while ignoring a distractor that is presented at some point before, during, or after the presentation of the word to be translated. When the distractor word appears in the language of production, there is semantic interference and form facilitation that is analogous to the results that have been reported for the picture-word task (La Heij, de Bruyn, Elens, Hartsuiker, Helaha, & Van Schelven, 1990).

However, when the distractor word appears in the language of the target word to be translated, Miller and Kroll (2002) found that there was neither semantic interference nor form facilitation. They argued that in translation, unlike picture naming, there is a cue to language membership available in the target word that initiates the task. If the word appears in Spanish, the bilingual knows not to speak Spanish. Moreover, research on task switching suggests that explicit cues reduce switch costs (e.g., Miyake, Emerson, Padilla, & Ahn, 2004). If script differences function as explicit cues to language status and bilinguals can exploit that language-specific information, then the process of planning the spoken utterance becomes similar to a within-language process in which only candidates in the language to be produced compete for selection.

2.4.2 Asymmetry in Language Processing

In the bilingual lexical processing literature, another controversial issue is the existence of a well-known asymmetry. The fact that processing in the backward direction (i.e., from L2−L1) is performed faster than processing in the forward direction (i.e., from L1−L2) is referred to as *asymmetry* or *directionality effect*. A number of findings from cross-language priming studies have provided consistent evidence for an asymmetry in which priming effects were observed only in the forward direction and not in the backward direction. For example, using a stimulus onset asynchrony (SOA) of 200 ms, Altarriba (1992) observed translation priming effects only in the L1−L2 direction. In 1994, Keatley, Spinks, and de Gelder tested

Chinese−English and French−Dutch bilinguals using prime-target pairs that were associatively related and observed unmasked and masked priming effects only when the direction was from L1−L2. Using Hebrew−English bilinguals and stimuli consisting of both cognates and non-cognates, Gollan, Forster, and Frost (1997) observed translation priming only in the L1−L2 direction, irrespective of the cognate status of the word. Jiang (1999) observed that when the translation direction was from L1−L2, translation priming effects were significant, whereas in the opposite direction, i.e., L2−L1, translation priming effects were weak or absent (see Chapter 4 for more details). The review of the research concerning the asymmetry in lexical processing presented in this chapter clearly delineates two crucial issues influencing the phenomenon, namely the application of either the conceptual or the lexical processing route and the word type effect which are discussed in the next section.

2.4.2.1 Processing Route

There is general consensus in the literature that forward processing involves the conceptual route, whereas, backward processing involves the lexical route (Kroll & Sholl, 1992; Kroll, 1993; Sholl, Sankaranarayanan, & Kroll, 1995). Moreover, depending on second language proficiency level of bilinguals, the direction of processing route is subject to change, which in turn, results in asymmetry. Although many models and theories have been proposed to explain the asymmetry, none of them are completely satisfactory. Perhaps the most popular model that provides a proper explanation to asymmetry in bilingual processing is the Revised Hierarchical Model which suggests that the asymmetry results from a fundamental difference in the mental representations of L1 and L2. Primary evidence in support of this model comes from word translation studies. The model also provides explanation to asymmetrical priming effects often observed in lexical decision tasks. The model proposes that the presence of significant priming effect in the L1−L2 direction is the result of strong connection between L1 lexical representation and conceptual representation, whereas the absence of priming effects in the L2−L1 direction is the result of weak connection between L2 lexical representations and conceptual representations. However, the model fails to explain the symmetric priming effects observed in semantic categorization tasks.

A second model trying to account for the asymmetry in bilingual processing was the Separate Memory Systems Account proposed by Jiang and Forster (2001). According to them, bilingual memory consists of two separate memory systems which results in asymmetrical processing. Evidence for this model comes from an “old-new” episodic recognition task in which they tested Chinese−English bilinguals. The task was to memorize a list of words in their first language and then they were shown a new list of target words which were preceded by its translation equivalent as the masked prime. They were then were asked to determine if the target words were in the original list. The results of the experiments showed masked priming only in the L2−L1 direction, which stands in stark contrast to the findings in lexical decision task where no such priming was observed. They attributed their findings by proposing that L1 and L2 words are stored in two different memory accounts—L1 words in lexical memory and L2 words in episodic memory. As a result of this, masked priming was observed in the “old-new” task because it involves episodic memory, and thereby, L2 primes could facilitate L1 targets, whereas, no priming was observed in lexical decision task which involves lexical memory, and thereby, L2 primes could not facilitate L1 targets. Although the Separate Memory Systems Account explains the priming difference between “old-new” task and lexical decision task, it shares similar weakness to the RHM in that, it fails in providing explanation to the task differences between lexical decision task and semantic categorization task.

A third model which attempted to account for the task differences in lexical decision task and semantic categorization task was the Sense Model proposed by Finkbeiner et al. (2004). According to this model, the absence of priming effect in L2−L1 direction in lexical decision task can be attributed to the fact that a bilingual speaker is familiar with considerably fewer senses associated with L2 words than with L1 words.

Another hypothesis providing tempting explanation to the bilingual processing asymmetry is the Language Mode Hypothesis by Soares and Grosjean (1984) and Grosjean (1992) which proposes that the language mode of a task is responsible for the asymmetry. The model draws its evidence from masked priming studies suggesting that the language of target is the immediate language in use in a masked priming experiment, where a participant is not consciously aware of the prime. As a result of this, a bilingual mode is employed in the L1−L2 direction, and since both languages are activated, the processing of L2 words is facilitated. On the other hand, a monolingual mode is employed in the L2−L1 direction, which activates only the L1, and therefore, the processing of L1 words is not facilitated by L2 primes.

However, the explanation provided by this hypothesis is contradicted by the findings of Jiang (1999), were Chinese−English bilinguals were being prompted to adopt a bilingual mode for a task. The stimuli consisted of Chinese and English target words presented in a random mixed order, so as to avoid the prediction of the target language. Surprisingly, no priming effects were observed in the L2−L1 direction, even with this design which puts the explanation provided by the Language Mode Hypothesis into question. In addition to the factor discussed above, asymmetry in language processing can also be an outcome of the divergences in processing of different types of words to which we shall turn in the following section.

2.4.2.2 The Word Type Effect

The asymmetry in lexical processing is also dependent on the type of words which are being processed, as it has been observed that different types of words can either slow down or speed up lexical processing. This phenomenon is referred to as the *word type effect* in scientific literature. Word type can be characterized by different variables such as cognateness, concreteness, frequency, etc. (De Groot, 1993; De Groot et al., 1994; De Groot & Comjis, 1995). Since one of the crucial areas of interest of the present study is the cognate status of the words/pictures, we will only review literature on this particular variable in the following section.

De Groot et al. (1994) conducted forward and backward word translation tasks in order to assess the role of cognateness in lexical processing. The stimuli consisted of both cognate and non-cognate words. They observed that response times for cognates were similar in both forward and backward direction. In contrast, non-cognates were responded to faster in the backward direction. Further, the speed of cognate translation was comparable to the speed of backward non-cognate translation, indicating the use of the same processing route in cognate translation and backward non-cognate translation. Following the predictions of the RHM, cognate processing (both forward and backward) can thus be assumed to proceed via the lexical route since lexical processing in backward direction is generally said to proceed via the lexical route. De Groot et al. (1994) further investigated the processing of cognates using variables such as imageability, context availability and definition accuracy in a translation production task. They observed that forward direction is highly influenced by semantic variables as opposed to backward direction which confirmed that the processing of cognates mainly engages the lexical route regardless of the processing direction. In subsequent experiments using the translation recognition task, De Groot and Comjis (1995) confirmed the stipulations described above.

Several models of bilingual mental lexicon give explanation on how different types of words affect the processing of language. One of such models is the DCF model by De Groot and colleagues (De Groot, 1992a, 1992b, 1993; De Groot et al., 1994; Van Hell &De Groot, 1998a, 1998b). According to this model, the phenomenon that cognates are processed faster than non-cognates is because of shared conceptual and lexical representation across languages in case of cognates. The word type effect is also explainable within the boundaries of the Mixed Memory Model of bilingual memory proposed by De Groot, 1992b; De Groot & Nas (1991), in line with the hierarchical models. However, this model assumes that the various connections between the lexical and conceptual level is dependent on the type of words being processed and not on the direction of processing.

2.5 Research on Bilingualism in India

As mentioned in Chapter 1, research on bilingualism in India has mostly concentrated on investigating the field from either educational or sociolinguistic perspectives. Much of the sociolinguistic research in India on bi/multilingualism addressed topics such as language maintenance (Deb, 2012, Mishra & Dutta, 1999, Mukherjee, 1996), functional distribution of communication patterns (Taylor, Mahadevan, & Koshal, 1978; Saghal, 1991, Sachdeva, 2002), convergence, code mixing and code switching (Doley, 2008).

In recent years, there has been a dramatic increase in research on language processing in bilinguals and second language learners world over. While this psycholinguistic oriented research has contributed to better understanding of the nature of mental representations and processes in bilingual lexicon and led to model building, it deals primarily with sequential bilingualism in the Western countries, and has not motivated research on simultaneous bilingualism in India (Vasanta, Alladi, Sireesha, & Bapu, 2010).As a result, there exist very few studies using neuroimaging technologies, and eye-tracking methodologies. For example, few published reports by researchers working in other countries have used Indian bilinguals for comparison and justifying theoretical claims (Bialystok & Viswanathan, 2009; Bialystok, Craik, Klain & Viswanathan, 2004). There has also been some attempt to investigate neural processing in Indian bilinguals with the use of neuroimaging techniques such as fMRI. For example, Kumar et al. (2010) investigated differences in brain activations for processing dissimilar orthographies. Few studies adopted a different approach where the focus has been on examining issues related to language loss/recovery in one language or the other in bilingual/multilingual patients (Karanth & Rangamani, 1988; Ijalba, Obler, & Chengappa, 2004). Using the visual world paradigm, Mishra and Singh (2014), Mishra and Singh (2015), and Mishra, Singh, and Singh (in press) have explored the cognitive mechanisms in Indian Hindi-English bilinguals. These studies have explored the role of language on a range of other cognitive functions, like the executive control, attentional mechanism etc.

2.6 Chapter Summary

This chapter provided a broad overview of the critical literature in the areas of bilingual lexical representation and processing. To summarize, research focusing on the representation part suggests that the two languages of a bilingual are represented in an integrated manner. Moreover, research focusing on the processing part suggests that bilinguals activate or access both their languages in a non-selective manner. In addition to that, several factors can have important consequences for language processing such as the cognate status of the word, the age of acquisition and proficiency in the second language, and the script. Finally, the review of the research concerning the asymmetry in lexical processing discussed two important issues which influences the phenomenon—the choice of the processing route and the word type effect. To sum up, despite intensive research efforts in these areas, there still exist many conflicting findings, making it difficult to reach firm conclusions even in areas where much research has been done.

3

RESEARCH DESIGN AND METHODOLOGY

This chapter provides a detailed description of all aspects of the design and procedures used to collect data in this study and explains their appropriateness to the exploration of the research questions.

Main Contents

3.1 Introduction

Bilingual study encompasses several disciplinary approaches and traditions of methodology. Though the methods employed in bilingual research borrow luxuriously from available disciplines of study, namely psychology and others, the choice of methodology to be used would, however, depend upon the central theme of the query that the research aims to address (Wei & Moyer, 2008).

Most bilingual studies by psycholinguists are experimental studies in which researchers study human participants in a laboratory setting and where the researchers can control exactly what information is presented to the subjects. Also, they can vary the information with similar or different participants in order to test specific hypotheses. For the present study, quantitative methods have been used for data collection and analysis. Fieldwork was a main component of the research. The following section gives a step by step overview of what was done in the conduct of the study.

3.2 Chapter Overview

This chapter provides an explanation to the various methodologies employed in order to generate credible data during the course of the study which includes the use of consultation, the designing of questionnaires and experiments, the application of instruments to gather appropriate data, the conduction of pilot study before the main fieldwork, or other actions. The chapter will begin by giving a brief background on the bilingual population involved in this study. A significant quantum of this chapter is centered on providing an insight to the procedural modalities and the results of the pilot study conducted. Included thereafter is the in-depth coverage of the procedural aspects in data collection during the main phase. The chapter concludes with a summary of the overall research design.

3.3 The Bodo−Assamese Bilinguals

The Bodos are believed to be among the earliest settlers of Assam. Historical notice of the Kacharis is available from the Annals of the Ahoms, according to which the first confrontation of the Kacharis with the advancing Ahoms happened in 1488 A.D., when the Kacharis were occupying Dimapur as their capital and from where they were driven away to Maibong by 1536 A.D. However, during retreats from invaders only the ruling chiefs (Rajas) along with a few followers escaped, while the rest of the Kachari population became subjugated to the victors and continued to live with them (Endle, 1911). The Bodos form a significant proportion of the existing linguistic groups in Assam. The total population of Assam was 312.05 lakhs (Census 2011) out of which the population of Bodos in Assam is to the extent of 4.36 % as per 2011 census data. The principal language spoken by Bodos is 'Bodo' (a.k.a. Boro) which is a language descending from the Tibeto-Burman family. The geographical spread of Bodo is patchy in nature. Bodo is spoken in communities across Assam. However, large blocks of Bodo localities are found only in western Assam. The majority of the Bodo people are found in the Bodoland Territorial Council (BTC) areas of Kokrajhar, Baksa, Udalguri and Chirang. In central and eastern Assam, the Bodos live in small villages, and are surrounded mainly by Assamese people. The Bodos also live outside the state of Assam, in the states of Arunachal Pradesh and Meghalaya (Baro 2001). Outside India, a small number of Bodo speakers are found in Nepal (Ethnologue). According to the 2001 census report, the total population of Bodo speakers in India is 1,543,300 and 3,300 in Nepal (Ethnologue).

3.3.1 The Bodo−Assamese Contact Situation

Based on two contact languages (Bodo and Assamese), a major proportion of the Bodo population in Assam can speak in both Bodo and Assamese. Most of them speak Assamese as their second language and a part of the tribe speaks Assamese as their mother-tongue. Strong and far reaching influence of Indo-Aryan languages, viz., Assamese/Bengali was noticeable even early on 1903, as reported in the Linguistic Survey of India (LSI). Hinduization of the Bodo tribe from as early times as the period of consolidation of Ahom rule in Assam and their own adoption of Hinduism has perhaps been one contributory factor to the strong Indo-Aryan influence on Bodo speech (Basumatary, 2015).

A strong tendency on the part of the Bodo people to switch over to contact Indo-Aryan languages and widespread and far-reaching bilingualism among the Bodo population was reported even earlier (Grierson, 1903). Since then, fortuitous bilingualism among the native speakers has been continuing. In the 1971 census, more than 56% of speakers of Bodo in Assam were reported to be bilingual, while more than 97% of them had returned Assamese as their second language. The majority of the people of this community are bilingual in the sense that they use their own Bodo dialect in speaking among themselves, while Assamese is used as the medium of expression with the neighboring Assamese people. As the plain tribe lives along with the Assamese people, it has become necessity for them to learn Assamese and they do speak Assamese while conversing with their neighbours. Due to this nature of contact, they can be called bicultural bilinguals as they freely move between the two cultures. The case is, however, not the same with the Assamese population as very few of them need to learn Bodo, as Assamese is the dominant language at the state level.

3.3.2 Linguistic Features of Bodo and Assamese

Bodo and Assamese are two distinctly different languages. They belong to two different language families. Bodo is a Tibeto-Burman language and it falls under the Bodo-Konyak-Jinghpaw subgroup of Tibeto-Burman family. Its genetic affinity can be represented as: Sino-Tibetan > Tibeto-Burman > Bodo-Konyak-Jinghpaw > Bodo-Koch > Bodo > Boro (Burling 2003). Similar to other languages in its family, it is a ‘tone’ language. There are two clearly distinguishable kinds of tone in Bodo:

Rising and *Falling*. Assamese is an Indo-Aryan language which belongs to the Indo-European language family. It is the easternmost member of the Indo-Aryan branch of the Indo-European language family. Its genetic affinity can be represented as: Indo-European > Indo-Aryan > Eastern Zone > Bengali-Assamese > Assamese (UCLA). It is spoken by over 20 million people primarily in the northeastern state of Assam and in parts of the neighboring states of West Bengal, Meghalaya and Arunachal Pradesh.

Bodo and Assamese have many dialects with distinctive set of words and phonological and grammatical variations. However, all dialects are mutually intelligible among them. As reported by Bhattacharya (1977, p. 11−12), Bodo has at least four varieties: (1) North Goalpara variety, spoken in the northern regions of Goalpara and Kamrup districts (though both varieties have salient differences), (2) A variety spoken in South Goalpara, Garo Hills and South Kamrup, (3) A variety spoken in Darrang, Lakhimpur and a few places of Arunachal Pradesh, called the north central Assam dialect, and (4) A variety spoken in the Nowgong, North Cachar and Karbi Hills. Basumatary (2005, p. 10−11), on the other hand, reported that Bodo has three major regional dialects: (1) Western dialect, spoken in Kokrajhar, Dhubri and Chirang, (2) Eastern dialect, spoken in Baksa, Kamrup (Northern part of the Brahmaputra valley and mainly Odalguri district respectively) and (3) Southern dialect, spoken in Goalpara (partially from Krishnai-Agia to Dudhnoi Sub-division) and particularly partial part of the Kamrup district (from Boko-Chaygaon to Rani area). Following Basumatary (2005), the variety represented in the current study belongs to the Eastern dialect.

Several regional dialects have been recognized in Assamese and in addition to that there also exist some aregional, community-based dialects. Kakati (1935, p. 16) has divided the Assamese dialects into two major groups: (1) Eastern Assamese, and (2) Western Assamese. However, recent linguistic studies have identified four dialect groups: (1) Eastern group spoken in and around Sivasagar District, (2) Central group spoken in Nagaon, Sonitpur, Morigaon districts and adjoining areas, (3) Kamrupi group spoken primarily in the Kamrup region, and (4) Goalpariya group spoken in the Goalpara region.

The two languages use different scripts and phonological systems. The Bodos had traditionally no script of their own. The Christian Missionaries used Roman script while translating their religious books and composing text books for schools children towards the end of the 19th century. During the first quarter of the 20th century, the Bodo writers used Assamese script for composing books and magazines. The script for teaching in school was Assamese up to 1975. In 1976, Devanagari script replaced Assamese script and is used till today. The Assamese language uses the Assamese script. The evolution of the Assamese script can be divided into three different stages: Old Assamese script or the Kamrupi script (4th/5th to 13th century), the origin of which, in turn, could be traced to the Gupta Brahmi script; Medieval Assamese script (13th to early part of 19th century) and Modern Assamese script from early part of the nineteenth century. Assamese language uses eleven symbols to represent vowels and thirty-seven symbols to represent consonants as against six vowels and sixteen consonants in Bodo (see Figure 3.1).

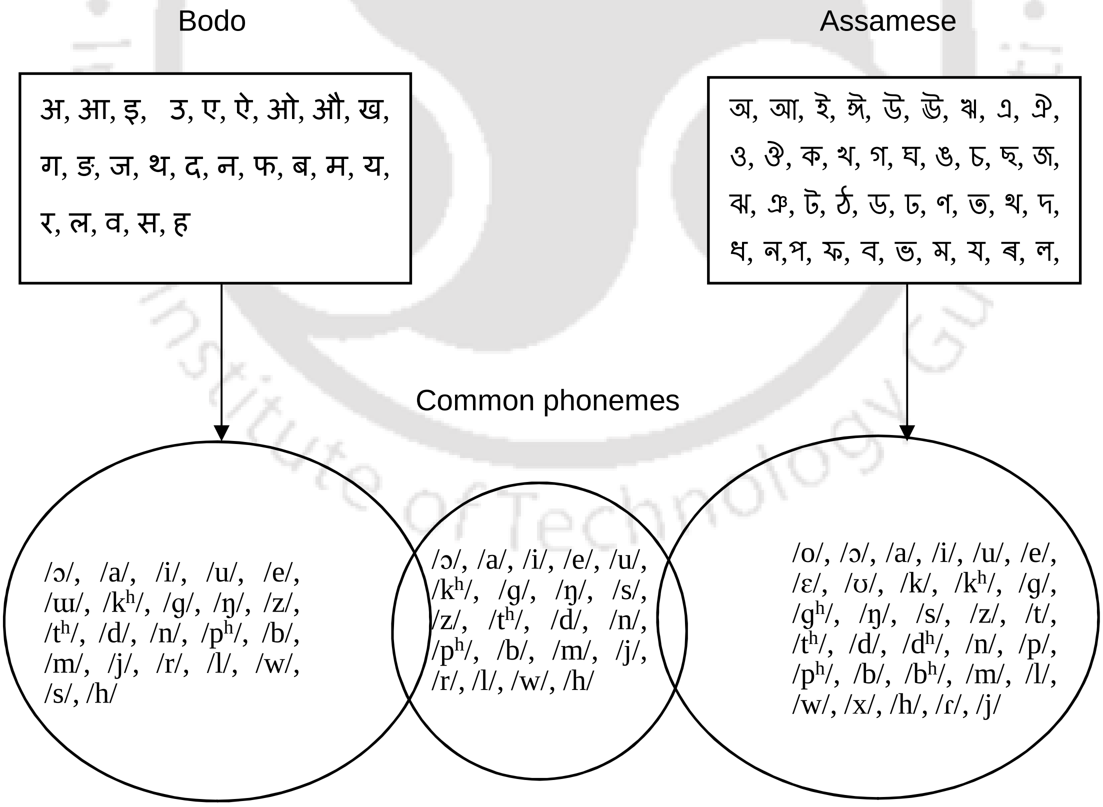


Figure 3.1 Symbols representing vowels and consonants in Bodo and Assamese and the associated phonemes in each language along with common phonemes.

The Assamese language has been deeply influenced by the various tribal languages in terms of grammar. Besides grammar, vocabulary has been the greatest contribution of the tribal groups towards the formation of the Assamese language, amongst which the Bodo tribe stands out as the biggest contributor (Phangcho, 2006). Assamese and Bodo are not genetically related, but structurally similar in various aspects due to mutual contact in between them. Both languages share a wide range of cognate words.

3.4 The Present Study

The experimental work carried out for the present study was divided into two parts. First a pilot study was carried out, with forty Bodo−Assamese bilinguals, in order to validate the feasibility of the study. After the first phase of the research, i.e., the pilot phase, careful considerations were taken to see how the research questions hold in the field, and how do the methods of investigation relate to what people actually do, say, are? Accordingly, necessary improvisations were made when and where required. Following this, the next phase started, where we carried out the main experiments and analyzed the data. The results emanating from the second phase has been elucidated in subsequent Chapters 4 and 5. In addition to that, a crucial aspect of fieldwork consisted of keeping a daily record of the research. In the next section we describe the pilot study in detail.

3.5 Phase One: Pilot Study

Prior to the main fieldwork, a pilot study was conducted to test out our approach, and identify any details that needed to be addressed before the main data collection phase. In other words, the goal of the pilot study was to make an assessment regarding whether the main study would be feasible in its entirety. Though the participants in both the pilot and main study were part of a homogenous group, it was ensured that there was no repeat participation in both studies in order to maintain the uniqueness and integrity of each study. The nature of the bilingual lexicon, i.e. how the lexical and conceptual information are represented and processed, was the focal entity of this study. Although research on bilingualism uses a number of different paradigms, the focus of this study was on research which employs the primed visual lexical decision task. This task has been an important instrument in exploring memory organization and lexical processing in general. Four cross-language primed visual lexical decision tasks were carried out to test hypotheses about the processes underlying cross-language priming. Bodo−Assamese bilinguals, differing in their second language age of acquisition and level of proficiency performed two unmasked translation priming tasks and two masked translation priming tasks in their first (L1) and second (L2) language, using non-cognate translation pairs.

In a translation priming paradigm, efforts to investigate whether the recognition of a target word (e.g. মেকুৰি [mekuri] 'cat' in Assamese) may be facilitated by the presentation of a preceding translation equivalent prime (e.g. मावजि [mauzi] 'cat' in Bodo) for a Bodo−Assamese bilingual, is undertaken. On the other hand, in a masked version of the translation priming paradigm, a series of symbols visually mask the translation prime. In order to examine the role of translation direction in both unmasked and masked translation priming paradigms, Experiment 1 and Experiment 3 tested priming effects in the L1−L2 direction and Experiment 2 and Experiment 4 tested priming effects in the L2−L1 direction. The following research questions were explored:

1) Does forward processing (L1−L2) and backward processing (L2−L1) exploit different mental processes?

2) What is the effect of age (at which the second language has been acquired) along-with the proficiency level on the representation and processing of the words associated with the first and second language?

3.5.1 Data Collection

As already mentioned, the pilot study was primarily envisaged to make an assessment whether the main study would be feasible in its entirety. Further it also aimed to therewith generate the requisite data for making sample size calculations, particularly necessitated by the absence of precedent studies providing an insight into the same. The next section aims to clearly underline the eligibility criterion selected for participations, and also delve into the physical settings, locales included, pertaining to the data collection part of the pilot study.

3.5.1.1 Method

Participants and Locations. A total of forty Bodo−Assamese bilinguals participated in the pilot study. These participants were recruited from four locations in Guwahati, Assam: (1) Indian Institute of Technology Guwahati, (2) Gauhati University, (3) Cotton College, and (4) Pandu College (see Appendix A). The same participants took part in all four pilot experiments. Out of the forty participants, twenty-two were male and eighteen were female. They ranged in age from 21 to 38 years (mean age = 25.5, *SD* = 4.60). Participants were native speakers of Bodo (L1) with Assamese as their second language (L2), living in an L2 dominant environment.

All participants were right handed and performed the tasks with the dominant hand. They completed a questionnaire which included questions on their language history and usage. In the questionnaire, participants provided self-report ratings of age of acquisition and proficiency for Bodo and Assamese, on the basis of which they were sorted into three groups: Early High Proficient, Late High Proficient, and Late Low Proficient bilinguals. The summarized data of the self-report ratings is presented in Table 3.1. In Table 3.1 it can be noted that, on all four proficiency measures the ratings of the high proficient group are higher than the low proficient group.

Moreover, for the low proficient groups, the scores are significantly higher in case of Bodo than Assamese.

Table 3.1 Self-Report Ratings in Bodo and Assamese for All Three Bilingual Groups

	Bodo (L1)			Assamese (L2)		
	Early (*n* = 17)	Late High (*n* = 10)	Late Low (*n* = 13)	Early (*n* = 17)	Late High (*n* = 10)	Late Low (*n* = 13)
Age of acquisition (years)	2.4	2.9	1.5	3.2	9.2	10.6
Mean daily usage (%)	47.8 %	46.2 %	47.9 %	31.4 %	21.2 %	19 %
Self-ratings (7 point scale)						
Speaking	6.8 (*1.0*)	6.8 (*0*)	6.6 (*0.7*)	6 (*0.8*)	6 (*0.7*)	3.8 (*0*)
Reading	6.8 (*0.8*)	6.8 (*0*)	6.3 (*0*)	6 (*0.8*)	6 (*0.7*)	3.1 (*0.7*)
Writing	6.8 (*0.8*)	6.8 (*0*)	6.4 (*0.7*)	5.3 (*2.6*)	4.2 (*0.7*)	1.5 (*0*)
Comprehension	6.7 (*1.4*)	6.4 (*0*)	6.3 (*2.1*)	5.3 (*2.6*)	4.6 (*1.4*)	2.8 (*0*)

In addition to AoA and proficiency in the two languages, another constraint, i.e., language dominance, for measuring the frequency of usage of the two languages was also administered. Participants rated the regularity in which they use each of the languages with different people and in different social and academic contexts. The self-report measures revealed that, Bodo is dominantly used with parents and siblings and less used with friends and co-workers. On the other hand, Assamese is more frequently used with friends and co-workers. Moreover, the self-ratings also gave an estimate of different activities done in Bodo and Assamese. It has been seen that speaking and listening is mostly done in Assamese whereas reading and writing in Bodo. These three groups took part in the priming experiments. The core question as to whether Early and Late (across High and Low proficiency spectrum) learners demonstrate similar priming effects has to be addressed, and the pattern of results would showcase an empirical evidence establishing the nature of effect of age of acquisition of second language, and proficiency thereof, on the construct of the language representation and processing system of the bilingual.

Stimuli and Design. The stimuli consisted of fifty non-cognate translation equivalents representing six semantic categories (fruits, vegetables, birds, animals, body parts, and natural objects). Each target was preceded once by a non-cognate translation prime and the other time by an unrelated control prime. None of the unrelated prime-target word pairs were morphologically or semantically related (see Appendix F). In addition to that, fifty orthographically legal and pronounceable nonword targets in Assamese and Bodo were generated by replacing letters of the word targets, while keeping a similar structure and maintaining pronounceability. The nonword targets were preceded by the translation primes and unrelated primes used for the word targets. The stimuli list was randomized. The stimuli remained the same for all four pilot experiments. Table 3.2 illustrates one set of stimulus in order to depict the experimentations.

Table 3.2 Examples of a Stimulus Set Used in Experiment 1

Prime Type	Word		Nonword	
	Prime	Target	Prime	Target
Translation	सैमा*‘dog’*	कुकुৰ*‘dog’*	सैमा	लुकुৰ
Control	बिजाब*‘book’*	कुकुৰ*‘dog’*	बिजाब	लुकुৰ

Note. * सैमा [swima]; *बिजाब [bizab]; *कुकुৰ [kukur]; *लुकुৰ [lukur]

Procedure. On all participants, two parts of the study were conducted in the following order: the language background survey, and the priming experiments. They were individually tested in a quiet room. Before the conduction of the experiments, they were given both verbal and written instructions about the task. Using the DMDX software (Forster & Forster, 2003), they were presented with stimuli consisting of prime and target words in the center of a laptop screen. Each trial consisted of the following sequence: First, the participant was presented with a fixation ‘+’ for 500 ms, followed by a prime word which appeared for 400 ms. The prime word was immediately replaced by a target word (or nonword) which remained on the screen until the participants responded or for a maximum of 2,000 ms. In the masked translation priming paradigm, the sequence of a trial presentation included the following: each trial began with a forward mask consisting of ten hash marks (##########) which appeared on the screen for 500 ms. It was immediately replaced by a prime word, appearing for a duration of 50 ms, which was followed by a target word (or nonword) and it remained on the screen until the participants responded or for a maximum of 2,000 ms. The presentation order of the word pairs was randomized for each participant. The participant initiated the trial by pressing the space bar key. Their task was to respond as quickly and as accurately as possible to a target word, by pressing the following keys on the keyboard: the "Y" key with their right index finger for a real word and "N" key with their left index finger for a nonword. Before the experiment proper, each participant went through a trial with fifteen numbers of items which resembled the main task. The reaction time data and the error data were measured and saved after each experiment and further analyzed.

3.5.2 Data Analysis

Reaction times were taken from the onset of the target presentation to the onset of the participant's response and measurement for all the target words were done in milliseconds. Separate analyses were conducted on the reaction time data and the error data. Outliers were removed and for the purpose of reaction time analysis, only correct responses in the range of 200 ms to 1800 ms were considered.

3.5.2.1 Results of Unmasked Translation Priming from L1−L2 (Experiment 1)

The analysis conducted on the reaction time data revealed a significant main effect of Prime Type (translation vs. control). Assamese targets preceded by Bodo translation equivalents (394 ms) were recognized faster than those preceded by Bodo control words (463 ms). This 69 ms priming effect was significant, [*F*(1,125)

= 20.078, *p* = .000]. The main effect of Bilingual Group did not approach significance [*F*< 1]. However, the interaction between Prime Type and Bilingual Group approached significance [$F(2,852) = 6.724$, $p = .001$]. The mean reaction times and percentage of errors are presented in Table 3.3.

A series of planned comparisons were conducted to investigate the effects of Bilingual Group on reaction times. The Early High Proficient group had a very significant priming effect of 140 ms. The Late High Proficient and Late Low Proficient groups also had priming effects of 40 ms and 26 ms respectively. The pattern of results shows that the AoA may be a critical factor in the conflicting results. Further analysis showed that nonwords were reacted slowly than words.

Table 3.3 Mean RTs (ms) and Percentage of Errors in the two priming conditions for all three Bilingual Groups in Experiment 1

	Overall	Early	Late High	Late Low
Priming Condition	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)
Translation	394 (4.5)	303 (7.6)	381 (9.2)	498 (6.1)
Control	463 (4.5)	443 (7.7)	421 (9.1)	524 (6.2)
Priming	**69**	**140**	**40**	**26**

The analysis conducted on the error data did not reveal a main effect of Prime Type [*F*< 1]. Percentage of error was similar when targets were preceded by translation primes and also when they were primed by control primes. However, the main effect of Bilingual Group tended towards significance in the error analysis [$F(2,36) =3.027$, $p = .032$]. Errors were numerous for the Late High Proficient bilinguals than the Early High Proficient and Late Low Proficient bilinguals. A robust translation priming effect from L1−L2 is evident from the results of Experiment 1, which is consistent with earlier bilingual word recognition studies, (e.g., Gollan, et al., 1997; Jiang, 1999; Jiang & Forster, 2001; Kim & Davis, 2003). In the next experiment, we tried to explore as to what happens when the direction of priming is from L2−L1, with only the languages of primes and targets reversed.

3.5.2.2 Results of Unmasked Translation Priming from L2−L1 (Experiment 2)

As in the previous experiment, separate analyses were run on the reaction time data and the error data. The mean reaction times and percentage of errors are presented in Table 3.4. Analyses conducted on the reaction time data revealed that the main effect of Prime Type did was marginal [$F(1,113) = 2.231$, $p = .018$]. This finding suggests that although Bodo−Assamese bilinguals were faster to respond to translation word pairs (324 ms) than to control ones (346 ms), the priming effect of 22 ms was much less compared to the effects observed in Experiment 1. Further investigations also revealed that the main effect of Bilingual Group was not significant [$F(2,36) = 2.413$, $p = .213$]. Consistent with our expectations, the Early High Proficient group produced robust priming effects of 79 ms. However, the Late bilinguals showed no translation priming whatsoever (−6 ms and −7 ms). The Late High Proficient group showed no facilitation, despite their fluency. Therefore, they provide empirical support that processing of second language words depends on the age of acquisition of L2, when proficiency is matched. This also proves that not only AoA and proficiency, but language direction also plays an important role in determining the priming effect.

Table 3.4 Mean RTs (ms) and Percentage of Errors in the two priming conditions for all three Bilingual Groups in Experiment 2

	Overall	Early	Late High	Late Low
Priming Condition	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)
Translation	324 (1.2)	283 (2.4)	365 (2.0)	325 (1.4)
Control	346 (1.1)	362 (2.1)	359 (1.9)	318 (1.3)
Priming	**22**	**79**	**−6**	**−7**

In Experiment 2, we observed that when the priming direction was from L2−L1, translation priming effect was evident but relatively smaller compared to the priming effect observed in Experiment 1. However, the presence of priming effect in the L2−L1 direction appears to contradict a number of previous studies in which significant translation priming effects in the L1−L2 direction have been observed but null translation priming effects have been evident when the priming direction was from L2−L1 (e.g., De Groot & Nas, 1991, Experiment 4; Grainger & Frenck-Mestre, 1998, Experiment 1; Kim & Davis, 2003, Experiment 1; Voga & Grainger, 2007, Experiment 2).

The differences in the time of processing in Experiment 1 and 2 were compared to evaluate the asymmetry in bilingual processing. The analysis revealed a significant main effect of Target Language [$F(1,1827) = 39.263$, $p = .000$] which indicates that the participants were faster when responding to Bodo target words (335 ms) than when responding to Assamese target words (428 ms). The numerical difference in the reaction time between the two directions was 47 ms which confirms that this difference was significant, thereby supporting the asymmetry in translation priming. The interaction between Prime Type and Target Language was reliable [$F(1,1222) = 3.673$, $p = .056$]. Moreover, the Bilingual Group and Target Language interaction was reliable [$F(2,619) = 3.469$, $p = .032$].

3.5.2.3 Results of Masked Translation Priming from L1−L2 (Experiment 3)

Calculations of mean reaction times for correct responses were done using identical procedure as that used in the first experiment. The mean reaction times and percentage of errors are presented in Table 3.5. Analysis on the reaction time data did not reveal a main effect of Prime Type [$F < 1$). A very insignificant priming effect of 5 ms was observed. Further analysis showed that nonword targets were reacted significantly more slowly than word targets. Comparisons were conducted to determine if there was a significant effect of Bilingual Group. The results showed that the main effect of Bilingual Group did not approach significance [$F < 1$]. This pattern was different than the pattern observed in Experiment 1 which followed the unmasked paradigm in the L1−L2 direction. In this experiment, the Early High Proficient group showed null effects (–29 ms). This null effect might indicate that the L1 primes were not able to facilitate the L2 targets because of the mask which means that the processing of words not only depends on AoA, proficiency and language direction, but also on different paradigms. Another interesting observation in this experiment was that contrary to the Early High Proficient group, the Late High and Low Proficient groups were able to produce priming effects of +11 ms and +34 ms respectively. What was noteworthy here was that the Late Low Proficient group had larger priming effect compared to the others which is indicative of using different processing mechanisms.

Table 3.5 Mean RTs (ms) and Percentage of Errors in the priming conditions for all three Bilingual Groups in Experiment 3

	Overall	Early	Late High	Late Low
Priming Condition	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)
Translation	945 (4.6)	906 (7.6)	906 (9.0)	1023 (6.8)
Control	950 (4.6)	877 (7.6)	917 (9.0)	1057 6.8)
Priming	**5**	**−29**	**11**	**34**

3.5.2.4 Results of Masked Translation Priming from L2−L1 (Experiment 4)

Analysis on the reaction time data did not reveal a main effect of Prime Type [$F < 1$]. Translation pairs (701 ms) and control pairs (708 ms) were responded to almost similarly, showing a very insignificant priming effect of 7 ms. Moreover, mean reaction times of nonwords were not significantly slower than words. Planned comparisons showed no significant effect of Bilingual Group [$F < 1$]. Contrary to Experiment 3, the Early High Proficient group did produce an effect 13 ms. The

Late High Proficient group and Late Low Proficient group also produced priming effects of 8 ms and 2 ms respectively, but it was not significant. Contrary to some of the previous findings, the present experiment did produce a priming effect in the L2−L1, although it was lesser in magnitude and not significant. The mean reaction times and percentage of errors are presented in Table 3.6.

Table 3.6 Mean RTs (ms) and Percentage of Errors in the two priming conditions for all five Bilingual Groups in Experiment 4

	Overall	Early	Late High	Late Low
Priming Condition	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)
Translation	701	659	699	743
Control	708	672	707	745
Priming	**7**	**13**	**8**	**2**

We conducted a combined analysis of Experiment 3 and 4 and the results revealed a significant main effect of Target Language [$F(1,1827) = 85.845$, $p = .000$]. This suggests that the participants were significantly faster to Bodo targets than to Assamese targets. A significant interaction was also observed between Target Language and Bilingual Group [$F(2,1256) = 4.744$, $p = .009$], indicating the role of second language age of acquisition and proficiency. This finding of our study is consistent with the assumptions of the RHM that mapping of L2 words into the lexical and conceptual representations is dependent on the proficiency of the bilinguals. In other words, high proficient bilinguals can directly access the conceptual representation, whereas, low proficient bilinguals access the conceptual representation indirectly via the L1 lexical representation.

3.5.3 Findings

Using a lexical decision task with unmasked and masked versions of the priming paradigm, the present study investigated translation priming in two directions:

L1−L2 and L2−L1. The stimuli consisted of non-cognate prime-target pairs. In Experiment 1, we observed significant translation priming effect, replicating previous studies. In Experiment 2, we observed reliable translation priming effects, contrasting a number of previous studies. Experiment 3 and 4 failed to produce significant priming effects in both L1−L2 and L2−L1 when the condition was masked. This finding contrasts a number of previous studies in which significant masked translation priming effects have been observed. Furthermore, age of acquisition and language proficiency also had a significant effect on reaction time differences in all the experiments.

The results show that the type of priming paradigm has a major effect in the processing of words. There was a significant difference in the retrieval time of target words in two different paradigms: *unmasked* and *masked*. Faster reaction times and greater priming effects were observed only in the unmasked paradigm. This may be because in a translation priming paradigm, the bilingual nature of the task is apparent which could imply that the bilinguals strategically connect one language with the other by detecting the relationship between the prime and the target. This results in some information about the prime reaching consciousness, i.e., the processing of the target is facilitated by a briefly presented translation prime. Whereas in a masked translation priming paradigm, the participants are unaware of the bilingual nature of the task and so the priming stimulus is unavailable for conscious report and thereby reduces the chance that an episodic trace is laid down by the prime. The following section discusses the results based on different variables.

Target Language. One of the central questions of this study was whether the magnitude of the translation priming effect was symmetrical in both direction (L1−L2 and L2−L1). Language direction (translation direction) has been found to have an effect on priming. Kroll and Stewart (1994) posited that translation times from L2−L1 are faster than vice versa and that this might indicate different processing strategies for the two translation directions: forward and backward. In other words, the lexical and conceptual connections between L1 and L2 might be asymmetric. The present pattern of results replicates the results found by Kroll and

Stewart (1994). The results of Experiment 1 and 2 showed significant cross-language translation priming from L1−L2 and also from L2−L1. However, there were clear asymmetries between the magnitude of the reaction times and translation priming effects across languages in both directions—reaction times from L2−L1 being faster than reaction times from L1−L2 and greater priming effects in L1−L2 than in L2−L1. An effect of target language has also been observed in terms of the error data, as Bodo targets preceded by Assamese primes were recognized more accurately than Assamese targets preceded by Bodo primes. This finding of our study is thus consistent with the RHM's predictions that forward and backward translation use different translation routes. In other words, forward direction primarily involves conceptual mediation, whereas, backward direction most often involves lexical mediation.

Bilingual Group. Another critical manipulation in our study was to explore whether processing of words depends on the age of second language acquisition, when matched on proficiency (as measured by language test). The finding in our study was that age of acquisition and language proficiency did have a significant effect on reaction time differences in all experiments, which indicates different processing strategies for different groups of bilinguals. The differential sensitivity to translation equivalents, as evident in the reaction time differences in the three groups of bilinguals support the claims of the RHM that the balance between lexical and conceptual links changes as proficiency increases. The more proficient a bilingual is the more conceptual mediation will occur. L2 learners therefore start out using the lexical link but once they are able to conceptually mediate L2 words, they will mostly always do so. The same principle can be applied to the early and late learners as well.

The primary aim of this study was to investigate unmasked and masked translation priming in Bodo−Assamese bilinguals living in an L2 dominant environment. The study tried to explore some controversial areas in language representation and processing such as, the effect of prime type, translation direction, age of acquisition and proficiency. Analysis on reaction times revealed a main effect of Prime Type—target words preceded by translation primes were responded to faster than target words preceded by unrelated primes. Moreover, the main effect of Target Language revealed that responses to L2 targets were significantly slower than responses to L1 targets. The results of our study further showed the existence of the much debated non-cognate priming effect in L2−L1 (unmasked), though weak and inconsistent than the effect observed in L1−L2. Important to mention, however, is that the priming effect in L2−L1 was not strong enough to be significant.

In general, the expected priming asymmetry in the lexical decision task was observed. Further analyses indicated that the difference in priming was also significant for different Bilingual Groups. The findings of our study suggest that in order to examine the mental organization and processing of a bilingual belonging to a particular group, both age of second language acquisition and level of proficiency must be considered. To conclude, the present study supports two of the central predictions of the RHM: (1) one with regard to priming asymmetry, and (2) the other concerning the second language proficiency of the bilinguals.

3.5.4 Validity and Reliability

The pilot study was generally a small version of the main study with the purpose of testing the proposed procedures, materials, and methods. After the completion of the study, the results were carefully analyzed and time was spent reflecting on the implications that the pilot study might have for the main study. Although the findings of the pilot study provided an indication in the behavioural patterns of language representation and processing in Bodo−Assamese bilinguals, which can be used for the main study, in order to build upon the findings of the pilot study, further investigations appeared necessary in light of observed constraints in the research design and preliminary hypothesis prepared on the basis on literature review. As such, the preliminary hypotheses were suitably modified on the basis of the insights gathered, as mentioned above, and presented in Chapter 1. These hypotheses were ultimately tested on the sample population of Bodo-Assamese bilinguals across six locations in Guwahati during the main phase of experimental data collection.

3.6 Phase Two: Main Fieldwork

After the pilot study, few months were spent to prepare an in-depth guide for the main fieldwork to explore the key themes which emerged from the pilot study. The purpose of the main fieldwork was to gain an in-depth understanding of factors influencing lexical representation and processing, and, in particular, of specific issues that impact the representation and processing of the two languages in case of Bodo−Assamese bilinguals. The information used for this research was collected from a variety of sources consisting of: (1) proficiency measures, (2) norming experiments, and (3) comprehension and production experiments.

3.6.1 Data Collection

This section discusses the practical part of the methodology which includes nature of the data and data collection techniques.

3.6.1.1 Method

Using various methods and techniques of investigation we sought to collect material and gain insights in order to formulate answers to our research questions.

3.6.1.1.1 *Participants and Locations*

At first, the research locations for the study were identified. Thereafter, the main fieldwork was conducted at six locations in Guwahati: (1) Bathoupuri Bodo M.E.

and H.E. School, (2) J. B. Hagzer Bhawan, (3) Bathoupuri, (4) Ganeshpara, (5) Champavati Higher Secondary School, and (6) Indian Institute of Technology Guwahati (see Figure 3.2 and Appendix B). The research was carried out by paying several visits to these locations. Out of the six locations two of them (Bathoupuri and Ganeshpara) received more attention because apart from the main experiments, the norming experiments were also conducted in these locations.

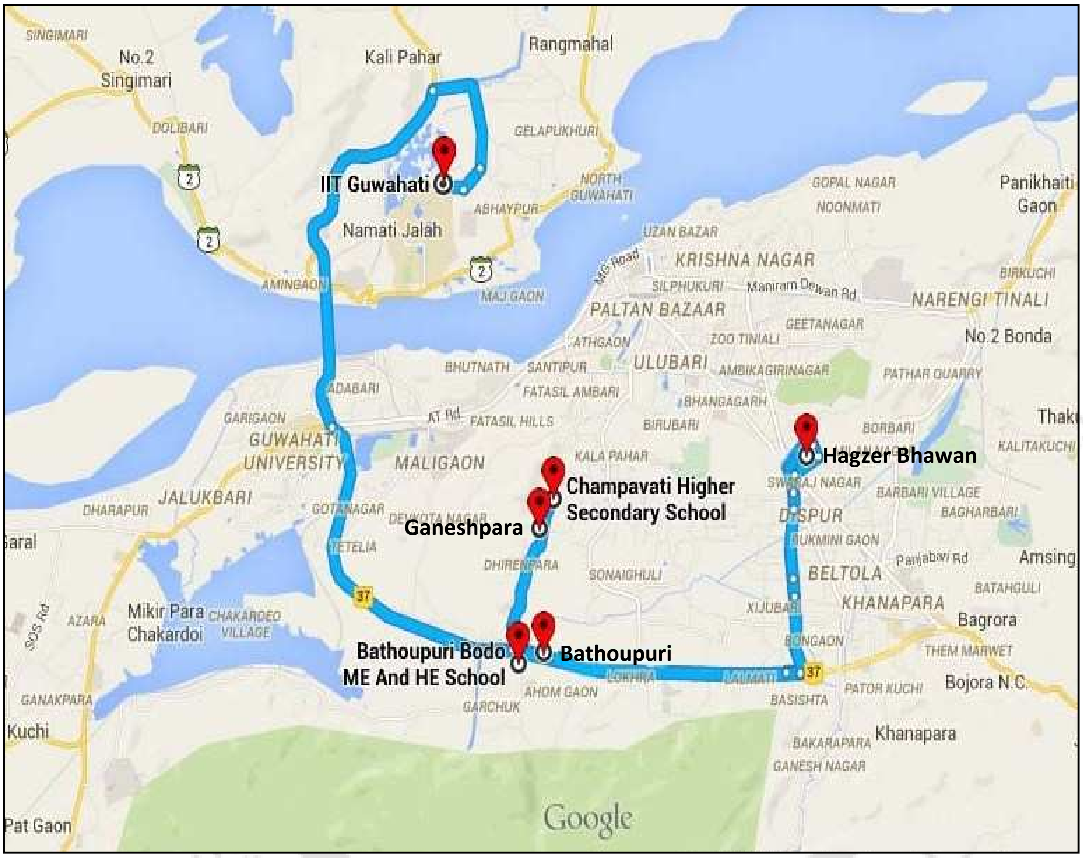


Figure 3.2 Locations for main fieldwork (adjusted from Google Maps™).

Participants were recruited through consultation that emphasized the need for native Bodo speakers who were bilinguals and used Assamese as their second language. In total, 107 Bodo−Assamese bilinguals took part in the experiments. Each participant took part in more than one experiment with a gap of minimum fifteen days between the experiments. They were presented with the tasks in the environment most convenient for them (participant’s home/workplace, research lab) and the tasks were completed in a quiet environment with only the researcher and the participant present.

3.6.1.1.2 Proficiency Measures

A sociolinguistic profile of the informants' background is necessary to predict bilingual behavior, or to exclude certain informants from participation. One of the most important reasons of asking questions about the sociolinguistics background is to find out how proficient bilinguals are in both languages, whether one of the languages is dominant, and what the language preferences are. To find out about these, four categories of questions were included: (1) language history, (2) language choice, (3) language dominance, and (4) language attitudes. Two measures of language proficiency were administered: Firstly, a self-assessment measure which formed a part of language background questionnaire, and secondly, an objective naming test in both languages.

Language Background Questionnaire. The questionnaire was initially constructed in English and subsequently translated to Bodo considering that the same was the mother tongue of the participants in the study. This is done in order to ensure eliciting of increased degree of valid responses considering the fact that the participants would be more comfortable in expression using the mother tongue. Reverse translation from Bodo to English was done in order to check the validity of translated questionnaire (see Figure 3.3, Appendix C (i) and C (ii)).

Measure for self-assessment by participants relating to age of acquisition of L1 and L2 were incorporated in the language background questionnaire in order to ensure that Bodo language was begun to be learnt by the participants first. The query on age of acquisition in the survey was also utilized to classify the participants on the basis of age of acquisition of second language (i.e. Early L2 learners and Late L2 learners). The criterion adopted for making the said classification was learning of Assamese language prior to 7 years[1] of age (designated as Early L2 learners) and

[1] Seven years of age was selected as the cut-off for Early L2 learning following the convention adopted by Kim et al.'s neuroimaging study.

post 7 years (designated as Late L2 Learners).The questionnaire also included a 7 point self-assessment scale to map the proficiency of the participants in speaking, reading, writing and comprehension in respect to both languages. This was used to bifurcate the Late L2 learners into high and low Proficient groups. Also, over and above the self-assessment proficiency measures as depicted above, the participants individually performed the Bodo and Assamese versions of the Objective Naming Test (see next section).

Figure 3.3 Participants in Bathoupuri filling out language background questionnaires.

Objective Naming Test. The objective naming test was an adaptation of the Boston Naming Test (BNT), which is a standardized test of object naming ability (Borod, Goodglass, & Kaplan, 1980; Kaplan, Goodglass, & Weintraub, 1976; 1983).

The test contains 60 line drawings of objects presented individually. In this test, participants are asked to name pictures as quickly as possible, which have grading in naming difficulty embedded, so that relatively familiar objects are put on display prior to less familiar objects. Considering that linguistic and cultural factors have a bearing on naming ability of individuals, a modified version of BNT was developed for the study. While maintaining the core procedural integrity of the original BNT, modifications were made on the itemized content. As such, 18 of the original 60 items were retained for the test, considering the objective validity of the items vis-à-vis the Bodo participants. In order to arrive at the stipulated item level of 60, 42 new items were added and were adjusted in the increasing order of difficulty.

During the course of experiment, this modified version of BNT was administered once in Bodo (L1) and once in Assamese (L2) to each participant, with embedded counterbalance of the order of presentation of language. The individual participants were accorded 15 seconds to name each of the object depicted in the pictures being presented one by one. As far as scoring was concerned, participants were awarded one point credit for correctly naming a picture. In case of objects with multiple names, credit was accorded for any one correct term being recorded by the participant. Further, dialectal variations, if any, were also accepted for the object naming task.

Zero credit was awarded to the participants in case of wrong responses, non-remembrance of names of objects (nil response) or responses after the stipulated time of 15 seconds. A median spilt was then performed on the Late group's scores after the summing up of the total scores of the individual participants. The Late High Proficient group of participants comprised of fluent bilingual speakers whose scores were above the median on the task pertaining to Assamese (their L2). Similarly, the Late Low Proficient group was demarcated to comprise of bilingual speakers who had scored below the median in the task pertaining to Assamese. The data obtained from the self-assessment reports were juxtaposed with the results obtained from the objective naming test to map their degree of convergence. Three bilingual groups, namely (i.e., Early High Proficient; Late High Proficient; and Late Low Proficient) were created out of the survey responses.

3.6.1.1.3 Tasks and Paradigms

In relation to bilingual studies, there exist multifarious tasks which are considered to be valid and reliable measures to cognitive performance (Altarriba & Heredia, 2013). The last decade has seen a growing body of research investigating various aspects of L2 learners' performance of tasks (see, for example, Bygate, Skehan, & Swain, 2001; Ellis, 2003). One of the most widely used experimental paradigms in psychological and linguistics studies is priming. It originated in first language (L1) perception and production research and have been gaining prominence in second language (L2) processing and acquisition studies since the beginning of early 1980s (McDonough & Trofimovich, 2009). In the context of language use, it refers to the phenomenon which involves the positioning of one word preceding the target word to which the participants are expected to respond. The second word against which the participants are to submit their responses is called TARGET while the word preceding the target is called PRIME, which is usually presented for a very short time frame. The time lapse between the presentation of PRIME and the presentation of TARGET is called Stimulus Onset Asynchrony (SOA). Primes can be a sentence, picture or auditory in nature. However, for the course of the study, focus is on primes which are written words or in the form of pictures. The way in which a prime is related to the target can result either in facilitation or inhibition. For example, previous research shows that words that are connected in some way (either semantically, phonologically, etc.) show facilitative effects, whereas words which are not connected shows inhibitive effects. However, as will be evident in the rest of the thesis, this issue is far more complex. For many decades now, experimental paradigms using primes have gained phenomenal popularity, largely because it assists in developing an understanding of how words are inter-linked or stored in memory and whether certain processes occur consciously or are initiated automatically. In other words, priming experimental paradigm assists psycholinguists to explore representation of lexical forms and semantics in memory. The priming paradigm with bilingual population involves the presentation of cross-language word pairs, in order to examine the organization and processing mechanisms of the bilingual's two languages. Another widely adopted version this paradigm in which the participants are not aware of the prime is the masked priming paradigm (Forster & Davis, 1984). This version has the added advantage that the participants are not aware of the bilingual nature of the task, and thereby, curtails strategic factors which may be evident in the general priming approach (De Groot and Nas, 1991; Davis et al., 2010).

In the present study, a priming research is typically carried out in order to establish generalizations about language representations and processes that provide insight into the organization of mental processes. In order to further investigate the influence of strategic factors, the present study also adopts the masked version of this popular paradigm, in order to examine the extent to which participants rely on controlled, strategic processing in completing the task. To minimize the visibility of prime words, we employed masking techniques which included forward masking (when a pattern mask preceded the prime). In all the tasks involved in our study, we also manipulated the amount of time involved between the presentation of each prime word and target word, that is, the SOA. It is generally acknowledged that a longer SOA results in a 'deeper', more elaborate processing of the prime and likely encourages participants to use certain strategies to perform the task. In contrast, a shorter SOA is believed to ensure that participants' performance on the task is influenced by an automatic, unstoppable activation of information available in the prime and target words (Trofimovich & McDonough, 2011). By manipulating SOA, we thus attempted to determine whether participants activate information automatically or by means of strategies. Thus we used longer SOAs as well as SOAs that were brief, and the prime was either preceded by a mask (masked paradigm) or not (unmasked paradigm).

The present research has focused broadly on a variety of design features of tasks and implementation procedures to explore how these factors impact on such aspects of language use as L1 and L2 comprehension and production. The purpose of using different task was to take into account different phenomenon that different tasks often probe when interpreting the findings. Thus from the psycholinguistic perspective, we attempted to deduce the underlying structure of the bilingual system from patterns of behaviour that Bodo−Assamese bilinguals exhibit over a range of tasks. This includes tasks such as visual lexical decision, semantic categorization, translation recognition, word naming, word translation, simple picture naming, picture word interference, and primed picture naming (see Table 3.7, Figure 3.4 and 3.5). All these tasks differ in terms of the processing operations involved in performing each task. For example lexical decision and semantic categorization tasks involve comprehension processes. In contrast, word naming and word translation tasks ostensibly include both comprehension and production components. In interpreting task results, it is important to consider how priming effects depends on access to lexical and semantic/conceptual information in comprehending versus speaking a language. Chapter 4 and 5 provide a comprehensive and accessible overview of priming methodology and its application to the present research.

3.6.1.1.4 *Stimuli*

In addition to different types of tasks used in the study, careful considerations were given to all stimulus characteristics that may have a bearing on the outcome of the study. This step was crucial because the quality of the study depends on the quality of the materials used. In the present study, all tasks included at least two types of prime words: words that are related to the target (either semantically or phonologically) and those that are not. Moreover, the related primes were related to the target in different ways. For example, priming effects have been investigated for prime-target word pairs that are translation equivalents (e.g. आखाइ [akhai]−হাত [hat] *'hand−hand'*), semantically related (e.g. आखाइ [akhai]−আঙুলি [anguli] *'hand−finger'*), associatively related (e.g. आखाइ [akhai]−খাৰু [kharu] *'hand−bangle'*), phonologically related (e.g. आखाइ [akhai]−আখৈ [akhoi] *'hand−puffed rice'*), or phonologically related to the translation equivalent (e.g. आखाइ [akhai]−হাৰ [har] *'hand−rate'*). By manipulating the types of relationships, we attempted to determine how Bodo−Assamese bilinguals represent and use various kinds of information in their memory.

Table 3.7 Overview of Experiments in the Present Research

Experiment	Task	Process	Task language	Critical item	Script
Exp. 1A, 1B, 1C, & 1D	Unmasked & masked translation priming	Comprehension	L2 & L1	Cognates & non-cognates	Present in task
Exp. 2A, 2B, 2C, & 2D	Unmasked & masked semantic priming	Comprehension	L2 & L1	Cognates & non-cognates	Present in task
Exp. 3A, 3B, 3C, &3D	Unmasked & masked associative priming	Comprehension	L2 & L1	Cognates & non-cognates	Present in task
Exp. 4A, 4B, 4C, & 4D	Unmasked & masked phonological priming	Comprehension	L2 & L1	Cognates & non-cognates	Present in task
Exp. 5A & 5B	Masked semantic categorization	Comprehension	L2 & L1	Cognates & non-cognates	Present in task
Exp. 6A & 6B	Translation recognition	Comprehension	L2 & L1	Cognates & non-cognates	Present in task
Exp. 7A & 7B	Word naming	Comprehension & production	L2 & L1	Cognates & non-cognates	Present in task
Exp. 8A & 8B	Word translation	Comprehension & production	L2 & L1	Cognates & non-cognates	Present in task
Exp. 9A & 9B	Picture naming	Production	L2 & L1	Cognates & non-cognates	Absent in task
Exp. 10A, 10B, & 10C	Picture-word interference	Production	L2, L1, & mixed	Cognates & non-cognates	Present in task
Exp. 11A, 11B, & 11C	Primed picture naming	Production	L2, L1, & mixed	Cognates & non-cognates	Present in task

Figure 3.4 Photograph of a participant performing the visual lexical decision task.

Figure 3.5 Photograph of a participant performing the simple picture naming task.

In addition to that, cognate status of target words and pictures was manipulated to examine its influence on the outcome. To make sure that the word pairs that were identified as related were indeed related in meaning and, conversely, that the word pairs identified as unrelated were indeed unrelated, we carried out our own word norming study prior to conducting our experiments (see Appendix E (i), (ii), (iii), (iv), and (v)). The nature of the processing of these word types across Bodo−Assamese bilinguals will be discussed in light of various experiments that examine the processing of those words across a bilingual's languages.

3.6.1.1.5 *Variables*

In all experiments, variables were manipulated to determine their effects on data patterns. The independent variable was the one which we surmised would be the cause of the intended result, while the dependent variable was the one which was measured to understand the impact of the independent variable. In the following section we discussion each type of variable separately.

Dependent variables. The dependent variables in the all the experiments were the response latencies (including correct and incorrect responses). In the calculation of reaction times, we considered only reaction times for correct trials. Reaction time was measured as the amount of time between the onset of the target word/picture and the participant's response to it. Percentage of error was measured as the proportion (or percentage) of correct trials to each type of target in a condition to the total number of each type of target presented in that condition.

Independent variables. We manipulated several independent variables in all the tasks. One such set of variables includes the Prime Type, i.e., the various meaning and form relationship between prime and target words. Cognate Status was another independent variable that we manipulated throughout the experiments to explore the role of cross-linguistic overlap. Moreover, the variable of Bilingual

Group was used to examine the role of age of acquisition and proficiency of the bilinguals.

3.6.1.1.6 Instrumentation

The data collection took place in computer-collected format. During experimentations, the protocol set for language usage was kept consistent with the purpose of the study.

Laptop. An Acer Aspire 5920 laptop computer with a 15 inch viewing screen was used as a tool for stimulus presentation, collection of responses from participant, storage of the data emanating from experiments conducted therewith and analysis of the raw data so obtained to generate meaningful output. During the experiments, participants were seated in front of the laptop computer at a distance of about 60 cm from the screen.

Software Program. All the experiments were run using the E-prime Software Package (Version 2.0, Schneider, Eschmann, & Zuccolotto, 2002) on Windows XP.

Microphone. In a production experiment, a voice key and a microphone are often used to record the participant's vocal reaction times (spoken responses). A voice key uses a bit of dedicated hardware, essentially a microphone pre-amp, which detects the onset of a vocal response, and sends out a signal when it occurs. For the present study, a Sennheiser microphone was used for registering the vocal reaction time of the participants in the production experiments. The microphone was plugged into the sound card of the stimulus computer and on each trial, the vocal responses were recorded as .wav files. Later on, the waveforms for each trial was examined in Audacity (a sound editor), by putting markers on the start of the speech manually, and calculating vocal reaction times relative to the start of the trial. This process was reasonably time-consuming, but very reliable and precise.

3.6.2 Data Analysis

Before analysis of collected data, the data was subjected to a preliminary exercise of cleaning, organizing and processing. Processing of the data, so undertaken, also assisted in developing a familiarity with the type and scope of data in hand. Organizing of the data is the ultimate basis on which analytical claims and evidence for claim shall be made, and as such, required proper classification and labeling (Sarangi, 1987).

3.6.2.1 Data Trimming

Before the analysis of data, outliers were removed. Outliers are essentially scores that are either on the excessively higher side or on the lower side, therefore depicting significant deviations from the distribution of observed score. While fast scores on the extremity denote anticipatory processes, extreme slow scores may showcase lapses in attention span.

From the analyses of response latencies, we excluded outliers (i.e., response latencies less than 200 ms and more than 1800 ms) and erroneous responses. In addition to that, three types of responses were considered as erroneous responses in the production analyses. These included: (1) when the participants named words and pictures in the non-target language, (2) verbal responses which were not fluent, and (3) failure in the recording process.

3.6.2.2 Statistical Procedures

In the section preceding this, we considered issues of data cleaning and organizing which of inherent necessity in the run up to data analysis. This section concerns itself with the issues pertaining to data analysis with special reference to the concerned statistical procedures. The data were analyzed quantitatively using the Statistical Package for Social Sciences (SPSS) for windows (Version 20.0). The following section aims to map the statistical techniques employed during the course of the study.

Distribution Statistics. The background information of participants who had been tested for the experiments, the prevalence of anticipated reactions of the questionnaires, and their sample characteristics were analyzed as frequencies, percentages, mean, and standard deviation.

T-tests. The t-test was employed in the language background data to understand whether there was any significant difference between the means of different groups. Using independent t-test, the means of two measures, based on the two different conditions of the experiment, on identical participant group were compared.

Mixed-effects Analysis. In recent times, psycholinguists have often come under the cloud for usage of statistical tests and measures which are generally connoted as sub-optimal (Baayen, Davidson, & Bates, 2006; Raaijmakers, 2003; Raaijmakers, Schrijnemakers, & Gremmen, 1999). Traditional analysis in psycholinguistics analyzed the data: (1) By-participants ANOVA (F_1): Analyzing condition means of all participants with participants as random variable, and (2) By-items ANOVA (F_2): Analyzing condition means for all items with items as random variable.

However, the use of F_1 and F_2 tests "to generalize over participants and items" has been debated because with this kind of analysis we can't simultaneously generalize over both participants and items. As a way out of this impasse, Clark (1973) floated a proposal to conduct F_2 analysis in addition to F_1 analysis and then calculate the minF. This method proposed by Clark allows for a relatively good estimate of F value (which he denoted as minF) as an output which could assist to draw a generalization across participants and items at the same time.

In the years after Clark (1973) psycholinguists developed incremental competencies in their usage of F_1 and F_2 by limiting their analyses to F_1 (to check whether the findings could be generalized across participants) and F_2 (to check whether the findings could be generalized across stimulus materials) and forgetting about minF' (Raaijmakers et al., 1999). This is exactly the 'F_1 x F_2 fallacy' connoted by Raaijmakers et.al (1999), wherein it was stated that a significant F_1 and F_2 does not suffice in generalization across stimuli and participants. This subsequently led to authors to alternatively report as minF'. Further, Raaijmakers et al., (1999) also stated against the necessity of F_2 analysis always. He argues that minF' is more potent as an analysis that separate F_1 and F_2 analysis. During the same time, Baayen opined about the avoidable complication of minF' analysis in conjunction with F_1 and F_2, and offered his views that the same can be effectively replaced with multilevel (mixed-effects modeling) (Baayen, 2007; Baayen et al., 2006). Brysbaert in his report written for RTN-LAB entitled, "Language-as-fixed-effect-fallacy" talks about this much better type of that is in use in stats courses (Brysbaert, 2007):

> Just like an ANOVA at its basis is nothing else than a multiple regression, so you can approach the problem of random participants and random stimuli as a regression problem. You try to predict an observed RT as the end result of (i) a participant, (ii) a stimulus, and (iii) the contribution of one (or more) IVs. (p. 13)

The mixed-effects analysis gives the same value that we obtain by calculating the minF'. However, this is much easier compared to what Clark (1973) and Raaijmakers et al., (1999) proposed. Mixed-effects models also offer a number of other advantages over traditional ANOVA-based designs, including the fact that they easily handle unequal group sizes, unequal variances, and missing data (Van Hell & Tanner, 2012). Therefore, this analysis has been used throughout the study which allowed us to generalize across both participants and items, by simultaneously including participants and items as random variables. We have used SPSS (Version 20.0) which has an algorithm for this type of analysis called MIXED. Mixed-effects analyses were run separately on the correct response latencies and errors for critical words.

3.7 Chapter summary

The foregoing chapter illustrated details regarding research methodology, purpose of the research, its design and subsequent implementation. The chapter discussed the series of activities involved in linking theory, research questions, method, and data. The research followed a dynamic process and the same abstained from following a pre-mediated sequential procedure. The study utilized the extant understanding of knowledge constituents in the phenomena of bilingualism in cohesion with research tools and forms of data, specifically used as supportive evidence to the said phenomenon. In the subsequent Chapter, an attempt will be undertaken to take into account the primary empirical evidence that implements the research designs and methods.

4

COMPREHENSION STUDIES: WORD RECOGNITION

This chapter investigates twenty experiments using three different tasks with the primary goal of exploring representation and processing mechanisms in bilingual word recognition.

Main Contents

4.1 Introduction

Understanding what people say and write (i.e., language comprehension) is more complicated than it might at first appear. Comprehending language involves a variety of capacities, skills, processes, knowledge, and dispositions that are used to derive meanings from spoken, written, and sign language. An initial step in understanding any message is the recognition of words and therefore, researchers in cognitive science have a long history of answering questions about the nature of mental processes through the examination of word recognition. In the area of word recognition research, there has been a debate for several decades about how exactly cross-language effects relate to the way words from different languages are stored and processed. In brief, most of the evidence on word recognition studies argued against the idea of separate lexical representations and suggests that lexical access in non-selective with respect to language, i.e., that word representations of both languages become active in parallel during recognition. The present study investigates language comprehension in Bodo−Assamese bilinguals using the priming paradigm. The next section provides a brief overview of the structure of this chapter.

4.2 Chapter Overview

In this chapter, we will investigate cross-language priming effects in visual word recognition using three different tasks: (1) visual lexical decision, (2) semantic categorization, and (3) translation recognition. The chapter will begin by discussing four sets of visual lexical decision experiments which will report the effects of translation priming, cross-language semantic priming, cross-language associative priming and cross-language phonological priming. The next section will discuss two semantic categorization experiments, in order to explore whether the differential sensitivity to priming found for cognate and non-cognate translations in visual lexical decision experiments is also apparent in this task. Finally, we will discuss two translation recognition experiments to examine the nature of the lexico-conceptual links in the bilingual lexicon.

4.3 Visual Lexical Decision

Lexical decision task (LDT) is one of the most frequently used tasks to investigate cross-language priming effect. In this task, a string of letters is presented on a computer screen and the participant has to decide whether the presented letter string is a word or not. Typically the participant presses a "yes" button when the letter string is a real word and a "no" button when it is not and the speed and accuracy of his or her decision is recorded. In psycholinguistic research, the LDT has been extensively used in both monolingual (e.g., Balota, 1994) and bilingual studies to examine lexical access. A visual lexical decision task using a priming paradigm investigates different types of word relation to focus on different kinds of representations and processing in bilingual memory. However, the unmasked priming paradigm has been criticized for inducing strategic factors which may influence the activation of the non-target language (Neely, Keefe, & Ross, 1989). Moreover, according to Grosjean (2001), an unmasked paradigm is equivalent to a bilingual mode which activates both languages of a bilingual to some degree and facilitates cross-language interactions. In order to avoid strategic influences, one of the widely adopted approaches is the masked priming paradigm (Forster & Davis, 1984) which keeps the participants in a strictly monolingual mode.

The present study, therefore, examined the performance of Bodo−Assamese bilinguals when they participated in both unmasked and masked visual lexical decision experiments. This allowed us to investigate the role that priming paradigm plays in cross-language interactions. Priming has been used by presenting a *prime* before a *target* and the prime had different relation with the target. The performance of the participants was then investigated to reveal any benefit in decision that occurs as a function of the prime. The first set of experiments was designed to test for unmasked and masked translation priming. In Experiments 1A and 1C, our aims were twofold: to replicate the L1−L2 translation priming effect, and to show that this effect generalizes to a population of Bodo−Assamese bilinguals. Experiment 1B and 1D then tested the more debated L2−L1 translation priming, using the same stimuli as in Experiment 1A and 1C (reversing translation primes and targets) in the same bilingual population. The next set of experiments (Experiment 2A, 2B, 2C, and 2D) was designed to test for unmasked and masked cross-language semantic priming from L1−L2 and vice-versa, using semantically related primes for the same targets as used in the translation priming experiments. The next set of experiments (Experiment 3A, 3B, 3C, and 3D) was designed to test for unmasked and masked cross-language associative priming in the two directions (L1−L2 and L2−L1) using primes that were not semantically related but had an associative relation with the target. The last set of experiments (Experiment 4A, 4B, 4C, and 4D) was designed to explore the extent to which phonologically related primes influence the processing of targets. A comparison between the four sets of experiments allowed to test whether translation priming, cross-language semantic priming, cross-language associative priming and cross-language phonological priming are all asymmetric to the same extent. Moreover, by using the same target words, we tried to rule out any differences in stimulus which can be a confound of asymmetries observed in priming studies.

4.3.1 Translation Priming

The processing of translations offers important insights on how bilinguals negotiate the representation of words from two languages in one mind and one brain (Dimitropoulou, Duñabeitia, & Carreiras, 2011). Therefore, an experimental procedure often used to examine bilingual lexical processing is the priming paradigm, using translation equivalents as primes and targets. Translation priming effect refers to the finding that bilinguals process a word faster when it is preceded by its translation equivalent in the other language than when it is preceded by an unrelated word in the other language. A number of studies using the unmasked priming paradigm have reported the translation priming effect. Moreover, numerous studies have made use of the masked version of the translation priming paradigm in order to examine how translation pairs are represented and to what extent their conceptual overlap leads to automatic co-activation. Many of these studies with some small variations in the sequence and timing of events have reported the masked translation priming effect. A summary of all the published data from unmasked and masked priming studies (using the lexical decision task and cognate/non-cognate stimuli) has been provided in Table 4.1.

In the translation priming literature, there exists a well-known asymmetry according to which in a lexical decision task, primes in L1 facilitates the decision times on targets in L2. In contrast, when primes are in L2 and targets in L1, this facilitation effect disappears. Evidence in support of this asymmetry comes from a number of unmasked and masked translation priming studies which have observed stronger priming effect in L1−L2 than the reverse. However, these studies have used unbalanced bilinguals, who were less proficient in their L2 than in their L1. The pattern of priming effects was on the other hand, found to be symmetric in some studies which have tested high proficient bilinguals (Basnight-Brown & Altarriba, 2007; Duñabeitia et al., 2010; Duñabeitia et al., 2010). In general, the pattern of effects obtained across different studies indicates that the language background of the participants can be a critical factor driving the pattern of effects. Moreover, what is less clear from the previous studies is whether the observed asymmetry is qualitative (priming exists from L1−L2, but not from L2−L1) or quantitative (priming is stronger from L1−L2 than from L2−L1). Therefore, in order to empirically test the issue of whether L2 age of acquisition and proficiency modulates translation priming effects, we conducted four lexical decision experiments, carefully designed to overcome the limitations previously enumerated. These experiments were performed by three groups Bodo−Assamese bilinguals, in which we compared translation priming for the exact same target words. The findings of the study are discussed in terms of current models of bilingual memory representation and processing.

Table 4.1 Priming Effects on Lexical Decision Reaction Times (in ms) for Published Masked Cross-Language Priming Studies Using Non-Cognate Stimuli (Adapted and Modified from Dimitropoulou et al., 2011)

Study	Language(s)	N	Exp.	Prime	Blank (interval)	Mask (backward)	SOA	L1−L2	L2−L1
De Groot & Nas, 1991	Dutch (L1) – English (L2)	17/19	Exp. 3 & 4	40	20	–	60	35*/40*/22*	–
Gollan, Forster, & Frost, 1997	Hebrew (L1) – English (L2)	40	Exp. 1 & 3	50	–	–	50	36*	9
	English (L2) – Hebrew (L1)	30	Exp 2 & 4	50	–	–	50	52*	−4
Grainger & Frenck-Mestre, 1998	French (L1) – English(L2)	12	Exp. 1	0	–	14	14	–	–4
				14	–	14	28	–	–3
				29	–	14	43	–	2
				43	–	14	57	–	10a
Jiang, 1999	Chinese (L1) – English (L2)	52	Exp. 1	50	–	–	50	45*	13*
		44	Exp. 2	50	–	–	50	68*	3
		16	Exp. 3	50	50	–	100	–	4
		18	Exp. 4 & 5	50	50	150	250	–	7/−2
Jiang & Forster, 2001	Chinese (L1) – English (L2)	18/24	Exp. 3 & 4	50	–	–	50	41*	4
	Chinese (L1) – English (L2)	26	Exp. 1	50	50	150	250	–	8
Kim & Davis, 2003	Korean (L1) – English (L2)	25	Exp. 1	50	–	–	50	40*	–
Finkbeiner, Forster, Nicol, & Nakamura, 2004	Japanese (L1) – English (L2)	18	Exp. 2	50	–	150	200	–	−4
Voga & Grainger, 2007	Greek (L1) – English (L2)	30	Exp. 2	50	–	–	50	23*	–
Basnight-Brown & Altarriba, 2007	Spanish (L1) – English (L2)	26	Exp. 2	100	–	–	100	33*	24*
Schoonbaert, 2008	Dutch (L1) – English (L2)	20	Exp. 1 & 2	50	50	150	250	90*	21*
Duyck&Warlop, 2009	Dutch (L1) – French (L2)			56	–	56	112	48	26
Duñabeitia et al., 2010	Basque (L1) – Spanish (L2)			50	–	–	50	16	20
Dimitropoulou, Duñabeitia & Carreiras, 2011	Greek (L1) – English (L2)	36	Exp. 1	50	–	–	50	29	−4

4.3.1.1 The Present Study

The present study is a replication of the pilot study. However, an attempt has been made to improve the methodology. For example, the unmasked lexical decision experiments of the pilot study contained a long SOA of 400 ms, which may have allowed strategic processes to be utilized. In addition, the experiment did not control for word type. In the present set of experiments, an attempt has been made to use a well-constrained design by using word stimuli that were well-controlled for SOA (short SOA of 100 ms) and word type (cognates vs. non-cognates). In four priming experiments, Bodo−Assamese bilinguals made lexical decision to Bodo and Assamese word targets which were primed by Assamese and Bodo translation equivalent primes. The purpose of these experiments was to determine how words in each language of a bilingual are represented and processed in memory.

4.3.1.2 Unmasked Translation Priming from L1−L2 (Experiment 1A)

Experiment 1A of the present study consisted of unmasked translation priming paradigm in which Bodo−Assamese bilinguals were presented with translation word pairs in the L1−L2 direction.

***4.3.1.2.1** Method*

Participants. A total of fifty-one participants took part in this and the rest of the translation priming experiments. Participants ranged in age from 23 to 40 years (mean age = 33.7 years, *SD* = 4.6). All of the bilinguals who were included in this and the subsequent experiments were native speakers of Bodo (L1) and spoke Assamese as a second language (L2). Each participant completed a language background questionnaire in which they rated their abilities in speaking, reading, writing and comprehension in both languages. They also rated their age of acquisition and daily usage in both languages. Table 4.2 shows the language background data reported for three groups of bilinguals.

Table 4.2 Self-report Ratings in Bodo and Assamese for All Three Bilingual Groups in Experiment 1A

	Bodo (L1)			Assamese (L2)		
	Early (*n* = 21)	Late High (*n* = 14)	Late low (*n* = 16)	Early (*n* = 21)	Late High (*n* = 14)	Late Low (*n* = 16)
Age of acquisition (years)	2.5	2	2	3.2	8.5	9
Mean daily usage (%)	50.6 %	49.2 %	49.8 %	35.8 %	29.1%	18%
Self-ratings (7 point scale)						
Speaking	6.3 (*1.0*)	7 (*0*)	6.5 (*0.7*)	6.7 (*0.8*)	6.5 (*0.7*)	4 (*0*)
Reading	6.5 (*0.8*)	7 (*0*)	7 (*0*)	6.5 (*0.8*)	6.3 (*0.7*)	4.5 (*0.7*)
Writing	6.3 (*0.8*)	7 (*0*)	6.5 (*0.7*)	5.3 (*2.6*)	4.1 (*0.7*)	3 (*0*)
Comprehension	5.5 (*1.4*)	7 (*0*)	5.5 (*2.1*)	5.5 (*2.6*)	4.5 (*1.4*)	1 (*0*)

The results of the self-report ratings show that the Bodo ratings of the three groups of bilinguals on all four proficiency measures are similar. However, the Assamese ratings on all four proficiency measures are higher for the high proficient groups than for the low proficient group. In order to further assess the proficiency levels of the bilinguals, all participants took part in an objective naming test. Table 4.3 provides the mean scores on the objective naming test in both Bodo and Assamese.

Table 4.3 Mean Scores on the Objective Naming Test in Bodo and Assamese for All Three Bilingual Groups in Experiment 1A

Bilingual Group	Bodo	Assamese
Early High Proficient	53.2	48.2
Late High Proficient	54.1	47.3
Late Low Proficient	52.2	38.3

The results of the Objective Naming Test show that the average L1 score for all three bilingual groups is similar. In case of L2, the average score for the Late High Proficient group matches the average score for the Early High Proficient group (47.3 vs. 48.2 respectively) and the scores do not yield a significant difference [$t(48) = 1.16$, $p = .823$]. This indicates that the proficiency level of the two groups is similar. However, the average score of the Late High Proficient group is noticeably higher than the average score of the Late Low Proficient group (47.3 vs. 38.3) and the scores yield a significant difference [$t(48) = 10.66$, $p = .000$].

Stimuli. Eighty Bodo words were used as primes and eighty Assamese words were used as targets. The critical stimuli consisted of forty cognate translation equivalents and forty non-cognate translation equivalents. Word length (i.e., the number of letters) for the Assamese targets was matched for the cognate and non-cognate priming conditions.

The translation equivalents used in this and the other translation priming experiments were originally selected in a norming experiment by ten participants (who did not take part in this experiment) as the most common translations in the dialect of the bilinguals (see Appendix E (i) and Appendix G for full description of material). In addition to word targets, eighty pronounceable nonword targets were created manually by changing one letter in the respective Assamese targets. Table 4.4 provides an example of a stimulus set.

Table 4.4 Examples of a Stimulus Set Used in Experiment 1A

	Cognate		Non-cognate	
Prime Type	Word	Nonword	Word	Nonword
Translation	फिथा–পিঠা *'pancake'*	फिथा–বিঠা	उदै–পেত *'stomach–stomach'*	उदै–ঘেত
Control	सानजा–পিঠা *'east–pancake'*	सानजा–বিঠা	राव–পেত *'language–stomach'*	राव–ঘেত

Note. फिथा [phitha]; পিঠা [pitha]; सानजा [sanza]; বিঠা [bitha]; उदै [udwi]; পেত [pet]; राव [rau]; ঘেত [ghet]

Procedure. Participants were tested individually in a quiet room. Verbal and written instructions about the task were given in Assamese before the experiment proper. Each trial began with the presentation of a fixation "+" (plus sign) for 500 ms in the center of the screen. This was followed by a prime word in Bodo which appeared for 100 ms and was then immediately replaced by an Assamese target word (or nonword). The target remained on the screen until the participants responded or for a maximum of 2,000 ms (see Figure 4.2). Participants were instructed to press the "m" key on the keyboard with their right index finger if the target letter string was a real word and the "z" key with their left index finger if a nonword appeared. They were told to respond as quickly and as accurately as possible. There were fifteen practice trials before the main trial.

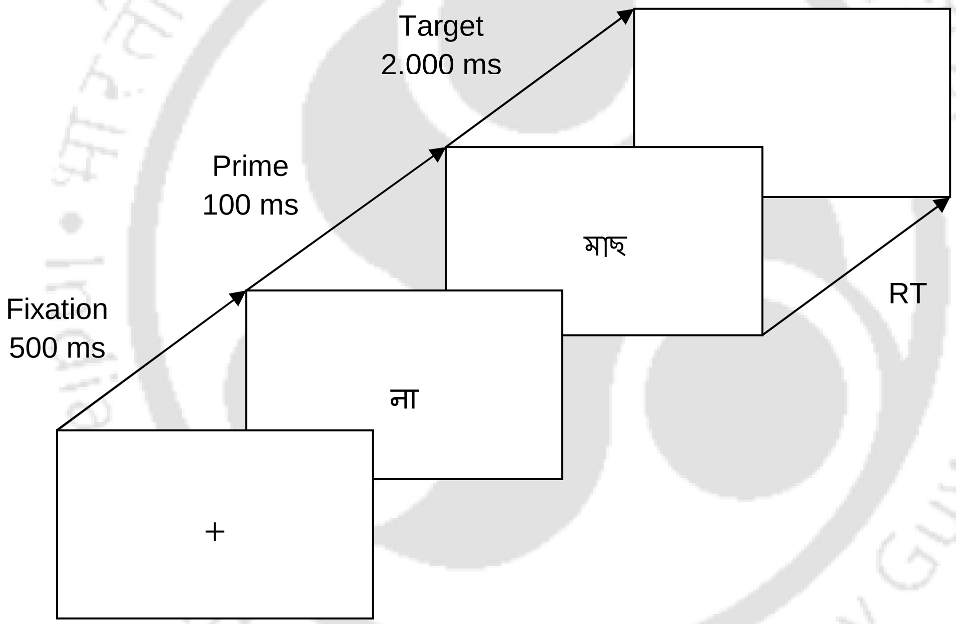


Figure 4.1 A schematic illustration of the procedure adopted for Experiment 1A. This illustration depicts the sequence of events for each trial. Words ना [na] and মাছ [mas] *'fish'* represent a prime-target pair that are translation equivalents.

4.3.1.2.2 Results

A mixed-effects analysis was conducted on the reaction time data and error data separately. The analysis conducted on the reaction time data did not reveal a main effect of Prime Type [$F(1,155) = 1.953$, $p = .164$]. Translation (879 ms) and control (860) word pairs were responded similarly. The main effect of Cognate Status also did not approach significance [$F(1,152) = 1.042$, $p = .309$]. Cognate words (877 ms) and non-cognate words (863 ms) had similar reaction times. The mean reaction times and percentage of error for each of the prime-target condition are presented in Table 4.5.

Table 4.5 Mean RTs (ms) and Percentage of Errors for Cognate and Non-Cognate Targets Primed by Translation Equivalents and by Unrelated Control Primes in Experiment 1A

		Cognate Status		
	Overall	Cognate	Non-cognate	
Prime Type	RT (Error %)	RT (Error %)	RT (Error %)	**Cognate effect**
Translation	876 (5.5)	882 (3.9)	876 (6.8)	**−6**
Control	860 (17.2)	871 (18.1)	849 (16.4)	**−22**
Priming	**−16**	**−11**	**−27**	

There was a significant interaction between Prime Type and Bilingual Group [$F(2,6860) = 54.811$, $p = .000$]. This finding suggests that Early High Proficient and Late High Proficient bilinguals were significantly faster to respond to translation word pairs than to control ones when the target words were cognates. Another interesting finding is the significant interaction between Cognate Status and Bilingual Group [$F(2,6844) = 8.362$, $p = .000$], suggesting that a cognate facilitation effect of 34 ms was obtained only for the Late High Proficient bilinguals. Finally, a significant three-way interaction was also observed [$F(2,6844) = 9.091$, $p = .000$].

Planned comparisons performed on the individual priming effects for the three groups of bilinguals revealed significant magnitudes of facilitation for only high proficient bilinguals. Significant translation priming effects of 31 ms and 46 ms were obtained in the cognate condition for Early High Proficient and Late High Proficient bilinguals respectively, indicating a cognate priming advantage. The mean reaction times and percentage of errors as a function of Prime Type, Cognate Status, and Bilingual Group are presented in Table 4.6.

Table 4.6 Mean RTs (ms) and Percentage of Errors for Cognate and Non-Cognate Targets Primed by Translation Equivalents and by Unrelated Control Primes for All Three Bilingual Groups in Experiment 1A

	Cognate Status/Bilingual Group					
	Cognate			Non-cognate		
	Early	Late high	Late low	Early	Late high	Late low
Prime Type	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)
Translation	871 (1.3)	844 (9.3)	932 (4)	864 (3.6)	878 (13.1)	887 (7.2)
Control	902 (3.3)	890 (10.5)	822 (5.6)	860 (1.2)	874 (10.7)	815 (5.3)
Priming	**31**	**46**	**−110**	**−4**	**−4**	**−72**

Results of the error data revealed a significant main effect of Prime Type [$F(1,155) = 6.523$, $p = .001$]. Targets were responded to more accurately when they were primed by translation primes (5.5%) as compared to when they were primed by unrelated controls (17.2%). The error data did not reveal a main effect of Cognate Status [$F < 1$]. However, the main effect of Bilingual Group approached significance in the error analysis [$F(2,6860) = 5.326$, $p = .005$]. Fewer errors were observed for the Early High Proficient bilinguals and greater errors were observed for the Late High Proficient bilinguals. Lastly, comparisons of the nonword data were conducted. Analyses of the mean reaction times to nonwords showed that the participants took significantly longer to respond to nonwords (939 ms) than to words (882 ms).

4.3.1.2.3 Discussion

The data from Experiment 1A showed clear priming for cognate translations and no priming for non-cognates when measured against unrelated controls. Robust translation priming effects were observed in case of Early High Proficient and Late High Proficient Bodo−Assamese bilinguals only in the cognate condition which indicates the use of different processing mechanisms by High and Low Proficient bilinguals. This confirms to the predictions of the RHM. Moreover, significantly shorter RTs were observed in the cognate condition than in the non-cognate condition which strongly indicates the processing advantage of cognates over non-cognates.

4.3.1.3 Unmasked Translation Priming from L2−L1 (Experiment 1B)

In Experiment 1B, the same predictions as in Experiment 1A were tested in an unmasked translation priming paradigm with the same participants in the backward direction (L2−L1). Cognate status of the target was manipulated, with half of the targets being cognate words and the other half being non-cognate words.

4.3.1.3.1 *Method*

Participants. The participants were the same Bodo−Assamese bilinguals who took part in Experiment 1A.

Stimuli. The eighty Assamese targets and their respective Bodo translation primes of Experiment 1A were used again, but now, respectively, as Assamese (L2) primes and corresponding Bodo (L1) word targets (see Appendix G).

Procedure. The design and procedure of the present experiment was identical to those of Experiment 1A with only the languages of prime and targets reversed. Verbal and written instructions about the task were given in Bodo before the experiment proper.

4.3.1.3.2 Results

Similar to Experiment 1A, a mixed-effects analysis was conducted on the reaction time data and error data separately. The analysis of the reaction time data showed that there was no significant effect of Prime Type [$F < 1$]. Responses to targets primed by translation equivalents (799 ms) and by control primes (802 ms) were similar. In terms of Cognate Status, the main effect was significant [$F(1,152) = 13.627$, $p = .000$]. However, this effect was inhibitive rather than facilitative, as non-cognate targets (780 ms) were processed faster than cognate targets (822 ms). Table 4.7 presents the mean reaction times and percentage of errors by Prime Type and Cognate Status.

Table 4.7 Mean RTs (ms) and Percentage of Errors for Cognate and Non-Cognate Targets Primed by Translation Equivalents and by Unrelated Control Primes in Experiment 1B

		Cognate Status		
	Overall	Cognate	Non-cognate	
Prime Type	RT (Error %)	RT (Error %)	RT (Error %)	**Cognate effect**
Translation	799 (5.6)	816 (6.9)	782 (4.5)	**−34**
Control	802 (10.6)	828 (13.2)	777 (8.3)	**−51**
Priming	**3**	**12**	**−5**	

There was a marginal effect of Bilingual Group [$F(2,48) = 4.242$, $p = .020$]. In addition, the interaction between Prime Type and Bilingual Group was significant [$F(2,7183) = 53.010$, $p = .000$], indicating that priming effects were observed only for Early High Proficient and Late High Proficient bilinguals in both cognate and non-cognate conditions. Moreover, there was also a significant interaction between Cognate Status and Bilingual Group [$F(2,7182) = 9.342$, $p = .000$].

To examine the effect of Bilingual Group on the pattern of translation priming effects, planned comparisons were carried out on the reaction time data. The results of the individual priming effects for the three groups of bilinguals revealed that low proficient bilinguals were faster than high proficient bilinguals for response latencies. The most important results were that only high proficient bilinguals produced significantly larger translation priming effects (Early = 19/4 ms, Late = 41/35 ms) in both cognate and non-cognate conditions. The mean reaction times and percentage of errors are presented in Table 4.8 by Prime Type, Cognate Status, and Bilingual Group.

Table 4.8 Mean RTs (ms) and Percentage of Errors for Cognate and Non-Cognate Targets Primed by Translation Equivalents and by Unrelated Control Primes for All Three Bilingual Groups in Experiment 1B

	Cognate Status/Bilingual Group					
	Cognate			Non-cognate		
	Early	Late high	Late low	Early	Late high	Late low
Prime Type	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)
Translation	834 (1.9)	823 (5.3)	791 (18.7)	816 (1.2)	775 (0)	757 (15.7)
Control	853 (5.3)	864 (11.8)	767 (30.7)	820 (1.8)	810 (7.1)	701 (22.9)
Priming	**19**	**41**	**−24**	**4**	**35**	**−56**

In the mixed-effects analysis on mean error percentages, the main effect of Prime Type tended towards significance [$F(1,155) = 4.341$, $p = .001$]. Participants recognized Bodo targets preceded by Assamese translation primes (5.6 %) more accurately than those preceded by Assamese unrelated controls (10.6 %). The main effect of Cognate Status was not significant, and neither was the interaction between Prime Type and Cognate Status [all Fs < 1]. The main effect of Bilingual Group approached significance in the error analysis [$F(2,6860) = 5.463$, $p = .001$]. Fewer errors were observed for the Early High Proficient bilinguals and greater errors were observed for the Late Low Proficient bilinguals. Lastly, comparison of the nonword data was conducted. Analyses of the mean reaction times to nonwords showed that the participants took significantly longer to respond to nonwords (934 ms) than to words (804 ms).

4.3.1.3.3 *Discussion*

Experiment 1B showed significant translation priming. Moreover, unlike Experiment 1A, Experiment 1B showed significant translation priming for both cognates and non-cognates only in case of high proficient bilinguals. This finding poses question for previous studies which have observed null or very small priming effects in the L2−L1 direction.

4.3.1.3.4 *Combined Analysis of Experiment 1A and 1B*

In order to examine asymmetry often observed in translation priming studies, we analyzed the data from Experiments 1A and 1B in one design. A mixed-effects analysis was run with Target Language (Assamese vs. Bodo) as an additional factor, again treating mean RT on correct trials as the dependent variable. As expected, there was a significant main effect of Target Language, indicating that Bodo targets (792 ms) were responded to faster than Assamese targets (889 ms). This 97 ms difference was significant [$F(1,14228) = 1178.00$, $p = .000$]. The interaction between Bilingual Group and Target Language also approached significance [$F(2,14224) = 253.951$, $p = .000$]. This interaction is shown in Figure 4.3. The Prime Type and Target Language interaction was also significant [$F(1,14233) = 5.622$, $p = .018$]. Another interesting observation was the interaction between Cognate Status and Target Language [$F(1,14225) = 23.669$, $p = .000$]. A significant interaction was also observed between Prime Type, Bilingual Group and Target Language [$F(2,14227) = 13.093$, $p = .000$]. The three-way interaction between Cognate Status, Bilingual Group and Target Language was also significant [$F(2,14220) = 11.054$, $p = .000$].

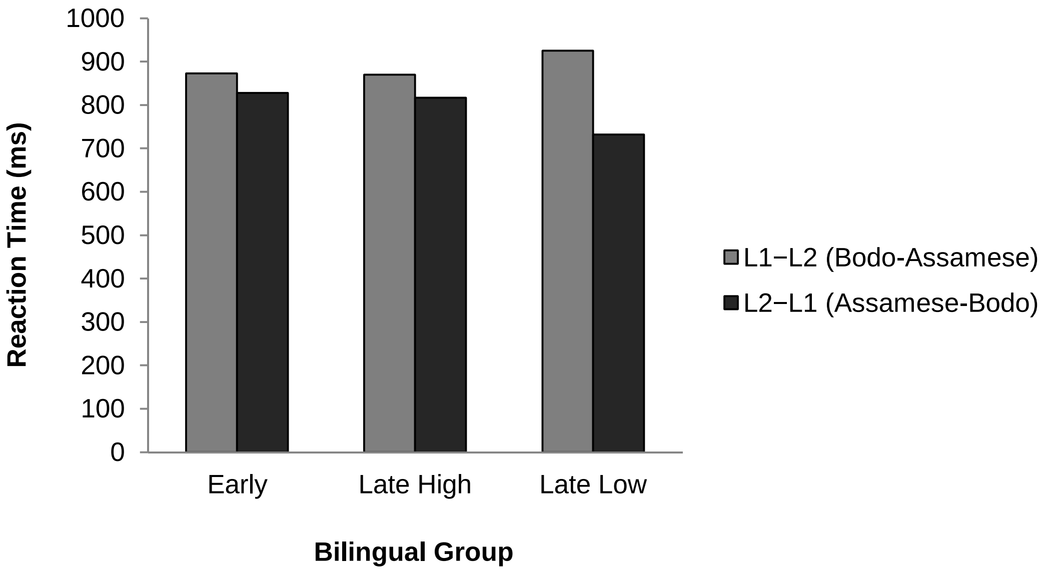


Figure 4.2 Mean RTs (ms) as a function of Bilingual Group and Target Language in Experiment 1A and 1B.

4.3.1.4 Masked Translation Priming from L1−L2 (Experiment 1C)

The purpose of Experiment 1C was to investigate whether translation priming effect is strategic or automatic by using a masked priming paradigm in which the visibility of the prime word is minimized. This paradigm combined with the same experimental constraints as those in Experiment 1A would show that any priming effects are the result of unconscious, automatic cognitive processes.

4.3.1.4.1 *Method*

Participants. The participants in this experiment were the same bilinguals who participated in Experiment 1A and 1B.

Stimuli. The materials used in this experiment were identical to those used in Experiment 1A.

Procedure. The experiment was conducted in the same manner as in Experiment 1A. The only difference in this experiment was that a forward mask was added to each experimental trial. Therefore, each trial consisted of the following sequence: first, the participant was presented with a row of ten hash marks (##########) for 500 ms which was immediately followed by a 50 ms prime word. The target word or nonword then replaced the prime word and remained on the screen until the participants responded or for a maximum of 2,000 ms (see Figure 4.4). The participants were instructed to press the "m" key on the keyboard with their right index finger if the target letter string was a real word and the "z" key with their left index finger if a nonword appeared. The participants were told to respond as quickly and as accurately as possible.

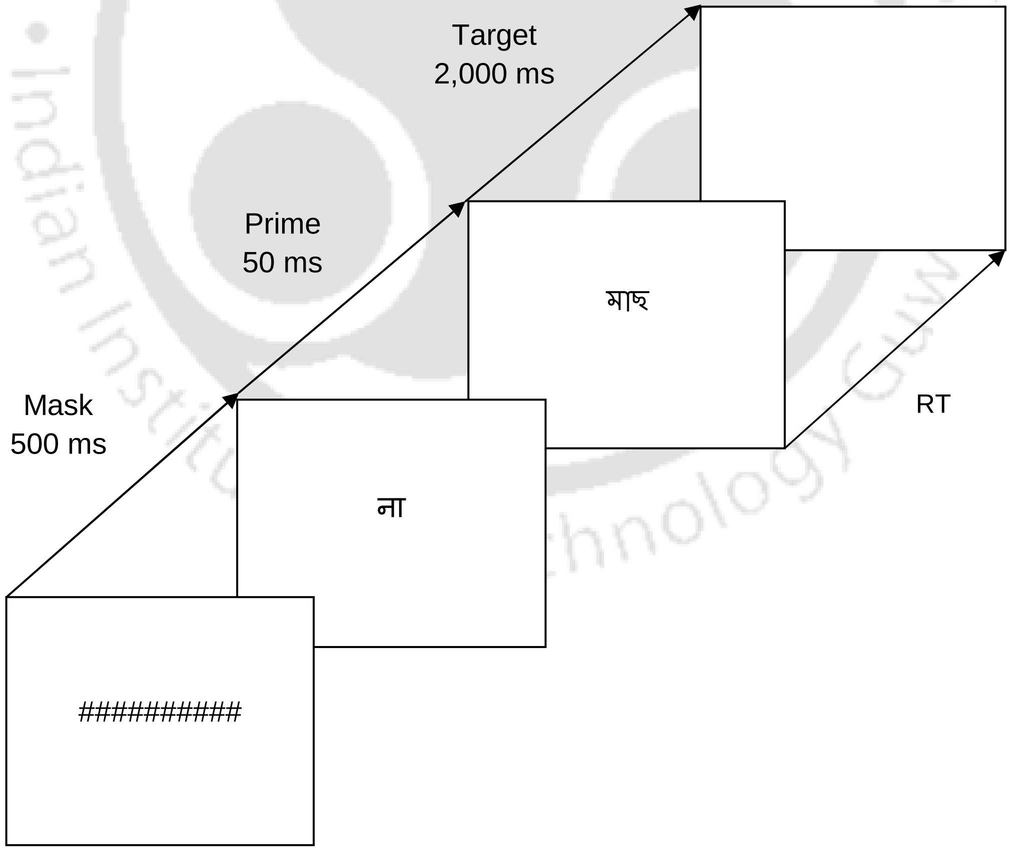


Figure 4.3 A schematic illustration of the procedure adopted for Experiment 1C.

4.3.1.4.2 Results

A mixed-effects analysis was run on the reaction time data and error data separately. Analysis on the reaction time data revealed a significant main effect of Prime Type [$F(1,142) = 18.481$, $p = .000$]. Bilinguals were significantly faster to respond to control (847 ms) word pairs than to translation (932 ms) word pairs which indicated that the effects were inhibitive rather than facilitative. The main effect of Cognate Status did not approach significance [$F(1,151) = 2.479$, $p = .117$]. Although cognates (905 ms) were responded to slowly than non-cognates (874 ms), this 31 ms difference was not significant. However, a main effect of Bilingual Group was observed [$F(2,47) = 16.126$, $p = .000$]. A significant interaction was also observed between Prime Type and Bilingual Group [$F(2,7299) = 50.543$, $p = .000$]. Another significant interaction was observed between Cognate Status and Bilingual Group [$F(2,7299) = 42.393$, $p = .000$], as revealed by the significant cognate effect (57 ms) observed for the Late High Proficient group. Mean reaction times and percentage of errors are presented in Table 4.9 by Prime Type and Cognate Status.

Table 4.9 Mean RTs (ms) and Percentage of Errors for Cognate and Non-Cognate Targets Primed by Translation Equivalents and by Unrelated Control Primes in Experiment 1C

		Cognate Status		
	Overall	Cognate	Non-cognate	
Prime Type	RT (Error %)	RT (Error %)	RT (Error %)	**Cognate effect**
Translation	932 (7.6)	933 (8.9)	932 (6.4)	**−1**
Control	847 (6)	877 (7.1)	816 (5)	**−61**
Priming	**−85**	**−56**	**−116**	

To examine the effect of Bilingual Group on the pattern of translation priming effects, planned comparisons were carried out on the reaction time data. The results of the individual priming effects for the three groups of bilinguals revealed no facilitation in any of the conditions for all three groups of bilinguals. The only exception was observed in the case of Late High Proficient bilinguals where no interference was observed and a very small insignificant facilitation of only 2 ms was present in the cognate condition. Moreover, greater inhibition was observed in case of non-cognates than cognates. Table 4.10 presents the mean reaction times and percentage of errors as a function of Prime Type, Cognate Status, and Bilingual Group.

Table 4.10 Mean RTs (ms) and Percentage of Errors for Cognate and Non-Cognate Targets Primed by Translation Equivalents and by Unrelated Control Primes for All Three Bilingual Groups in Experiment 1C

	Cognate Status/Bilingual Group					
	Cognate			Non-cognate		
	Early	Late high	Late low	Early	Late high	Late low
Prime Type	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)
Translation	972 (5.7)	766 (6.6)	1061 (21.1)	957 (6.3)	823 (3.7)	1015 (9.5)
Control	912 (4.8)	768 (10.7)	950 (10.5)	856 (3.9)	756 (2.4)	837 (10.7)
Priming	**−60**	**2**	**−111**	**−101**	**−67**	**−178**

The mixed-effects analysis of the error data did not reveal a main effect of Prime Type [$F < 1$]. The main effect of Cognate Status was marginal [$F(1,151) = 2.479$, $p = .034$], indicating that participants made more errors to cognate targets than to non-cognate targets. The main effect of Bilingual Group was significant [$F(2,47) = 8.119$, $p = .000$]. Errors were numerous more the low proficient group than the high proficient groups. All other interactions were not significant [all Fs < 1]. As in Experiment 1A, comparison of the nonword data was conducted. Analyses of the mean reaction times to the nonwords showed that the participants responded significantly more quickly to words (884 ms) than to nonwords (1065 ms).

4.3.1.4.3 Discussion

In this experiment, we investigated masked priming using translation pairs as prime and target. The results of the analyses revealed that when a forward mask preceded the prime, word processing is slowed down in case where the target word is primed by a translation prime than in case when it is preceded by an unrelated prime. This indicates that masked translation priming, in general, is inhibitive.

The pattern of results of our study however contradicts the findings of previous studies, in which robust masked facilitative translation priming effects were observed at different SOAs. The findings of our study suggest that some semantic or conceptual component at some level was sensitive to the forward mask, allowing it to influence processing.

4.3.1.5 Masked Translation Priming from L2−L1 (Experiment 1D)

In order to explore the asymmetry often observed in previous masked translation priming experiments, Experiment 1D was designed to investigate translation priming using a masked paradigm in the L2−L1 direction.

4.3.1.5.1 Method

Participants. The same fifty-one Bodo−Assamese bilinguals who took part in the previous translation priming experiments participated in this experiment.

Stimuli. The stimuli used were identical to those in the previous experiments.

Procedure. The procedure of Experiment 1C was followed except that in this experiment, participants were asked to make lexical decisions to Bodo target words primed by Assamese words. Verbal and written instructions were provided in their native language, Bodo.

4.3.1.5.2 Results

A mixed-effects analysis of the reaction time data showed a main effect of Prime Type [$F(1,154) = 5.904$, $p = .016$], indicating that control words (807 ms) were responded to faster than translation words (844 ms). The main effect of Cognate Status approached significance [$F(1,154) = 9.112$, $p = .003$]. A significant main effect of Bilingual Group was also observed [$F(2,48) = 7.592$, $p = .001$]. The Prime Type and Bilingual Group interaction approached significance [$F(2,7895) = 34.341$, $p = .000$]. Another significant interaction was observed between Cognate Status and Bilingual Group [$F(2,7891) = 12.201$, $p = .000$]. The mean reaction times and percentage of errors are provided in Table 4.11 as a function of Prime Type and Cognate Status.

Table 4.11 Mean RTs (ms) and Percentage of Errors for Cognate and Non-Cognate Targets Primed by Translation Equivalents and by Unrelated Control Primes in Experiment 1D

		Cognate Status		
	Overall	Cognate	Non-cognate	
Prime Type	RT (Error %)	RT (Error %)	RT (Error %)	**Cognate effect**
Translation	844 (4.4)	863 (7.2)	825 (1.8)	**−38**
Control	807 (4.1)	834 (6.6)	781 (1.8)	**−53**
Priming	**−37**	**−29**	**−44**	

To examine the effect of Bilingual Group on the pattern of translation priming effects, planned comparisons were carried out on the reaction time data. The results of the individual priming effects for the three groups of bilinguals revealed no facilitation in any of the conditions for all three groups of bilinguals. Moreover, greater inhibition was observed in case of low proficient than for high proficient bilinguals. Table 4.12 presents the mean reaction times and percentage of errors as a function of Prime Type, Cognate Status, and Bilingual Group.

Table 4.12 Mean RTs (ms) and Percentage of Errors for Cognate and Non-Cognate Targets Primed by Translation Equivalents and by Unrelated Control Primes for All Three Bilingual Groups in Experiment 1D

	Cognate Status/Bilingual Group					
	Cognate			Non-cognate		
	Early	Late high	Late low	Early	Late high	Late low
Prime Type	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)
Translation	857 (5.9)	888 (9.2)	844 (8)	842 (1.8)	831 (2.4)	802 (1.2)
Control	853 (5.3)	878 (6.6)	770 (9.3)	819 (1.8)	803 (2.4)	721 (1.2)
Priming	**−4**	**−10**	**−74**	**−23**	**−28**	**−81**

A mixed-effects analysis of the error data did not reveal any main effects [*F*s < 1]. As in the previous experiments, post hoc comparisons of the nonword data were conducted. Analyses of the mean reaction times to the nonwords showed that the participants responded significantly more quickly to words (818 ms) than to nonwords (1017 ms).

4.3.1.5.3 Discussion

The results of Experiment 1D revealed that, in accordance with Experiment 1C, translation priming was absent in the masked design. The results of the study are consistent with the findings of some studies demonstrating null or weak masked priming effects in the L2−L1 direction. However, it refutes findings of other studies in which robust masked translation priming has been observed when the direction was from L2−L1.

4.3.1.5.4 Combined Analysis of Experiment 1C and 1D

To test for differences between translation priming in both directions, we analyzed the data from Experiment 1C and 1D in one design using a mixed-effects analysis. As in unmasked translation priming (Experiment 1A and 1B), the main effect of Target Language was significant [$F(1,15489) = 376.048$, $p = .000$]. Responses to L1 targets (822 ms) were faster than to L2 targets (880 ms). This 58 ms effect was significant. A significant interaction was observed between Bilingual Group and Target Language [$F(2,15429) = 461.959$, $p = .000$]. This interaction is shown in Figure 4.5. The interaction between Prime Type and Target Language approached significance [$F(1,15469) = 77.430$, $p = .000$]. The Cognate Status and Target Language interaction was also significant [$F(1,15441) = 13.850$, $p = .000$]. The three-way interaction between Prime Type, Bilingual Group and Target Language approached significance [$F(2,15379) = 6.069$, $p = .002$]. Another significant three-way interaction was observed between Cognate Status, Bilingual Group and Target Language [$F(2,15378) = 37.636$, $p = .000$].

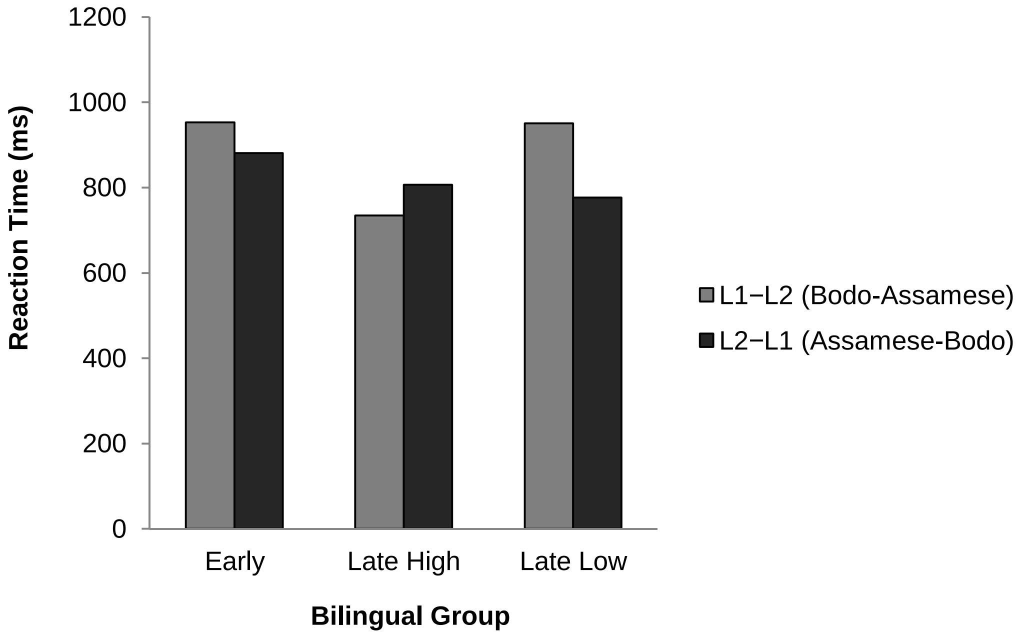


Figure 4.4 Mean RTs (ms) as a function of Bilingual Group and Target Language in Experiment 1C and 1D.

4.3.1.6 General Discussion

The aim of the present study was to gain insight into the way in which Bodo–Assamese bilinguals represent and process their two languages in memory. A lexical decision task involving a priming paradigm was used to examine how words from the two languages that are translation equivalents of each other would be recognized under unmasked and masked conditions. In Experiments 1A and 1B, the participants were presented with cross-script translation word pairs in an unmasked lexical decision task. The results revealed significant translation priming in both language directions but only for the high proficient bilinguals. In Experiment 1C and 1D, a masked translation priming study was conducted on the same group of Bodo–Assamese bilinguals as those in Experiment 1A and 1B. The results from the masked priming experiments revealed inhibitive translation priming effects in both language directions. This finding deviates from the results reported in previous studies where robust facilitative masked translation priming has been found in both L1−L2 and L2−L1 direction, for both same-script and different-script bilinguals. Since no such result has been reported in the literature before for the same task, the explanations attempted here will be rather speculative. In the next section we discuss at least two reasons that can be referred to as possible sources of this deviation: priming paradigm and SOA.

One of the manipulations of our study was the priming paradigm of the experiment. The results yielded by the four experiments conducted so far revealed different results for the unmasked and masked paradigms— significant priming was evident only in the unmasked paradigm. In the unmasked paradigm, the nature of the experimental task required that both languages were active. For that reason, if priming took place in one language, and the target was presented in the other language, there was direct lexical input from both languages during the experiment. So, in a sense, there was no reason to deactivate one of the languages even if selective activation was possible. This is in line with the suggestions put forward by Grosjean (1997a, 1998a) and Li (1996) that when both languages of a bilingual are simultaneously active, selective activation is less plausible. On the other hand, in the masked paradigm, although input from the other language was presented for a very brief period of time (50 ms), the participants were not aware of it. Thus, the nature of the experimental task required only the target language to be active. This aspect of our result is in line with the predictions of Grosjean (1997a) that both lexicons can be active at the same time when there is lexical input from both languages. However, they do not demonstrate that both lexicons are active at the same time when there is no external activation of the second language.

Another manipulation of our study was the cognate status of the word. It has been shown in several studies that cognates are responded to faster than non-cognates, an effect known as cognate facilitation effect. Although the pattern of results of our study did not show cognate facilitation effect, it did show a healthy trend of cognate priming advantage. That is, cognates produced larger and more stable translation priming effects than non-cognates. The results of our study revealed translation priming effect in unmasked paradigm for cognates. However, for non-cognates, the translation priming effect was either absent or weak. This finding conforms to the previous studies by De Groot and Nas (1991), Gollan et al. (1997) and Sánchez-Casas et al. (1992), in which stronger effects of cognate translations were observed compared to non-cognate translations. The cognate priming advantage can be interpreted as a combination of meaning and form priming effects—since cognates share both meaning and phonology with the target word, it can facilitate target processing via the partial activation of the target word's meaning representation during prime processing, as well as via activation of form representations (e.g. phonemes) shared by prime and target. As a result, this form-based facilitation can add to top-down semantic facilitation to increase translation priming effects with cognates in the lexical decision task.

Another interesting finding of our study is the observed differences in the results of the three groups of bilinguals—translation priming effects were observed only in case of Early High Proficient and Late High Proficient Bodo−Assamese bilinguals. It has been suggested in the past that translation priming occurs because such pairs are connected at the lexical level and that semantics and conceptual representations are not activated when translation equivalents are processed (De Groot & Nas, 1991;

Kroll and Stewart, 1994). Moreover, following the predictions of the RHM, the low proficient bilinguals were assumed to have especially strong translation priming from L2−L1 as a consequence of the relatively strong lexical connections in this direction. However, the finding of our study refutes the role of direct connections between the translation pairs' lexical representation in the translation process. One possible explanation as to why translation priming was observed in high proficient bilinguals may be due to semantic feature overlap, which has also been suggested by De Groot and Nas (1991). Whereas semantic and translation word pairs are linked in a similar manner at the lexical level, translations may be different in that they have increased overlap at the conceptual level. Therefore, the translation priming effects observed with the high proficient bilinguals tested in the present experiment are mediated by semantic representations shared by translation equivalents and not by excitatory connections between distinct form representations (e.g., whole-word orthographic representations) in memory. This finding refutes Grainger and Jacob's (1996) argument that the lexical decision task can be successfully performed by monitoring activity in whole-word orthographic representations. To conclude, we attempted to examine lexical representation and processing in Bodo–Assamese bilinguals, using unmasked and masked translation priming paradigms in the present study. The present findings revealed that proficiency rather than age of acquisition in a bilingual's two languages can influence how words are represented and processed in memory. Moreover, the priming paradigm in which the words are presented has a larger impact on the processing of words. In the next section, we investigate one of the most studied effects in psycholinguistics—the so called "semantic priming effect". After a brief survey of the literature, four lexical decision experiments are presented which examines the connections between lexical entries in the mental lexicon.

4.3.2 Semantic Priming

The discussion that a prime word facilitates the subsequent pronunciation or identification of a related target word has been a subject of controversy (Shelton and

Martin, 1992; McRae and Boisvert, 1996). Initially, different researchers have described the effect in different ways. For example, Meyer and Schvaneveldt (1971) described the it as an "effect of association", whereas Neely (1977) described it as a "semantic facilitation effect". Thompson-Schill et al. (1998) puts it as:

> Associative relatedness is a normative description of the probability that one word will call to mind a second word (e.g., Postman and Keppel, 1970). Associative relations are assumed to reflect word use rather than word meaning (e.g., "needle-thread," "spider-web"). The source of these associations might be temporal contiguity in verbal or written language (Plaut, 1995) or co-occurrence with propositions (McNamara, 1992). On the other hand, semantic relatedness reflects the similarity in meaning or the overlap in featural descriptions of two words (e.g., "whale-dolphin," "duck-chicken"). Although the degree of associative relatedness and semantic relatedness between two words often vary together, it is possible for words to be either highly associated yet semantically dissimilar (e.g., "coat-rack") or weakly associated yet semantically similar (e.g., "radish-beet"). (p. 440)

Therefore, in the present study, we investigated these two relations separately (see section 4.3.3 for associative priming). The semantic priming technique is plausibly the most frequently used technique in monolingual and bilingual psycholinguistic studies. In these studies, a target word is preceded by a semantically related prime word, an unrelated prime word, or a "neutral" prime, and the effect of the prime on target processing is measured. The semantic priming effect is the finding that a target preceded by a semantically related prime is responded to faster than a target preceded by an unrelated or neutral prime. In the masked version, the prime word is visually degraded (e.g., by presenting it very briefly or interspersed between two noise signals) in order to prevent conscious perception of the prime (De, Groot, 2011).

The semantic priming effect was first reported by Meyer and Schvaneveldt (1971) and has been a standard finding in monolingual studies of word recognition (e.g., Bleasdale, 1987; Ferrand & New, 2003; Neely, Keefe, & Ross, 1989; Perea & Rosa, 2002; and see Hutchison, 2003; Lucas, 2000; and Neely, 1991, for reviews). In the bilingual domain, cross-language semantic priming has been found by in a number of studies using unmasked lexical decision task (e.g., Keatley et al., 1994; Altarriba, 1992; De Groot & Nas, 1991; Jin, 1990; Chen & Ng,1989; Schwanenflugel & Rey, 1986), as well as masked priming paradigm (De Groot & Nas, 1991; Duyck, 2005; Basnight-Brown & Altaribba, 2007). However, a similar asymmetry like translation priming is often observed with this other variant of cross-language priming—semantic priming effects are generally larger when the primes are in L1 and the targets in L2 than vice versa in both same-script and different-script bilinguals, especially when the SOA is relatively short (Schwanenflugel & Rey, 1986; Chen & Ng, 1989; De Groot & Nas, 1991; Duyck, 2005; Basnight-Brown & Altaribba, 2007). In contrast, the effect has been shown to be equally large in both directions with longer SOAs (Frenck & Pynte, 1987; Kirsner et al., 1984).

Several theories have been proposed to explain the semantic priming effect found so far. The RHM assumes that the connections between L1 word form memory and conceptual memory are stronger than those between L2 word form memory and conceptual memory. On the other hand, according to the distributed meaning representation account, a semantic priming effect results from the fact that the prime's representation in lexical memory directly activates the elementary meaning node it shares with the target's representation in lexical memory. In this set-up, no connections between nodes shared within conceptual memory are required. Overall, the finding that semantically related prime can facilitate the target has been taken as evidence that L1 and L2 share the conceptual level—there are not separate sets of conceptual units for the two languages. This view of course does not preclude the existence of some conceptual units that could be specific to one language, for example, if that language has a word expressing a concept that does not have a particular lexical correlate in the other language.

4.3.2.1 The Present Study

To gain further insight into the language asymmetry in visual lexical decision task, four more experiments were conducted using cross-language semantic priming.

Non-associative semantically related words (members of the same category) were used, avoiding explicitly associative relationships. Using a priming paradigm, three groups of Bodo−Assamese bilinguals were visually presented with pairs of words that either had a semantic relation (semantically related) to the target or no relation (unrelated) to the target word. With regard to the RHM which suggests that conceptual information is not as easily accessed in the L2, it was hypothesized that semantic priming effect would, therefore, be larger in the L1–L2 direction than in the L2–L1 direction. Moreover, with regard to RHM's another claim regarding proficiency, it was expected that, low proficient bilingual would show null or weak effects of semantic priming when primes are in L2 and targets in L1, whereas high proficient bilinguals would show robust semantic priming effects regardless of direction.

4.3.2.2 Unmasked Semantic Priming from L1−L2 (Experiment 2A)

Experiment 2A examines cross-language semantic priming from L1−L2, using the same target words as in the translation priming experiments. The primes were semantic related to the targets. As before, half of the stimuli were cognate words, while the other half were non-cognate words.

***4.3.2.2.1** Method*

Participants. Forty-nine participants with an average age or 28.8 years (SD = 4.04) voluntarily took part in this and the following semantic priming experiments. They were from Bathoupuri and were from the same population and had a similar L2 history as the participants in the translation priming experiments. The participants were asked to rate (from 1 to 7) their abilities in speaking, reading, writing and comprehension in both languages. Table 4.13 reveals the mean ratings and language background data reported for the three groups of bilinguals.

Table 4.13 Self-Report Ratings in Bodo and Assamese for All Three Bilingual Groups in Experiment 2A

	Bodo (L1)			Assamese (L2)		
	Early (*n* = 17)	Late High (*n* = 14)	Late low (*n* = 18)	Early (*n* = 17)	Late High (*n* = 14)	Late Low (*n* = 18)
Age of acquisition (years)	4.5	3.2	3.5	3	8	8.6
Mean daily usage (%)	49.5 %	47.2 %	50.1 %	36.6 %	31.4 %	16.6 %
Self-ratings (7 point scale)						
Speaking	6.7 (*0.6*)	7 (0)	6.2 (*1.7*)	6 (*1.7*)	6 (1.2)	4.5 (*0.8*)
Reading	6 (*1.7*)	6.8 (0.5)	6.5 (*0.5*)	5.8 (*1.5*)	5.3 (1.0)	2.8 (*0.9*)
Writing	6 (*1.7*)	6.8 (1.2)	6.2 (*1.7*)	5.1 (*2*)	4.5 (1.2)	1.8 (*0.9*)
Comprehension	5.7 (*2.3*)	6 (1.2)	5.2 (*2.3*)	5.2 (*2.6*)	5.2 (0.5)	2 (*1.3*)

Analyses of the self-report data revealed that speaking, reading, writing, and comprehension skills were rated as being significantly better in Bodo than in Assamese. The ratings for Bodo on all four measures were similar for the Early High Proficient and the Late High Proficient groups, with no significant differences between high proficient groups and low proficient group. However, the Assamese ratings on all four proficiency measures were higher for the high proficient groups than for the low proficient group. In order to further assess the proficiency levels of the participants, all participants took part in an objective naming test. Table 4.14 provides the mean scores on the objective naming test in both Bodo and Assamese.

Table 4.14 Mean Scores on the Objective Naming Test in Bodo and Assamese for All Three Bilingual Groups in Experiment 2A

Bilingual Group	Bodo	Assamese
Early High Proficient	50.2	49.6
Late High Proficient	50.3	47.5
Late Low Proficient	51.1	38.1

T-tests performed on the means of the Assamese scores provide statistical support for the proficiency and AoA manipulations. The results show that the Early High Proficient group's scores and the Late High Proficient group's scores did not yield a significant difference [$t(46) = 1.13$, $p = .642$], indicating that the two groups were similar in L2 proficiency (49.6 vs. 47.5). However, the average L2 (Assamese) score for the Late High Proficient group is noticeably higher than the corresponding average for the Late Low Proficient group (47.5 vs. 38.1) and the scores yielded a significant difference [$t(46) = 8.71$, $p = .000$].

Stimuli. All target stimuli were identical to the translation priming experiments. Eighty Bodo words were selected as semantically related primes, replacing the translation primes of translation priming experiments (see Appendix H). These related primes were selected from a norming study (see Appendix E (ii)) conducted with 10 participants from the same bilingual population who did not take part in this and the subsequent experiments. The unrelated primes and nonwords were the same as those used in the translation priming experiments. Table 4.15 provides an example of a stimulus set.

Table 4.15 Examples of a Stimulus Set Used in Experiment 2A

	Cognate		Non-cognate	
Prime Type	Word	Nonword	Word	Nonword
Translation	लारु–पिठा "*laddu–pancake*"	लारु–बिठा	उथुमाय–পেত "*navel–stomach*"	उथुमाय–ঘেত
Control	सानजा–पिठा "*east–pancake*"	सानजा–बिठा	राव–পেত "*language–stomach*"	राव–ঘেত

Note. *लारु [laru], *पिठा [pitha]; *सानजा [sanza]; *बिठा [bitha]; *उथुमाय [uthumai]; *পেত [pet]; *राव [rau]; *ঘেত [ghet]

Procedure. The same procedure as in the unmasked translation priming experiments was used for stimulus presentation and data collection. Participants were tested individually in a quiet room. Each trial began with a fixation '+' for 500 ms, followed by the prime, which stayed on the screen for 100ms, and then the target appeared and remained on the screen until the participant performed the lexical decision or for a maximum of 2,000 ms.

4.3.2.2.2 Results

A mixed-effects analysis was run on the reaction time data and error data separately. The results of the reaction time data did not reveal a main effect of Prime Type [$F < 1$]. The main effect of Cognate Status was also not significant [$F < 1$]. However, significant a main effect of Bilingual Group was evident [$F(2,46) = 14.096$, $p = .000$]. Another interesting observation was a significant interaction between Prime Type and Bilingual Group [$F(2,6577) = 42.237$, $p = .000$]. Only the Late low proficient bilinguals produced significant priming effects of 48 ms and 32 ms in both cognate and non-cognate conditions respectively. Table 4.16 shows the mean reaction times (ms) and percentage of errors as a function of Cognate Status and Prime Type.

Table 4.16 Mean RTs (ms) and Percentage of Errors for Cognate and Non-Cognate Targets Primed by Semantically Related and by Unrelated Control Primes in Experiment 2A

		Cognate Status		
	Overall	Cognate	Non-cognate	
Prime Type	RT (Error %)	RT (Error %)	RT (Error %)	**Cognate effect**
Semantic	805 (14.5)	809 (13.7)	800 (15.4)	**−9**
Control	806 (17.2)	824 (19.5)	788 (15.4)	**−36**
Priming	**1**	**15**	**−12**	

Planned comparisons performed on the individual priming effects for the three groups of bilinguals revealed that reaction times of the Early High Proficient bilinguals (740 ms) were the shortest as compared to Late High Proficient (816 ms) and Late Low Proficient bilinguals (870 ms). Moreover, none of the bilinguals showed any facilitation for cognate words. The mean reaction times and percentage of errors as a function of Prime Type, Cognate Status, and Bilingual Group are presented in Table 4.17.

Table 4.17 Mean RTs (ms) and Percentage of Errors for Cognate and Non-Cognate Targets Primed by Semantically Related and by Unrelated Control Primes for All Three Bilingual Groups in Experiment 2A

	Cognate Status/Bilingual Group					
	Cognate			Non-cognate		
	Early	Late high	Late low	Early	Late high	Late low
Prime Type	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)
Semantic	764 (1.3)	790 (4.7)	854 (22.1)	755 (3.7)	789 (6.5)	846 (23.2)
Control	745 (6.6)	762 (9.2)	902 (28.3)	697 (1.2)	732 (8.1)	878 (24.8)
Priming	**−19**	**−28**	**48**	**−58**	**−57**	**32**

Results of the error data did not reveal a main effect of Prime Type [$F < 1$]. Number of errors was almost similar to targets when they were primed by semantically related primes and by unrelated controls. The error data did not reveal a main effect of Cognate Status [$F < 1$]. However, the main effect of Bilingual Group approached significance in the error analysis [$F(2,46) = 11.037$, $p = .000$]. Fewer errors were observed for the Early High Proficient bilinguals and greater errors were observed for the Late Low Proficient bilinguals. Lastly, post hoc comparisons of the nonword data were conducted. Analyses of the mean reaction times to nonwords showed that the participants took significantly longer to respond to nonwords (965ms) than to words (810 ms).

4.3.2.2.3 Discussion

Experiment 2A adopted a semantic priming paradigm and found that bilinguals produced cross-language priming effects. This finding is consistent with previous within-language and cross-languages semantic priming studies.

4.3.2.3 Unmasked Semantic Priming from L2−L1 (Experiment 2B)

The aim of Experiment 2B was to examine cross-language semantic priming from L2−L1 using the same stimuli as in Experiment 2A.

4.3.2.3.1 Method

Participants. The participants who took part in Experiment 2A, participated in this experiment.

Stimuli. The stimuli remained the same.

Procedure. The procedure adopted for Experiment 2A, was used for this experiment.

4.3.2.3.2 Results

As in Experiment 2A, a mixed-effects analysis was run on the reaction time data and error data. The results of the reaction time analysis showed that the main effect of Prime Type was not significant [$F < 1$]. The main effect of Cognate Status approached significance [$F(1,151) = 11.402$, $p = .001$]. The interaction between Prime Type and Bilingual Group approached significance [$F(2,7163) = 32.980$, $p = .000$]. The Cognate Status and Bilingual Group interaction was also found to be significant [$F(2,7164) = 23.904$, $p = .000$]. Finally, the three-way interaction between Prime Type, Cognate Status, and Bilingual Group reached significance [$F(2,7163) = 5.727$, $p = .017$]. Table 4.18 shows the mean reaction times and percentage of errors as a function of Cognate Status and Prime Type.

Table 4.18 Mean RTs (Ms) and Percentage of Errors for Cognate and Non-Cognate Targets Primed by Semantically Related and by Unrelated Control Primes in Experiment 2B

		Cognate Status		
	Overall	Cognate	Non-cognate	
Prime Type	RT (Error %)	RT (Error %)	RT (Error %)	**Cognate effect**
Semantic	718 (4.9)	736 (5.3)	700 (4.5)	**−36**
Control	698 (7.5)	725 (10)	670 (9.2)	**−55**
Priming	**−20**	**−11**	**−30**	

As in the previous experiments, planned comparisons were performed on the individual priming effects for the three groups of bilinguals. Unlike Experiment 2A, the results revealed similar reaction times for all three bilinguals (Early High Proficient = 708 ms, Late High Proficient = 730 ms, Late Low Proficient = 708 ms). However, as in Experiment 2A, all three Bilingual Groups failed to produce any cognate facilitation effect. Table 4.19 shows the mean reaction times and percentage of errors as a function of Prime Type, Cognate Status, and Bilingual Group.

Table 4.19 Mean RTs (ms) and Percentage of Errors for Cognate and Non-Cognate Targets Primed by Semantically Related and by Unrelated Control Primes for All Three Bilingual Groups in Experiment 2B

	Cognate Status/Bilingual Group					
	Cognate			Non-cognate		
	Early	Late high	Late low	Early	Late high	Late low
Prime Type	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)
Semantic	735 (3.3)	746 (4.9)	737 (6.9)	718 (3.6)	783 (5.3)	682 (5.3)
Control	713 (7.9)	722 (8.6)	738 (11.5)	664 (4.8)	732 (6.1)	676 (5.6)
Priming	**−22**	**−24**	1	**−54**	**−51**	**−6**

In the mixed-effects analysis on mean error percentages, the main effect of Prime Type tended towards significance [$F(1,151) = 2.273$, $p = .034$]. Participants recognized Bodo targets preceded by Assamese semantic primes more accurately than those preceded by Assamese unrelated controls. The main effect of Cognate Status was not significant, and neither was the interaction between Prime Type and Cognate Status [all Fs < 1].

The main effect of Bilingual Group approached significance in the error analysis [$F(2,7163) = 4.945$, $p = .001$]. Fewer errors were observed for the Early High Proficient bilinguals and greater errors were observed for the Late Low Proficient bilinguals. Lastly, comparisons of the nonword data were conducted. Analyses of the mean reaction times to nonwords showed that the participants took significantly longer to respond to nonwords (836 ms) than to words (702 ms).

4.3.2.3.3 Discussion

Contrary to Experiment 2A, the result of this experiment did not show any cross-language semantic priming effect. This finding is consistent with the predictions of the RHM, a strong version of which predicts null effects of semantic priming when the primes are in L2 and the targets in L1.

4.3.2.3.4 Combined Analysis of Experiment 2A and 2B

Combined analysis of the data of Experiment 2A and 2B using a mixed-effects analysis provided the following results. The main effect of Target Language approached significance [$F(1,13924) = 1653$, $p = .000$]. The interaction between Prime Type and Target Language was also significant [$F(1,13924) = 25.165$, $p = .000$]. The Cognate Status and Target Language interaction approached significance [$F(1,13924) = 11.939$, $p = .001$]. Another significant interaction was observed between Bilingual Group and Target Language [$F(2,13907) = 707.151$, $p = .000$]. This interaction is shown in Figure 4.6.

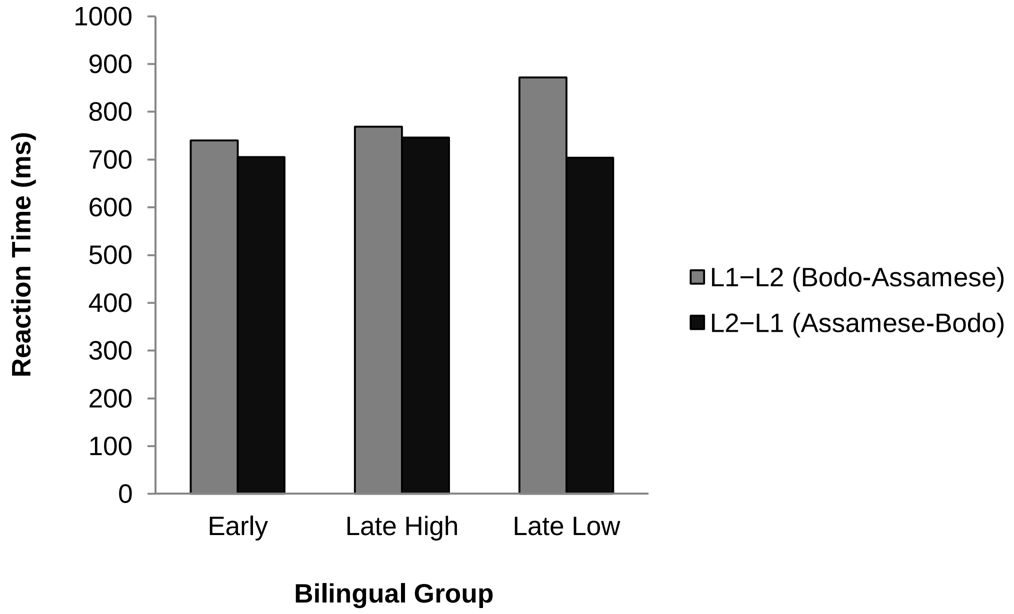


Figure 4.5 Mean RTs (ms) as a function of Bilingual Group and Target Language in Experiment 2A and 2B.

The three-way interaction between Prime Type, Bilingual Group, and Target Language approached significance [$F(2,13907) = 14.760$, $p = .000$]. The Cognate Status, Bilingual Group and Target Language was also found to be significant [$F(1,13907) = 11.830$, $p = .001$]. Finally, The Prime Type, Cognate Status and Target Language interaction also approached significance [$F(1,13924) = 8.130$, $p = .004$].

4.3.2.4 Masked Semantic Priming from L1−L2 (Experiment 2C)

In Experiment 2C, we investigated cross-language semantic priming effects using a masked paradigm. Unlike previous unmasked semantic priming experiments in which the prime and target were both visible, the primes in a masked priming experiment were presented so briefly that participants were not aware of the prime.

4.3.2.4.1 Method

Participants. The participants for this experiment were the same Bodo−Assamese bilinguals who took part in Experiment 2A and 2B.

Stimuli. The stimuli were identical to Experiment 2A.

Procedure. The experiment was conducted in the same manner as in Experiment 2A. The only difference in Experiment 2C was that a mask had been added to each experimental trial. Therefore, each trial began with a forward mask (represented by ten hash marks) which appeared for 500 ms and was immediately replaced by a 50 ms prime word. The target word or nonword then replaced the prime word and remained on the screen until the participants responded or for a maximum of 2,000 ms The participants were instructed to press the "m" key on the keyboard with their right index finger if the target letter string was a real word and the "z" key with their left index finger if a nonword appeared. The participants were told to respond as quickly and as accurately as possible.

4.3.2.4.2 Results

Outliers were removed from the analysis and a mixed-effects analysis was run on the reaction time data and error data separately. Table 4.20 shows the mean reaction times and percentage of errors as a function of Prime Type and Cognate Status. The result of Experiment 2C revealed a significant main effect of Prime Type [$F(1,149) = 25.875$, $p = .000$]. However, semantically related words (851 ms) were reacted to more slowly than unrelated words (768 ms) which indicate that there was inhibition rather than facilitation. The main effect of Cognate Status was marginal [$F(1,149) = 3.347$, $p = .021$], indicating that reaction times of the non-cognate words (794 ms) were faster than cognate words (824 ms). This indicates that there was no cognate facilitation effect. The main effect of Bilingual Group approached significance [$F(2,46) = 7.057$, $p = .011$]. The interaction between Prime Type and Bilingual Group approached significance [$F(2,6294) = 10.985$, $p = .001$]. A significant Cognate Status and Bilingual Group interaction was also observed [$F(2,6294) = 6.867$, $p = .009$].

Table 4.20 Mean RTs (ms) and Percentage of Errors for Cognate and Non-Cognate Targets Primed by Semantically Related and by Unrelated Control Primes in Experiment 2C

		Cognate Status		
	Overall	Cognate	Non-cognate	
Prime Type	RT (Error %)	RT (Error %)	RT (Error %)	**Cognate effect**
Semantic	851 (25.3)	862 (19.3)	840 (19.4)	**−22**
Control	768 (21.9)	787 (17.3)	748 (12.7)	**−39**
Priming	**−83**	**−75**	**−92**	

Planned comparisons performed on the individual priming effects for the three groups of bilinguals revealed no semantic priming for any of the Bilingual Groups. Unlike Experiment 2A and 2B, reaction times of the Early High Proficient bilinguals (889 ms) were longest as compared to the Late High Proficient (824 ms) and Late Low Proficient bilinguals (730 ms). Table 4.22 shows the mean reaction times and percentage of errors as a function of Prime Type, Cognate Status, and Bilingual Group.

Results of the error data revealed a marginal main effect of Prime Type [$F(1,149) = 2.119$, $p = .018$]. Targets were responded to more accurately when they were primed by unrelated controls as compared to when they were primed by semantically related words. The main effect of Cognate Status was not significant [$F < 1$]. However, the main effect of Bilingual Group approached significance in the error analysis [$F(2,46) = 9.062$, $p = .000$]. Fewer errors were observed for the Early High Proficient bilinguals and greater errors were observed for the Late High Proficient bilinguals. Lastly, comparison of the nonword data was conducted. Analyses of the mean reaction times to nonwords showed that the participants took significantly longer to respond to nonwords (1057 ms) than to words (770 ms).

Table 4.21 Mean RTs (ms) and Percentage of Errors for Cognate and Non-Cognate Targets Primed by Semantically Related and by Unrelated Control Primes for All Three Bilingual Groups in Experiment 2C

	Cognate Status/Bilingual Group					
	Cognate			Non-cognate		
	Early	Late high	Late low	Early	Late high	Late low
Prime Type	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)
Semantic	942 (15.8)	910 (17.1)	782 (21.1)	904 (12.8)	946 (15.3)	775 (22.7)
Control	878 (14.9)	849 (13.5)	695 (18.5)	831 (9.6)	852 (15.6)	666 (14.3)
Priming	**−64**	**−61**	**−87**	**−73**	**−94**	**−109**

4.3.2.4.3 Discussion

The results of Experiment 2C showed that unlike Experiment 2A, L1 primes failed to facilitate L2 targets when a masked paradigm was used. The results of the study is consistent with the findings of Basnight-Brown & Altarriba (2007), who did not find significant semantic priming for semantically related words with a forward mask design.

4.3.2.5 Masked Semantic Priming from L2−L1 (Experiment 2D)

To gain further insight into the language asymmetry in the masked cross-language priming paradigm, Experiment 2D was run using cross-language semantic priming.

4.3.2.5.1 Method

Participants. The same participants, who took part in the previous semantic priming experiments, participated in this experiment as well.

Stimuli. The eighty Assamese word targets of Experiment 2C and their respective Bodo translation primes were used again, but now, respectively, as Assamese (L2) translation primes and corresponding Bodo (L1) word targets.

Procedure. The design and procedure of the present experiment were identical to those of Experiment 2C.

4.3.2.5.2 Results

Similar to the previous experiments, a mixed-effects analysis was run on the reaction time data and error data after removing outliers from the data. Table 4.22 shows the mean reaction times and percentage of errors as a function of Prime Type and Cognate Status. In the reaction time analysis, the main effect of Prime Type was observed to be significant [$F(1,146) = 20.269$, $p = .000$]. However, similar to Experiment 2C, semantically related words (752 ms) were responded to slowly as compared to unrelated control words (685 ms).

The main effect of Cognate Status approached significance [$F(1,146) = 15.312$, $p = .000$]. The main effect of Bilingual Group was not significant [$F < 1$]. However, the interaction between Prime Type and Bilingual Group approached significance [$F(2,6757) = 24.633$, $p = .000$]. The Cognate Status and Bilingual Group interaction was also significant [$F(2,6757) = 19.858$, $p = .000$]. Finally, a significant three-way interaction between Prime Type, Cognate Status, and Bilingual Group was also observed [$F(2,6757) = 28.028$, $p = .000$].

Table 4.22 Mean RTs (ms) and Percentage of Errors for Cognate and Non-Cognate Targets Primed by Semantically Related and by Unrelated Control Primes in Experiment 2D

		Cognateness		
	Overall	Cognate	Non-cognate	
Prime Type	RT (Error %)	RT (Error %)	RT (Error %)	**Cognate effect**
Semantic	752 (15.7)	785 (21.8)	719 (10.2)	**−66**
Control	685 (9.8)	710 (12.1)	659 (7.7)	**−51**
Priming	**−67**	**−75**	**−60**	

Planned comparisons performed on the individual priming effects for the three types of bilinguals revealed that the reaction time differences between all three Bilingual Groups was not significant (Early High Proficient = 733 ms, Late High Proficient = 736 ms, Late Low Proficient = 703 ms). Moreover, no cognate facilitation effect was observed with any of the bilingual groups, replicating the pattern of Experiment 2A, 2B, and 2C. The mean reaction times and percentage of errors as a function of Prime Type, Cognate Status, and Bilingual Group are presented in Table 4.23.

Table 4.23 Mean RTs (ms) and Percentage of Errors for Cognate and Non-Cognate Targets Primed by Semantically Related and by Unrelated Control Primes for All Three Bilingual Groups in Experiment 2D

	Cognate Status/Bilingual Group					
	Cognate			Non-cognate		
	Early	Late high	Late low	Early	Late high	Late low
Prime Type	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)
Semantic	806 (21.7)	824 (22.7)	763 (22.1)	744 (7.8)	752 (10.2)	695 (13.6)
Control	733 (11.8)	729 (11.9)	688 (12.4)	650 (2.4)	640 (5.8)	668 (11.2)
Priming	**−73**	**−95**	**−75**	**−94**	**−112**	**−27**

In the mixed-effects analysis on the error data, the main effect of Prime Type tended towards significance [$F(1,146) = 12.409$, $p = .000$]. Participants recognized Bodo targets preceded by Assamese unrelated control primes more accurately than those preceded by Assamese semantically related primes. The main effect of Cognate Status was significant, [$F(1,146) = 13.153$, $p = .000$]. Errors were numerous for cognate targets than for non-cognate targets. The main effect of Bilingual Group did not approach significance in the error analysis [$F < 1$]. However, the Cognate Status and Bilingual Group interaction was found to be significant [$F(2,6757) = 9.239$, $p = .000$]. The percentage of errors for all three Bilingual Groups was numerous for the cognate targets than for the non-cognate targets. Lastly, comparisons of the nonword data were conducted. Analyses of the mean reaction times to nonwords showed that the participants took significantly longer to respond to nonwords (882 ms) than to words (709 ms).

4.3.2.5.3 *Discussion*

The results of this experiment demonstrated the lack of facilitation in the L2−L1 direction, when primes were semantically related to the targets. This finding is consistent with Basnight-Brown and Altarriba's (2007) results where no semantic facilitation was observed in the L2−L1 direction. The finding also conforms to the predictions of the RHM which predicts null effects in this direction.

4.3.2.5.4 *Combined Analysis of Experiment 2C and 2D*

To test for differences between translation priming in both directions, we analyzed the data from Experiment 2C and 2D in one design using a mixed-effects analysis. The combined analysis revealed a significant main effect of Target Language [$F(1,13271) = 562.029$, $p = .000$]. The interaction between Prime Type and Target Language approached significance [$F(1,13266) = 7.170$, $p = .007$]. The Cognate Status and Target Language interaction was also found to be significant [$F(1,13265)$

= 16.818, *p* = .000]. Of crucial interest, was the interaction between Bilingual Group and Target Language which was found to be very significant [$F(2,13261) = 307.603$, $p = .000$]. This interaction is shown in Figure 4.7. Finally, the three-way interaction between Relatedness, Bilingual Group and Target Language approached significance [$F(2,13226) = 22.394$, $p = .000$].

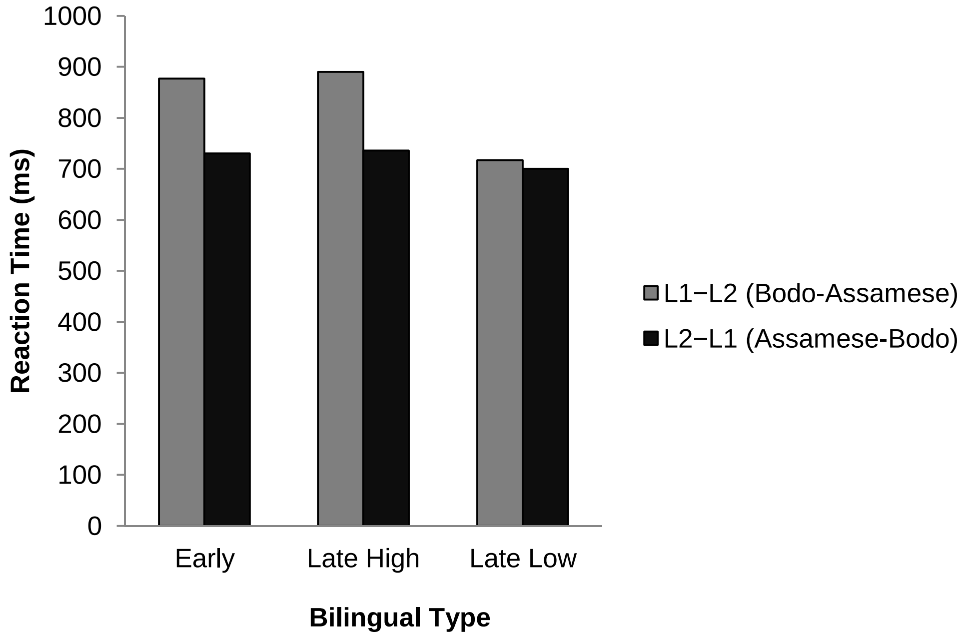


Figure 4.6 Mean RTs (ms) as a function of Bilingual Group and Target Language in Experiment 2C and 2D.

4.3.2.6 General Discussion

The present study used semantic priming as an experimental procedure, in two different paradigms (unmasked and masked), to examine the connections between entries in the mental lexicon. Experiment 2A and 2B employed unmasked priming paradigm and Experiment 2C and 2D employed masked priming paradigm. Because conceptual memory is the locus of the effect, priming effects were expected to occur if access to conceptual memory had indeed taken place. The results of the experiments showed a pattern different from the translation priming experiments. When the prime and the target were semantically related, cross-language priming was found only in L1−L2. As mentioned, the RHM assumes that the connections between the L1 word form memory and conceptual memory are stronger than those between L2 word form memory and conceptual memory. As a consequence, accessing conceptual representations from L1 form representations is easier than from L2 form representations, and conceptual access from an L2 representation may often fail. In other words, a strong version of the model would predict null effects of semantic priming when the primes are in L2 and the targets in L1 (De Groot, 2011). The findings of our study conform to the predictions of the RHM—the pattern of cross-language semantic priming effect from L1−L2 was strong and consistent, but the effect from L2−L1 was null.

One of the factors that might be responsible for the asymmetric semantic priming effects is the stimulus onset asynchrony (SOA). According to Kroll and Sholl (1992), "semantic priming effects are generally larger when the primes are in (the stronger) L1 and the targets in (the weaker) L2 than vice versa, especially when the duration between the onset of prime and target is relatively short. In contrast, with relatively long SOAs the effect has at least twice been shown to be equally large with primes in L2 and targets in L1 as with primes in L1 and targets in L2". In our study, the SOAs of 50 ms and 100 ms were relatively short, which can account for the observed asymmetry. Therefore, with the combined results obtained with shorter SOAs we can assume that L2 words may also access conceptual memory directly but do so less often or less often quickly enough.

Although the pattern of results in the present study supports one of the predictions of the RHM, that is, L1 primes produced stronger semantic priming effects as opposed to null priming effects produced by L2 primes in the unmasked paradigm, it refutes the other prediction of the model regarding the link between the proficiency of bilinguals and processing routes. As per the model, high proficient bilinguals should produce larger priming effects than low proficient bilinguals because high proficient bilinguals share direct and stronger conceptual links than low proficient bilinguals, who access the conceptual system only via the L1 lexical system. However, a problem in the present study is that it showed a pattern of result quite different than the predictions of the RHM. In Experiment 2A, only Late Low Proficient bilinguals produced stronger semantic priming effects. Since no such result has been reported in the literature before for the same task, the explanations attempted here will be rather speculative. One possible explanation for the possible sources of this deviation can be attributed to the architectural systems of the bilinguals. As mentioned before, a number of studies that have examined the neural underpinnings of bilingual representations suggest that different architectures are found in those who learned their second languages before age seven, versus later (e.g., Kim, Relkin, Lee, & Hirsch, 1997; Weber-Fox &Neville, 1999; Wuillemin & Richardson, 1994). Based on this finding, if we assume that bilinguals having high proficiency in L2, store and access L1 and L2 words from two language-specific conceptual representations, then cross-language priming effects should not be obtained. However, if only low L2 experience bilinguals store and access L1 and L2 words from a common conceptual representation, while high L2 experience bilinguals have separate lexicons, then cross-language priming effects will be obtained for Low, but not High, L2 proficient participants. Although, the pattern of results observed in our study is consistent with the hypothesis on the architecture of the bilinguals relative to their proficiency, further research is required for the clarification of this point.

To conclude, although the present study very clearly shows that the order of presenting prime and target languages affects the degree of semantic priming, they are less clear in demonstrating the effects of L2 age of acquisition and proficiency responsible for semantic priming. Moreover, the examination of whether L1 and L2 semantic information is stored and retrieved from a shared semantic system or two language specific semantic systems in bilinguals with high and low L2 proficiency, provided support for the notion that words in low proficient bilingual's two languages share a common conceptual representation. However, the overall results for the high proficient bilinguals provided support for the notion of separate conceptual representations. These findings have several implications for models of lexical access in bilinguals that provide support for the hypothesis that there is a common conceptual representation in bilinguals irrespective of their second language age of acquisition and level of proficiency. In the next section we continue our investigation of cross-language priming effects in Bodo−Assamese bilinguals using the associative priming paradigm.

4.3.3 Associative Priming

As mentioned above, the degree of semantic and associative relatedness between two words has been an issue of debate. A number of studies have tried to disentangle the relationship between semantic and associative words. For example, Fischler (1977) investigated priming effects using word pairs which were associatively related (e.g., cat-dog) and word pairs that were semantically related but not associated (e.g., table-stool) in a double lexical decision task. The word pairs were presented simultaneously and the participants had to decide whether both strings of letters were words or not. Fischler observed both associative and semantic priming and thereby concluded that semantic priming can not only result from word association but from semantic relations among words as well. However, when Lupker (1984) and Shelton and Martin (1992) used a standard lexical decision task, they failed to replicate the result of Fischler, thereby attributing the priming effects to the use of simultaneous lexical decision task. Shelton and Martin (1992), in particular, suggested that in Fischler's study, priming effect observed for semantically related but unassociated word pairs resulted from controlled rather than automatic processing, providing support for theories on priming based on associative relatedness. Indeed, Shelton and Martin (1992, p. 1204) concluded that "words that are very similar in meaning or sharing many features will not show automatic semantic priming if they are not also associated". Moreover, Lucas (2000) and Hutchison (2003) examined semantic priming across different tasks (such as naming, paired lexical decision, lexical decision with a mask, and serial or continuous lexical decision) in their meta-analyses of the literature and showed that the effects were similar across tasks (a conclusion also shared by Hutchison, 2003), with only a smaller priming effect observed in naming. They further concluded that nevertheless, careful selection of word pairs related semantically but not associatively can produce "pure semantic" priming effect (see also McRae & Boisvert, 1998; Moss, Ostrin, Tyler, & Marslen-Wilson, 1995; Perea & Gotor, 1997; Perea & Rosa, 2002; Seidenberg, Waters, Sanders, & Langer, 1984; Thompson-Schill et al., 1998; Williams, 1996). For example, the study by McRae and Boisvert

(1998) provide one of the most convincing demonstration of "pure semantic" priming effect. They used two types of experiments, namely, lexical decision task and semantic decision task and observed robust automatic semantic priming effect for highly similar prime-target pairs that were unassociated (such as "whale-dolphin", "missile-bomb"). To further test the role of similarity and frequency, they conducted a final experiment in which they tested triplets, i.e., target (e.g., jar) was paired with both a highly similar prime (e.g., bottle) and a less similar prime (e.g., plate) at two different SOAs (250 ms and 750 ms). The results showed that for highly similar pairs priming was evident at both SOAs, but for less similar pairs priming was observed only at the long SOA, indicating that for highly similar pairs, priming is indeed automatic. McRae and Boisvert (1998) therefore attributed the null priming effects in Shelton and Martin's experiments to be the result of a number of factors—the prime-target pairs were moderately similar and targets were relatively short and frequent (such as "duck-cow", "knife-hammer", "nose-hand").

In 1998, Thompson-Schill et al. (1998) investigated the role of direction in obtaining priming effects in a lexical decision task and a word naming task. They used two types of word pairs, (1) semantically related and (2) associatively related without semantic similarity. They observed that semantically related pairs showed comparable priming effects in both direction, whereas, the associatively related pairs did not produce priming effects in either direction in a naming task. The findings of this study seem to indicate that semantic similarity is sufficient to produce priming whereas associative relatedness is not (but see Hutchison, 2003, for a criticism). Reliable priming effects for pairs that were highly semantically related but associatively unrelated (such as synonyms, antonyms and coordinates) were also observed by Perea and Rosa (2002) in a masked lexical decision experiment using different SOAs (83 ms, 100 ms, 116 ms and 166 ms). The overall findings of the studies mentioned above thus firmly establish the existence of "pure semantic" priming effect, i.e., automatic semantic priming in the absence of normative association.

The number of studies which have taken the issue of "pure associative" priming (i.e., word pairs that are associatively related but semantically unrelated) is very less (see Lucas, 2000, and Hutchison, 2003, for reviews). For example, Hodgson (1991) and Williams (1996) investigated pure associative priming in lexical decision and naming tasks. The critical stimuli in the experiment included phrasal associates, i.e., words that tend to co-occur in common phrases (e.g., help-wanted). The results showed robust associative priming effects in both tasks, and thus suggesting the presence of "pure associative" priming because phrasal associates share very little semantic overlap. However, Lucas (2000) argued that the experiments of Hodgson (1991) had methodological problems and the stimuli in the study by William (1996) were semantically related in many ways. To sum up, although, semantic and associative priming effects have become the subject of some controversy, most of the previous studies have explored the two effects separately, with different stimuli. This point has been addressed explicitly in the present study where we tested both semantic priming (see Experiment 2A, 2B, 2C, and 2D) and associative priming with the same stimuli.

4.3.3.1 The Present Study

The experiments reported in the present study focused on associative relationship in the absence of semantic similarity. The aim of the study was to examine under which conditions automatic associative priming effects can be obtained, and to analyze the time course of associative activation in memory. The present series of experiments used two priming paradigms—the unmasked priming paradigm and the masked priming paradigm.

4.3.3.2 Unmasked Associative Priming from L1−L2 (Experiment 3A)

Experiment 3A examined the nature of cross-language priming effects with associatively related pairs (without semantic relation) which were presented at SOA of 100 ms in a lexical decision task with the unmasked priming technique.

Participants. A total of fifty participants with an average age of 32.6 years (*SD* = 5.02) from Ganeshpara, Guwahati, took part in this and the rest of the associative priming experiments. Participants were native speakers of Bodo with Assamese as their second language. All of them had either normal vision or corrected-to-normal vision. Each participant completed a language background questionnaire indicating their use of Bodo and Assamese in various contexts. They also rated proficiency in both languages. Self-report data of the participants' ratings of their current ability to speak, read, write, and understand in both Bodo and Assamese on a 7-point scale was included. Responses on the language history questionnaire indicated that all the participants had learned Bodo before Assamese. Table 4.24 presents other data like the mean age at which participants reported beginning to acquire both Bodo and Assamese and their mean daily usage in the two languages.

Table 4.24 Self-report Ratings in Bodo and Assamese for All Three Bilingual Groups in Experiment 3A

	Bodo (L1)			Assamese (L2)		
	Early (*n* = 14)	Late High (*n* = 17)	Late low (*n* = 19)	Early (*n* = 14)	Late High (*n* = 17)	Late Low (*n* = 19)
Age of acquisition (years)	1.3	1.7	2.1	3.3	14.3	15.6
Mean daily usage (%)	52.3 %	49 %	48 %	39.1 %	36.7 %	20.1 %
Self-ratings (7 point scale)						
Speaking	6.7 (0.6)	7	6.5 (0.5)	6.7 (1.5)	6.5 (1)	4.2 (1.0)
Reading	6.3 (0.6)	6.5 (1)	6.5 (0.5)	6.3 (1.2)	5.5 (1)	3.4 (1.2)
Writing	6.3 (0.6)	7	6.2 (1.2))	5.7 (2.3)	4.2 (2.2)	2.3 (1.2)
Comprehension	6 (1)	7	6.1 (1.0)	5.3 (2.0)	4.5 (1.7)	3.0 (2.3)

The results of the self-report ratings show that the Bodo ratings of the three groups of bilinguals on all four proficiency measures are similar. However, the Assamese ratings on all four proficiency measures are higher for the high proficient groups than for the low proficient group. Apart from the self-report measures, participants took part in two versions of the Objective Naming Test in both Bodo and Assamese, as an objective measure of language fluencies in the two languages. Table 4.25 provides the mean scores of the objective naming test in Bodo and Assamese.

Table 4.25 Mean scores on the Objective Naming Test in Bodo and Assamese for all three Bilingual Groups in Experiment 3A

Bilingual Group	Bodo	Assamese
Early High Proficient	52.4	49.3
Late High Proficient	51.1	50.3
Late Low Proficient	50.2	38.4

Stimuli. The target words used in the translation priming and semantic priming experiments were selected for this task with the exception that prime-target pairs were associatively related to each other. In search for "purity" in our experimental stimuli we controlled association values (in terms of strength of verbal association) of the pairs for "pure associative pairs" (non-semantic). Associative strength of these words was assessed using a norming study (see Appendix E (iii)). The related primes matched to the unrelated primes for frequency of occurrence and word length. Prime-target pairs were counterbalanced across two experimental lists. Participants were randomly assigned to one of the two stimulus lists.

Table 4.26 Examples of a Stimulus Set Used in Experiment 3A

	Cognate		Non-cognate	
Prime Type	Word	Nonword	Word	Nonword
Associative	फोथा–কপাল *"bindi–forehead"*	फोथा–মপাল	उथुमाय–পেত *"navel–stomach"*	उथुमाय–ঘেত
Control	जोगोनार–কপাল *"pumpkin–forehead"*	जोगोनार–মপাল	राव–পেত *"language–stomach"*	राव–ঘেত

Note. *फोथा [phwtha]; *কপাল [kopal]; *जोगोनार [zwgwnar]; *মপাল [mopal]; *उथुमाय [uthumai]; *পেত [pet]; *राव [rau]; *ঘেত [ghet]

Procedure. Participants were tested individually in a quiet room. On each trial, a fixation composed of a plus sign (+) was presented for 500 ms on the center of the screen. Next, a prime word in Bodo was presented for 100 ms. The prime word was immediately replaced by an Assamese target item and it remained on the screen until the participants responded or for a maximum 2,000 ms. Participants were instructed to press one of two buttons on the keyboard ('m' for yes and 'z' for no) to indicate whether the Assamese target word was a legitimate Assamese word or not. This decision had to be done as quickly and as accurately as possible. When the participant responded, the target disappeared from the screen. Reaction times were measured from target onset until participants' response. Each participant received a total of fifteen practice trials (with the same manipulation as in the experimental trials) prior to the main experimental trials. Stimulus presentation was randomized, with a different order for each participant.

4.3.3.2.2 Results

Outliers were removed and a mixed-effects analysis was run on the reaction time data and error data. The analysis on the overall reaction time data did not show a significant main effect of Prime Type [$F < 1$]. Targets preceded by associative primes (837 ms) and targets preceded by control primes (823 ms) were responded to in a similar manner. The main effect of Cognate Status was reliable [$F(1,155) = 3.722$, $p = .018$]. However, no facilitation was reported as cognate targets (843 ms) were responded to slowly than non-cognate targets (816 ms). The main effect of Bilingual Group approached significance [$F(2,47) = 17.264$, $p = .000$].

A significant interaction was observed between Prime Type and Bilingual Group [$F(2,7248) = 48.168$, $p = .000$] which reflected that the effect of Prime Type was observed only for Early High Proficient bilinguals in the cognate condition. This priming effect of 45 ms was significant. The Cognate Status and Bilingual Group interaction approached significance [$F(2,7248) = 46.064$, $p = .000$]. Finally, the three-way interaction between Prime Type, Cognate Status and Bilingual Group also approached significance [$F(2,7248) = 8.530$, $p = .000$]. The mean reaction times and percentage of errors as a function of Prime Type and Cognate Status are presented in Table 4.27.

Table 4.27 Mean RTs (ms) and Percentage of Errors for Cognate and Non-Cognate Targets Primed by Associatively Related and by Unrelated Control Primes in Experiment 3A

		Cognate Status		
	Overall	Cognate	Non-cognate	
Prime Type	RT (Error %)	RT (Error %)	RT (Error %)	**Cognate effect**
Associative	837 (10)	842 (14.9)	831 (5.6)	**−11**
Control	823 (5)	844 (5.9)	802 (4.2)	**−42**
Priming	**−14**	**2**	**−29**	

To examine the individual priming effects for the three groups of bilinguals, planned comparisons were performed. The analysis revealed longer reaction times for the Early High Proficient bilinguals (904 ms) that the Late High Proficient (756 ms) and Late Low Proficient bilinguals (677 ms). Moreover, no cognate facilitation effect was observed with any of the bilinguals. The mean reaction times and percentage of errors as a function of Prime Type, Cognate Status, and Bilingual Group are presented in Table 4.28.

Results of the error data revealed a significant main effect of Prime Type [$F(1,155) = 6.492$, $p = .001$]. Targets were responded to more accurately when they were primed by unrelated control primes as compared to when they were primed by associatively related words. The main effect of Cognate Status was significant [$F(1,155) = 10.156$, $p = .000$]. Errors were numerous for the cognate targets than for the non-cognate targets. The main effect of Bilingual Group approached significance in the error analysis [$F(2,47) = 15.732$, $p = .000$]. Greater errors were observed for the early bilinguals and fewer errors were observed for the late bilinguals. Lastly, comparison of the nonword data was conducted. Analyses of the mean reaction times to nonwords showed that the participants took significantly longer to respond to nonwords (930ms) than to words (825 ms).

Table 4.28 Mean RT (ms) and Percentage of Errors for Cognate and Non-Cognate Targets Primed by Associatively Related and by Unrelated Control Primes for All Three Bilingual Groups in Experiment 3A

	Cognate Status/Bilingual Group					
	Cognate			Non-cognate		
	Early	Late high	Late low	Early	Late high	Late low
Prime Type	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)
Associative	903 (18.4)	781 (8.1)	702 (9.6)	882 (7.2)	780 (2.4)	732 (5.8)
Control	948 (6.6)	740 (5.3)	642 (6.7)	881 (3.6)	722 (4.8)	635 (5.3)
Priming	**45**	**−41**	**−60**	**−1**	**−58**	**−97**

4.3.3.2.3 *Discussion*

The overall results of Experiment 3A demonstrated significant associative priming effect only for the cognate targets in case of the Early High Proficient group. This finding indicates that associative priming effect was modulated by the cognate status of the word as well the age of acquisition of the bilinguals.

4.3.3.3 Unmasked Associative Priming from L2−L1 (Experiment 3B)

Experiment 3B was identical to Experiment 3A, except that the targets of Experiment 3A served as primes in this experiment. In this way, it was possible to examine the asymmetry in the time course of semantic activation.

4.3.3.3.1 Method

Participants. The participant of Experiment 3A took part in this experiment.

Stimuli. The stimuli used were the same as those used in the Experiment 3A. The number and order of the word pairs were also identical to those used in Experiment 3A.

Procedure. The experiment was conducted in the same manner as in Experiment 3A.

4.3.3.3.2 Results

A mixed-effects analysis was run on the reaction time data and error data after removing the outliers, following the criterion followed in the above experiments. The mean reaction times and percentage of errors on the stimulus words are shown in Table 4.29. Analysis on the reaction time did not reveal a main effect of Prime Type [$F < 1$]. The reaction time of targets preceded by associative primes (866 ms) and by control primes (852 ms) were similar. The main effect of Cognate Status approached significance [$F(1,154) = 10.371$, $p = .002$]. Cognates (886 ms) were responded to slowly than non-cognates (832 ms), indicating the absence of cognate facilitation effect. The main effect of Bilingual Group was also significant [$F(2,45) = 13.011$, $p = .000$]. The Prime Type and Bilingual Group interaction approached significance [$F(2,7188) = 17.452$, $p = .000$]. Small priming effects of 4 ms and 6 ms were found for only Early High Proficient and Late High Proficient bilinguals respectively in the cognate condition. The Cognate Status and Bilingual Group interaction also approached significance [$F(2,7188) = 4.482$, $p = .000$]. Finally, the three-way interaction between Prime Type, Cognate Status and Bilingual Group also reached significance [$F(2,7188) = 14.499$, $p = .000$].

Table 4.29 Mean RTs (ms) and Percentage of Errors for Cognate and Non-Cognate Targets Primed by Associatively Related and by Unrelated Control Primes in Experiment 3B

		Cognate Status		
	Overall	Cognate	Non-cognate	
Prime Type	RT (Error %)	RT (Error %)	RT (Error %)	**Cognate effect**
Associative	866 (6.25)	884 (8.6)	848 (4.2)	**−36**
Control	852 (5.6)	888 (8.6)	816 (2.9)	**−72**
Priming	**−14**	**4**	**−32**	

Planned comparisons performed on the individual priming effects for the three groups of bilinguals revealed significant difference in the reaction times of the three bilingual groups. The mean reaction times and percentage of errors as a function of Prime Type, Cognate Status, and Bilingual Group are presented in Table 4.32. Similar to Experiment 3A, reaction times of the Early High Proficient bilinguals (957 ms) were significantly longer than the reaction times of the Late High Proficient (762 ms) and Late Low Proficient bilinguals (681 ms). Moreover, although the high proficient bilinguals showed very insignificant priming effect for the cognate targets, no cognate facilitation was observed with any of the Bilingual Groups.

Table 4.30 Mean RTs (ms) and Percentage of Errors for Cognate and Non-Cognate Targets Primed by Associatively Related and by Unrelated Control Primes for All Three Bilingual Groups in Experiment 3B

	Cognate Status/Bilingual Group					
	Cognate			Non-cognate		
	Early	Late high	Late low	Early	Late high	Late low
Prime Type	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)
Associative	978 (7.9)	789 (9.3)	707 (11.4)	962 (1.2)	734 (7.2)	699 (12.6)
Control	982 (6.6)	795 (10.7)	689 (13.2)	904 (2.4)	728 (3.6)	632 (10.4)
Priming	**4**	**6**	**−18**	**−58**	**−6**	**−67**

In the mixed-effects analysis on the error data, the main effect of Prime Type did not reach significance [$F < 1$]. The main effect of Cognate Status was significant [$F(1,154) = 11.514$, $p = .000$]. Participants recognized non-cognate targets more accurately than cognate targets. The main effect of Bilingual Group tended towards significance [$F(2,45) = 4.047$, $p = .001$].

Fewer errors were observed for the high proficient bilinguals as compared to the low proficient bilinguals. Moreover, the Cognate Status and Bilingual Group interaction also approached significance [$F(2,7188) = 5.126$, $p = .000$]. Lastly, comparisons of the nonword data were conducted. Analyses of the mean reaction times to nonwords showed that the participants took significantly longer to respond to nonwords (1001 ms) than to words (857 ms).

4.3.3.3.3 *Discussion*

Contrary to Experiment 3A, this experiment failed to show significant associative priming effects when the priming direction was from L2−L1. The results indicate that the language of the target has a major impact on the processing of languages, supporting the predictions of the RHM.

4.3.3.3.4 *Combined Analysis of Experiment 3A and 3B*

To test for differences between translation priming in both directions, we analyzed the data from Experiment 3A and 3B in one design using a mixed-effects analysis. A comparative analysis of the reaction time data revealed a main effect of Target Language Target Language [$F(1,14629) = 138.221$, $p = .000$]. Targets in the L2−L1 direction (830 ms) were preceded faster than targets in L1−L2 direction (857 ms). The interaction between Cognate Status and Target Language approached significance [$F(1,14613) = 15.231$, $p = .000$]. The Bilingual Group and Target Language interaction was very significant [$F(2,14622) = 112.265$, $p = .000$]. This interaction is shown in Figure 4.8. The three-way interaction between Prime Type, Bilingual Group and Target Language approached significance [$F(2,14605) = 110.497$, $p = .000$]. Finally, another significant three-way interaction was observed between Cognate Status, Bilingual Group and Target Language [$F(2,14606) = 21.562$, $p = .000$].

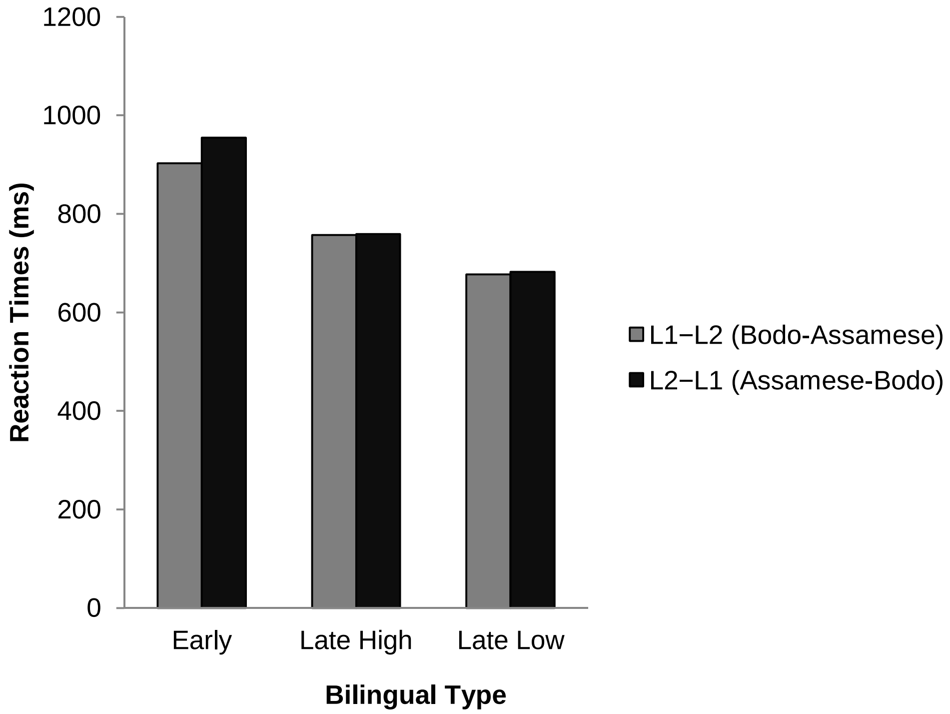


Figure 4.7 Mean RTs (ms) as a function of Bilingual Group and Target Language in Experiment 3A and 3B.

4.3.3.4 Masked Associative Priming from L1−L2 (Experiment 3C)

Experiment 3A and 3B examined associative priming effect using an unmasked priming paradigm, with an SOA of 100 ms. In this experiment, we wanted to further explore associative priming effect by employing a masked priming paradigm, with an SOA of 50 ms which is supposed to reflect automatic effects. The goal of this experiment was to explore whether pure associative priming without semantic relation is automatic or not.

4.3.3.4.1 Method

Participants. Participants in this experiment were the same Bodo−Assamese bilinguals who took part in Experiment 3A and 3B.

Stimuli. The stimuli remained the same.

Procedure. The experiment was conducted in the same manner as in Experiment 3A. The only difference in this experiment was that a mask had been added to each experimental trial.

4.3.3.4.2 Results

A mixed-effects analysis was run on the reaction time data and error data after removing the outliers, following the criterion followed in the above experiments. The overall analysis on the reaction time data revealed a significant main effect of Prime Type [$F(1,147) = 33.470$, $p = .000$]. However, targets preceded by control primes (843 ms) were responded to more rapidly than targets preceded by associative primes (946 ms). The main effect of Cognate Status approached significance [$F(1,147) = 6.186$, $p = .014$].

Furthermore, the interaction between Prime Type and Bilingual Group also approached significance [$F(2,7248) = 11.020$, $p = .001$]. Finally, a significant three-way interaction between Prime Type, Cognate Status and Bilingual Group was also observed [$F(2,7248) = 16.282$, $p = .000$]. Table 4.31 shows the mean reaction times and percentage of errors as a function of Cognate Status and Prime Type.

Table 4.31 Mean RTs (ms) and Percentage of Errors for Cognate and Non-Cognate Targets Primed by Associatively Related and by Unrelated Control Primes in Experiment 3C

		Cognate Status		
	Overall	Cognate	Non-cognate	
Prime Type	RT (Error %)	RT (Error %)	RT (Error %)	**Cognate effect**
Translation	946 (7.5)	962 (9.8)	930 (5.5)	**−32**
Control	843 (6.1)	871 (9.8)	815 (2.7)	**−56**
Priming	**−103**	**−91**	**−115**	

Planned comparisons performed on the individual priming effects for the three groups of bilinguals did not reveal any facilitation for cognates. Moreover, in this experiment, longer reaction times were observed in case of Late High Proficient bilinguals (910 ms) than the Early High Proficient (879 ms) and Late Low Proficient bilinguals (879 ms). The mean reaction times and percentage of errors as a function of Prime Type, Cognate Status, and Bilingual Group are presented in Table 4.32.

Table 4.32 Mean RTs (ms) and Percentage of Errors for Cognate and Non-Cognate Targets Primed by Associatively Related and by Unrelated Control Primes for All Three Bilingual Groups in Experiment 3C

	Cognate Status/Bilingual Group					
	Cognate			Non-cognate		
	Early	Late high	Late low	Early	Late high	Late low
Prime Type	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)
Translation	947 (11.8)	977 (7.1)	918 (8.2)	925 (8.4)	935 (1.6)	889 (2.6)
Control	859 (9.9)	884 (9.7)	820 (9.4)	784 (2.4)	845 (3.2)	818 (3.5)
Priming	**−88**	**−93**	**−98**	**−141**	**−90**	**−71**

Results of the error data did not reveal a main effect of Prime Type [$F < 1$]. The percentage of errors was similar when targets were primed by associative words and when they were primed by unrelated controls. However, the error data revealed a main effect of Cognate Status [$F(1,147) = 7.136$, $p = .002$]. Errors were numerous for cognate targets than for non-cognate targets. The main effect of Bilingual Group approached significance in the error analysis [$F(2,45) = 7.0118$, $p = .000$]. Greater errors were observed for the early bilinguals and fewer errors were observed for the late bilinguals. Moreover, the Cognate Status and Bilingual Group interaction also approached significance [$F(2,7188) = 4.826$, $p = .001$]. Lastly, comparisons of the nonword data were conducted. Analyses of the mean reaction times to nonwords showed that the participants took significantly longer to respond to nonwords (1086ms) than to words (890 ms).

4.3.3.4.3 *Discussion*

Experiment 3C revealed that when a forward mask was used, no associative priming effect was observed. This is in line with the findings of the masked semantic priming experiment (see Experiment 2C).

4.3.3.5 Masked Associative Priming from L2−L1 (Experiment 3D)

To explore whether the asymmetry in language processing observed in the other experiments is also apparent in masked associative priming studies, this experiment tested Bodo−Assamese bilinguals when they made lexical decisions to masked L2 primes and L1 targets.

4.3.3.5.1 *Method*

Participants. The same subjects from Experiment 3A, 3B, and 3C participated in the present experiment.

Stimuli. The Assamese word targets of Experiment 3C and their respective Bodo translation primes were used again, but now, respectively, as Assamese (L2) translation primes and corresponding Bodo (L1) word targets.

Procedure. The design and procedure of the present experiment were identical to those of Experiment 3C.

4.3.3.5.2 Results

Outliers were removed and a mixed-effects analysis was run on the reaction time data and error data. Table 4.33 presents the mean reaction times and percentage of errors as a function of Cognate Status and Prime Type.

Table 4.33 Mean RTs (ms) and Percentage of Errors for Cognate and Non-Cognate Targets Primed by Associatively Related and by Unrelated Control Primes in Experiment 3D

		Cognate Status		
	Overall	Cognate	Non-cognate	
Prime Type	RT (Error %)	RT (Error %)	RT (Error %)	**Cognate effect**
Associative	907 (6.6)	934 (10.5)	881 (3.1)	**−53**
Control	812 (7.3)	847 (12)	778 (3.1)	**−69**
Priming	**−95**	**−87**	**−103**	

The results of Experiment 3D revealed a main effect of Prime Type [$F(1,153) = 31.903$, $p = .000$]. However, there was interference rather than facilitation as targets preceded by unrelated control primes (812 ms) were responded to faster than associative primes (907 ms). The main effect of Cognate Status approached significance [$F(1,153) = 13.132$, $p = .000$]. The main effect of Bilingual Group was significant [$F(2,48) = 14.951$, $p = .000$]. The interaction between Prime Type and

Bilingual Group was found to be significant [*F*(2,7241) = 7.275, *p* = .007]. The Cognate Status and Bilingual Group interaction was marginally significant [*F*(2,7241) = 3.452, *p* = .063]. Finally, the three-way interaction between Prime Type, Cognate Status, and Bilingual Group approached significance [*F*(2,7241) = 38.345, *p* = .000].

In order to examine the individual differences of the Bilingual Groups, planned comparisons were performed on the individual priming effects for the three groups of bilinguals which revealed longer reaction times for the Early High Proficient bilinguals (926 ms) than the Late High Proficient (794 ms) and Late Low Proficient bilinguals (750 ms). The mean reaction times and percentage of errors as a function of Prime Type, Cognate Status, and Bilingual Group are presented in Table 4.34.

Table 4.34 Mean RTs (ms) and Percentage of Errors for Cognate and Non-Cognate Targets Primed by Associatively Related and by Unrelated Control Primes for All Three Bilingual Groups in Experiment 3D

	Cognate Status/Bilingual Group					
	Cognate			Non-cognate		
	Early	Late high	Late low	Early	Late high	Late low
Prime Type	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)
Associative	987 (14.5)	880 (5.3)	800 (6.9)	949 (1.8)	812 (4.8)	784 (4.6)
Control	931 (12.5)	762 (11.5)	732 (11.4)	834 (1.2)	721 (5.6)	685 (6.1)
Priming	**−56**	**−118**	**−68**	**−115**	**−91**	**−99**

In the mixed-effects analysis on the error data, the main effect of Prime Type did not approach significance [*F* < 1].The main effect of Cognate Status was significant [*F*(1,153) = 11.583, *p* = .000] .Participants recognized non-cognate targets more accurately than cognate targets. The main effect of Bilingual Group approached significance in the error analysis [*F*(2,48) = 9.654, *p* = .000]. Moreover, the Cognate Status and Bilingual Group interaction was marginally significant [*F*(2,7241) =

11.489, p = .000]. For cognate targets, greater errors were observed for the early bilinguals and fewer errors were observed for the late bilinguals; on the other hand, for non-cognate targets, fewer errors were observed for the early bilinguals and greater errors were observed for the late bilinguals. Lastly, comparisons of the nonword data were conducted. Analyses of the mean reaction times to nonwords showed that the participants took significantly longer to respond to nonwords (1043 ms) than to words (852 ms).

4.3.3.5.3 *Discussion*

Similar to Experiment 3C, Experiment 3D failed to reveal facilitative associative priming effects when the priming direction was from L2−L1. The lack of facilitation in both directions indicates that masked associative priming is symmetric rather than asymmetric.

4.3.3.5.4 *Combined Analysis of Experiment 3C and 3D*

To test for differences between translation priming in both directions, we analyzed the data from Experiment 3C and 3D in one design using a mixed-effects analysis. The combined analysis revealed a main effect of Target Language [$F(1,14732)$ = 137.490, p = .000]. The interaction between Prime Type and Target Language was found to be significant [$F(1,14732)$ = 6.180, p = .013]. The Cognate Status and Target Language interaction was also observed to be significant [$F(1,14683)$ = 12.621, p = .000]. Of crucial interest was the interaction between Bilingual Group and Target Language which was found to be very significant [$F(2,14668)$ = 872.395, p = .000]. This interaction is shown in Figure 4.9. Finally, the three-way interaction approached significance [$F(2,14668)$ = 8.063, p = .005].

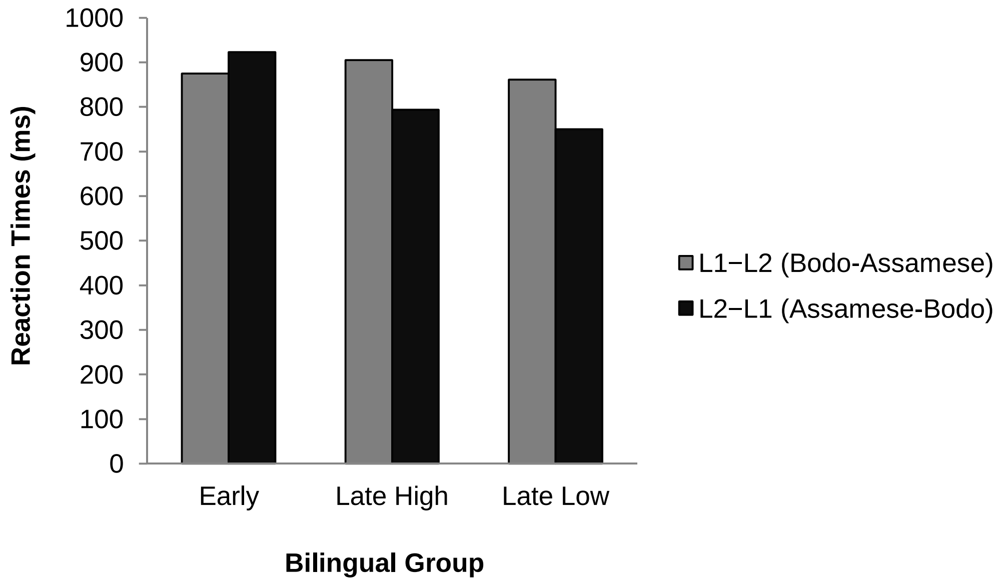


Figure 4.8 Mean RTs (ms) as a function of Bilingual Group and Target Language in Experiment 3C and 3D.

4.3.3.6 General Discussion

In the present study, forward and backward priming effects were measured using word pairs that shared associative features, but were semantically unrelated, associated according to word association norms. The study was designed to examine semantic memory by focusing on pure associative relatedness. To investigate this, we examined cognate and non-cognate word pairs that shared only associative relation with each other without having a semantic relation. Bodo−Assamese bilinguals performed four lexical decision tasks (3A, 3B, 3C, and 3D) in both unmasked and masked priming paradigms. The results of our experiments demonstrated the presence of purely associative priming in the absence of semantic similarity for cognate words, only in case of Early High Proficient Bodo−Assamese bilinguals. We replicated the results of Hodgson (1991), Williams (1996), and Ferrand and New (2003) for bilinguals whose two languages share the same Roman alphabets and extended the finding to bilinguals whose two languages differ in script. However, this finding is contrary to the evidence presented by Thompson-

Schill et al. (1998), who argued that “associatively related pairs in and of themselves do not automatically prime unless they are also semantically related”. Moreover, they utilized experimental manipulations different from our study. They used a naming task with very high frequency targets. Therefore, the demonstration of a null priming effect in these circumstances is far from compelling.

The results of our study clearly demonstrated that there can be associative priming without semantic relation only in the unmasked paradigm, which may suggest that this associative priming, when it was observed, was due to strategic rather than automatic processing. Strategic processes take time to develop and are thought to be found only during later stages of processing—that is, with greater SOAs and a longer amount of time to process the prime and target might lead to greater associative priming. Therefore, the additional time available for strategic processes such as integrating the prime with the target might have caused priming effect in the unmasked paradigm. This can also explain why the effect was observed from L1−L2 and not vice versa. Because of the relatively weak links, the access process was too slow and therefore, the short interval between the prime and target did not allow strategic processes to develop, because by the time the target is presented, it has not yet been successfully completed. Our results are further in line with those of Plaut (1995), who argued that with associated pairs, the priming effect increased with prime duration. Our study tested associative priming effects at two prime durations: 100 ms (for unmasked) and 50 ms (for masked). The results showed a significant priming effect only with an SOA of 100 ms, which indicates that the SOA of 50 ms was short enough to produce any priming effect. This conforms to the findings of Plaut (1995). Associative priming with very short prime exposures and visual masking of the prime would be restricted to conditions where that associative link has been established (i.e. within a language; see also Grainger & Beauvillain, 1988).

The results of our study further demonstrated robust facilitative effects for cognate words. This can be explained in terms of the arguments by De Groot (1992a) and De Groot and Nas (1991) that only cognate translations have completely overlapping semantic (conceptual) representations in memory in bilinguals, whereas, non-cognate translations have only partially overlapping semantic representations. This would account for the absence of cross-language associative priming with such stimuli, as the likelihood of semantically associated words from different languages sharing semantic features is smaller in the case of non-cognate translations than cognates.

Another, critical finding in our result is that associative priming effect is significantly modulated by second language age of acquisition of the bilinguals. The result of our study demonstrated associative priming only in case of Early High Proficient bilinguals. This finding can be interpreted with the predictions of the spreading-activation theory. According to Collins and Loftus (1975), "automatic associative priming would result from spreading activation between (non-semantic) lexical representations. In other words, pure associative priming would result from connections between lexical representations that have developed on the basis of co-occurrence of frequency, rather than from connections at the meaning level". Therefore, the results of our study can be explained if we assume words that often occurred together in text or speech would be close together (or strongly linked) in the lexical network of the Early High Proficient bilinguals. An alternative account is the lexical entrenchment explanation, which emphasizes the strength/weakness of the lexical memory representations themselves. According to this explanation, extensive practice with words enhances the entrenchment of lexical representations, which implies faster activation and less interference from similar representations, leading to smaller processing differences between high and low frequency words. To conclude, the findings of the present study provide evidence in support of a pure associative priming effect independently of a pure semantic priming effect for different-script bilinguals. Moreover, it follows that if associative priming without semantic relation is due solely to strategic processes, the effect is larger under conditions that enable strategic processing—that is, when SOAs are long and when unmasked paradigm is used. On the other hand, the effect is null under conditions that obstruct strategic processing—that is, when the masked lexical decision task is used. Moreover, the associative priming effect is largely modulated by the second language age of acquisition of the bilinguals. These results are easily explained if one assumes that associative priming arises not, or at least not principally, through shared modal semantic representations but via language-specific knowledge of familiar word combinations. In the following sections, we examine four lexical decision experiments in which form relatedness between the word pairs was manipulated.

4.3.4 Phonological Priming

One of the key issues in the area of bilingual representation and processing research is the representational status of phonologically similar words. Improved recognition of targets preceded by primes that share phonological similarity with the targets is referred to as phonological or form-based priming. Research on phonological priming has received little attention, in comparison to the vast literature on semantic priming in visual and auditory word recognition (see Neely, 1991, for review). Moreover, while a number of studies have already investigated lexical representation and processing in bilinguals with a focus on their phonological representations, most of these studies have been conducted with bilinguals whose languages use the same script. Evidence for non-selective activation of phonological representation has been provided by the majority of the studies of same-script bilinguals (Dijkstra, Jaarsveld, & Brinke, 1998; Jared & Kroll, 2001; Jared & Szucs, 2002, Haigh & Jared, 2007) and by somewhat limited number of studies of different-script bilinguals (Gollan et al., 1997; Kim & Davis, 2003; and Nakayama, Sears, Hino, & Lupker, 2012). Moreover, non-selective activation of phonological information has been consistent across various tasks such as word naming (Jared & Kroll, 2001; Jared & Szucs, 2002), unmasked lexical decision task (Haigh & Jared, 2007), masked lexical decision tasks (Brysbaert, Van Dyck, & Van de Poel, 1999; Duyck, Drieghe, Diependaele, & Brysbaert, 2004; Nakayama, Sears, Hino, & Lupker, 2012). Taken at face value, activation of phonological representations of both languages in even monolingual experimental situations has been considered by the majority of studies to be one of the crucial evidence in support of the idea that bilingual lexical access is language non-selective. The research presented here examined whether theoretical conclusions drawn from these studies can be generalized to Bodo−Assamese bilinguals, whose two languages use different scripts. Observation of similar cross-language priming effects is expected to occur even in different-script bilinguals if language non-selective activation of phonological information occurs as a result of representations shared between languages.

4.3.4.1 The Present Study

The primary goal of this study was to examine whether Bodo−Assamese bilinguals activate a common phonological representations of both languages when Bodo phonological words prime Assamese targets and also when Assamese phonological words prime Bodo targets. More specifically, the goal of the research was to determine whether the enhanced priming effect would result purely from phonological overlap between primes and targets, or because of meaning overlap between primes and targets. To achieve this, we used both cognates and non-cognate words. Furthermore, to provide stronger evidence that phonological activation is typically not selective for language, we used a task that does not require participants to explicitly activate phonological information, that is, a lexical decision task. Participants were asked to make a lexical decision to target words that were preceded briefly by phonological primes and unrelated primes from the other language in unmasked and masked priming paradigms. The use of phonologically related but orthographically dissimilar cross-language word pairs with a cross-script manipulation aims to reveal pure phonological unmasked and masked priming effect.

We expected to obtain facilitative phonological priming effects in Experiment 4A, 4B, 4C, and 4D when Assamese and Bodo targets were preceded by Bodo and Assamese phonologically related primes respectively, which would be expected in a language non-selective view. The secondary goal of the research was to see examine the role of other parameters such as cognate status of the words as well as the second language AoA and proficiency of the bilinguals on the time course of any priming effects.

4.3.4.2 Unmasked Phonological Priming from L1−L2 (Experiment 4A)

Using an unmasked paradigm, Experiment 4A investigated whether there is cross-language phonological priming in Bodo−Assamese bilinguals. The participants made lexical decisions on Assamese words which were preceded either by a phonologically related or an unrelated control Bodo prime.

4.3.4.2.1 *Method*

Participants. Fifty-two Bodo−Assamese bilinguals with an average age of 31.3 years (*SD* = 8.4) from Ganeshpara and IIT Guwahati participated in this and the following phonological priming experiments. However, there was at least a fifteen-day gap between all the experimental sessions. The order of the sessions was also counterbalanced across participants. All of the participants were native speakers of Bodo (L1) who learned Assamese (L2) as a second language at different ages. All of them were right-handed and had normal or corrected-to-normal vision. They completed a Bodo version of the Language Background Questionnaire (see Appendix C (ii)). A summary of participants' mean proficiencies in Bodo and Assamese are displayed in Table 4.35.

Self-reported measures on a 7-point Likert scale showed that speaking, reading, writing, and comprehension skills were rated as being significantly better in Bodo than in Assamese. Moreover, the ratings for Assamese on all four proficiency measures were higher for the high proficient groups than for the low proficient group.

Table 4.35 Self-Report Ratings in Bodo and Assamese for All Three Bilingual Groups in Experiment 4A

	Bodo (L1)			Assamese (L2)		
	Early (*n* = 20)	Late High (*n* = 17)	Late low (*n* = 15)	Early (*n* = 20)	Late High (*n* = 17)	Late Low (*n* = 15)
Age of acquisition (years)	2	2	3	3.8	10.7	12
Mean daily usage (%)	52.4 %	50.6 %	49.6 %	37.3 %	37.8 %	19.6 %
Self-ratings (7 point scale)						
Speaking	6.5 (0.6)	7	7	6.4 (0.9)	6 (0.9)	5.2
Reading	6.5 (0.6)	7	7	5.8 (0.9)	5.8 (1.0)	3.5 (0.7)
Writing	6.5 (0.6)	6.8 (0.4)	7	5.5 (2.0)	4.2 (1.9)	3
Comprehension	6.2 (0.5)	7	7	4.8 (1.3)	4.5 (2.6)	3 (0.7)

In order to further assess the proficiency levels of the bilinguals, all participants took part in an objective naming test. Table 4.36 provides the mean scores on the objective naming test in both Bodo and Assamese.

Table 4.36 Mean Scores on the Objective Naming Test in Bodo and Assamese for All Three Bilingual Groups in Experiment 4A

Bilingual Group	Bodo	Assamese
Early High Proficient	53.3	47.4
Late High Proficient	54.1	46.5
Late Low Proficient	53.3	34.3

The results of the Objective Naming Test show that the average L1 score for all three bilingual groups is similar. In case of L2, the average score for the Late High Proficient group matches the average score for the Early High Proficient group (46.5 vs. 47.4 respectively) and the scores do not yield a significant difference [$t(49)$ = 1..01, p = .781]. This indicates that the proficiency level of the two groups is similar. However, the average score of the Late High Proficient group is noticeably higher than the average score of the Late Low Proficient group (46.5 vs. 34.3) and the scores yielded a significant difference [$t(48) = 8.04$, $p = .000$].

Stimuli. Twenty Bodo and Assamese word pairs were selected as primes and targets (see Appendix J). Half of the targets were cognate words and the other half were non-cognate words. The cognate and non-cognate words were similar with respect to mean word length and mean frequency. Each Assamese target word (e.g., চৰাই [sorai] *'bird'*) was paired with two types of Bodo word primes: (1) a phonologically related prime (e.g., गराय [gorai] *'horse'*), and (2) an unrelated control prime (e.g.,बेसर [besor]*'mustard'*) (see Appendix J for complete stimuli list). The phonological relatedness between Assamese targets and Bodo primes was assessed in a norming study (see Appendix E (iv)). In addition to the word targets, twenty nonword targets in Assamese were created which were preceded phonologically related and unrelated Bodo primes. Table 4.37 presents an example of a stimulus set.

Table 4.37 Examples of a Stimulus Set Used in Experiment 4A

	Cognate		Non-cognate	
Prime Type	Word	Nonword	Word	Nonword
Phonological	फोथा−কপাল *"bindi−forehead"*	फोथा−মপাল	उथुमाय−পেত *"navel−stomach"*	उथुमाय−ঘেত
Control	जोगोनार−কপাল *"pumpkin−forehead"*	जोगोनार−মপাল	राव−পেত *"language−stomach"*	राव−ঘেত

Note. *फोथा [phwtha]; *কপাল [kopal]; *जोगोनार [zwgwnar], *মপাল [mopal]; *उथुमाय [uthumai]; *পেত [pet]; *राव [rau]; *ঘেত [ghet]

Procedure. Each participant was tested individually in a quiet room. Instructions were provided in Assamese. The task was to make a lexical decision to the target in Assamese. Participants were instructed to make their decisions as quickly and accurately as possible by pressing the 'm' (Yes) or 'z' (No) keys in the keyboard. At the beginning of each trial, a fixation sign (+) was presented for 500ms.

Subsequently, a prime in Bodo was presented for 100 ms. Finally, an Assamese target was presented. The target remained on the display until the participant made a response or for a maximum of 2,000 ms. Reaction times were measured from target onset until participant's response. Participants completed fifteen practice trials to familiarize themselves with the task prior to the main experimental trials. The session was divided into two blocks: (1) phonologically related and (2) phonologically unrelated. The order of stimuli within a block was randomized for each participant.

4.3.4.2.2 Results

Outliers were removed and the mean reaction times for correct responses on the Assamese targets and the mean error rates were analyzed using mixed-effects analysis. Table 4.38 presents the mean reaction times and percentage of errors as a function of Prime Type and Cognate Status.

Table 4.38 Mean RTs (ms) and Percentage of Errors for Cognate and Non-Cognate Targets Primed by Phonologically Related and by Unrelated Control Primes in Experiment 4A

		Cognate Status		
	Overall	Cognate	Non-cognate	
Prime Type	RT (Error %)	RT (Error %)	RT (Error %)	**Cognate effect**
Phonological	924 (15.4)	949 (20.4)	899 (11.5)	**−50**
Control	876 (12.9)	894 (14.1)	859 (11.5)	**−35**
Priming	**−48**	**−55**	**−40**	

In the reaction time data, the main effect of Prime Type was marginally significant [$F(1,36) = 2.446$, $p = .18$]. However, the priming effect was inhibitive as lexical decisions to the targets primed by phonologically related primes were slower (924 ms) compared to the targets primed by unrelated primes (876 ms). Although, responses to cognate words (921 ms) were slower than to non-cognate words (879 ms), the main effect of Cognate Status did not approach significance [$F(1,36) = 1.926$, $p = .174$]. However, the main effect of Bilingual Group was significant [$F(2,49) = 6.165$, $p = .004$]. There was a significant interaction between Cognate Status and Bilingual Group [$F(2,1847) = 14.561$, $p = .000$]. The interaction between Prime Type and Bilingual Group was also significant [$F(2,1847) = 5.633$, $p = .004$]. The three-way interaction also approached significance [$F(2,1847) = 10.427$, $p = .000$].

To evaluate the significant interaction between Bilingual Group and other variables, separate planned interaction contrasts were carried out to assess the phonological priming effects for each of the three Bilingual Groups. In general, the Early High Proficient bilinguals responded to targets significantly faster (812 ms) than the Late High Proficient (920 ms) and Late Low Proficient (968 ms) bilinguals. However, no phonological priming effect was observed for Early High Proficient and Late High Proficient bilinguals. For these bilinguals, phonologically related primes produced inhibition rather than facilitation as compared to unrelated primes. A significant phonological priming effect of 18 ms was evident only for the Late Low Proficient bilinguals, in which participants responded faster to targets that were primed by phonologically related primes (900 ms) compared to unrelated primes (918 ms). Table 4.39 presents the mean reaction times and percentage of errors as a function of Prime Type, Cognate Status, and Bilingual Group.

Results of the error data did not reveal a main effect of Prime Type [$F < 1$]. The main effect of Cognate Status approached significance [$F(1,36) = 5.734$, $p = .001$]. Non-cognate targets were responded to more accurately as compared to cognate targets. The main effect of Bilingual Group approached significance in the error analysis [$F(2,49) = 8.390$, $p = .000$]. Moreover, there was a significant interaction between Cognate Status and Bilingual Group [$F(2,1847) = 5.413$, $p = .000$]. For the cognate targets, fewer errors were observed for the Late High Proficient bilinguals than the Late Low Proficient and Early High Proficient bilinguals; on the other hand, for the non-cognate targets, fewer errors were numerous for the early bilinguals as compared to the late bilinguals.

Lastly, comparisons of the nonword data were conducted. Analyses of the mean reaction times to nonwords showed that the participants took significantly longer to respond to nonwords (1162ms) than to words (904 ms).

Table 4.39 Mean RTs (ms) and Percentage of Errors for Cognate and Non-Cognate Targets Primed by Phonologically Related and by Unrelated Control Primes for All Three Bilingual Groups in Experiment 4A

	Cognate Status/Bilingual Group					
	Cognate			Non-cognate		
	Early	Late high	Late low	Early	Late high	Late low
Prime Type	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)
Phonological	835 (36.1)	936 (9.4)	1077 (23.5)	874 (25.6)	923 (4.6)	900 (4.8)
Control	798 (30.6)	904 (7.5)	978 (5.9)	741 (25.6)	919 (3.1)	918 (9.5)
Priming	**−37**	**−32**	**−99**	**−133**	**−4**	**18**

4.3.4.2.3 Discussion

The overall results of the present study showed that the response latencies for Assamese targets were not facilitated when they were primed with phonologically related Bodo words. Moreover, participants made more errors in the phonologically related condition compared to the unrelated condition. However, a reliable phonological priming effect was observed in case of the Late Low Proficient bilinguals which suggest that such an effect is modulated by L2 proficiency. The result of our study can be interpreted in terms of the argument that if the bilinguals are low proficient in L2, their reliance on phonological information during lexical decision-making tends to increase.

4.3.4.3 Unmasked Phonological Priming from L2−L1 (Experiment 4B)

Experiment 4B further sought to determine the extent to which phonological similarity facilitates lexical decision responses to targets in a cross-language unmasked priming paradigm using different-script languages.

***4.3.4.3.1** Method*

Participants. The same group of participants from Experiment 4A took part in this experiment.

Stimuli. The Assamese words that served as targets in Experiment 4A were now used as primes. Accordingly, the Bodo primes from Experiment 4A were now presented as targets. An additional set of 20 orthographically legal nonwords in Bodo (e.g.,) pair-wise matched to the target words were also created for this experiment.

Procedure. The same procedure as in Experiment 4A was followed. Verbal and written instructions to the participants were given in Bodo.

***4.3.4.3.2** Results*

A mixed-effects analysis was run on the reaction time data and error data separately after removing outliers. For the reaction times, the main effect of Prime Type tended towards significance [$F(1,36) = 3.093$, $p = .087$]. Lexical decisions to Bodo targets primed by phonologically similar Assamese words were slower (853 ms) compared to lexical decisions to targets primed by unrelated Assamese words (810 ms). The main effects of Cognate Status and Bilingual Group did not reach significance [*F*s <

1]. However, there was a significant three-way interaction for response latencies [$F(2,1828) = 14.868$, $p = .000$]. Table 4.40 presents the mean reaction times and percentage of errors for both cognate and non-cognate targets in phonological and control conditions.

Table 4.40 Mean RTs (ms) and Percentage of Errors for Cognate and Non-Cognate Targets Primed by Phonologically Related and by Unrelated Control Primes in Experiment 4B

		Cognate Status		
	Overall	Cognate	Non-cognate	
Prime Type	RT (Error %)	RT (Error %)	RT (Error %)	**Cognate effect**
Phonological	853 (8.8)	846 (8.3)	861 (9.1)	**15**
Control	810 (5.8)	793 (4.6)	827 (6.9)	**34**
Priming	**−43**	**−53**	**−34**	

Planned comparisons were carried out to assess the phonological priming effects for each of the three Bilingual Groups. The overall response latencies of three groups of bilinguals indicate that, the Early High Proficient bilinguals responded to targets significantly faster (768 ms) than the Late High Proficient (832 ms) and Late Low Proficient (894 ms) bilinguals. Moreover, for the Early High Proficient and Late High Proficient bilinguals, no phonological priming effect was observed. In this condition, phonologically related primes produced inhibition rather than facilitation as compared to unrelated primes. However, the Late Low Proficient bilinguals produced a phonological priming effect of 11 ms for the non-cognate words. These participants responded faster to targets that were primed by phonologically related primes (905 ms) compared to unrelated primes (916 ms). Table 4.41 presents the mean reaction times and percentage of errors as a function of Prime Type, Cognate Status, and Bilingual Group.

In the mixed-effects analysis on the error data, the main effect of Prime Type tended towards significance [$F(1,36) = 2.341$, $p = .045$]. Participants recognized Bodo targets preceded by unrelated control primes more accurately than those preceded by Assamese phonologically related words. The main effect of Cognate Status was not significant, and neither was the interaction between Prime Type and Cognate Status [all *F*s < 1]. However, the main effect of Bilingual Group approached significance in the error analysis [$F(2,49) = 4.612$, $p = .000$]. Moreover, there was a significant interaction between Cognate Status and Bilingual Group [$F(2,1847) = 3.413$, $p = .001$]. For cognate targets, errors were numerous for the high proficient bilinguals and for non-cognate targets, errors were numerous for the low proficient bilinguals. Lastly, comparison of the nonword data was conducted. Analyses of the mean reaction times to nonwords showed that the participants took significantly longer to respond to nonwords (1021 ms) than to words (815 ms).

Table 4.41 Mean RTs (ms) and Percentage of Errors for Cognate and Non-Cognate Targets Primed by Phonologically Related and by Unrelated Control Primes for All Three Bilingual Groups in Experiment 4B

	Cognate Status/Bilingual Group					
	Cognate			Non-cognate		
	Early	Late high	Late low	Early	Late high	Late low
Prime Type	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)
Phonological	764 (8.3)	824 (9.4)	949 (5.9)	809 (9.3)	870 (7.7)	905 (14.3)
Control	755 (5.6)	816 (3.8)	807 (5.9)	744 (6.9)	820 (6.2)	916 (9.5)
Priming	**−9**	**−8**	**−142**	**−65**	**−50**	**11**

4.3.4.3.3 Discussion

The results of this experiment produced results similar to Experiment 4A. The overall results revealed no cognate facilitation effect and no phonological priming effect. Moreover, participants made more errors in the phonologically related condition compared to the unrelated condition. Only in case of Late Low Proficient bilinguals, reaction times for Bodo non-cognate targets were facilitated when they were primed with phonologically related Assamese words. The findings of the study suggest that L2 proficiency does have a major impact on the phonological priming effect.

4.3.4.3.4 Combined Analysis of Experiment 4A and 4B

To test for differences between translation priming in both directions, we analyzed the data from Experiment 4A and 4B in one design using a mixed-effects analysis. The results of the combined analysis showed that the main effect of Target Language was significant [$F(1,3770) = 96.478$, $p = .000$]. Reaction times were faster for Bodo targets (829 ms) than for Assamese targets (900 ms). The interaction between Cognate Status and Target Language approached significance [$F(1,3761) = 17.409$, $p = .000$]. The Bilingual Group and Target Language interaction was marginal [$F(2,3799) = 2.772$, $p = .063$]. This interaction is shown in Figure 4.10. The three-ways interaction between Cognate Status, Bilingual Group and Target Language approached significance [$F(2,3756) = 6.469$, $p = .002$]. The Prime Type, Bilingual Group and Target Language [$F(2,3756) = 3.126$, $p = .044$] tended towards significance.

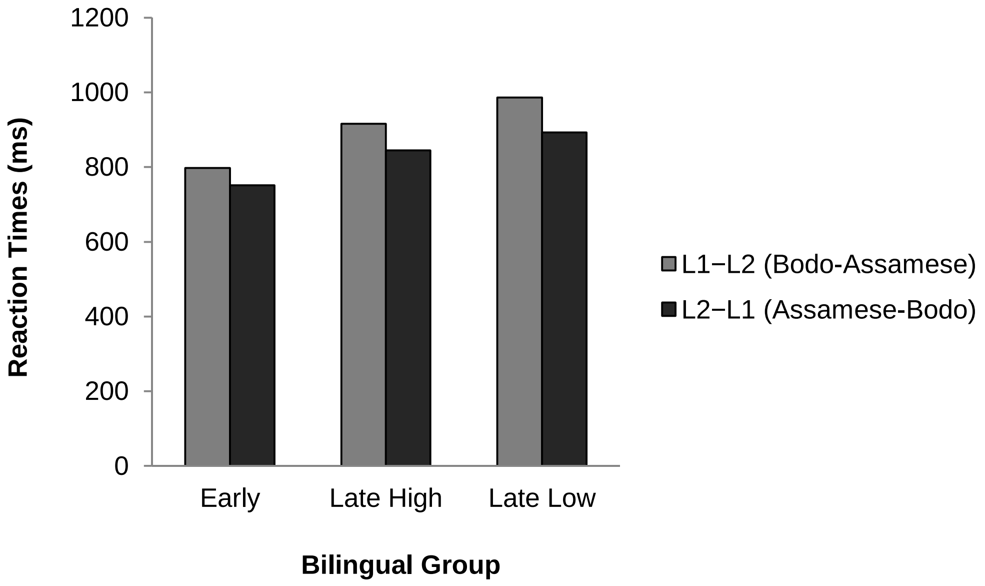


Figure 4.9 Mean RTs (ms) as a function of Bilingual Group and Target Language in 4A and 4B.

4.3.3.4 Masked Phonological Priming from L1−L2 (Experiment 4C)

The purpose of this was to determine if a cross-script phonological priming effect would be observed for different-script bilinguals using a lexical decision task with masked primes, and if so, whether such an effect would be modulated by L2 proficiency. It is assumed that the masked paradigm will provide further information on the time course of the phonological priming effect.

4.3.3.4.1 *Method*

Participants. The participants of this experiment were the same Bodo−Assamese bilinguals who took part in Experiment 4A and 4B.

Stimuli. The stimuli were identical to Experiment 4A.

Procedure. In this experiment, the same procedure adopted for Experiment 4A was utilized. However, one major difference from Experiment 4A was that, in this experiment a mask intervened between the prime and the target.

4.3.3.4.2 *Results*

A mixed-effects analysis was run on the reaction time data and error data separately. In the reaction time data, the main effect of Prime Type was significant [$F(1,36) = 16.032$, $p = .000$]. Similar to the results in Experiment 4A and 4B, the numerical comparisons indicated that reaction times were slower in the phonological (1035 ms) than in the unrelated control (908 ms) condition. The main effect of Cognate Status was not significant [$F < 1$]. The mean reaction times for the cognate (983 ms) words were greater than for the non-cognate (960 ms) words. However, the interaction between Prime Type and Bilingual Group was significant [$F(2,1734) = 21.842$, $p = .000$]. The three-way interaction between Prime Type, Cognate Status, and Bilingual Group approached significance [$F(2,1731) = 6.715$, $p = .001$]. Table 4.42 presents the mean reaction times and percentage of errors as a function of Prime Type and Cognate Status.

Table 4.42 Mean RTs (ms) and Percentage of Errors for Cognate and Non-Cognate Targets Primed By Phonologically Related and By Unrelated Control Primes in Experiment 4C

		Cognate Status		
	Overall	Cognate	Non-cognate	
Prime Type	RT (Error %)	RT (Error %)	RT (Error %)	**Cognate effect**
Phonological	1035 (14.6)	1070 (17.6)	998 (12.2)	**−72**
Control	908 (9.6)	895 (12.3)	921 (7.6)	**26**
Priming	**−127**	**−175**	**−77**	

Further planned comparisons performed on the individual priming effects for the three groups of bilinguals revealed an effect of second language age of acquisition and proficiency on the data. The reaction times of the Late High Proficient bilinguals (1010 ms) were longer than the Late Low Proficient (961 ms) and Early High Proficient bilinguals (942 ms). Moreover, none of the bilingual groups produced any cognate facilitation effect. The mean reaction times and percentage of errors as a function of Prime Type, Cognate Status, and Bilingual Group are presented in Table 4.43.

Results of the error data revealed a significant main effect of Prime Type [$F(1,36) = 10.523$, $p = .000$]. Targets were responded to more accurately when they were primed by unrelated controls as compared to when they were primed by phonologically related words. The error data also revealed a significant main effect of Cognate Status [$F(1,36) = 5.118$, $p = .000$]. Errors were numerous for cognate targets than for non-cognate targets. The main effect of Bilingual Group approached significance in the error analysis [$F(2,49) = 9.723$, $p = .000$]. Greater errors were observed for the early bilinguals and fewer errors were observed for the late bilinguals. Moreover, there was a significant interaction between Cognate Status and Bilingual Group [$F(2,1847) = 7.021$, $p = .000$]. Lastly, comparisons of the nonword data were conducted. Analyses of the mean reaction times to nonwords showed that the participants took significantly longer to respond to nonwords (1248ms) than to words (961 ms).

Table 4.43 Mean RTs (ms) and Percentage of Errors for Cognate and Non-Cognate Targets Primed By Phonologically Related and By Unrelated Control Primes for All Three Bilingual Groups in Experiment 4C

	Cognate Status/Bilingual Group					
	Cognate			Non-cognate		
	Early	Late high	Late low	Early	Late high	Late low
Prime Type	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)
Phonological	979 (30.6)	1146 (11.3)	1084 (11.8)	949 (27.9)	1081 (6.2)	965 (0)
Control	915 (16.7)	922 (7.5)	849 (17.6)	925 (18.6)	890 (3.1)	947 (0)
Priming	**−64**	**−224**	**−235**	**−24**	**−191**	**−18**

4.3.3.4.3 Discussion

The results of this experiment revealed no phonological priming effect when a masked priming paradigm was used. This finding is in line with the results of the translation priming, cross-language semantic priming and cross-language associative priming.

4.3.3.5 Masked Phonological Priming from L2−L1 (Experiment 4D)

To further explore the time course of the cross-script phonological priming effect, Experiment 4D was designed to examine whether such effect would be modulated by the target language.

4.3.3.5.1 Method

Participants. The same subjects from Experiment 4A, 4B, and 4C participated in the present experiment.

Stimuli. The stimuli and design were the same as that used in Experiment 4B. The same Assamese primes and Bodo target words presented in Experiment 4B, were presented in this Experiment.

Procedure. The presentation of stimuli was identical to Experiment 4C.

4.3.3.5.2 Results

A mixed-effects analysis was run on the reaction time data and error data separately. Table 4.44 gives the mean reaction times and percentage of errors for the cognate and non-cognate targets in the two conditions (phonologically related and unrelated control).

Table 4.44 Mean RTs (ms) and Percentage of Errors for Cognate and Non-Cognate Targets Primed By Phonologically Related and By Unrelated Control Primes in Experiment 4D

		Cognate Status		
	Overall	Cognate	Non-cognate	
Prime Type	RT (Error %)	RT (Error %)	RT (Error %)	**Cognate effect**
Phonological	863 (8.8)	862 (8.3)	863 (9.2)	**1**
Control	838 (7.5)	851 (8.3)	825 (6.9)	**−26**
Priming	**−25**	**−11**	**−38**	

Analysis of the reaction time data showed that the interaction between Prime Type and Bilingual Group approached significance [$F(2,1809) = 21.945$, $p = .000$]. There was also a significant interaction between Cognate Status and Bilingual Group

[F(2,1809) = 7.313, p = .001]. The three-way interaction between Prime Type, Cognate Status and Bilingual Group tended towards significance [F(2,1809) = 2.979, p = .019].

As in the previous experiments, planned comparisons were performed on the individual priming effects for the three groups of bilinguals. The results revealed significant magnitudes of facilitation for only the Late Low Proficient bilinguals. Significant phonological priming effects of 99 ms and 25 ms were obtained for cognate and non-cognate targets respectively and greater magnitude of facilitation for cognates indicates a cognate priming advantage. Moreover, significant cognate facilitation effects of 16 ms and 65 ms were observed in case of Late High Proficient and Low Proficient bilinguals respectively. The mean reaction times and percentage of errors as a function of Prime Type, Cognate Status, and Bilingual Group are presented in Table 4.45.

Table 4.45 Mean RTs (ms) and Percentage of Errors for Cognate and Non-Cognate Targets Primed By Phonologically Related and By Unrelated Control Primes for All Three Bilingual Groups in Experiment 4D

	Cognate Status/Bilingual Group					
	Cognate			Non-cognate		
	Early	Late high	Late low	Early	Late high	Late low
Prime Type	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)
Phonological	909 (16.7)	855 (3.8)	824 (5.9)	829 (11.6)	871 (6.2)	889 (14.3)
Control	851 (11.1)	781 (7.5)	923 (5.9)	807 (13.9)	755 (1.5)	914 (9.5)
Priming	**−58**	**−74**	**99**	**−22**	**−116**	**25**

In the mixed-effects analysis on the error data, the main effect of Prime Type was not significant [F < 1]. The main effect of Cognate Status was not significant, and neither was the interaction between Prime Type and Cognate Status [all Fs < 1]. However, the main effect of Bilingual Group approached significance in the error analysis [F(2,49) = 10.729, p = .000].

Moreover, there was a significant interaction between Cognate Status and Bilingual Group [$F(2,1847) = 6.421$, $p = .001$]. For cognate targets, errors were numerous for the early bilinguals than the late bilinguals, and for non-cognate targets, errors were numerous for the Early High proficient and Late Low Proficient bilinguals than the Late High Proficient bilinguals. Lastly, comparison of the nonword data was conducted. Analyses of the mean reaction times to nonwords showed that the participants took significantly longer to respond to nonwords (1117 ms) than to words (832 ms).

***4.3.3.5.3** Discussion*

The overall result of Experiment 4C demonstrated no facilitation when Bodo cognate and non-cognate words were preceded by masked phonological primes. However, in accordance with the results of Experiment 4A and 4B, only low proficient bilinguals exhibited significant phonological priming effects. Interestingly, the size of the effect was much stronger compared to the effects observed in Experiment 4A and 4B.

***4.3.3.5.4** Combined Analysis of Experiment 4C and 4D*

To test for differences between translation priming in both directions, we analyzed the data from Experiment 4C and 4D in one design using a mixed-effects analysis. The combined analysis of the reactions times revealed a significant main effect of Target Language [$F(1,3622) = 265.578$, $p = .000$]. Reaction times were faster when the participants responded to Bodo targets (851 ms) than when the participants responded to Assamese targets (971 ms). The interaction between Prime Type and Target Language approached significance [$F(1,3621) = 44.127$, $p = .000$]. There was also a significant interaction between Bilingual Group and Target Language [$F(2,3621) = 26.365$, $p = .000$]. This interaction is shown in Figure 4.11.

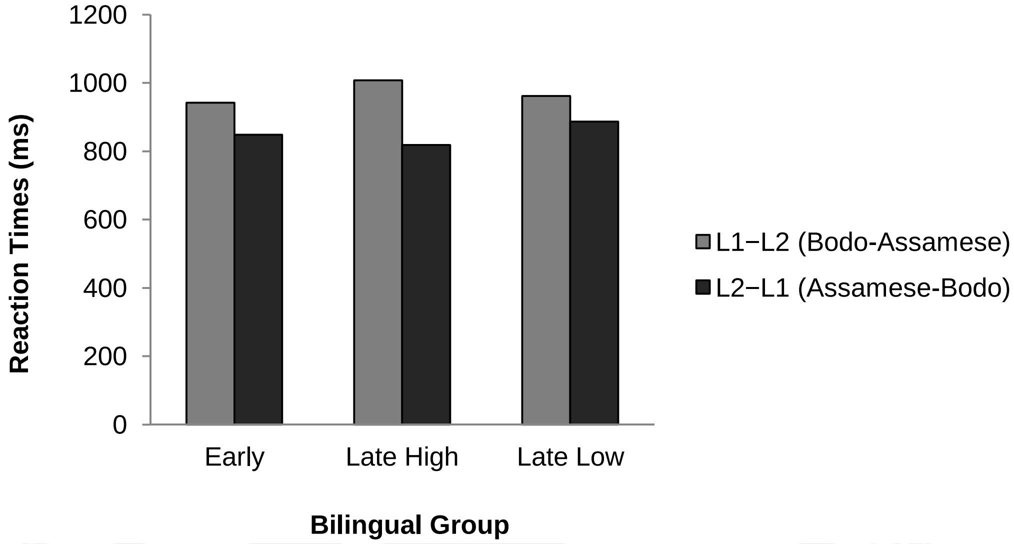


Figure 4.10 Mean RTs (ms) as a function of Bilingual Group and Target Language in Experiment 4C and 4D.

The three-way interaction between Prime Type, Cognate Status and Target Language also approached significance [$F(1,3620) = 15.139$, $p = .000$]. The Cognate Status, Bilingual Group and Target Language interaction tended towards significance [$F(2,3619) = 4.556$, $p = .011$].

4.3.3.6 General Discussion

The purpose of this experiment was to determine if a cross-script phonological priming effect would be observed for different-script Bodo−Assamese bilinguals using a lexical decision task in unmasked and masked conditions, and if so, whether such an effect would be modulated by L2 age of acquisition and proficiency. We hypothesized that if the phonological representations for a bilingual's two languages are integrated even though those languages use different scripts, then a phonological priming effect would be effect, i.e., lexical decision performance should be facilitated when target words are primed by phonologically related words, relative to when the same targets are primed by unrelated words. On the other hand, if the phonological representations for the two languages are separate, then there should be no phonological priming effect. Moreover, we assumed that if L2 proficiency of the bilinguals plays a major role on the processing of targets, then larger priming effects would be expected for low proficient bilinguals than for high proficient bilinguals. If the non-selective view is also true for Bodo−Assamese bilinguals, it is expected that the reaction times for the related condition should be faster than for the unrelated condition, since phonological activation of Bodo words should facilitate the processing of similar sounding Assamese words. The following paragraphs will summarize the findings and discuss the results in accordance with each of the variables: cognate status, bilingual group and target language.

The overall findings of the reaction time from the unmasked priming experiments (Experiment 4A and 4B) showed that responses to target words were not facilitated when they were preceded by a similar sounding prime word from the other language. However, there was a small priming effect for the Late Low Proficient bilinguals in the non-cognate condition. The results from the masked priming experiments revealed similar trends. However, this time, significant priming effects for the Late Low Proficient bilinguals were observed in both cognate and non-cognate conditions. The results of our study provided evidence in support of the idea that bilingual lexical access is language non-selective based on findings that bilinguals activate phonological representations of both languages even when using only one of them. However, it is important to note that such simultaneous activation of phonological representations does not occur in all circumstances. One of the circumstances is that, the language of response modulated the phonological priming effect—influence of phonological activation from L2 was usually stronger compared to activation from L1. This finding can be explained by the interpretations of the RHM.

We also examined the question of whether the degree of phonological facilitation was greater when proficiency in L2 was low, as suggested by Gollan et al. (1997). The results of our study demonstrated a clear impact of L2 proficiency on the phonological priming effect—only the Late Low Proficient bilinguals exhibited significant priming effects in both unmasked and masked conditions. The magnitude of the effect was however greater in the masked condition. Gollan et al. (1997) argued that the cognate advantage increased for these participants because reliance on phonological information during lexical decision-making tends to increase if bilinguals are less proficient in L2. Taken together, these significant differences between high and low proficient bilinguals suggest that phonological priming effects differ considerably in their sensitivity to L2 proficiency. Moreover, the results of our study showed that phonological priming effect is independent of the priming paradigm. This finding suggests that when a masked prime is presented, its phonological representation appears to be activated automatically regardless of the differences between the two languages' scripts, leading to a facilitation of target processing, if the prime and target (partially) share phonology.

To conclude, the present study showed evidence for cross-script phonological priming effect using Bodo−Assamese bilinguals. The most straightforward interpretation of the phonological priming observed in the present study is that phonological representations are shared across languages, even when orthographic representations are not. Thus, the present research has added to the growing body of evidence showing that phonological processing in bilinguals occurs in language non-selective manner regardless of what script the two languages use. This pattern also led Dimitropoulou et al. (2011) to suggest that phonological priming effects may be more readily observed with languages that do not share orthographies, because orthographic competition between primes and targets with similar orthographies may make it difficult to observe a facilitative phonological priming effect. Our results, obtained using languages with completely different scripts (Devanagari and Assamese), support this suggestion. The more important point is that our results clearly support the view that a bilingual's phonological representations are integrated even when the two scripts are quite different. However, it is still questionable whether the cognate status of the word can have an impact on the phonological facilitation. Further studies are required to find out why some primes show clear priming effect while others do not. Our results also showed that the phonological priming effect is largely modulated by target language and L2 proficiency. We conclude that phonological activation plays much the same role in visual word recognition for different-script bilinguals as it does for same-script bilinguals and monolinguals.

In the experiments discussed above, we examined bilingual lexical representation using a priming paradigm. Typically, we used a lexical decision task to examine cross-language semantic and form priming under conditions where the prime and target words were translation equivalents, semantically related, associatively related, and phonologically related. These studies have systematically found that given sufficient processing time, priming is found across languages. However, the standard assumption has been that priming will index aspects of lexical organization when the processing task specifically involved a lexical judgement. In the section that follows, we used a semantic categorization task which necessarily requires retrieval of semantic information to be successfully performed.

4.4 Semantic Categorization Task

A semantic categorization task, which is used to examine how categories and their exemplars are organized in memory, has been reported to elucidate the relationship between L1 and L2 lexical representations. In this task, participants are presented with prime and target words in the same manner as in traditional semantic priming; however rather than making a lexical decision, participants must determine if the words belong to a specific category (Schreuder & Weltens, 1993). Like lexical decision tasks, semantic categorization tasks have also been used in semantic priming research in both L1 (Frenck-Mestre & Bueno, 1999; Bueno & Frenck-Mestre, 2002; Forster & Hector, 2002) and L2 (Sánchez-Casas et al., 1992; Grainger & Frenck-Mestre, 1998; Alvarez et al., 2003; Finkbeiner et al. 2004; Phillips, Segalowitz, O'Brien, & Yamasaki, 2004).

Recently, this task has become the focal point of much discussion because the outcomes of studies employing these task differ from outcomes of studies that employ lexical decision tasks previously reported, suggesting task difference (Grainger & Frenck-Mestre, 1998; Finkbeiner et al., 2004). These two studies observed that when a semantic categorization task was used robust masked translation priming effects were produced for non-cognates in the L2−L1 direction, but when a lexical decision task was used no such effects were observed, which is in line with several other researchers. However, in a semantic categorization task, Sánchez-Casas et al. (1992), observed no masked L2–L1 translation priming unless the translation pairs were cognates. Wang and Forster (2010) reported the results of several semantic categorization experiments to test several assumptions of the Sense Model. They argued that the priming asymmetry in lexical decision was not due to differential degrees of semantic activation of the prime in L1 and L2.

Therefore, based on the findings of the research presented above, it appears that the finding that asymmetry present in lexical decision is absent in semantic categorization appears to be quite inconsistent. A comparison of these studies reveals several differences in the methodology that could have produced the contradictory findings. To further account for the translation asymmetry and task effect in the masked priming literature, the present study used a masked semantic categorization task in Bodo−Assamese bilinguals.

4.4.1 The Present Study

The present study is an adaptation of Sánchez-Casas et al.'s (1992) study. However, some changes were adopted: (1) the repetition priming condition was not used, (2) different-script bilinguals were used, and (2) the role of age of acquisition and proficiency of the Bodo−Assamese bilinguals was considered. The purpose of the present study was (1) to confirm the task difference between semantic categorization and lexical decision in masked L2–L1 translation priming, originally reported by Grainger and Frenck-Mestre (1998), (2) to examine whether masked translation priming effects for both cognate and non-cognate translation equivalents are similar, and (3) to test theoretical account of masked translation priming that at once is able to accommodate the task difference, the masked translation priming asymmetry, and the robust L1−L2 masked priming effects.

Under the assumption that L2 primes are processed at the semantic level in both semantic categorization and lexical decision and that a bilinguals' two languages have a common conceptual component, the Sense Model argues that translation priming depends on the ratio of primed to unprimed semantic senses associated with the target. Since the ratio in the L1−L2 direction is conceivably larger than in the L2−L1 direction because L1 usually has more senses than L2, L2−L1 priming is not as effective and significant in lexical decision task. However, the category information in semantic categorization can enhance the effectiveness of L2 primes by filtering out L1 senses unrelated to the pre-specified category information, which increases the ratio in L2-L1. The present study, therefore, provided a further test of masked translation priming effects for both cognate and non-cognate translation equivalents. Due to differences in methodology opted in several previous studies, the present experiment maximizes the probability of observing an effect by testing three group of bilinguals differing on their L2 AoA and proficiency on the one hand, and using both cognates and non-cognates on the other.

4.4.2 Semantic Categorization from L1−L2 (Experiment 5A)

In Experiment 5A, participants saw prime-target word pairs on a computer screen and were asked to decide if the second word (target in Assamese) is a member of a specific semantic category. We were interested in participants' reaction times and percentage of errors with which they are able to categorize each target word as a member of a given category. Evidence of translation priming will be obtained in this task if participants' responses to the exemplar targets preceded by translation primes are facilitated in comparison to their responses to exemplar targets preceded by control primes.

4.4.2.1 Method

Participants. A total of fifty-four Bodo−Assamese bilinguals with an average age of 29.2 years (*SD* = 14.1) from Bathoupuri School, Hagzer Bhawan and Bathoupuri participated in this and the following experiment. All participants were native speakers of Bodo and used Assamese as their second language. They were selected on the basis of information about their language history obtained using a questionnaire and objective naming test. Table 4.46 presents the self-report ratings of the three groups of bilinguals for both Bodo and Assamese.

The results of the self-report ratings show that the Bodo ratings of the three groups of bilinguals on all four proficiency measures are similar. However, the Assamese ratings on all four proficiency measures are higher for the high proficient groups than for the low proficient group. In order to further assess the proficiency levels of the bilinguals, all participants took part in an objective naming test. Table 4.47 provides the mean scores on the objective naming test in both Bodo and Assamese.

Table 4.46 Self-Report Ratings in Bodo and Assamese for All Three Bilingual Groups in Experiment 5A

	Bodo (L1)			Assamese (L2)		
	Early (*n* = 22)	Late High (*n* = 14)	Late low (*n* = 18)	Early (*n* = 22)	Late High (*n* = 14)	Late Low (*n* = 18)
Age of acquisition (years)	3.8	2	4.3	3.5	9	8.5
Mean daily usage (%)	18 %	40.3 %	31.9 %	19.2 %	10.6 %	16.8 %
Self-ratings (7 point scale)						
Speaking	6.7 (0.8)	7	6 (1.4)	6.3 (1.2)	6	4.8 (0.9)
Reading	6.7 (0.8)	7	6.8 (0.5)	6.3 (1.2)	6	3 (1.4)
Writing	6.5 (0.8)	7	6 (1.4)	5 (2.6)	4.8	2 (1.2)
Comprehension	6 (1.3)	7	4.5 (2.6)	5 (2.6)	4.8	1.5 (1)

Table 4.47 Mean Scores on the Objective Naming Test in Bodo and Assamese for All Three Bilingual Groups in Experiment 5A

Bilingual Group	Bodo	Assamese
Early High Proficient	48.5	45.2
Late High Proficient	47.2	46.2
Late Low Proficient	45.4	36.5

The results of the Objective Naming Test show that the average L1 score for all three bilingual groups is similar. In case of L2, the average score for the Late High Proficient group matches the average score for the Early High Proficient group (46.2 vs. 45.2 respectively) and the scores do not yield a significant difference [$t(51) = 1.05$, $p = .162$]. This indicates that the proficiency level of the two groups is similar. However, the average score of the Late High Proficient group is noticeably higher than the average score of the Late Low Proficient group (46.2 vs. 36.5) and the scores yielded a significant difference [$t(51) = 9.03$, $p = .000$].

Stimuli. As in the lexical decision experiments, prime-target word pairs were used in this task as well. The critical items belonged to two different categories (*fruit* and *animal*). Altogether, forty Assamese words were selected as targets which required a “Yes” response. These targets consisted of two types of words—cognate translation and non-cognate translations. Two different priming conditions have been used for cognate and non-cognate translation:

1. A *translation* condition, where the prime for each target word was similar in form (e.g., गाद’-গাধ ‘*donkey*’/सैमा-কুকুৰ ‘*dog*’).
2. A *form control* condition, where the target word was preceded by a nonword which showed the same form overlap as the cognate or non-cognate pair (e.g.लाद’-গাধ/गैमा-কুকুৰ). Thus, any facilitation observed could not be attributed simply to form overlap.

For each word type, translation equivalent primes preceded half of the targets and form control primes which were unrelated to the targets preceded the other half of the targets. Both these targets were "exemplar" targets, requiring a "YES" response when presented in the respective category. Before each block containing mask-prime-target strings (see procedure below), a category was presented. For example, a "YES" response to the target word কুকুৰ [kukur] '*dog*' would have been preceded by a category such as জন্তু [zontu] '*animal*'. Other semantic category used was fruit. The remainder of the task included another set of Assamese words which were used as targets requiring a "NO" response when presented in the respective categories. These non-exemplar words were matched to the exemplar targets in frequency and word length and just like the exemplar targets, these targets and were also primed in a similar manner with translation equivalent prime (e.g. जौ [zwu]–মদ [mod] '*wine*') and form control prime (e.g. लाद' [lado]–মদ [mod]). All exemplar and non-exemplar prime-target pairs were randomized and then presented to the participants blocked by semantic category (e.g. "fruits", "animals"). Table 4.48 shows an example of a stimulus set.

Table 4.48 Examples of a Stimulus Set Used in Experiment 5A

Priming Condition	Exemplars	Non-exemplars
<u>Cognate</u>		
Cognate translation	गाद'-গাধ	जौ-মদ
Control	लाद'-গাধ	लाद'-মদ
<u>Non-cognate</u>		
Non-cognate translation	सैमा-কুকুৰ	रुवा-কুঠাৰ
Control	गैमा-কুকুৰ	गैमा-কুঠাৰ

Note. *गाद' [gado]; *গাধ [gadho]; *लाद' [lado]; *सैमा [swima]; *কুকুৰ [kukur]; *गैमा [gwima]; *जौ [zwu]; *মদ [mod]; *रुवा [ruwa]; *কুঠাৰ [kuthar]

For each category, there were ten exemplar and ten non-exemplar trials. This resulted in a total of forty ''Yes'' items (twenty per category) and forty "No" items. The SOA between the first and the second item of the pair was very brief, and the prime was preceded by a mask, so participants may not be aware of its presence.

Two versions of the experiments were constructed so that each target appeared in each of the priming conditions without being repeated within a version (see Appendices K (i) and K (ii) for complete list of stimuli). A set of fifteen practice items was constructed and preceded the experimental materials.

Procedure. Participants were told that they will see the name of a semantic category followed by several pair of words. They were then instructed to indicate, by pressing a response key as quickly and as accurately as possible, whether the second word in each pair was a member of the given semantic category. Each trial consisted of the following sequence: First, a category was presented for 500 ms. Then, the participants were presented with a forward mask of ten hash marks (##########) for 500 ms, followed by a Bodo prime (translation or form control) for 50 ms, and then the Assamese target word appeared and remained on the screen until the participants responded or for a maximum of 2,000ms (see Figure 4.12).

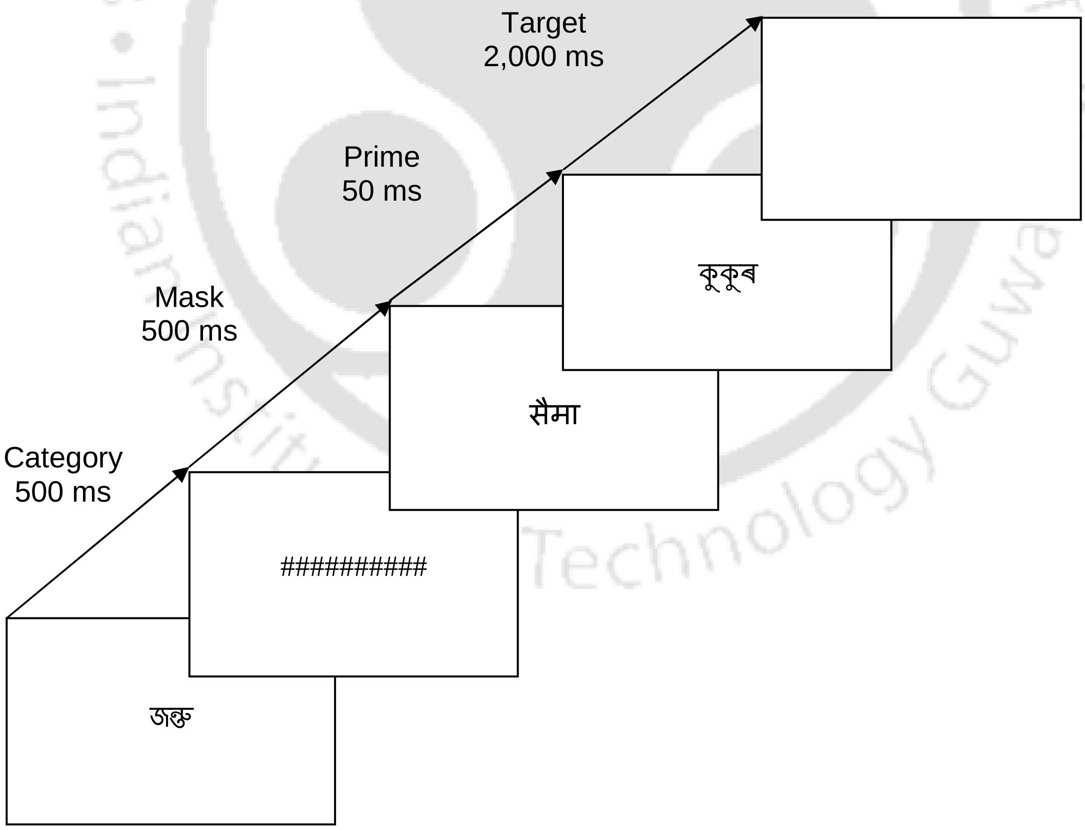


Figure 4.11 A schematic illustration of stimuli presentation in the block of “animal” in Experiment 5A.

4.4.2.2 Results

Reaction times represent data from “yes” trials only. A mixed-effect analysis was performed with Prime Type, Cognate Status, and Bilingual Group as the independent variables. The results of Experiment 5A did not reveal a main effect of Prime Type [$F(1,34) = 2.139$, $p = .153$]. Mean response latencies were 750 ms in the translation prime condition, and 715 ms in the form control prime condition. This 35 ms difference was not significant. The main effect of Cognate Status did not approach significance [$F < 1$]. However, the Cognate Status and Bilingual Group interaction approached significance [$F(2,1844) = 4.966$, $p = .007$]. The three-way interaction between Cognate Status, Prime Type and Bilingual Group was also significant [$F(2,1843) = 4.700$, $p = .009$]. Table 4.49 presents the mean reactions times and percentage of errors for the exemplars as a function of Prime Type and Cognate Status.

Table 4.49 Mean RTs (ms) and Percentage of Errors for Cognate and Non-Cognate Targets Primed by Translation Equivalents and by Form Control Primes in Experiment 5A

		Cognate Status		
	Overall	Cognate	Non-cognate	
Prime Type	RT (Error %)	RT (Error %)	RT (Error %)	**Cognate effect**
Translation	750 (10.9)	759 (10.1)	741 (11.6)	**−18**
Form Control	715 (7.3)	728 (6.1)	702 (8.3)	**−26**
Priming	**−35**	**−31**	**−39**	

Planned comparisons performed on the individual priming effects for the three groups of bilinguals did not reveal facilitative translation priming effects for any of the bilingual groups. These bilinguals showed inhibition rather than facilitation to translation primes. The only exception was the Late High Proficient bilinguals who showed neither inhibition nor facilitation for non-cognate targets. Another observation of our study related to the cognate status of the word was that no cognate facilitation effect was observed with any of the bilinguals groups. Table 4.50 presents the mean reaction times and percentage of errors for the exemplars as a function of Prime Type, Cognate Status, and Bilingual Group.

Table 4.50 Mean RTs (ms) and Percentage of Errors for Cognate and Non-Cognate Targets Primed by Translation Equivalents and by Form Control Primes for All Three Bilingual Groups in Experiment 5A

	Cognate Status/Bilingual Group					
	Cognate			Non-cognate		
	Early	Late high	Late low	Early	Late high	Late low
Prime Type	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)
Translation	773 (0)	724 (0)	780 (40)	756 (3.7)	707 (33.3)	760 (36)
Control	753 (0)	688 (0)	743 (24)	694 (1.9)	708 (11.1)	704 (32)
Priming	**−20**	**−36**	**−37**	**−62**	**1**	**−56**

Results of the error data revealed a significant main effect of Prime Type [$F(1,34) = 4.246$, $p = .032$]. Targets were responded to more accurately when they were primed by form control primes as compared to when they were primed by translation equivalents. The error data did not reveal a main effect of Cognate Status [$F < 1$]. However, the main effect of Bilingual Group approached significance in the error analysis [$F(2,51) = 12.135$, $p = .000$]. Moreover, the interaction between Cognate Status and Bilingual Group was found to be significant [$F(2,1981) = 4.689$, $p = .000$]. For cognate targets, errors were observed only for Late Low Proficient bilinguals. On the other hand, for non-cognate bilinguals, fewer errors were observed for the high proficient bilinguals and greater errors were observed for the low proficient bilinguals. Lastly, comparisons of the non-exemplar data were conducted. Analyses of the mean reaction times to non-exemplar showed that the participants took significantly longer to respond to non-exemplars (804 ms) than to exemplars (747 ms).

4.4.2.3 Discussion

The findings of Experiment 5A did not reveal facilitative masked translation priming effects in the L1−L2 direction when the task was semantic categorization. The lack of facilitative priming effects in this task confirms to the findings of our masked translation priming experiment (Experiment 1C), when the task was to make lexical decision to cognate and non-cognate words. However, it contradicts the hypothesis put forward by Grainger and Frenck-Mestre (1998) that semantic categorization task is extra sensitivity to translation than lexical decision tasks. It also contradicts the predictions of the RHM, in that the model assumes stronger and direct conceptual connections from L1 words to concepts. As a result, it is not clear how the RHM could accommodate these findings. To further examine whether the same pattern is also exhibited in the L2−L1 direction, we conducted the next experiment, using the same materials and masking procedure, changing only the direction to L2−L1.

4.4.3 Semantic Categorization from L2−L1 (Experiment 5B)

In Experiment 5B, we further investigated the task and directionality effects in semantic categorization task. This experiment was identical to that of Experiment 5A, the only exception being that target words were present in the participants' native language, Bodo.

4.4.3.1 Method

Participants. The same participants who took part in Experiment 5A participated in this experiment.

Stimuli. The stimuli for this experiment were identical to those used in Experiment 5A.

Procedure. The procedure also remained the same as in Experiment 5A.

4.4.3.2 Results

A mixed-effects analysis was run on the reaction time data and error data separately. Table 4.51 presents the mean reaction times and percentage of errors for the exemplars as a function of Prime Type and Cognate Status.

Table 4.51 Mean RTs (ms) and Percentage of Errors for Cognate and Non-Cognate Targets Primed by Translation Equivalents and by Form Control Primes in Experiment 5B

		Cognate Status		
	Overall	Cognate	Non-cognate	
Prime Type	RT (Error %)	RT (Error %)	RT (Error %)	**Cognate effect**
Translation	713 (3.6)	689 (1.8)	738 (5.5)	**49**
Form Control	660 (4.5)	663 (0.9)	657 (8.1)	**−6**
Priming	**−53**	**−26**	**−81**	

The results of Experiment 5B revealed a reliable main effect of Prime Type [$F(1,36) = 4.440$, $p = .012$]. Mean response latencies were longer in the translation prime condition (713 ms) than in the form control prime condition (660 ms) which indicates inhibition rather than facilitation. The main effect of Cognate Status did not reach significance [$F < 1$]. However, the main effect of Bilingual Group approached significance [$F(2,51) = 5.730$, $p = .006$]. The interaction between Cognate Status and Bilingual Group was found to be significant [$F(2,1981) = 10.446$, $p = .000$]. There was also a significant interaction between Prime Type and Bilingual Group [$F(2,1981) = 20.416$, $p = .000$]. Finally, the three-way interaction between Prime Type, Cognate Status, and Bilingual Group approached significance [$F(2,1981) = 7.911$, $p = .000$].

Further planned comparisons performed on the individual priming effects for the three groups of bilinguals revealed that none of the bilinguals showed any translation priming effect, replicating the results of Experiment 5A. However, unlike Experiment 5A, signification cognate facilitation effects were observed for all three Bilingual Groups. The magnitude of facilitation was larger for the high proficient bilinguals (Early High Proficient = 63 ms and Late High Proficient = 56 ms) than low proficient bilinguals (Late Low Proficient = 26 ms). The mean reaction times and percentage of errors for the exemplars as a function of Prime Type, Cognate Status, and Bilingual Group are presented in Table 4.52.

Table 4.52 Mean RTs (ms) and Percentage of Errors for Cognate and Non-Cognate Targets Primed by Translation Equivalents and by Form Control Primes for All Three Bilingual Groups in Experiment 5B

	Cognate Status/Bilingual Group					
	Cognate			Non-cognate		
	Early	Late high	Late low	Early	Late high	Late low
Prime Type	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)
Translation	740 (0)	697 (0)	631 (5.1)	803 (3.3)	753 (0)	657 (10.3)
Control	688 (1.7)	664 (0)	637 (0)	730 (8.3)	603 (10)	637 (7.7)
Priming	**−52**	**−33**	**6**	**−73**	**−150**	**−20**

In the mixed-effects analysis on the error data, the main effect of Prime Type was not significant [$F < 1$]. However, the main effect of Cognate Status tended towards significance [$F(1,17) = 7.528$, $p = .000$]. Cognate targets were responded to more accurately as compared to non-cognate targets. The main effect of Bilingual Group approached significance [$F(2,51) = 6.117$, $p = .001$]. Fewer errors were observed for the Early High Proficient bilinguals and greater errors were observed for the Late

Low Proficient bilinguals. The interaction between Cognate Status and Bilingual Group was found to be significant [$F(2,1981) = 4.792$, $p = .001$]. There was also a significant interaction between Prime Type and Bilingual Group [$F(2,1981) = 5.038$, $p = .001$]. Lastly, as in Experiment 5A, comparisons of the non-exemplar data were conducted. Analyses of the mean reaction times to non-exemplars showed that the participants took significantly longer to respond to non-exemplars (781 ms) than to exemplars (702 ms).

4.4.3.3 Discussion

The findings of Experiment 5B failed to show masked facilitative translation priming effects in the L2−L1 direction, contrary to the findings of Grainger and Frenck-Mestre (1998), Finkbeiner et al. (2004), and Sánchez-Casas et al. (1992). However, contrary to Experiment 5A, significant cognate facilitation effect was observes for all bilingual groups. The findings of this experiment indicate that our participants possessed insufficient L2 lexical processing skills to exhibit reliable masked translation priming effects in the L2–L1 direction in a semantic categorization task.

4.4.3.4 Combined Analysis of Experiment 5A and 5B

To test for differences between translation priming in both directions, we analyzed the data from Experiment 5A and 5B in one design using a mixed-effects analysis. The combined analysis revealed a significant main effect of Target Language [$F(1,3943) = 124.618$, $p = .000$]. The interaction between Cognate Status and Target Language was significant [$F(1,3920) = 8.530$, $p = .004$]. The Bilingual Group and Target Language interaction approached significance [$F(2,3909) = 65.027$, $p = .000$]. This interaction is shown in Figure 4.13. The three-way interaction between

Cognate Status, Prime Type and Target Language reached was significant [$F(1,3919) = 29.509$, $p = .000$]. Another significant three-way interaction was observed between Cognate Status, Bilingual Group and Target Language [$F(2,3909) = 11.893$, $p = .000$]. Finally, the Prime Type, Bilingual Group and Target Language interaction was also found to significant [$F(2,3909) = 15.433$, $p = .000$].

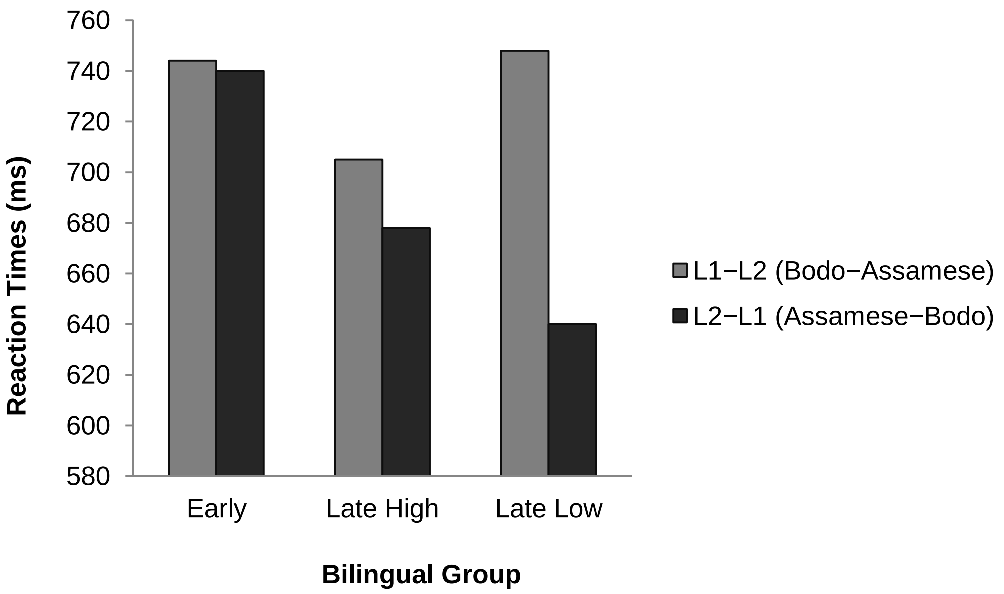


Figure 4.12 Mean RTs (ms) as a function of Bilingual Group and Target Language in Experiment 5A and 5B.

4.4.4 General Discussion

The present study provided a further test to account for the *translation asymmetry* and *task effect* in the masked priming literature. Two semantic categorization experiments (Experiment 5A and 5B) examined whether the differential sensitivity to priming found for cognate and non-cognate translations in primed lexical decision task is apparent in this task as well. Taken together, the findings of Experiments 5A and 5B demonstrated clearly that L2–L1 priming is not task dependent, contrary to the finding of Sánchez-Casas et al. (1992). Despite observing robust within-L2 masked repetition priming (confirming the findings of Gollan et al.,1997; Jiang, 1999), and clear L2–L1 masked translation priming in semantic categorization (confirming the finding reported by Grainger & Frenck-Mestre, 1998), there was a marked absence of both L1−L2 and L2–L1 translation priming in our study (cf. Gollan et al., 1997; Grainger & Frenck-Mestre, 1998; Jiang, 1999; Keatly et al., 1994).

A comparison of the previous studies and our study reveals several differences that could have produced the contradictory findings. First, the reason for the failure to obtain facilitation from both cognate and non-cognate translations in our study can be attributable by the use of nonwords rather than word primes as the across-condition control. Using both words and nonwords as primes may not be an optimal comparison, as the lexical status of the prime may influence target processing independently of the relationship between the prime and the target. Although Sánchez-Casas et al. (1992) obtained translation priming for cognates, the possible reason for the null effect observed in both cognate and non-cognates conditions of our study, might be the use of different groups of bilinguals. Moreover, in Sánchez-Casas et al.'s (1992) study, the bilinguals were same-script Spanish−English bilinguals, whereas, in our study we used different-script Bodo−Assamese bilinguals, who differed on their L2 AoA and language proficiency. A second reason for the different results might be that, category names were provided on each trial in the study of Sánchez-Casas et al. (1992), a procedure that may have an impact on the size of priming effects. In contrast, in our study, items were presented in a blocked design such that all of the exemplars (and an equal number of non-exemplars) appeared together (Bueno & Frenck-Mestre, 2002; Forster & Hector, 2002; Forster, Mohan, & Hector, 2003; Frenck-Mestre & Bueno, 1999). Any of these factors may have accounted for the failure to obtain masked facilitative cognate and non-cognate translation priming in our study.

Moreover, an interesting finding of our study was that we observed was significant cognate facilitation effect in the L2−L1 direction. Previous research on the basis of masked translation and associative priming argued that that only cognate translations have completely overlapping semantic (conceptual) representations in memory in bilinguals, whereas, non-cognate translations have only partially overlapping semantic representations (De Groot, 1992a; De Groot & Nas, 1991). This would account for the presence of cognate facilitation effect in our study. This finding further demonstrates that semantic categorization is more sensitive than the lexical decision task to cognate facilitation effect. In the lexical decision experiments employing masked translation primes (discussed above), no cognate facilitation effect was observed in the L2−L1 direction. The more robust effects of translation primes in semantic categorization compared with lexical decision follows logically from the fact that the former task requires access to semantic information whereas the latter task does not (Balota & Chumbley, 1984; Lupker, 1984; Shelton & Martin, 1992). However, why such facilitation was obtained only in the L2−L1 direction is still questionable. In sum, the results of our experiments indicate that the pattern of priming is not task-specific and this needs to be taken into account when explaining bilingual lexical processing. The results are consistent with a model where both form and meaning affect relation between the bilingual's languages, with cognates sharing effectively a single lexical representation while non-cognates do not. Moreover, the paradigm and the demands of the tasks partially or fully determine the extent to which inhibitive and facilitative effects are observed in words with different meaning or form relation. Although it is obvious that in all the lexical decision tasks used, the meaning of words is processed, as facilitative and inhibitive effects can be observed in all of them, the participants have to decide whether the two words have the same meaning only in the translation recognition task. This decision could require greater demands for semantic processing than lexical decisions. We shall turn to this issue in the next section.

4.5 Translation Recognition Task

In the study of bilingual lexical representation and processing, translation recognition task has proved to offer a lot of advantages than other recognition or production tasks. In this task, two words from two different languages are presented to a participant who has to decide if they are translations of each other (first used by De Groot, 1992b, Experiment 2). As no production is required, any observed effect is that of recognition. The procedure used in this task varies in several ways across studies. For example, the critical items can be either positive items (translation pairs) or negative items (non-translation pairs). Several studies by De Groot and her colleagues have relied on positive items (De Groot, 1992b; De Groot & Comijs, 1995; De Groot, Delmaar, & Lupker, 2000). In contrast, almost all studies that used the task to explore lexical versus conceptual connections in bilingual lexical organization, particularly in relation to the RHM, have used negative items as critical stimuli (Talamas, Kroll, & Dufour, 1999). Studies using the translation recognition task have manipulated the relation between the two words. For example, some studies examined words which were related by virtue of form similarity or meaning (Talamas et al., 1999; Ferré, Sanchez-Casas, & Guasch, 2006; Sunderman and Kroll, 2006; Guasch, Sánchez-Casas, Ferré, & García-Albea, 2008; Moldovan, Sanchez-Casas, Demestre, & Ferre, 2012). Moreover, some previous studies have shown evidence of interference effects produced by word pairs that are either related in form (e.g., *ruc-berro*; donkey-watercress) or very closely semantically related (e.g., *ruc-caballo*, donkey-horse) (Ferré et al., 2006; Guasch et al., 2008). Interestingly, word pairs having a less close semantic relation (e.g., *ruc-oso*, donkey-bear) did not produce any such effects which could be attributed to the low level of activation of the corresponding semantic representations by the time the translation decision has to be made. Another interesting observation of these studies was the influence of proficiency—the more and less fluent bilinguals demonstrated different results for the two types of related trials.

There is a consensus among the various theoretical models of bilingual memory regarding the two levels of representation to be posited: a lexical level, containing information of the orthographic and phonological form of the word, and a semantic-conceptual level that represents its meaning. All these models agree that the level of semantic/conceptual representation is shared (to a greater or lesser extent) between the two languages, but while some postulate local representations (e.g. the RHM or the BIA+ model), others propose distributed representations (e.g. the DCF model). The RHM predicts that less proficient bilinguals will rely heavily on the translation equivalent to access meaning, whereas more proficient learners will not. While the RHM assumes that translation equivalents are active during L2 processing particularly for less proficient bilinguals, other models, such as the BIA+ model, which contains both phonology and semantics within the word identification system, predicts a very different type of form activation. The BIA+ model is the extended version of the BIA model that includes phonology and would predict that phonological information is activated in a non-selective manner. In its current formulation, the RHM and BIA+ do not explain how the degree of similarity could modulate the effect of interference. A model that could suggest a possible answer to the question under examination here, as well as to provide an alternative explanation of the different performance between high and low proficient bilinguals, is the DCF model. The DCF model represents the semantic/conceptual word level as a set of nodes which correspond to semantic features and which are connected to the corresponding lexical forms in the two languages. The model also assumes that the greater the similarity in meaning between two words, the larger the number of nodes shared by their semantic representations (e.g., Schoonbaert, 2008). Thus, two words which are very closely related in meaning across the two languages would be expected to activate more shared nodes than words with less close semantic relationships, and consequently, to produce greater interference effects than less close words. The present study, therefore, builds upon the existing literature about the roles of phonological, orthographical, and semantic factors and levels of proficiency in the mental representation and processing of two languages. Given that the three models mentioned above provides testable explanations regarding the influence of semantic and phonological relations across languages in translation recognition, and the role of meaning and form similarity in determining the magnitude of interference effects, these models were adopted as the main theoretical framework in the present study.

4.5.1 The Present Study

The present study was conducted to determine the extent to which semantics and phonology play a role when a Bodo−Assamese bilingual speaker takes part in a visual word recognition study. This was accomplished by using a translation-recognition task. In order to fulfill the objectives of the study, two translation recognition experiments were undertaken, from L1−L2 (Experiment 6A) and from L2−L1 (Experiment 6B). The materials and procedure were the same in both experiments. The critical focus concerned those trials on which the two words were not translation equivalents (i.e. the *no* trials). These two words were related by virtue of word form similarity or meaning. To investigate the fundamental effect of second language age of second language acquisition and proficiency on the architecture of the bilingual's language processing system, three groups of Bodo−Assamese bilinguals participated in each experiment. So by comparing how long it takes participants to correctly reject form-related and meaning related distracters and their controls in translation recognition, one can infer whether lexical activation or concept activation is involved. The first and primary of the present study was to test whether different-script bilinguals utilize the translation equivalent in a similar manner to same-script bilinguals. A second aim of this study was to ascertain whether the direction of the translation recognition task affects the pattern of the interference effects. The third aim was to establish the influence of L2 AoA and language proficiency on the pattern of effect. Based on the developmental argument of the RHM, the highly proficient Bodo−Assamese bilinguals in this study would not be expected to be reliant on the translation equivalent to access meaning. In other words, in the context of a translation recognition task, highly proficient bilinguals should not have interference to the translation equivalent foil. However, given that these developmental predictions have arisen based on same-script bilinguals, it is not clear whether different-script bilinguals may adopt a distinct lexical processing strategy to perform translation recognition. In this sense we will be able to test generalisability of the RHM for languages that do not share scripts.

4.5.2 Translation Recognition from L1−L2 (Experiment 6A)

In Experiment 6A, we compared the performance of three groups of Bodo−Assamese bilinguals on a translation recognition task. The participants were shown pairs of words in succession—the first word was briefly presented in Bodo (L1) and it was followed by a word in Assamese (L2). The task was to decide whether the second word was the correct translation of the first. For example, the pair हाजो [hazw]–পাহাৰ [pahar]*‘mountain’* would constitute a correct translation trial.

4.5.2.1 Method

Participants. A total of fifty-eight Bodo–Assamese bilingual adults (39 male and 19 female) from Ganeshpara and IIT Guwahati participated in this and the following experiment. Participants ranged in age from 21 to 43 years (mean age = 30.1, *SD* = 8.3). Participants were native speakers of Bodo with Assamese as their second language, living in an L2 dominant environment. All participants completed a questionnaire which included self-report measures of age of acquisition and proficiency in their L1 and L2. The data from the self-report ratings is summarized in Table 4.53.

Table 4.53 Self-Report Ratings in Bodo and Assamese for All Three Bilingual Groups in Experiment 6A

	Bodo (L1)			Assamese (L2)		
	Early (*n* = 22)	Late High (*n* = 19)	Late low (*n* = 17)	Early (*n* = 22)	Late High (*n* = 19)	Late Low (*n* = 17)
Age of acquisition (years)	3.7	2	2.4	3.3	10.5	10
Mean daily usage (%)	51.6 %	50.6 %	49.9 %	40.9 %	38.2 %	19.2 %
Self-ratings (7 point scale)						
Speaking	6.8 *(0.4)*	7	6.8 *(0.4)*	6.2 *(1.2)*	6.3 *(1.2)*	4.8 *(1.0)*
Reading	6.8 *(0.4)*	7	7	6.3*(0.9)*	5.8 *(0.5)*	3.8 *(0.8)*
Writing	6.8 *(0.4)*	7	6.8 *(0.4)*	5.7 *(2.0)*	5.1 *(1.5)*	3
Comprehension	6.3 *(1.2)*	7	6.4 *(1.3)*	5.8 *(2.3)*	5.3 *(0.5)*	2.4 *(1.3)*

The results of the self-report ratings show that the Bodo ratings of the three groups of bilinguals on all four proficiency measures are similar. However, the Assamese ratings on all four proficiency measures are higher for the high proficient groups than for the low proficient group. In order to further assess the proficiency levels of the bilinguals, all participants took part in an objective naming test. Table 4.54 provides the mean scores on the objective naming test in both Bodo and Assamese.

Table 4.54 Mean Scores on the Objective Naming Test in Bodo and Assamese for All Three Bilingual Groups in Experiment 6A

Bilingual Group	Bodo	Assamese
Early High Proficient	46.5	43.7
Late High Proficient	48.1	44.3
Late Low Proficient	45.3	35.1

The results of the Objective Naming Test show that the average L1 score for all three bilingual groups is similar. In case of L2, the average score for the Late High Proficient group matches the average score for the Early High Proficient group (44.3 vs. 43.7 respectively) and the scores do not yield a significant difference [$t(48) = 1.12$, $p = .261$]. This indicates that the proficiency level of the two groups is similar. However, the average score of the Late High Proficient group is noticeably higher than the average score of the Late Low Proficient group (44.3 vs. 35.1) and the scores yielded a significant difference [$t(48) = 9.28$, $p = .000$].

Stimuli. A total of four sets of forty words each (twenty cognates and twenty non-cognates) were selected as critical material for the experiment. All words were specific nouns and belonged to various semantic categories. The words were presented in pairs and the first word in the pair was always presented in Bodo and the second in Assamese. For each pair two meaning related and two form related distracters were created. The meaning related distracters were either: (1) semantically related to the first item of the pair or (2) associatively related to the first item of the pair. The form related distracters were either: (1) phonologically related to the first item of the pair or (4) phonologically related to the second item of the pair, i.e., the translation. The words in Bodo could be presented with one of the following four distracters:

1) *Semantic:* The first type of meaning relation investigated was the semantically related condition. In this condition, in the Bodo to Assamese direction, participants were presented with a Bodo word आखाइ [akhai] *'hand'* and then were presented with a distracter that was semantically related to the translation equivalent such as আঙুলি [anguli] *'finger'*.

2) *Associative:* The second type of meaning relation investigated was the associatively related condition. To briefly reiterate, in this condition in the Bodo to Assamese direction, participants were presented with a Bodo word आखाइ [akhai] *'hand'* and then were presented with a distracter that was associatively related to the Bodo word such as খাৰু [kharu] *'bangle'*.

3) *Phonological:* The first type of form relation investigated was the phonological condition. In this condition in the Bodo to Assamese direction participants were presented with a Bodo word आखाइ [akhai] *'hand'* and then were presented with a distracter that was phonologically, but not orthographically, similar to the Bodo word such as আখৈ [akhoi] *'puffed rice'*.

4) *Phonological translation:* The second type of form relation investigated was the phonological translation condition. In this condition, in the Bodo to Assamese direction, participants were presented with a Bodo word आखाइ [akhai] *'hand'* and then were presented with a distracter that was phonologically similar to the translation equivalent হাত [hat] *'hand'* such as সাত [xat] 'seven'.

In total, there were forty translation pairs and their related distracters in each condition (forty in the semantic condition, forty in the associative condition, forty in the phono-translation condition and forty in the phonological condition. Next, for each of the related distracters, unrelated distracters matched on word length and frequency to their respective related pairs in each of the four conditions, were also constructed. We generated individual unrelated distracters for each condition separately (see Appendices L (i) and L (ii) for complete list of stimuli). Therefore, within each type of relatedness investigated in this experiment the unrelated and related pairs were matched on length and frequency only within each type of relatedness, but not across relatedness. Table 4.55 contains an illustration of the materials in the critical ''no'' trials for the cognate pair फिथा−पिठा [phitha−pitha]*'pancake'* and the non-cognate pair आखाइ−हात [akhai−hat]*'hand'*.

Table 4.55 Examples of a Stimulus Set for the "No" Trials Used in Experiment 6A

Example	*Related*	*Unrelated*	*Condition*
Cognate			
फिथा *'pancake'*	লাৰু *'laddu'*	কুঠাৰ *'axe'*	Semantically related
फिथा *'pancake'*	বিহু *'Bihu'*	পানী *'water'*	Associatively related
फिथा *'pancake'*	ফিটা *'ribbon'*	চকু *'eye'*	Phonologically related
फिथा *'pancake'*	পিতা *'father'*	গ'ৰু *'cow'*	Phonological translation
Non-cognate			
आखाइ *'pancake'*	আঙুলি *'finger'*	বেঙেনা *'brinjal'*	Semantically related
आखाइ *'pancake'*	খাৰু *'bangle'*	নিমখ *'salt'*	Associatively related
आखाइ *'pancake'*	আখৈ *'puffed rice'*	পাহাৰ *'mountain'*	Phonologically related
आखाइ *'pancake'*	হাৰ *'necklace'*	ঘৰ *'house'*	Phonological translation

*Note.**फिथा [phitha]; *आखाइ [akhai]; *লাৰু [laru]; *বিহু [bihu]; *ফিটা [phita]; *আঙুলি [anguli]; *খাৰু [kharu]; *আখৈ [akhoi]; *হাৰ [har]; *কুঠাৰ [kuthar]; *পানী [pani]; *চকু [soku]; *গ'ৰু [goru]; *বেঙেনা [bengena]; *নিমখ [nimokh]; *পাহাৰ [pahar]; *ঘৰ [ghor]

In total, three hundred and twenty distracters were selected to be included in the experiment. Of the three hundred and twenty distracters, eighty belonged to the semantic condition (forty related and forty unrelated), eighty to the associative (forty related and forty unrelated), eighty to the phono-translation (forty related and forty unrelated) and the remaining eighty to the phonological condition (forty related and forty unrelated). Note that these critical items were not the correct translations and therefore required a ''no'' response. Each participant saw forty related and forty unrelated items within each of the four conditions. Each participant saw an item distracter pair twice: once as a critical item (related distracter) and once as a control (unrelated distracter), albeit in a randomized presentation order. The same procedure was used in the Assamese to Bodo direction with appropriate distracters. In addition, because the correct translations that generated the distracters for the critical pairs described above were never actually presented in the experiment, we created four sets of forty non-critical yes trials that were matched to the correct translations of the critical set as closely as possible on word length and frequency.

Procedure. The participants were tested individually. Participants were told that they would be shown word pairs and were asked to decide whether the second word in a pair was a correct translation of the first. They had to answer by pushing one of two keys: the "M" key on the keyboard with their right index finger if the second word in the translation was a correct translation and the 'N' key with the left index finger if it was not the correct translation. The computer generated a pseudo-random order of presentation for each participant, thereby avoiding the consecutive appearance of more than two stimuli in the same condition. The presentation sequence was as follows: first, a fixation point ("+") appeared for 500 ms; immediately afterwards, the first word of the pair was presented for 250 ms, and immediately afterwards, the second word was presented for 2,000 ms in one of the four experimental conditions (see Figure 4.14).

Before starting the experiment, the participants were given verbal instructions by the experimenter in addition to instructions that appeared on the computer screen. These instructions explained the task, and emphasized that they had to answer as accurately and as quickly as possible, but not quickly enough to lead to a high percentage of errors. The experiment began with fifteen practice stimuli that represented the different conditions in the experiment.

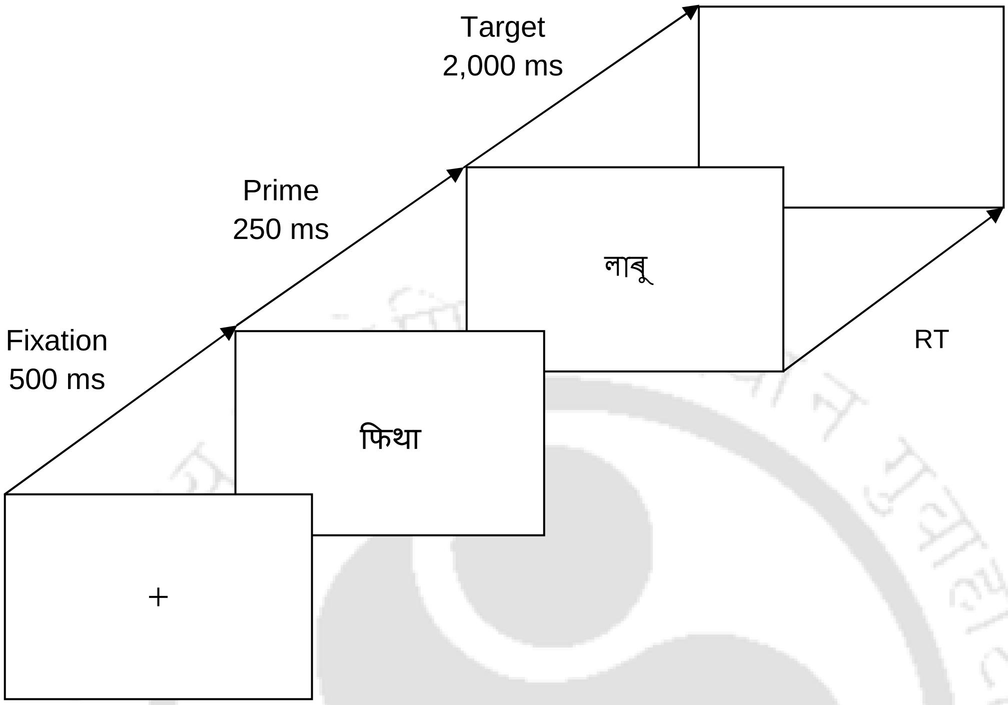


Figure 4.13 A schematic illustration of the procedure adopted for Experiment 6A.

4.5.2.2 Results

Separate analyses were performed on the mean correct reaction time data and error data (for correct and critical trials) for each type of distracter to test the reliability of the pattern emerging in Experiment 6A. A mixed-effects analysis was performed with four independent variables, Relation Type (semantic, associative, phonological, and phonological-translation), Relatedness (related and unrelated), Cognate Status (cognate and non-cognate) and Bilingual Group (Early High Proficient, Late High Proficient, and Late Low Proficient).

Correct translation pairs. While our main interest was in the critical no conditions, it is useful to examine the performance on the yes conditions, where the two words were translation equivalents of each other. The complete results for the correct translation pairs are shown in Table 4.56. Analysis on the reaction time data of the correct translation pairs revealed that the overall mean reaction time was 740 ms. A significant main effect of Relation Type was observed [$F(3,157) = 17.528$, $p = .000$]. The interaction between Relation Type and Bilingual Group was also significant [$F(6,6067) = 7.302$, $p = .000$]. This interaction is shown in Figure 4.15.

Table 4.56 Mean RTs (ms) and Percentage of Errors of the Correct Translation Pairs as a function of Cognate Status and Relation Type in Experiment 6A

		Cognate Status		
	Overall	Cognate	Non-cognate	
Relation Type	RT (Error %)	RT (Error %)	RT (Error %)	**Cognate effect**
Semantic	830 (11.9)	822 (9.7)	837 (14.1)	**15**
Associative	720 (9.5)	717 (8.5)	723 (10.7)	**6**
Phonological	691 (15.9)	666 (16.4)	717 (15.7)	**51**
Phono-translation	721 (3.1)	714 (3.1)	729 (3.1)	**15**

Results of the error data revealed a significant main effect of Relation Type [$F(3,157) = 10.728$, $p = .000$]. Errors were numerous for the phonological distracters and fewer for phono-translation distracters. The effect of Cognate Status tended towards significance [$F(1,18) = 3.132$, $p = .002$]. Overall, fewer errors were observed for cognate targets than for non-cognate targets.

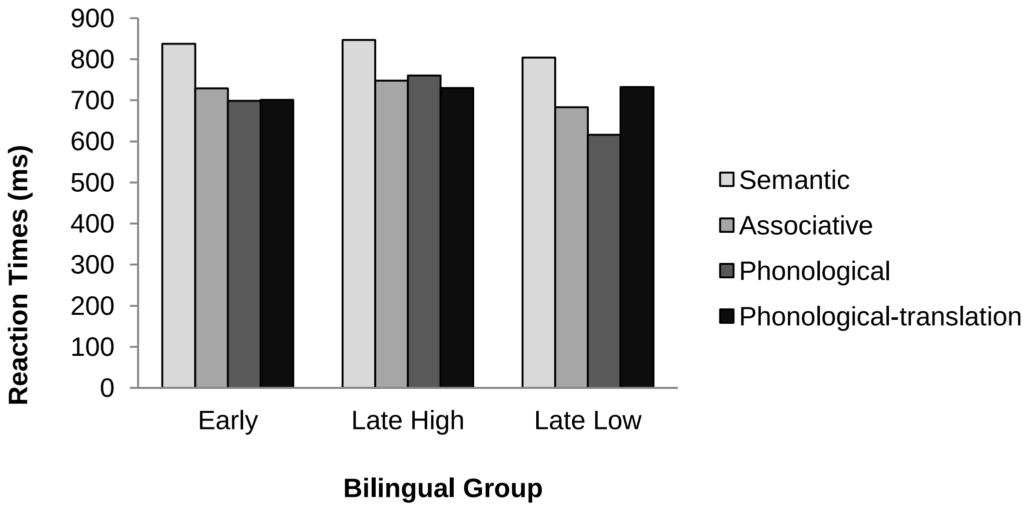


Figure 4.14 Mean RTs (ms) of correct translation pairs as a function of Bilingual Group and Relation Type in Experiment 6A.

Critical trials. There were four types of critical no trials. These pairs were meaning-related distracters and form-related distracters of the target word. The magnitude of interference was calculated for each type of distracter as the difference between the related and the unrelated trials. The difference in scores gives an indication of the sensitivity to each distracter type in each condition. The complete results for the critical translation trials are shown in Table 4.57 where the mean reaction times and percentage of errors are given for each type of word pair.

Table 4.57 Mean RTs (ms) and Percentage of Errors of the Critical Trials as a Function of Cognate Status and Relation Type in Experiment 6A

		Cognate Status	
	Overall	Cognate	Non-cognate
Relationship Type	RT (Error %)	RT (Error %)	RT (Error %)
Semantic			
Related	1106 (47.8)	1109 (52.1)	1103 (44.6)
Unrelated	1027 (23.2)	1039 (20.9)	1016 (25.1)
Interference	**79**	**70**	**87**
Associative			
Related	970 (22.3)	990 (19.6)	950 (24.6)
Unrelated	942 (15.4)	930 (13.3)	953 (17.1)
Interference	**28**	**60**	**−3**
Phonological			
Related	982 (22.6)	935 (25.4)	1029 (20.7)
Unrelated	940 (13.8)	963 (14.1)	918 (13.8)
Interference	**42**	**−28**	**111**
Phono-translation			
Related	886 (26.4)	839 (25.4)	934 (27.6)
Unrelated	890 (13.2)	895 (11.3)	885 (14.9)
Interference	**−4**	**−56**	**49**

Analysis on the reaction times revealed a main effect of Relatedness [$F(1,150) = 6.933$, $p = .009$]. Reaction times were longer for related words (986 ms) than unrelated words (950 ms). The main effect of Relation Type approached significance [$F(3,161) = 27.227$, $p = .000$]. Analyses on reaction times did not reveal an effect of Cognate Status and Bilingual Group [Fs < 1]. The three-way interaction between Relatedness, Cognate Status and Bilingual Group was reliable [$F(2,5172) =$

4.670, p = .009]. The Relatedness, Relation Type and Bilingual Group interaction was also reliable [F(6,5174) = 5.079, p = .000].

Planned comparisons performed on the individual interference effects for the three groups of bilinguals revealed a significant interaction was observed between Cognate Status and Bilingual Group [F(2,5173) = 9.310, p = .000]. The magnitude of interference differed as a result of the cognate status of the word. For instance, for the Early High Proficient bilinguals, significant semantic and associative interference and no phonological and phono-translation interference were observed for cognate targets, whereas, for non-cognate targets, significant semantic, phonological and phono-translation interference but no associative interference was observed. For the Late High Proficient bilinguals the interference effects were similar to Early High Proficient bilinguals for cognate targets.

However, for non-cognate targets, the magnitude of phonological and phono-translation interference was greater as compared to the Early High Proficient bilinguals. Finally, for the Late Low Proficient bilinguals, only associative interference was observed for cognate targets, and for non-cognate targets, we observed interference from all four distracters, but the phonological interference was the greatest. The mean reaction times and percentage of errors as a function of Prime Type, Cognate Status, and Bilingual Group are presented in Table 4.58.

Results of the error analysis revealed a significant main effect of Relatedness [F(1,150) = 8.249, p = .000]. Targets were responded to more accurately in the unrelated condition as compared to when they were in the related condition. The main effect of Relation Type approached significance [F(3,161) = 4.172, p = .001]. Errors were numerous for the semantic distracters than the other three distracters. The error data revealed a marginal effect of Cognate Status [F(1,18) = 3.045, p = .002]. The main effect of Bilingual Group approached significance [F(2,56) = 11.492, p = .000]. Overall, fewer errors were observed for the Late High Proficient bilinguals and greater errors were observed for the Late Low Proficient and Early High Proficient bilinguals. Moreover, a significant interaction was observed between Cognate Status and Bilingual Group [F(2,5173) = 7.569, p = .000].

Table 4.58 Mean RTs (ms) and Percentage of Errors of the Critical Trials for All Three Bilingual Groups as a Function of Cognate Status and Relation Type in Experiment 6A

	Cognate Status/Bilingual Group					
	Cognate			Non-cognate		
	Early	Late high	Late low	Early	Late high	Late low
Relation Type	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)
Semantic						
Related	1081 (58.7)	1125 (37.1)	1122 (56.8)	1059 (38.2)	1084 (34.9)	1168 (62.9)
Unrelated	987 (14.5)	946 (20)	1181 (31.8)	929 (17.1)	1005 (16.3)	1112 (44.4)
Interference	**94**	**179**	**−59**	**130**	**79**	**56**
Associative						
Related	971 (14.5)	968 (11.4)	1030 (34.1)	906 (17.1)	913 (18.6)	1031 (40.7)
Unrelated	891 (8.1)	936 (5.7)	964 (27.3)	937 (11.8)	926 (9.3)	994 (31.5)
Interference	**80**	**32**	**66**	**−31**	**−13**	**37**
Phonological						
Related	916 (23.1)	925 (30.8)	965 (23.5)	900 (34.4)	1032 (12.5)	1154 (14.3)
Unrelated	925 (26.9)	989 (3.8)	973 (11.8)	873 (28.1)	927 (0)	955 (14.3)
Interference	**−9**	**−64**	**−8**	**27**	**105**	**199**
Phono-translation						
Related	867 (20)	775 (11.1)	874 (38.5)	869 (25.6)	917 (9.1)	1015 (37.5)
Unrelated	865 (0)	872 (0)	947 (30.8)	834 (6.9)	832 (0)	989 (31.3)
Interference	**2**	**−97**	**−73**	**35**	**85**	**26**

The results were also reported separately for each of the four distracter types: semantically related, associatively related, phonologically related, and phonologically related to the translation equivalent, which will be discussed in the next section.

Semantically related. The main effect of Relatedness was significant [$F(1,37) = 11.219$, $p = .002$]. The participants were significantly slower to reject the semantically related pairs (1088 ms) compared to the unrelated controls (1004 ms). This main effect was qualified by a significant interaction between Relatedness and

Bilingual Group [$F(2,1444) = 9.857$, $p = .000$]. The magnitude of interference for the Early High Proficient (114 ms) and Late High Proficient (135 ms) bilinguals were significantly greater than to the Late Low Proficient (4 ms) bilinguals.

Associatively related. The reaction time data revealed no main effect of Relatedness [$F < 1$].

Phonologically related. In the reaction time data, there was no main effect of Relatedness [$F < 1$].

Phonologically related to the translation equivalent. The main effect of Relatedness was not significant [$F < 1$]. Responses to phonologically related translation pairs (810 ms) and unrelated controls (813 ms) were similar.

4.5.2.3 Discussion

In Experiment 6A, we investigated bilingual lexical representation and processing in translation recognition task when Bodo−Assamese bilinguals recognized whether word pairs presented in the L1−L2 direction are translations of each other. The results showed that all Bodo−Assamese bilinguals, regardless of their L2 AoA and proficiency, showed interference from meaning related and form related distracters. However, high proficient bilinguals were more sensitive to meaning related distracters and low proficient bilinguals were more sensitive to form related distracters.

4.5.3 Translation Recognition from L2−L1 (Experiment 6B)

Experiment 6B was carried out with Bodo−Assamese bilinguals in the critical translation direction (i.e., from L2−L1) in order to more rigorously analyze the influence of the degree of semantic and form similarity on interference effects in the translation recognition task.

4.5.3.1 Method

Participants. The participants who took part in Experiment 6A participated in Experiment 6B.

Stimuli. The material was the same as used in Experiment 6A. Only in this experiment, the first word was presented in Assamese and second word in Bodo.

Procedure. The procedure and equipment used were the same as those used in Experiment 6A.

4.5.3.2 Results

As in Experiment 6A, separate analyses were performed on the correct reaction time data and error data for the correct and critical trials for each type of distracter (semantic, associative, phonological, and phonological-translation) to further test the influence of different types of distracters on the target word.

Correct Translations. The pattern of results for the correct translations is similar to that obtained in Experiment 6A. The complete results for the correct translation pairs are shown in Table 4.59. The results revealed that the overall mean reaction time was 711ms. A main effect of Relation Type was observed [$F(3,158) = 8.867$, $p = .000$]. The interaction between Relation Type and Bilingual Group approached significance [$F(6,6275) = 9.447$, $p = .000$]. This interaction is shown in Figure 4.16.

The Cognate Status and Bilingual Group interaction not significant [$F(2,6254) = 2.717$, $p = .066$].

Table 4.59 Mean RTs (ms) and Percentage of Errors of the Correct Translation Pairs as a Function of Cognate Status and Relation Type in Experiment 6B

		Cognate Status		
	Overall	Cognate	Non-cognate	
Relation Type	RT (Error %)	RT (Error %)	RT (Error %)	**Cognate effect**
Semantic	774 (7.1)	774 (6.3)	774 (7.8)	**0**
Associative	690 (7.1)	681 (5.9)	699 (8.2)	**18**
Phonological	680 (9.1)	661 (9.4)	699 (8.8)	**38**
Phono-translation	702 (4.7)	692 (3.1)	712 (6.3)	**20**

Results of the error analysis revealed a significant main effect of Relation Type [$F(3,157) = 5.628$, $p = .000$]. Errors were numerous for the phonological distracters and fewer for phono-translation distracters. The effect of Cognate Status tended towards significance [$F(1,18) = 3.403$, $p = .001$]. Overall, fewer errors were observed for cognate targets than for non-cognate targets.

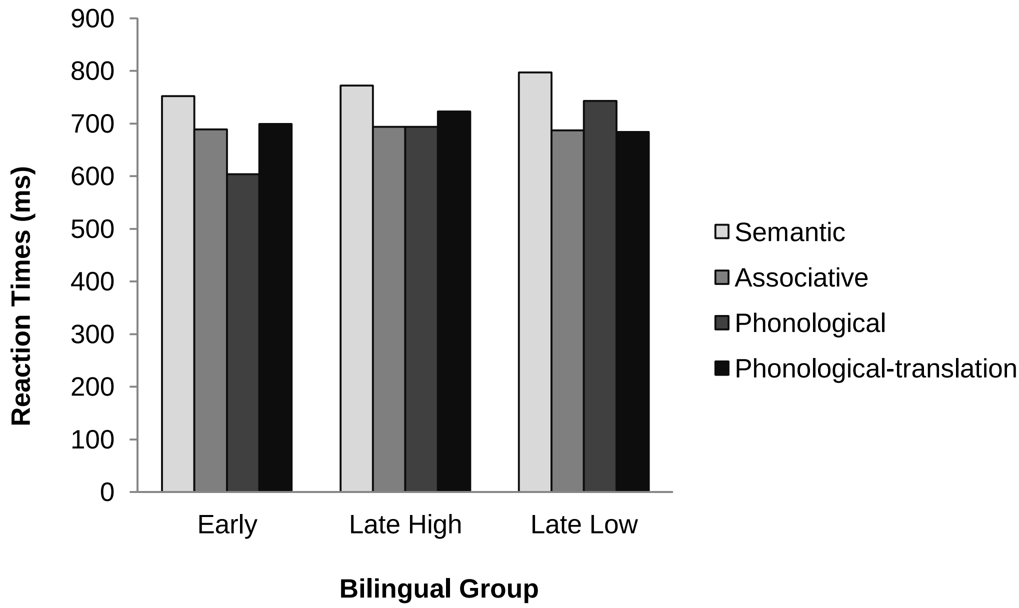


Figure 4.15 Mean RTs (ms) of the correct translation pairs as a function of Bilingual Group and Relation Type in Experiment 6B.

Critical Trials. The result of Experiment 6B was similar to those obtained in the previous experiment. In the analysis of the RTs, both Relatedness [$F(1,145) = 33.886$, $p = .000$] and Relationship Type [$F(3,153) = 28.101$, $p = .000$] were significant. As predicted by the DCF model, the results of this experiment also showed that the interference effects are modulated by the degree of meaning and form similarity. Analysis on response time revealed a significant interaction between Relation Type and Bilingual Group [$F(6,5807) = 6.591$, $p = .000$]. The complete results for the critical translation trials are shown in Table 4.60 where the mean reaction times and percentage of errors are given for each type of word pair.

Table 4.60 Mean RTs (ms) and Percentage of Errors of the Critical Trials as a Function of Cognate Status and Relation Type in Experiment 6B

		Cognate Status	
	Overall	Cognate	Non-cognate
Type of Relation	RT (Error %)	RT (Error %)	RT (Error %)
Semantic			
Related	1035 (39.1)	1022 (50)	1048 (30.3)
Unrelated	926 (7.8)	933 (7.7)	919 (8)
Interference	**109**	**89**	**129**
Associative			
Related	900 (14.1)	915 (13.3)	886 (14.9)
Unrelated	822 (4.1)	802 (13.5)	842 (4.6)
Interference	**78**	**113**	**44**
Phonological			
Related	846 (18.2)	825 (12.7)	866 (22.9)
Unrelated	803 (5.7)	820 (5.6)	786 (5.7)
Interference	**43**	**5**	**80**
Phono-translation			
Related	883 (10.7)	883 (15.5)	883 (6.9)
Unrelated	798 (0.6)	768 (0)	829 (1.1)
Interference	**85**	**115**	**54**

Planned comparisons were performed on the individual interference effects for the three groups of bilinguals. The results revealed that the magnitude of interference differed as a result of the cognate status of the word. For the high proficient bilinguals, the magnitude of semantic interference was greater for non-cognate targets as compared to cognate targets, and for the low proficient bilinguals the pattern was opposite. The magnitude of associative interference was greater for cognate targets as compared to non-cognate targets for all three Bilingual Groups. For cognate targets, the magnitude of phonological interference was observed only for the low proficient bilinguals, whereas all three Bilingual Groups produced significant phonological interference for non-cognate targets.

Lastly, all three Bilingual Groups produced significant phono-translation interference for cognate targets, with magnitude of interference being greater for the high proficient bilinguals than the low proficient bilinguals. On the other hand, for non-cognate targets, significant phono-translation interference was observed only for Early High Proficient and Late Low Proficient bilinguals. Mean reaction times and percentage of errors are presented in Table 4.61 by Prime Type, Cognate Status, and Bilingual Group.

In the mixed-effects analysis on the error data, the main effect of Relatedness was significant [$F(1,150) = 12.582$, $p = .000$]. Targets were responded to more accurately in the unrelated condition as compared to when they were in the related condition. The main effect of Relation Type approached significance [$F(3,161) = 6.117$, $p = .001$]. As in Experiment 6A, errors were numerous for the semantic distracters than the other three distracters.

The error data revealed a significant effect of Cognate Status [$F(1,18) = 5.921$, $p = .001$]. The main effect of Bilingual Group approached significance [$F(2,56) = 9.569$, $p = .000$]. Overall, fewer errors were observed for the Late High Proficient bilinguals and greater errors were observed for the Late Low Proficient and Early High Proficient bilinguals. Moreover, a significant interaction was observed between Cognate Status and Bilingual Group [$F(2,5173) = 6.193$, $p = .000$].

Table 4.61 Mean RTs (ms) and Percentage of Errors of the Critical Trials for All Three Bilingual Groups as a Function of Cognate Status and Relation Type in Experiment 6B

	Cognate Status					
	Cognate			Non-cognate		
	Early	Late high	Late low	Early	Late high	Late low
Relation Type	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)
Semantic						
Related	989 (53.9)	962 (40)	1115 (54.4)	1070 (31.6)	998 (30.2)	1077 (29.6)
Unrelated	924 (8.1)	916 (11.4)	959 (4.5)	874 (6.6)	926 (4.7)	956 (12.9)
Interference	**65**	**46**	**156**	**196**	**72**	**121**
Associative						
Related	943 (19.4)	907 (5.7)	894 (11.4)	891 (15.8)	846 (13.9)	919 (14.8)
Unrelated	789 (1.6)	790 (5.7)	829 (4.5)	853 (2.6)	803 (0)	870 (11.1)
Interference	**154**	**117**	**65**	**38**	**43**	**49**
Phonological						
Related	783 (11.5)	795 (7.7)	898 (23.5)	834 (31.3)	881 (21.9)	882 (14.3)
Unrelated	783 (11.5)	804 (3.8)	873 (0)	737 (9.4)	790 (6.3)	832 (0)
Interference	**0**	**−9**	**25**	**97**	**91**	**50**
Phono-translation						
Related	919 (17.1)	865 (11.1)	864 (15.4)	925 (2.3)	850 (9.1)	874 (12.5)
Unrelated	808 (0)	716 (0)	780 (0)	828 (2.3)	843 (0)	816 (0)
Interference	**111**	**149**	**84**	**97**	**7**	**58**

As in the previous experiment, the results were also reported separately for each of the four distracter types: semantically related, associatively related, phonologically related, and phonologically related to the translation equivalent, to which we shall turn to in the next section.

Semantically related. The main effect of Relatedness was significant [$F(1,34) = 14.002$, $p = .001$]. The participants were significantly slower to reject the semantically related word pairs (1036 ms) as compared to the unrelated controls (927 ms). This main effect was qualified by a significant interaction between Relatedness and Bilingual Group [$F(2,1700) = 6.312$, $p = .002$]. The magnitude of interference for the Early High proficient (131 ms) and Late Low Proficient (139 ms) bilinguals were significantly greater than the Late High Proficient (58 ms) bilinguals. This pattern of result is quite different from what we have observed in Experiment 6A for the semantically related condition.

Associatively related. The reaction time data revealed a main effect of Relatedness [$F(1,35) = 7.544$, $p = .009$]. Reaction times of the participants were slower for the associatively related pairs than for the unrelated control. The magnitude of interference was significant (78 ms). All other interactions were not significant [Fs < 1].

Phonologically related. There was a marginal effect of Relatedness in the reaction time data [$F(1,33) = 2.875$, $p = .022$]. Reaction times of the participants were slower when they responded to phonologically related word pairs (932 ms) than when they responded to unrelated controls (889 ms). All other interactions were not significant [Fs < 1].

Phonologically related to the translation equivalent. In the reaction time data, there was a main effect of Relatedness [$F(1,35) = 13.059$, $p = .001$]. Participants were slower when they responded to phonologically related translation pairs (785 ms) than when they responded to unrelated controls (700 ms). This interference effect of 85 ms was significant. No significant interactions were observed with any other variables [Fs < 1].

4.5.3.3 Discussion

In this experiment, performance of three groups of Bodo−Assamese bilinguals were compared when they performed a translation recognition task in which they recognized whether word pairs presented in the L2−L1 direction are translations of each other. The results showed that similar to Experiment 6A, all bilinguals experienced interference from meaning related and form related distracters. However, unlike Experiment 6A, in this experiment high proficient and low proficient bilinguals were equally sensitive to meaning related and form related distracters.

4.5.3.4 Combined Analysis of Experiment 6A and Experiment 6B

Planned comparisons were performed to compare the magnitude of the interference effects across the relevant conditions in the two translation directions (L1−L2 and L2−L1). Although the results of the correct trials were similar in both directions, the results obtained for the critical trials in the two directions were not similar to each other. In the mixed-effects analysis of the reaction time data, the results revealed a significant main effect of Target Language [$F(1,11239) = 425.487$, $p = .000$]. The magnitude of interference in the Assamese to Bodo (L2−L1) direction was significantly greater than in the Bodo to Assamese (L1−L2) direction.

In other words, there was a larger relatedness effect in the L2−L1 direction. Moreover, responses were faster in the L2−L1 (875 ms) direction than in the L1−L2 (967 ms) direction. This main effect was qualified by a significant interaction between Relatedness and Target Language [$F(1,11233) = 25.563$, $p = .000$]. Figure 4.17 shows the magnitude of the interference effect in the four experimental conditions: semantic, associative, phonological and phono-translation.

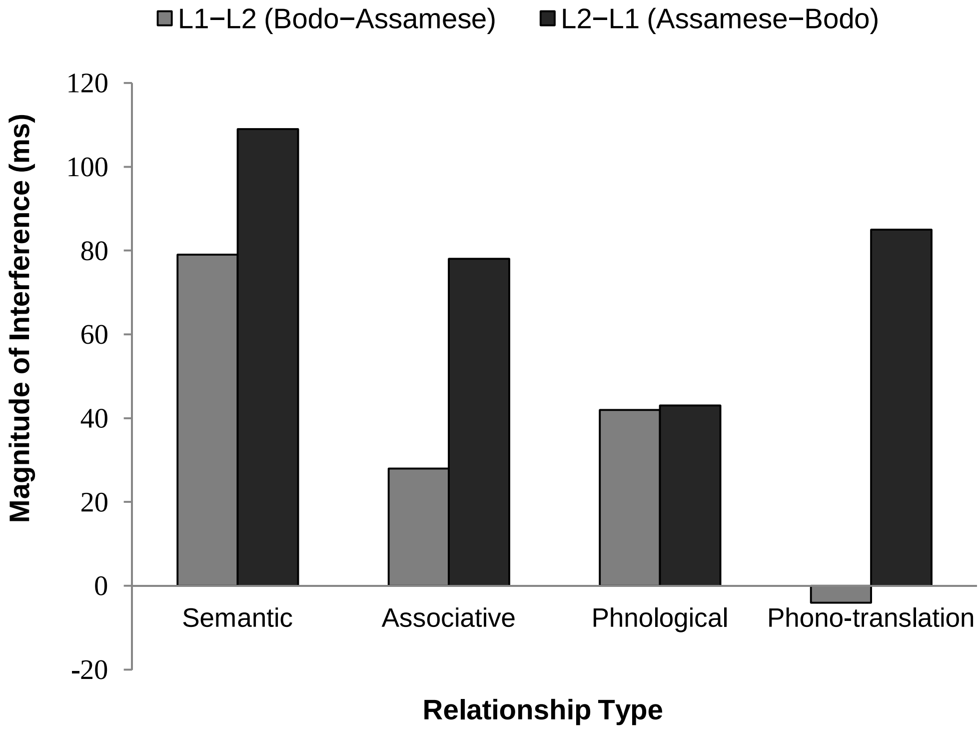


Figure 4.16 Magnitude of the interference effect (ms) in the four types of word relations (semantic, associative, phonological, and phono-translation) and in the two translation directions (L1−L2 *vs.* L2−L1).

4.5.4 General Discussion

This study considered few related questions regarding the processing of semantics, phonology and script, as well as the role of L2 AoA and proficiency. The main aim of this study was to examine the effect of the degree of similarity between L1 and L2 words in order to determine how words from the two languages are connected at the semantic/conceptual representation level, and to what extent meaning is activated across languages during the translation processes. In order to achieve this aim, we carried out two experiments with three groups of Bodo−Assamese bilinguals by using the translation recognition task and by manipulating the degree of similarity in meaning and form between the words from both languages (semantic, associative, phonological and phonological-translation).

A comparison of the interference effect of the four types of word relations showed a difference in magnitude. In terms of the meaning related relationships, the results showed greater inference in the semantic condition than in the associative condition. The difference is more obvious in the L1−L2 direction. This suggests that the greater the similarity in meaning, the greater the interference effect. These data could be interpreted as evidence that the degree of semantic similarity may also modulate semantic activation across languages in the interference paradigm, which is in line with the predictions of the DCF model. This pattern of results is important, as it suggests that the degree of meaning similarity can be used as an index of the extent to which semantic representations are activated across the two languages. In its current formulation, the RHM does not explain how the degree of similarity could modulate the effect of semantic interference.

One of the aims of our study was to investigate the influence of L2 AoA and proficiency in the pattern of interference effects. The results of our study clearly show that the pattern of results for the high and low proficient bilinguals is not similar, not only in terms of the pattern of interference effects, but also with respect to the magnitude of these effects. If we consider the nature of the translation recognition task, a participant upon presentation of the first word would begin translating the word into the other language.

The RHM predicts that if one is a high proficient bilingual, this process will take place directly through the conceptual store. In other words, only low proficient bilinguals will resort to the lexical level links to access meaning. The results show that there was a difference in the magnitude of the inference effects observed across bilinguals in two different directions. The high proficient bilinguals were slower when they had to reject as non-translations those pairs that were related in meaning (e.g. शাত–आसि [hat-asi] ‘*hand-finger*’) than when the pairs were related in form (e.g. शাত–हार [hat-har] ‘*hand-enter*’) which could imply that they were less reliant on the lexical level link and access the conceptual system directly.

If we look at the type of distracters we can see that the high proficient bilinguals showed greater interference effect with semantically related distracters and null interference effect with distracters related in form in the L1−L2 direction. Although, the semantic interference effect was same in the L2−L1 direction, we did not report a null interference as opposed to L1−L2. The same magnitude of the semantic interference effects in both translation directions with high proficient bilinguals confirm the prediction of the DCF model that high proficient bilingual speakers would present no differences in the magnitude of interference effects regardless of the language they are translating from (L1 or L2), supporting the view that semantic representations are shared across languages and are activated during access from either language.

However, for the high proficient Bodo−Assamese bilinguals, when presented with a word that was phonologically related to the actual translation equivalent, there was interference. In order for there to be interference, we have to assume that the lexical link was active. This type of interference has not been found with same-script advanced bilinguals in the past. Thus, we could interpret the current finding in terms of proficiency, meaning that these bilinguals were not immediately conceptually mediating and were relying on the translation equivalent much like low proficient same-script bilinguals. Yet, these bilinguals were highly proficient in both languages and not at all similar to the low proficient bilinguals in previous studies that had reported this type of interference.

To conclude, this study was designed to contribute to a greater understanding of how words from L1 and L2 are connected at different levels of representations, and to what extent their meanings can be accessed directly from both languages. Overall, the results of this study provide evidence for the salient role of meaning and phonology in the lexical links of different-script bilinguals.

The results of this study provide a challenge for the RHM's developmental prediction that reliance on the translation equivalent diminishes as proficiency increases and, instead, highlights script as potential factors in the use of the translation equivalent. The current study also found non-selective activation for different-script bilinguals and extends the predictions of models such as BIA+ for languages that do not share script. Likewise, the results have confirmed that the amount of semantic activation can vary depending on the degree of proximity in meaning, as the DCF model predicts.

4.6 Chapter Summary

In this chapter we examined a series of word recognition experiments using cross-language priming paradigm and the results of all these tasks provided useful information regarding the mental representation and processing of the bilingual lexicon. The overall findings of the experiments posit co-activation of both languages in the bilingual brain and thereby support the language non-selective lexical access hypothesis.

5

PRODUCTION STUDIES

This chapter investigates bilingual word production using five different tasks in order to explore bilingual lexical representation and processing.

Main Contents

5.1 Introduction

Language production refers to the production of spoken or written language. It cannot be considered entirely from the perspective of a theory of language, rather it is very definitely a goal-directed activity, in the sense that people speak and write in order to make friends, influence people, convey information, and so on. More is known about language comprehension than about language production. This is perhaps because it is generally easier for an experimenter to exercise control over the comprehension material than to constrain a subject's language production.

Psycholinguistic studies on bilingual language production have gratefully taken advantage of the large body of knowledge acquired in earlier research on monolingual language production. They pose similar questions about the content and structure of the knowledge base underlying language production, the processing mechanisms involved, the nature of the processes through which stored knowledge is accessed and exploited during language production and the order in which these processes are executed.

Many studies on speech production, both monolingual and bilingual, have focused on one specific part of the full speech production process—word production. Word production consists of several processing stages from (and including) the conceptualization of the lexical concept the speaker intends to verbalize to articulating the associated word. To get the word production process going, the concept to be verbalized must first be established in the experimental participant’s mind, preferably by means of a stimulus that is non-verbal because in veridical speech production the process also starts off with a non-verbal mental representation. The most popular way to do this is by presenting the participant with a picture depicting the targeted word, with the instruction to name it as rapidly as possible. While generating the naming response the participant passes through various mental stages, starting with the visual analysis of the picture. The first stage is of no particular interest to the speech production researcher but it is a necessary prerequisite for triggering the stages of interest because it loads the concept to name in the production system. Then follow the stages of interest.

Just as in the study of bilingual comprehension, research on language production in bilinguals has pursued the question of whether bilingual language production is language selective or language non-selective or perhaps both, depending on specific characteristics of the linguistic and extra-linguistic context and/or the bilingual speaker. As Wei and Moyer (2008) put it:

> Although there is debate in the literature about the selectivity of language production (e.g., Costa, 2005), a great deal of evidence suggest that words in both of the bilingual's languages are active at least to the level of abstract lexical representations and perhaps to the point of actually specifying the phonology associated with the translation. (p. 114)

In this chapter, the primary focus is on how bilinguals represent and process their two languages in order to produce words in their intended language. The debate on the activation or access of the non-target language in speaking only one language has been investigated by using different tasks and paradigms. The next section gives an overview of this chapter.

5.2 Chapter Overview

The chapter will begin by testing the performance of Bodo−Assamese bilinguals in two word naming experiments which not only requires recognizing the word but also pronouncing it. The next section will investigate two experiments that employ the word translation task. The sections that follow discuss different versions of the picture naming task. In addition to two simple picture naming experiments, three picture-word interference experiments and three primed picture-naming experiments have been used. The chapter will conclude with a summary of the overall findings.

5.3 Word Naming

In a word naming task, participants simply read printed words aloud and response latencies and/or reading accuracy are registered. What makes this task unique is the fact that, it requires elements of both recognition and production (De Groot, 2011). Research with monolingual high proficient readers has shown them to be activating phonological representations rapidly from printed letter strings even when a spoken response is not required (e.g., Rastle & Brysbaert, 2006). This makes reading in one language hard enough. The picture becomes much more complicated when we take the case of bilinguals because in their case, written information from both languages are being activated and processed simultaneously (Jared, Haigh, & Friesen, 2008). This raises an important question on whether bilingual readers selectively activate phonological representations from only the language in use or they non-selectively activate phonological representations from both of their languages.

Over the past three decades, several bilingual studies employing the reading task have provided support for the non-selective activation of the non-target language orthography and/or phonology (e.g., De Groot et al., 2000; Nas, 1983; Van Heuven, 2000; Van Heuven et al., 1998). Evidence comes from studies employing bilinguals sharing the same-script (Brysbaert et al., 1999; Costa et al., 1999; Dijkstra et al., 1999; Jared & Kroll, 2001; Jared and Szucs, 2002) and also from different-script bilinguals (Tzelgov et al., 1996).

However, the activation of phonological information of the non-target language in different-script bilinguals is still under debate (but see Feldman & Turvey, 1983; Lukatela, Savic, Gligorijevic, Ognjenovic, & Turvey, 1978). Moreover, a great deal of evidence suggests that word naming can be accomplished without conceptual access (e.g., Lupker, 1984; Potter, Kroll, Yachzel, Carpenter, & Sherman, 1986). Studies investigating this issue have explored the cognate status of the word in relation to this. It is hypothesized that if cognates share a lexical level representation across languages, then naming should be facilitated for cognates, particularly in the case of naming L2 words, because it should be possible to take advantage of greater automaticity in retrieving L1 words. However, if cognates share only a conceptual level representation across languages, there should be no difference between cognates and non-cognates, as naming does not appear to require conceptual access. Another interesting observation with respect to cognates is that, whereas in many tasks cognates are processed faster than matched non-cognates, in word naming they are often responded to more slowly (Schwartz, Kroll, & Diaz, 2007). The likely reason for this has been related to the specific requirements of the task, i.e., stimulus must be named aloud.

Therefore, it seems clear that although the issue of whether language activation in bilinguals is selective or non-selective has been extensively studied with respect to lexical access (see Dijkstra, 2005 for a review), but there has been much less research on this issue with respect to phonological processing. Moreover, most of the studies which have reported language non-selective activation in word naming have observed the phenomenon when participants performed the task in their second language, but when bilinguals perform the task in their first language, there is less evidence. To examine the implications of the above predictions for word naming, the present study compared the performance of Bodo−Assamese bilinguals when they named words in their first language Bodo (L1) and in their second language Assamese (L2).

5.3.1 The Present Study

In the present study, we used a word naming task in order to investigate phonological processing dynamics in bilingual word recognition and production because a word naming task is likely to reveal subtle phonological effects than a lexical decision task. Apart from examining whether phonological representations from the non-target language are activated by the bilinguals, we also wanted to provide evidence concerning the locus of any effects of non-target language phonology. This was done by examining whether cognate status of the word facilitates lexical retrieval. The language pair used was Bodo and Assamese. The main purpose of the study was to explore the differences in L1 and L2 lexical processing involving cognate and non-cognate words. Moreover, we examined whether the influence of the non-target language differs depending on the second language age of acquisition and proficiency of the bilinguals.

In Experiment 7A, word naming latencies for cognate and non-cognate words were compared for Bodo−Assamese bilinguals when words were presented in their second language, Assamese. In Experiment 7B, naming latencies for the same cognate and non-cognate words were compared when words were presented in their native language, Bodo. The naming tasks were done in different sessions with a gap of minimum fifteen days between two sessions.

We hypothesized that if bilinguals activate non-target language phonological representations then, naming latencies for cognates would differ from non-cognates—faster naming latencies for cognates would suggest facilitative or overlapping connections between phonological representations for cross-language members of a cognate pair. On the other hand, longer naming latencies for cognates would suggest activation of meaning associated with the member of the cognate pair in the non-target language from phonology. We hypothesized that Bodo being the native language of the participants, word naming latencies in Bodo should be similar for the three bilingual groups, whereas naming latencies in Assamese should be less accurate and slower for the low proficient bilinguals and should become more accurate with increasing proficiency.

5.3.2 Word Naming in L2 (Experiment 7A)

In Experiment 7A, each participant performed a simple word naming task in which a word was presented on the computer screen and the participant simply had to read the word aloud as quickly as possible in their second language, i.e., Assamese.

5.3.2.1 Method

Participants. A total of fifty-two Bodo−Assamese bilinguals (29 male and 23 female) from Bathoupuri took part in this study. Participants ranged in age from 21 to 38 years (mean age = 29.8 years, *SD* = 4.09). The participants considered Bodo to be their dominant language and Assamese to be their second language. Each participant completed a language background questionnaire indicating their use of Bodo and Assamese in various contexts. They also rated their proficiency in both languages. Self-report data of the participants' ratings of their current ability to speak, read, write, and understand in both Bodo and Assamese on a 7-point scale was included. Table 5.1 presents the summarized data of the self-report ratings.

Table 5.1 Self-Report Ratings in Bodo and Assamese for All Three Bilingual Groups in Experiment 7A

	Bodo (L1)			Assamese (L2)		
	Early (*n* = 21)	Late High (*n* = 13)	Late low (*n* = 18)	Early (*n* =21)	Late High (*n* = 13)	Late Low (*n* = 18)
Age of acquisition (years)	2.3	2.6	3	3.5	8.3	9
Mean daily usage (%)	51.5 %	49.5 %	46.6 %	37.2 %	38.6 %	21.5 %
Self-ratings (7 point scale)						
Speaking	7 (0.7)	7 (0.3)	6 (0.6)	6 (0.5)	5.5 (0.7)	5 (1.1)
Reading	7 (0.1)	7 (0.6)	6.6 (0.4)	5.6 (1.2)	5.5 (0.5)	2.3 (1.2)
Writing	7 (0.2)	7 (0.3)	6 (1.0)	4.8 (1.4)	4.8 (1.2)	1.7 (1.2)
Comprehension	7 (0.6)	7 (0.3)	4.6 (0.3)	4.9 (0.3)	4.3 (0.2)	1.7 (0.7)

In Table 5.1, responses on the age of acquisition indicated that all the participants had learned Bodo before Assamese. It can also be noted that the Bodo ratings of the three groups of bilinguals on all four proficiency measures are similar. However, on all four proficiency measures, the Assamese ratings of the high proficient groups are higher than the low proficient group. Apart from the self-report measures, participants took part in two versions of the Objective Naming Test in both Bodo and Assamese, as a measure of language fluencies in the two languages. Table 5.2 provides the mean scores of the objective naming test in Bodo and Assamese.

Table 5.2 Mean Scores on the Objective Naming Test in Bodo and Assamese for All Three Bilingual Groups in Experiment 7A

Bilingual Group	Bodo	Assamese
Early High Proficient	51.3	47.6
Late High Proficient	50.1	47.1
Late Low Proficient	49.7	39.2

The results of the Objective Naming Test show that the average L1 score for all three bilingual groups is similar. In case of L2, the average score for the Late High Proficient group matches the average score for the Early High Proficient group (47.1 vs. 47.6 respectively) and the scores do not yield a significant difference [$t(49) = 1.07$, $p = .784$]. This indicates that the proficiency level of the two groups is similar. However, the average score of the Late High Proficient group is noticeably higher than the average score of the Late Low Proficient group (47.1 vs. 39.2) and the scores yielded a significant difference [$t(49) = 8.89$, $p = .000$].

Stimuli. The stimuli consisted of fifty words in the categorized list (see Appendix M (i)) and sixty words in the randomized list (see Appendix M (ii)). The critical items in the categorized list belonged to five different semantic categories (fruits, vegetables, animals, birds, and kitchen items) and the critical items in the randomized list consisted of words from six different categories (clothing, body parts, unit of time, natural objects, education, and food). Two types of cross-language words were included: cognates and non-cognates. In each list, half of these words were cognates and the other half were non-cognates. Each cognate word in Assamese was matched with a non-cognate Assamese word on written frequency and word length. An example of categorized and randomized stimulus lists based on the cognate status of the word is shown in Table 5.3.

Table 5.3 Examples of Categorized and Randomized Word Lists used in Experiment 7A

Categorized		Randomized	
Cognate	**Non-cognate**	**Cognate**	**Non-cognate**
ফেঁচা *'owl'*	কাউৰী *'crow'*	হাড় *'bone'*	পানী *'water'*
বাদুলি *'bat'*	ঘনচিৰিকা *'sparrow'*	গাখীৰ *'milk'*	ৰাতি *'night'*
ভাটৌ *'parrot'*	বগলী *'cane'*	ঘন্টা *'hour'*	আকাশ *'sky'*
হাঁহ *'duck'*	ময়ূৰ *'peacock'*	শাৰী *'saree'*	তেল *'oil'*
পাৰ *'pigeon'*	শালিকা *'Indian Myna'*	নিয়ৰ *'dew'*	তাৰিখ *'date'*

Note. *ফেঁচা [phesa]; *বাদুলি [baduli]; *ভাটৌ [bhatou]; *হাঁহ [hah]; *পাৰ [paro]; *কাউৰী [kauri]; *ঘনচিৰিকা [ghonsirika]; *বগলী [bogoli]; *ময়ূৰ [moyur]; *শালিকা [xalika]; *হাড় [har]; *গাখীৰ [gakhir]; *ঘন্টা [ghonta]; *শাৰী [xari]; *নিয়ৰ [niyor]; *পানী [pani]; *ৰাতি [rati]; *আকাশ [akax]; *তেল [tel]; *তাৰিখ [tarikh]

Procedure. Participants were instructed that they would see words in Assamese and they were asked to read each word aloud as quickly and accurately as possible. Stimuli were presented one at a time at the center of a computer screen. The trial structure of the experiment was as follows: First, a fixation point (an asterisk) was shown in the center of the screen for 500 ms. This was followed by a blank interval of 500 ms. Then, the word (in Assamese) was presented. If a response was not provided within 2,000 ms from the offset of the word the next trial started automatically (see Figure 5.2).

Naming latencies were measured from the appearance of the word on the computer screen to the beginning of the naming response. Two lists of fifteen practice words were constructed, one in Bodo and one in Assamese, which were presented at the onset of the experiment.

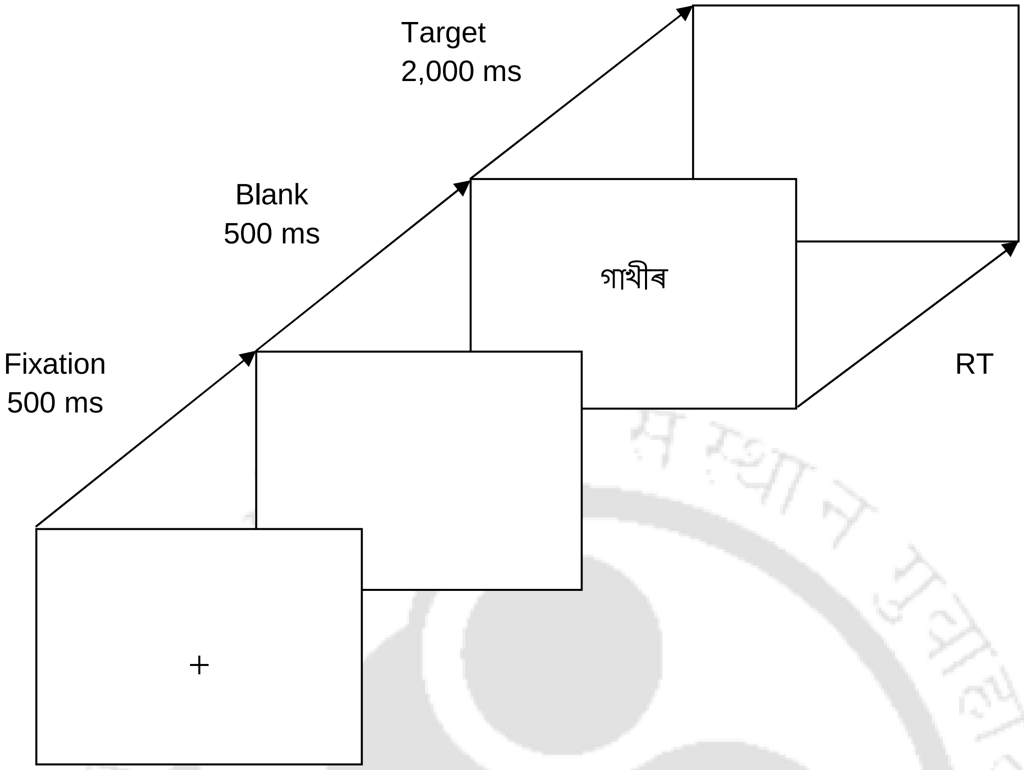


Figure 5.1 A schematic illustration of the procedure adopted for Experiment 7A.

5.3.2.2 Results

A mixed-effects analysis was run on the reaction time data and error data separately, for the performance of three groups of Bodo−Assamese bilinguals. The dependent measures were correct response latencies and errors for critical words. The independent variables were Cognate Status (cognate vs. non-cognate), List Type (categorized vs. randomized), and Bilingual Group (Early High Proficient, Late High Proficient, and Late Low Proficient). The results revealed that the main effect of Cognate Status was not significant [$F < 1$]. Reactions times for the cognate words (800 ms) and non-cognate words (807 ms) were similar.

However, the main effect of List Type was significant [$F(1,3039) = 22.204$, $p = .000$]. Participants took longer to name words in the categorized list (823 ms) than in the randomized list (783 ms). This 40 ms difference between the categorized and randomized list replicates the well-known category interference found in previous studies (Kroll & Stewart, 1994). Mean reaction times and percentage of errors for cognate and non-cognate words in the two conditions (categorized and randomized) are shown in Table 5.4. There was also a significant main effect of Bilingual Group [$F(2,50) = 24.600$, $p = .000$]. The critical result, however, was a significant interaction between Bilingual Group and List Type [$F(2,2971) = 7.898$, $p = .000$].

Table 5.4 Mean RTs (ms) and Percentage of Errors for Cognate and Non-Cognate Words in Experiment 7A

		Cognate Status		
	Overall	Cognate	Non-cognate	
List Type	RT (Error %)	RT (Error %)	RT (Error %)	**Cognate effect**
Categorized Lists	823 (9.2)	819 (11.2)	828 (7.2)	**9**
Randomized Lists	783 (14.6)	781 (11.3)	786 (7.3)	**5**
Category interference	**40**	**38**	**42**	

Planned comparisons were conducted to investigate the individual effects for the three groups of bilinguals. The overall results revealed that naming latencies of the Early High Proficient and Late High Proficient bilinguals (647 ms/663 ms) were faster than Late Low Proficient bilinguals (960 ms), indicating an effect of proficiency rather than age of acquisition.

With respect to the two types of list in which the word were presented, the overall results showed that the magnitude of category interference was greater in case of the Late Low Proficient bilinguals (63 ms) than in case of the Early High Proficient and Late High Proficient bilinguals (17 ms/24 ms). The effect of cognate status was not robust in any of the bilinguals. Table 5.5 shows the mean reaction times and percentage of errors for cognate and non-cognate words in the two conditions (categorized and randomized) for the three groups of bilinguals (Early High Proficient, Late High Proficient, and Late Low Proficient).

Table 5.5 Mean RTs (ms) and Percentage of Errors for Cognate and Non-cognate Words for All Three Bilingual Groups in Experiment 7A

	Cognate Status/Bilingual Group					
	Cognate			Non-cognate		
	Early	Late high	Late low	Early	Late high	Late low
List Type	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)
Categorized	655 (2)	678 (4.2)	982 (17.3)	656 (0)	689 (2.1)	1000 (12)
Randomized	630 (0)	645 (3.9)	931 (34.8)	647 (0)	672 (3.2)	925 (22.5)
Category interference	**25**	**33**	**51**	**9**	**17**	**75**

The data of the error analysis revealed that the main effect of Cognate Status did not reach significance [$F(1,3039) = 2.239$, $p = .056$]. The main effect of List Type was significant [$F(1,3039) = 4.325$, $p = .005$]. Participants made greater errors in the randomized list (14.6 %) than in the categorized list (9.2 %). Analysis of the error data also revealed a significant main effect of Bilingual Group [$F(2,50) = 19.348$, $p = .000$]. Low proficient bilinguals made more errors than the high proficient bilinguals. However, the interaction between List Type and Bilingual Group did not reach significance [$F(2,2971) = 4.012$, $p = .052$]. The magnitude of the error rate for the Late Low Proficient bilinguals was greater in the randomized list than in the categorized list. All other interactions were not significant [*F*s < 1].

5.3.2.3 Discussion

In the present study, we investigated the effect of cognate status of the word, age of acquisition and proficiency, and list type in L2 word naming with the goal of understanding how activation in the non-target language flows through the word recognition system of bilinguals. Participants were Bodo−Assamese bilinguals and they were simply asked to read aloud the word in their second language, Assamese. The pattern of results from Experiment 7A showed that words produced *category interference* when they were named in a semantically organized list. The category interference was larger for low proficient bilinguals than for high proficient bilinguals. If the effect of categorizing the list was to increase top-down activation from concepts to lexical entries, this finding suggests that word naming cannot be accomplished without conceptual access since clustering the words into semantic categories involves semantic manipulation (contradicting previous evidence by Lupker, 1984; Potter et al., 1986). Therefore, the effect of this manipulation suggests the activation of meaning representations when naming in L2. Moreover, the lack of cognate facilitation effect in Experiment 7A replicates previous findings. In the next, experiment, we further investigate if the pattern observed in this experiment is also evident when participants performed the naming task in their native language, Bodo.

5.3.3 Word Naming in L1 (Experiment 7B)

In Experiment 7B, participants completed the word naming task in L1. The design and procedure of this experiment was similar to Experiment 7A. It was conducted in a different session, at least 15 days after Experiment 7A.

5.3.3.1 Method

Participants. The fifty-two Bodo−Assamese bilinguals, who took part in Experiment 7A, took part in this experiment.

Stimuli. The stimuli for the present experiment consisted of the same cognate and non-cognate target words used in Experiment 7A. However, the only difference is that in the present experiment, the target words were in Bodo.

Procedure. The procedure adopted for previous experiment was used in this experiment. As the participants had to name the target words in Bodo, verbal and written instructions were also provided in Bodo.

5.3.3.2 Results

Similar to Experiment 7A, a mixed-effects analysis was run separately on correct reaction time data and error data for the performance of the three groups of bilinguals. Results of Experiment 7B showed no main effect of Cognate Status [$F < 1$]. Naming responses for cognates (705 ms) and non-cognates (706 ms) were the same. The main effect of List Type was not evident [$F < 1$]. Bilinguals named words in the categorized list (704 ms) and randomized list (706 ms) in a similar way. Table 5.6 shows the mean reaction times and percentage of errors as a function of Cognate Status and List Type.

Table 5.6 Mean RTs (ms) and Percentage of Errors for Cognate and Non-cognate Words in Experiment 7B

		Cognate Status		
	Overall	Cognate	Non-cognate	
List Type	RT (Error %)	RT (Error %)	RT (Error %)	**Cognate effect**
Categorized Lists	704 (0.8)	710 (0.8)	698 (0.8)	**−12**
Randomized Lists	706 (1.3)	700 (2.6)	713 (0)	**−13**
Category interference	**−2**	**10**	**−15**	

However, there was a significant main effect of Bilingual Group [$F(2,51) = 14.743$, $p = .000$] indicating that the three groups of bilinguals named cognate and non-cognate words differently. The interaction between Cognate Status and List Type was significant [$F(1,3424) = 5.478$, $p = .019$]. The results showed that for non-cognates there was no effect of the semantic context of the list, consistent with the findings of previous studies suggesting that naming can be accomplished at a lexical level without semantic influence. For cognates, however, there was a marginal category interference effect of 10 ms such that cognates were named more slowly in the categorized than in the randomized lists. The Cognate Status and Bilingual Group interaction was also significant [$F(2,3366) = 6.327$, $p = .012$]. Of crucial interest in the result was the significant interaction between the variables Bilingual Group and List Type [$F(2,3324) = 35.335$, $p = .000$].

To investigate the individual effects, planned comparisons were conducted on the results of the three groups of bilinguals. As in Experiment 7A, the overall results revealed that naming latencies of the Early High Proficient and Late High Proficient bilinguals (653 ms/669 ms) were faster than Late Low Proficient bilinguals (758 ms), indicating an effect of proficiency rather than age of acquisition. With respect to the two types of list in which the word were presented, the overall results showed that significant category interference effects were observed only in case of the Early High Proficient and Late High Proficient bilinguals (34 ms/37 ms). The main effect of cognate status was not significant in any groups of bilinguals. Table 5.7 shows the mean reaction times and percentage of errors as a function of Cognate Status, List Type, and Bilingual Group.

Table 5.7 Mean RTs (ms) and Percentage of Errors for Cognate and Non-cognate Words for All Three Bilingual Groups in Experiment 7B

	Cognate Status/Bilingual Group					
	Cognate			Non-cognate		
	Early	Late high	Late low	Early	Late high	Late low
List Type	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)
Categorized	665 (0)	689 (0.5)	754 (1.7)	674 (0)	685 (0)	722 (0)
Randomized	627 (1.4)	667 (1.5)	773 (3.4)	644 (0)	664 (0)	782 (0)
Category interference	**38**	**22**	**−19**	**30**	**21**	**−60**

The error analysis did not reveal a main effect of Cognate Status [$F < 1$]. The number of errors was similar for cognate and non-cognate words. The main effect of List Type did not reach significant [$F < 1$]. Although, the overall error analysis shows a difference in the categorized (0%) and randomized (1.4 %) conditions, this difference was not significant [$F < 1$].

The main effect of Bilingual Group was not significant [$F < 1$]. However, the three-way interaction between Cognate Status, List Type and Bilingual Group was also found to be significant [$F(2,2971) = 4.012$, $p = .021$]. Bodo−Assamese bilinguals made more errors when naming cognate words in the randomized list than in the categorized list. All other interactions were not significant [Fs < 1].

5.3.3.3 Discussion

The pattern of results from Experiment 7B showed that in contrast to Experiment 7A, words did not show sensitivity to the semantic context of the list in case of non-cognate words. The lack of category interference when naming non-cognate words in the native language suggests that L1 can be affected by lexical processing in case of non-cognates. That is, naming in L1 seemed to be more sensitive to the orthographical representation of the Bodo words activated by the visual code, without accessing its meaning.

This finding is consistent with the claim that word naming reflects activity primarily at a lexical level of processing (Balota & Chumbley, 1984; Forster, 1981; Seidenberg et al., 1984) which suggests that word naming can be accomplished without conceptual access in case of non-cognate words. However, the category interference effect observed in naming cognates suggests that effect may have resulted because of joint activation of the corresponding lexical entry in the other language by bottom-up activation from the target word and by top-down activation from the category. Moreover, similar to Experiment 7A, no cognate facilitation effect was observed.

5.3.3.4 Combined Analysis of Experiment 7A and 7B

In order to examine asymmetry, we analyzed the data from Experiments 7A and 7B in one design, using a mixed-effects analysis. The combined analysis of the results of the two experiments revealed that the main effect of Target Language was significant [$F(1,6551) = 479.765$, $p = .000$]. Word naming is Bodo (705 ms) was significantly faster than word naming in Assamese (799 ms).

The interaction between Bilingual Group and Target Language was also significant [$F(2,6551) = 531.287$, $p = .000$], which suggests that proficiency rather than age of acquisition have differential effects on bilingual memory. This interaction is shown in Figure 5.3. There was also a significant interaction between List Type and Target Language [$F(1,6549) = 20.760$, $p = .000$]. The three-way interaction between Bilingual Group, List Type and Target Language also reached significance [$F(2,6550) = 53.863$, $p = .000$].

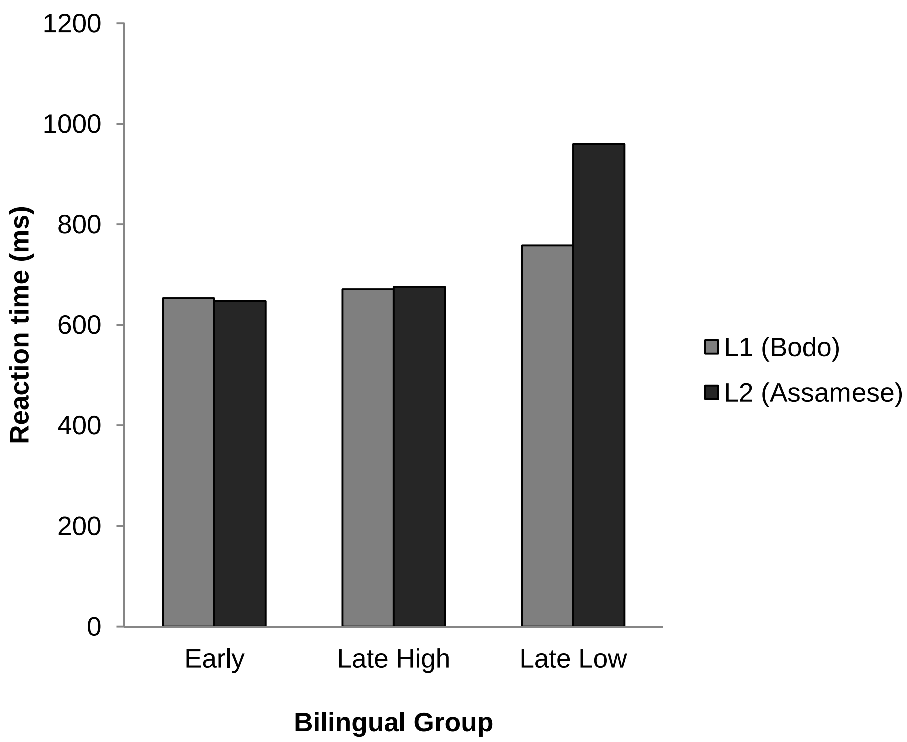


Figure 5.2 Mean RTs (ms) as a function of Bilingual Group and Target Language in Experiment 7A and 7B.

5.3.4 General Discussion

The aim of this study was to investigate the dynamics of phonological processing in bilingual word naming by three groups of Bodo−Assamese bilinguals in two different conditions: *Categorized* and *Randomized*. To achieve this, we investigated whether cognates are named faster than non-cognates and whether the size of any cognate effect differs when naming in the two languages. A crucial observation of our study when bilinguals performed word naming in their first language (Bodo) and second language (Assamese) is that the results produced significant category interference effect—naming latencies were longer for words in the semantically clustered lists than for words in the randomized lists. This finding suggests the activation of semantic representations even though they are not required in the word naming task. However, the magnitude of the interference effect was found to be greater in case of naming words in the second language, suggesting that since response latencies are slower, they give more time for feedback to phonology to occur.

Another manipulation of the study, i.e., the Cognate Status of the word did not yield any significant results. No cognate facilitation effect was observed when naming in L2 and L1. The lack of facilitation for cognates replicated those of Schwartz et al. (2007) quite closely. This finding indicates that the activation of the non-target language is not sufficient to influence naming performance in some conditions, particularly when words were cognates. The results of our phonological priming experiments (4A, 4B, 4C, and 4D) have provided evidence that the phonological activation of visually presented word is language non-selective. Therefore, the lack of facilitation for cognates may be understood if we look at the specific requirement of the naming task to pronounce the target word that does not hold for the lexical decision tasks. The activated phonological representation of the cognate's translation in the non-target language triggers a response that mismatches the correct response. This pending response will act as a nuisance competitor in the naming process. The consequence is delayed naming response. Moreover, in our study, we employed different-script bilinguals and therefore, cognate words shared only meaning and phonology, but no orthography. Previous studies employing the eye-tracking technique have shown that "with increasing cross-language overlap of the two terms in the cognate pairs, first fixation duration, gaze duration, and regression path duration all decreased" (Van Assche, Duyck, Hartsuiker, & Diependaele, 2009). Apparently, degree of between-language cognate similarity is a factor to be taken into account. However, naming in L1 was sensitive to the cognate status of the word in the sense that category inference was observed only with cognate words. If we assume that cognates share a lexical-level representation across languages, then naming should not have produced category inference in case of cognates, particularly in the case of naming L1 words, because it should have been possible to take advantage of greater automaticity in retrieving L1 words.

However, the presence of category interference indicates that cognates share both lexical and conceptual-level representation across languages. Therefore, when a cognate target word appears in a categorized list, the corresponding lexical entry in the other language is activated jointly by bottom-up activation from the target word and by top-down activation from the category. Moreover, the use of different-script bilinguals can also explain as to why the cognates followed the conceptual route. If cognate provided a reliable cue to all features of the lexical representation in the other languages, then it would make sense to be able to take advantage of lexical similarity and to override concept mediation. If cognates do not reliably map all lexical features between languages, however, then it may be risky to adopt a purely lexical strategy in translation.

Naming was also sensitive to the proficiency of the bilinguals: greater interference was observed with Low Proficient bilinguals than with High Proficient bilinguals. As clustering of the words into semantic categories involves semantic manipulation, sensitivity to this manipulation indicates that the three groups of Bodo−Assamese bilinguals activate meaning representations and therefore exploit conceptual access, contradicting previous evidence which suggest that word naming can be achieved at the lexical-level.

To summarize, the present study explored the processing dynamics involved in bilingual word naming and discussed the various cross-language effects produced in naming words in the first and second language. We provided evidence in support of non-selective activation of language in bilinguals. The study showed that L1 words can be named faster than L2 words, supporting previous findings (e.g., Kroll & Stewart, 1994). Moreover, contrary to the hierarchical model, the finding of the present study suggests that the L2 lexical links can be affected by semantic factors such as the category interference effect. In the next section, we investigate two word translation experiments which also involve processing mechanisms of both word recognition and production. However, it is different from the word naming task in that it requires subjects to generate translations, and word translation requires subjects to know the meaning of a word in order to translate it. The purpose of using this paradigm was to test for word effects in bilingual memory more directly.

5.4 Word Translation

One frequently used task which involves both a comprehension component and a production component is the word translation task. Another salient feature of this task is that, by definition, it always implicates the use of both languages. Unlike picture naming and the Stroop task, which at least in theory can be performed with the non-target (or "non-response") language completely at rest, word translation is only possible when both languages are activated, either simultaneously or in rapid alternation: Its comprehension component requires one language (the "source" language) to be active and its production component requires that the other language (the "target" language) is on the alert (De Groot, 2011). The word translation task has a long history in the cognitive study of bilingualism, but it has been used primarily to study the question of how L2 word-forms are mapped onto meaning (e.g., De Groot, 1992b; Kroll & Curley, 1988; Kroll & Stewart, 1994, Potter et al., 1984) or simply to find out what aspects of words make them had or easy to translate (De Groot, 2011). Previous research shows that bilinguals take longer to translate from L1−L2 (forward) than from L2−L1 (backward). This translation asymmetry is well captured by Kroll & Stewart (1994) in their Revised Hierarchical Model, according to which strength differences between the various connections in the bilingual memory structures results in asymmetric processing. Unpublished data from Kroll and Curley (1986) and from Kroll and Stewart (1989) focused on the role of translation direction and proficiency of the participants. The specific details of these two experiments differ, but the main point is that in each experiment participants performed the translation task in both directions and the results were always the same—naming latencies were consistently faster when the participants translated into the first language than into the second language.

Kroll and Stewart (1994) further provided support for the RHM in a series of translation experiments. The participants were fluent Dutch−English bilinguals who translated 144 Dutch and English words into the opposite language. The authors observed that participants took longer to translate Dutch words into English (i.e., L1−L2) than to translate English words into Dutch (i.e., L2−L1), a finding that had been reported before in literature (e.g., Sánchez-Casas et al., 1992). Kroll and Stewart (1994) viewed this result as consistent with the RHM's prediction concerning lexical links from L2−L1 words to be stronger than the lexical links from L1−L2. However, in a number of other translation studies the two translation directions produced equally long response times (De Groot, Dannenburg, & Van Hell, 1994; De Groot &Poot, 1997; La Heij, Hooglander, Kerling, & Van der Velden, 1996; Van Hell & De Groot, 1998b) or even shorter response times in L1−L2 translation (De Groot et al., 1994; Duyck&Brysbaert, 2004; La Heij et al., 1996; De Groot & Poot, 1997).

Another prediction of the RHM with regards to directional effects comes from meaning variables. The model suggests that meaning related variables affect translation from L1−L2 but not from L2−L1, or the latter to a lesser extent than the former. Kroll and Stewart (1994) provided such evidence in a study including Dutch−English bilinguals. The words were presented either blocked by semantic category or in random order (weapons, vegetables, furniture, birds, clothing, fruits, animals, and vehicles). The results demonstrated that when the participants translated Dutch words into English, naming latencies were longer when they were blocked by semantic category than when they were presented in random order. However, when the participants translated English words into Dutch, no effect of order was observed. The longer response times in the blocked condition was described as *categorical inference by* Kroll and Stewart (1994). They explained category interference to be the result of viewing multiple words from the same semantic category which caused activation of all members of that category. The increased activation of multiple items leads to difficulties in word retrieval, which results in slower translation times. Moreover, the presence of robust category interference in the L1−L2 direction and the lack of it in the L2−L1 direction were explained to be the result of stronger memory links between the conceptual representation and L1 words than between conceptual representation and L2 words. This is in line with the prediction of the RHM that category interference should occur for fluent bilingual participants only when they translate from L1−L2. But contradicting the findings of Kroll and Stewart's (1994) study, Salamoura & Williams (1999), in a Greek−English study obtained a category interference effect in backward translation, as manifested by faster translation of the clustered words.

Moreover, in a word translation study, De Groot and Poot (1997) obtained conceptually similar results as did Duyck and Brysbaert (2004, 2008) in two number translation studies. De Groot and Poot (1997) looked at word translation performance of Dutch native speakers with different levels of proficiency in English L2. Concreteness effects on response times, error scores, and omission scores were obtained for both translation directions—concrete words were translated faster, more often, and more often correctly, than abstract words. These effects suggest semantic processing and, therefore, the involvement of conceptual memory, in both translation directions. As with the analogous effects in La Heij et al.'s study (1996), these effects were either equally large in both translation directions or larger in backward translation. Perhaps most challenging for the revised hierarchical model was the fact that the concreteness effects tended to be largest in backward translation by participants at earliest stage of L2 development, the group predicted by the model to rely on word-association translation most.

Another robust finding in simple word translation studies is that cognates are translated faster than non-cognates (Christoffels, De Groot, & Kroll, 2006; De Groot, 1992b; De Groot et al., 1994). De Groot (2011) identified three sources of the cognate effect in word translation: (1) facilitated name retrieval due to language non-selective phonological encoding that favors cognates over non-cognates; (2) representational differences between cognate and non-cognates at the semantic-representational level and/or a morphological level; and (3) relatively strong activation of the associated semantic nodes when a cognate is presented for translation. In translation production, these various sources may all join forces in privileging the processing of cognates over non-cognates. The question of whether the process of translation is the same or different for cognates and non-cognates is theoretically interesting because some past research suggests that cognates may be the only words across languages that share the same lexical and/or conceptual representations (e.g., De Groot & Nas, 1991; Sánchez-Casas et al., 1992). If cognates share lexical representations or have privileged access to the lexical representations in the other language, then it should be possible to bypass concept mediation altogether when translation from L1 to L2.

5.4.1 The Present Study

The experiments reported in this study employed a design similar to the one used by Kroll and Stewart (1994). Bodo−Assamese bilinguals for whom Bodo was the first language viewed a series of words in Bodo and Assamese and were instructed to translate each word into the opposite language, as quickly as possible. As in Kroll and Stewart (1994), participants translated words that were randomized or blocked by semantic category. The main aim of the study was to replicate an observation made repeatedly in other studies of bilingual translation—bilingual participants can translate from L2−L1 more quickly than from L1−L2. Another goal of the two experiments was to investigate whether category interference would occur when Bodo−Assamese bilinguals translate words in both directions. Furthermore, the study also aimed to replicate the cognate facilitation effect as observed in previous research. Following the assumptions of the RHM, the prediction was that response latencies would be longer in the L1−L2 direction than the opposite direction and category interference would be produced only in the L1−L2 direction. Moreover, no category interference should be observed for translating cognates from L1−L2 under the same conditions that produce interference for translating non-cognates.

5.4.2 Word Translation from L1−L2 (Experiment 8A)

In Experiment 8A, Bodo−Assamese bilinguals performed a word translation task from L1−L2. A word in their L1, Bodo was presented on a computer screen and the participant was asked to translate the word into their L2, Assamese. Words were presented in two different conditions: categorized and randomized.

5.4.2.1 Method

Participants. Fifty-eight Bodo−Assamese bilinguals for whom Bodo was the first language and Assamese was the second language participated in the experiment. There were 41 male and 17 female with an average age of 34 years (*SD* = 5.9). Each participant completed a language background questionnaire in which they provided proficiency ratings for their ability to speak, read, write, and understand Bodo and Assamese on a 7-point scale. They also indicated their age of acquisition in Bodo and Assamese and also their use of both languages in various contexts. Table 5.8 presents the summarized data of the self-report ratings. Analyses of the self-report ratings revealed that speaking, reading, writing, and comprehension skills were rated as being significantly better in Bodo than in Assamese. Moreover, the ratings for Assamese on all four proficiency measures were higher for the high proficient groups than for the low proficient group.

Table 5.8 Self-report ratings in Bodo and Assamese for all three Bilingual Groups in Experiment 8A

	Bodo (L1)			Assamese (L2)		
	Early (n = 22)	Late High (n = 19)	Late low (n = 17)	Early (n = 22)	Late High (n = 19)	Late Low (n = 17)
Age of acquisition (years)	3.7	1.5	5	3.9	13.5	9
Mean daily usage (%)	53.4 %	50.4 %	51.6 %	40.4 %	39.8 %	20.6 %
Self-ratings (7 point scale)						
Speaking	6.8 (0.1)	7 (0.1)	6 (0.4)	6.7 (0.3)	6.1 (0.4)	5 (1.4)
Reading	6.6 (0.5)	7 (0.2)	6.6 (0.2)	6.3 (0.6)	6.3 (0.3)	2.3 (1.2)
Writing	6.6 (0.3)	7 (0.7)	6 (0.8)	5.6 (1.1)	4.5 (1.5)	1.6 (1.5)
Comprehension	6.4 (0.3)	7 (0.1)	4.6 (0.5)	5.5 (0.2)	5.5 (0.7)	1.6 (0.7)

In order to further assess the proficiency levels of the all three Bilingual Groups, all the participants took part in an Objective Naming Test. Table 5.9 shows the mean scores of the objective naming test for Bodo and Assamese.

Table 5.9 Mean Scores on the Objective Naming Test in Bodo and Assamese for All Three Bilingual Groups in Experiment 8A

Bilingual Group	Bodo	Assamese
Early High Proficient	50.1	48.3
Late High Proficient	51.4	48.1
Late Low Proficient]	50.2	39.6

The results of the objective naming test show that the average L1 score for all three bilingual groups is similar. In case of L2, the average score for the Late High Proficient group matches the average score for the Early High Proficient group (48.1 vs. 48.3 respectively) and the scores do not yield a significant difference [$t(55) = 1.02$, $p = .723$]. This indicates that the proficiency level of the two groups is similar. However, the average score of the Late High Proficient group is noticeably higher than the average score of the Late Low Proficient group (48.1 vs. 39.6) and the scores yielded a significant difference [$t(55) = 8.52$, $p = .000$]. The data from the self-report ratings were compared with the results of the objective naming test to examine whether they converged nicely with each other.

Stimuli. The material used in this experiment included words that were cognates and non-cognates. The stimuli consisted of one hundred ten items, representing eleven semantic categories: (1) fruits; (2) vegetables; (3) animals; (4) birds; (5) kitchen items; (6) body parts; (7) food; (8) time (9) education; (10) clothing; and (11) natural objects (see Appendix M (i) and M (ii) for complete list of the words that were used in Experiment 8A and 8B). In each category, ten pairs of words (i.e., a Bodo word and the matching Assamese translation equivalent) were used in the experiment. Only words with one dominant translation equivalent were selected. Words were selected using results of a preliminary norming study (see Appendix E (i)). Bodo words and their Assamese translation equivalents were closely matched on length and frequency. An example of the material used in the present experiment in shown in Table 5.10.

Table 5.10 Examples of Categorized and Randomized Word Lists used in Experiment 8A

Categorized		Randomized	
Cognate	Non-cognate	Cognate	Non-cognate
आफेल *'apple'*	थाइजौ *'mango'*	खाफाल *'forehead'*	बिजाब *'book'*
आंगुर *'grape'*	सेंफ्रेम *'guava'*	गामसा *'towel'*	अखा *'rain'*
खानथाल *'jackfruit'*	थालिर *'banana'*	दालां *'bridge'*	थाखो *'class'*
नाचपति *'pear'*	रायमालि *'pineapple'*	थुफि *'cap'*	संख्रि *'salt'*
तरमुज *'watermelon'*	मोदोमफुल *'papaya*	फिथा *'pancake'*	हाजो *'mountain'*

Note. *आफेल [aphel]; *आंगुर [angur]; *खानथाल [khanthal]; *नाचपति [naspoti]; *तरमुज [tormuz]; *थाइजौ [thaizwu]; *सेंफ्रेम [sengphrem]; *थालिर [thalir]; *रायमालि [raimali]; *मोदोमफुल [mwdwmphul]; *खाफाल [khaphal]; *गामसा [gamsa]; *दालां [dalang]; *थुफि [thuphi]; *फिथा [phitha]; *बिजाब [bizab]; *अखा [okha]; *थाखो [thakhw]; *संख्रि [songkhri]; *हाजो [hazw]

Procedure. Participants were instructed to translate each word into the opposite language as quickly as possible. The experimental task involved participants viewing two sets of trials. One set of trials was blocked by semantic category (categorized) and the other set of trials was presented in random order (randomized). The trial structure of the experiment was as follows: First, a fixation point (an asterisk) was shown in the center of the screen for 500 ms. This was followed by a blank interval of 500 ms. Then, the word (in Assamese) was presented. If a response was not provided within 2,000 ms from the offset of the word the next trial started automatically (see Figure 5.4).

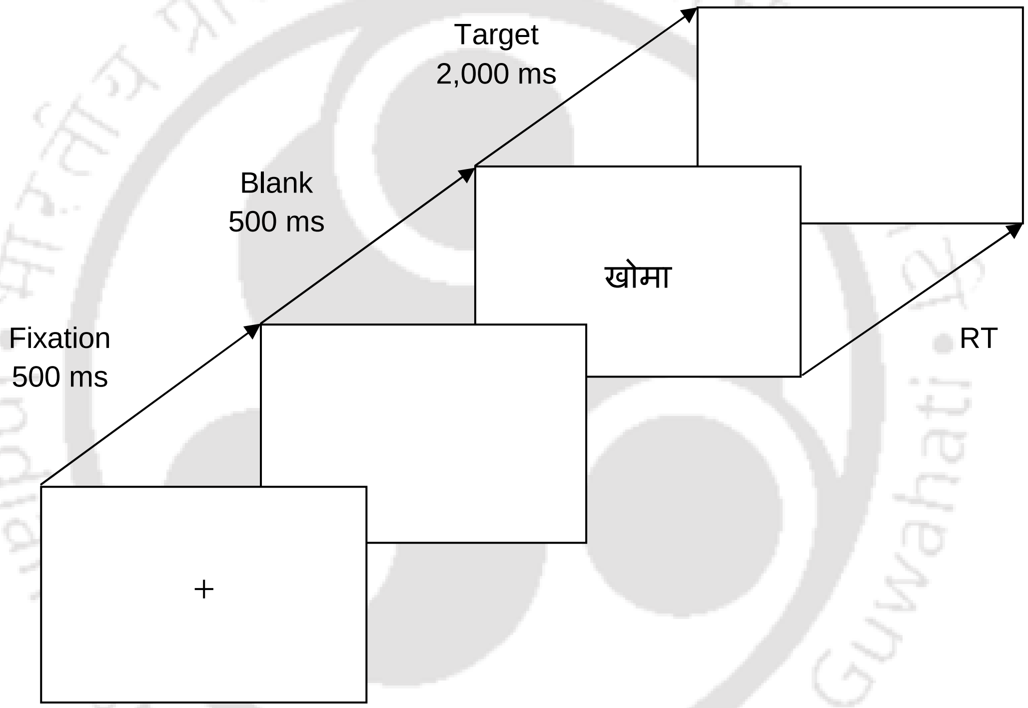


Figure 5.3 A schematic illustration of the procedure adopted for Experiment 8A.

Half of the participants received the randomized trials first, and half received the blocked trials first. All words were displayed in black letters on a white background. Stimuli were presented one at a time at the center of a computer screen. Naming latencies were measured from the appearance of the word on the computer screen to the beginning of the naming response. Two lists of fifteen practice words were constructed, one in Bodo and one in Assamese, which were presented at the onset of the experiment. None of the words in the practice block were used in the subsequent experiment.

5.4.2.2 Results

Mean reaction times and percentage of error for the critical trials were calculated for each condition. A mixed-effects analysis was conducted on the reaction time data of the correct trials including Cognate Status, List Type and Bilingual Group as independent variables. The results revealed a significant main effect of Cognate Status, [$F(1,398) = 68.306$, $p = .000$]. The results showed that on the average, cognates were translated 146 ms faster than non-cognates. No main effects of List Type and Bilingual Group were observed [Fs < 1]. The mean reaction times and percentage of errors are presented in Table 5.11 as a function of Cognate Status (cognate or non-cognate) and List Type (categorized or randomized).

Table 5.11 Mean Translation Latencies (ms) and Error Percentage for Cognate and Non-cognate Targets in Experiment 8A

		Cognate Status		
	Overall	Cognate	Non-cognate	
List Type	RT (Error %)	RT (Error %)	RT (Error %)	**Cognate effect**
Categorized Lists	1257 (31.5)	1123 (18.2)	1391 (45.2)	**268**
Randomized Lists	1269 (21.2)	1257 (20.9)	1281 (21.5)	**24**
Category interference	**−12**	**−134**	**110**	

Of crucial interest in this experiment was the interaction between the variables Cognate Status and List Type. The interaction was significant [$F(1,4650) = 346.695$, $p = .000$], with greater magnitude of cognate effect in the categorized list (268 ms) than in the randomized list (24 ms). Another critical prediction, that cognates would not show category interference effect in translating from L1−L2, was also supported. Although cognates were translated more quickly than non-cognates, category interference effect was observed only for non-cognates, suggesting that for cognates concept mediation was not mandatory when translating from L1−L2. Planned comparisons were conducted on the reaction time data of the three groups of bilinguals to further assess the role of age of acquisition and proficiency in translating words. Table 5.12 present the mean reaction times and percentage of errors as a function of Cognate Status, List Type, and Bilingual Group.

Table 5.12 Mean RTs (ms) and Error Percentage for Cognate and Non-cognate Targets for All Three Bilingual Groups in Experiment 8A

	Cognate Status/Bilingual Group					
	Cognate			Non-cognate		
	Early	Late high	Late low	Early	Late high	Late low
List Type	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)
Categorized	1200 (18.7)	1128 (14.3)	1040 (20.2)	1450 (46.2)	1451 (40.8)	1273 (47.3)
Randomized	1281 (21.7)	1245 (22)	1244 (19.1)	1322 (23.3)	1308 (18.6)	1214 (20.2)
Category interference	**−81**	**−117**	**−204**	**128**	**143**	**59**

The results revealed that a significant interaction was observed between the variables Bilingual Group and List Type [$F(2,4626) = 26.328$, $p = .000$]. The category interference effects for the Early High Proficient (128 ms) and Late High Proficient (143 ms) bilinguals were greater than Late Low Proficient bilinguals (59 ms), indicating that greater conceptual access by the high proficient bilinguals than the low proficient ones. Moreover, a significant interaction between Cognate Status and Bilingual Group was also evident [$F(2,4629) = 19.531$, $p = .000$]. All the three groups of bilinguals produced robust cognate facilitation effects in the categorized list, with the Late Low Proficient bilinguals producing the strongest effect (323 ms). However, in the randomized list, cognate facilitation effect was observed only for the Early High Proficient (41 ms) and Late High Proficient (63 ms) bilinguals.

The analysis of the error data revealed a significant interaction between Cognate Status and List Type [$F(1,4650) = 18.493$, $p = .000$]. In the categorized list, participants made more errors when translating non-cognate words (45.2%) than cognate words (18.2%), whereas, in the randomized list, the number of errors was similar for both cognates (20.9 %) and non-cognates (21.5 %). All other interactions were not significant [*F*s < 1].

5.4.2.3 Discussion

The pattern of results from Experiment 8A showed that translation for non-cognates words produced category interference when they were translated in a semantically organized list from L1−L2. The sensitivity to meaning-related variables indicates the use of conceptual access by non-cognate words. Moreover, robust cognate facilitation effects were observed in both categorized and randomized list for all three Bilingual Groups. This finding indicates differences in processing involving cognate and non-cognate words.

5.4.3 Word Translation from L2−L1 (Experiment 8B)

The purpose of Experiment 8B was to further test for the different variables when Bodo−Assamese bilinguals performed a word translation from their Assamese (L2) to Bodo (L1).

5.4.3.1 Method

Participants. The same subjects from Experiment 8A participated in the present experiment. After completing Experiment 8A, there was a gap of fifteen days before the participants took part in this experiment

Stimuli. The stimuli and design were the same as that used in Experiment 8A, except that the Bodo words which served as targets in Experiment 8A, were replaced by Assamese translation equivalents as targets.

Procedure. The apparatus used in this experiment and the presentation of stimuli were identical to Experiment 8A. The only difference was that in this experiment participants were given verbal and written instruction in Assamese, their L2.

5.4.3.2 Results

Similar to Experiment 8A, a mixed-effects analysis was run on the reaction time data and error data separately. The mean reaction times and percentage of errors are presented in Table 5.13 as a function of Cognate Status (cognate or non-cognate) and List Type (categorized or randomized).

Table 5.13 Mean RTs (ms) and Error Percentage for Cognate and Non-cognate Targets in Experiment 8B

		Cognate Status		
	Overall	Cognate	Non-cognate	
List Type	RT (Error %)	RT (Error %)	RT (Error %)	**Cognate effect**
Categorized Lists	1198 (21.8)	1173 (14.6)	1223 (29.3)	**50**
Randomized Lists	1173 (13.7)	1218 (14.3)	1128 (13)	**−90**
Category interference	**25**	**−45**	**95**	

The results revealed that there was a significant main effect of List Type, [$F(1,4755) = 17.666$, $p = .000$]. The overall category interference effect of 25 ms was significant, indicating that backward translation was also sensitive to the meaning related variables. A significant effect of Bilingual Group emerged [$F(2,54) = 6.240$, $p = .004$]. However, no main effect of Cognate Status was observed [$F < 1$]. There was a significant interaction between the variables Cognate Status and List Type [$F(1,4989) = 138.064$, $p = .000$]. A cognate facilitation effect of 50 ms was observed only in the categorized list condition. Moreover, as in Experiment 8A, category inference effect was evident only in case of non-cognate words.

Individual differences of the bilinguals were measured by conducting planned comparisons on the response latencies of the three groups of bilinguals. The results revealed a significant interaction between the variables Bilingual Group and List Type [$F(2,4944) = 23.468$, $p = .000$]. Table 5.14 present the mean reaction times and percentage of errors as a function of Cognate Status, List Type, and Bilingual Group.

Table 5.14 Mean RTs (ms) and Error Percentage for Cognate and Non-cognate Targets for All Three Bilingual Groups in Experiment 8B

	Cognate Status/Bilingual Group					
	Cognate			Non-cognate		
	Early	Late high	Late low	Early	Late high	Late low
List Type	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)
Categorized	1170 (11.6)	1144 (0)	1206 (31)	1182 (22.8)	1207 (22.4)	1280 (47.3)
Randomized	1192 (9.3)	1137 (6.8)	1326 (28)	1108 (6.7)	1071 (1.7)	1205 (31.5)
Category interference	**−22**	**7**	**−120**	**74**	**136**	**75**

Contrary to Experiment 8A, the category interference effects produced by the Late High Proficient bilinguals (136 ms) was significant, compared to the Early High Proficient and Late Low proficient bilinguals, who produced similar effects of 74 ms and 75 ms respectively. Moreover, a significant interaction between Cognate Status and Bilingual Group was also observed [$F(2,4923) = 4.262$, $p = .014$]. Similar to Experiment 8A, the Late Low Proficient bilinguals (74 ms) produced the strongest cognate facilitation effect for non-cognates, followed by the Late High Proficient ones (63 ms). The effect for the Early High Proficient group was not significant.

The results of the error analysis revealed a significant main effect of Bilingual Group [$F(2,54) = 9.043$, $p = .002$]. Overall, the Early High Proficient and Late Proficient bilinguals made fewer errors than Late Low Proficient bilinguals. A significant interaction was observed between Cognate Status and List Type [$F(1,4989) = 11.254$, $p = .001$]. In the categorized list, participants made more errors when translating non-cognate words (29.3%) than cognate words (14.6%), whereas, in the randomized list, the number of errors was almost similar for both cognates (14.3%) and non-cognates (13%). All other interactions were not significant [Fs < 1].

5.4.3.3 Discussion

The results of Experiment 8B produced significant category interference in translating non-cognate words, contrary to previous claims that meaning-related variables affect translation from L1−L2 but not from L2−L1.

5.4.3.4 Combined Analysis of Experiment 8A and 8B

To test for differences between reaction times in both directions, we analyzed the data from Experiment 8A and 8B in one design. A mixed-effects analysis revealed that there was a significant main effect of Translation Direction, [$F(1,9673) = 367.754$, $p = .000$]. Reaction times were approximately 80 ms longer to translate from L1−L2 than those to translate from L2−L1. The pattern of data thus replicates the translation asymmetry found in previous studies (Kroll & Curley, 1986; Kroll &

Stewart, 1989) in that translation from L1−L2 was reliably longer than translation from L2−L1. The interaction between Cognate Status and Translation Direction was reliable, [$F(1,9668) = 21.128$, $p = .000$]. The interaction between Bilingual Group and Translation Direction reached significance, [$F(2,9670) = 239.832$, $p = .000$]. This interaction is shown in Figure 5.5. The List Type and Translation Direction was also significant [$F(1,9673) = 8.357$, $p = .004$]. Finally, the three way interaction between the variables Cognate Status, List Type, and Translation Direction also reached significance [$F(1,9671) = 40.115$, $p = .000$]. The three-way interaction between Cognate Status, Bilingual Group and Translation Direction was significant [$F(2,9666) = 5.229$, $p = .005$]. The analysis of the error data revealed that there was a significant effect of Translation Direction, [$F(1,9001) = 7.794$, $p = .005$]. Participants were more accurate in translating from L1−L2 than in translating from L2−L1.

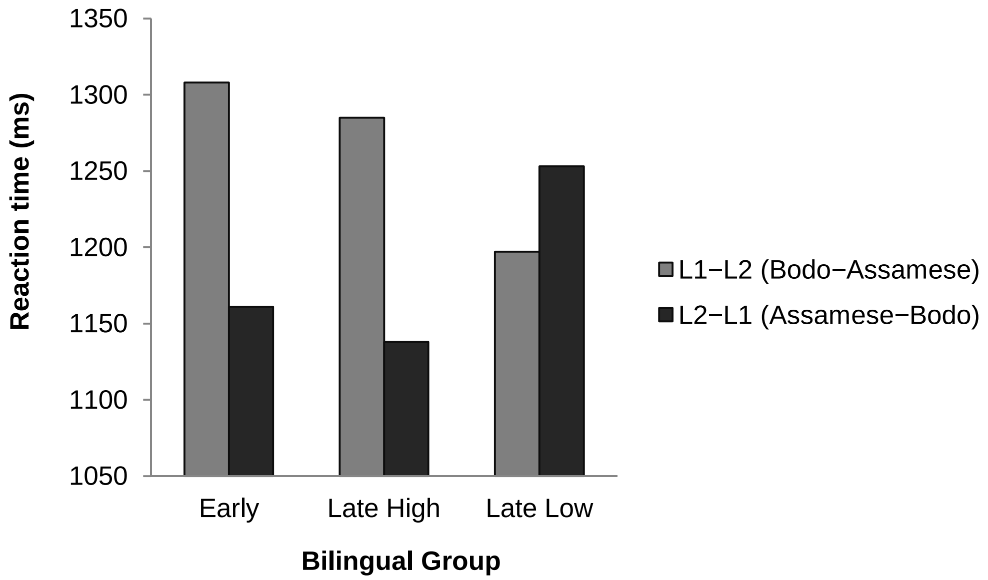


Figure 5.4 Mean RTs (ms) as a function of Bilingual Group and Translation Direction in Experiment 8A and 8B.

5.4.4 General Discussion

The present study examined word translation in the context of either clustering the words to be translated into semantic categories or presenting them in random order.

Two word translation experiments (Experiment 8A and 8B) tested the performance of three groups of Bodo−Assamese bilinguals when they translated cognate and non-cognate words into the other language. Based on the RHM, we predicted that (1) response latencies would be faster from L2−L1 than from L1−L2 and (2) only translation from L1−L2 which is conceptually mediated would be affected by the semantic context, but not from L2−L1.

The results of the present study support one of the predictions of the RHM. We were able to replicate the translation asymmetry as reported in previous studies. The overall results demonstrated longer reaction times and fewer errors when participants translated from L1−L2 than vice versa. However, the question of interest, given that we were able to replicate the translation asymmetry was whether the two directions of translation were differentially sensitive to the effects of semantic context. Following Kroll and Stewart (1994), categorical interference was expected to be observed in the L1−L2 direction, but not in the L2−L1 direction. If L1−L2 was longer than L2−L1 because the L1−L2 translation route required concept mediation, then translation from L1−L2 should also have been influenced by semantic context of the lists in which translation was performed. However, if translation from L2−L1 was performed lexically, it should not have been influenced by semantic context, and naming latencies should also have been independent of the semantic form of the list.

The data from Experiment 8A and 8B does not support this prediction. Category interference was equally observed in both directions. We regard this category interference in backward translation as a signature of conceptual processing and, thus, of translation via conceptual memory. Accordingly, their presence in both translation directions led us to conclude that conceptual memory is involved in both forward and backward translation. In other words, the data refuted a strong version of the RHM, which would claim that conceptual memory is never implicated in backward translation.

Another question that arises about the pattern of results is whether it describes performance on cognates and non-cognates equally well. The material used in this experiment included words that were cognates and non-cognates. The question of whether the process of translation is the same or different for cognates and non-cognates is theoretically interesting because some past research suggests that cognates may be the only words across languages that share the same lexical and/or conceptual representations(e.g., De Groot & Nas, 1991; Sánchez-Casas et al., 1992). If cognates share lexical representations or have privileged access to the lexical representations in the other language, then it should be possible to bypass concept mediation altogether when translation from L1−L2. For the conditions of the present experiment, the prediction is that no category interference should be observed for translating cognates from L1−L2 under the same conditions that produce interference for translating non-cognates. The result of the present study support this prediction, as no category interference effect in word translation was observed for translating cognates from L1−L2 as well from L2−L1.

Moreover, for cognates and non-cognates alike, translation was faster from L2−L1 than translation from L1−L2, and the presence and absence of category interference was determined by the direction of translation as well as the cognate status of the word. With regard to cognate effect, facilitation was observed more in the categorized condition.

However, the result of the present study refutes another prediction of the RHM with regard to the proficiency of the bilinguals. As per the prediction of the model, the low proficient bilinguals should be faster as compared to high proficient bilinguals when translating from L2−L1, since they are assumed to use the shorter lexical route. However, the result of the present study tells a different story. Late Low proficient bilinguals were slowest when translating from L2−L1. Since no such result has been reported in the literature before, we would like to reserve our comment on the reasons till further studies are carried out using similar condition. In the next section we discuss two simple picture naming experiments where the primary question of interest is whether a particular component of the depicted object's lexical representation in the non-target language affects responding. If it does, this would provide evidence in support of language non-selective access in bilingual word production (Robinson & Ellis, 2008).

5.5 Simple Picture Naming

Examining the mechanisms involved in naming a picture is one way to investigate the processes involved in lexical access. In the simplest version of the task, the participants are presented with pictures presented own their own, unaccompanied by a distracter and are instructed to name each of the pictures as rapidly as possible. It is the task used most frequently in word production research because the outcome of the picture analysis process is regarded similar to the output of the mental conceptualization process in natural speech production, and this output is thought to set off the remainder of the production process in the same way in picture naming and common speech production. In brief, the full picture-naming process is assumed to consist of the following chain of operations—the computation of the visual percept, the activation of the appropriate lexical concept, the selection of the target word from the mental lexicon, phonological encoding, phonetic encoding, and the initiation of articulation (Levelt, Praamsma, Meyer, Helenius, & Salmelin, 1998).

Another important aspect of the simple picture naming paradigm is the perceptual absence of the written lexical form. Recent within-language research suggests that during speech production, the orthographic effect can be found only in case of perceptual presence of orthography in the task (Alario, Perre, Castel, & Ziegler, 2007; Roelofs, 2006). In the simple picture naming experiment, the distinct script of the bilingual's language may not modulate the degree of cross-language activation and the locus of language selection.

Unlike the within-language research, however, it may be possible to observe an orthographic effect during production in the L2 because the speech planning in the L2 is slower than in the L1 which makes the demonstration of the effects of orthographic feedback, if present, more likely (e.g., Kroll et al., 2006). Furthermore, the presence of script differences across languages may serve as a language cue to direct lexical access or may function to more rapidly inhibit unintended alternatives and thereby facilitate lexical selection (e.g., Miller & Kroll, 2002). If script functions as an explicit cue to language status and if bilinguals can exploit that information, then the process of speech planning becomes similar to the monolingual case for different-script bilinguals even when the task itself does not contain the lexical written form.

Moreover, as reviewed in Chapter 2, a number of studies on picture naming have shown that cognate pictures are named more quickly than non-cognate pictures by bilinguals, suggesting that during the planning of single word utterances, lexical candidates in the unintended language are activated to the level of phonology (e.g., Costa et al., 2000; Kroll et al., 2000; Hoshino, 2006). Although these effects are typically larger in the L2, they have also been reported for L1 (Costa et al., 2000). However, previous results are based on the performance of bilinguals whose two languages are orthographically similar (Spanish and Catalan in the study by Costa et al., 2000, and Dutch and English in the study by Kroll et al., 2000). Therefore, it is crucial to determine whether the conclusion that there is activation of the non-target language all the way to the level of the phonology is restricted to bilinguals whose L1 and L2 are orthographically similar.

5.5.1 The Present Study

In the present study, we investigated performance of Bodo−Assamese bilinguals, in two simple picture naming experiments to determine whether cross-language activation in spoken production is modulated for bilinguals whose languages use different scripts. Moreover, to test the hypothesis that script modulates cross-language activation in spoken production, we examined cognate facilitation in L1 and L2 simple picture naming. In other words, the purpose of the present study was to determine whether there is cognate facilitation even when two languages differ in scripts (i.e., when cognate status is based on shared phonology only). Another goal of this study was to investigate whether the category interference effect observed in previous picture naming studies (Kroll and Curley, 1988) under between-subject conditions could be replicated with Bodo−Assamese bilinguals, when they used both their first and second language to respond. Furthermore, the final goal of the present study is to evaluate the contribution of L2 AoA and proficiency in constraining cross-language activation. The logic here is to compare bilinguals who differ in the age they acquired their second language and the degree to which they differ in their second language proficiency.

In Experiment 9A and 9B, the task was simple picture naming in which Bodo−Assamese bilinguals were asked to name each picture in their L2 and L1 respectively. All participants first named pictures in their L2 and then in their L1. The critical materials were cognates picture targets and non-cognate picture targets that were matched on lexical properties with the cognates. The study was designed to explore the extent to which picture naming is affected by the cognate status of the picture names. Three groups of Bodo−Assamese bilinguals participated in Experiment 9A and 9B. The comparison of bilinguals in both the experiments allowed us to examine the contribution of the L2 AoA and proficiency to the activation and inhibition of the unintended language. Moreover, since the written lexical form is perceptually absent during production in the simple picture naming task that the present experiment used, a crucial aim of the study was to explore whether the presence of script differences may serve as a language cue or may function to inhibit unintended alternatives and thereby facilitate lexical selection (e.g., Miller & Kroll, 2002).

We predicted that, if the name of the picture in the non-target language is activated at the phonological level even when L1 and L2 differ in script, then cognate facilitation effects should be observed for all bilinguals. Such a finding would support word production models that assume non-selective/cascaded processing. However, to the extent that script differences serve as a language cue to direct lexical access selectively and/or modulate phonological processing, then Bodo–Assamese bilinguals were not expected to produce cognate facilitation, which would support the selective/discrete model word production. We further test the assumptions made by the cascaded activation models on the assumption that the activation level of the non-selected word is greater when it is a word in the dominant language than when it is a word in the second, non-dominant language (as suggested by Peterson & Savoy, 1998). Therefore, we assume that if the level of activation of the segmental nodes of non-selected words depends on the level of activation of their corresponding lexical nodes, the cognate facilitation effect should be larger when picture naming is performed in the non-dominant language.

5.5.2 Simple Picture Naming in L2 (Experiment 9A)

In Experiment 9A, three groups of Bodo−Assamese bilinguals were asked to name cognate and non-cognate pictures in their L2 which were presented in semantically categorized or randomized lists. The aim of the study was to explore the extent to which picture naming is affected by the semantic context and cognate status of the pictures.

5.5.2.1 Method

Participants. Fifty-five Bodo−Assamese bilinguals with an average age of 30.3 years took part in this and the following experiments. All participants were from Bathoupuri. They were all native speakers of Bodo with Assamese as their second language. Participants were asked to fill in a language background questionnaire about how often they use the two languages and how proficient they were in the two languages. The data on their self-assessed ratings for the L1 and L2 are summarized in Table 5.15.

The results of the self-report ratings show that the Bodo ratings of the three groups of bilinguals on all four proficiency measures are similar. However, the Assamese ratings on all four proficiency measures are higher for the High Proficient group than for the Low Proficient group.

Table 5.15 Self-Report Ratings in Bodo and Assamese for All Three Bilingual Groups in Experiment 9A

	Bodo (L1)			Assamese (L2)		
	Early (*n* = 19)	Late High (*n* = 15)	Late low (*n* = 21)	Early (*n* = 19)	Late High (*n* = 15)	Late Low (*n* = 21)
Age of acquisition (years)	3.2	2	5	3.4	15	9
Mean daily usage (%)	55.4 %	50 %	52.6 %	37.6 %	33.2 %	17.5 %
Self-ratings (7 point scale)						
Speaking	6.9 (0.4)	7 (0.2)	6 (0.1)	6.8 (0.7)	6.5 (0.5)	5 (0.6)
Reading	6.6 (0.4)	6.5 (0.7)	6.6 (0.3)	6 (1.2)	5.7 (1.1)	2.3 (1.7)
Writing	6.6 (0.5)	6.5 (1.2)	6 (1.1)	5 (0.7)	3.5 (1.4)	1.7 (2.0)
Comprehension	6.4 (0.2)	6.5 (0.4)	4.6 (1.2)	5 (0.3)	4 (1.1)	1.7 (1.6)

In order to further assess the proficiency levels of the bilinguals, all participants took part in an objective naming test. Table 5.16 provides the mean scores on the objective naming test in both Bodo and Assamese.

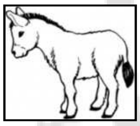
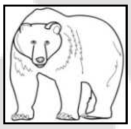
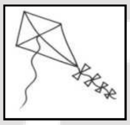
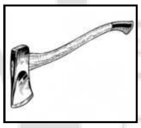
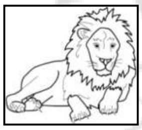
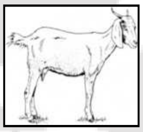
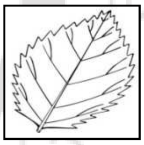
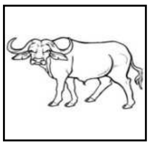
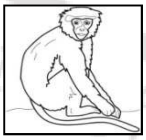
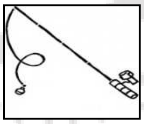
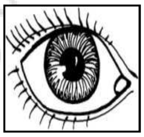
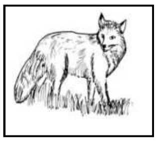
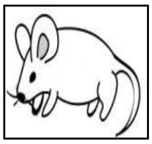
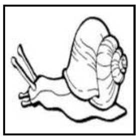
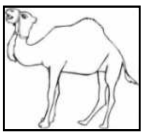
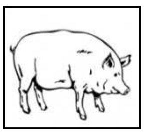
Table 5.16 Mean Scores on the Objective Naming Test in Bodo and Assamese for All Three Bilingual Groups in Experiment 9A

Bilingual Group	Bodo	Assamese
Early High Proficient	54.2	48.4
Late High Proficient	54.2	49.2
Late Low Proficient	51.3	35.4

The results of the Objective Naming Test show that the average L1 score for all three bilingual groups is similar. In case of L2, the average score for the Late High Proficient group matches the average score for the Early High Proficient group (49.2 vs. 48.4 respectively) and the scores do not yield a significant difference [$t(52) = 1.01$, $p = .712$]. This indicates that the proficiency level of the two groups is similar. However, the average score of the Late High Proficient group is noticeably higher than the average score of the Late Low Proficient group (49.2 vs. 35.4) and the scores yielded a significant difference [$t(52) = 12.47$, $p = .000$].

Stimuli and Design. A total of hundred pictures were selected from a wide range of semantic categories (e.g., animal, bird, fruit, vegetable, utensil, insect, body part, natural object, vehicle, etc.). The pictures were blocked into lists that were either semantically categorized or randomly mixed. The cognate status of the picture was manipulated which resulted in two experimental conditions: (1) fifty pictures with cognate names, and (2) fifty pictures with non-cognate names. Each cognate picture was matched as closely as possible with a non-cognate picture on word length of the picture's name (number of characters and number of syllables) and frequency (see Appendix N (i) and N (ii) for the complete set of the experimental materials). Examples of the categorized and randomized stimulus lists are shown in Fig 5.17.

Table 5.17 Examples of categorized and randomized pictures used in experiment 9A

Categorized List		**Randomized List**	
Cognate	Non-cognate	Cognate	Non-cognate
 *'donkey'*	 *'bear'*	 *'kite'*	 *'axe'*
 *'lion'*	 *'goat'*	 *'lock'*	 *'leaf'*
 *'buffalo'*	 *'monkey'*	 *'fishing rod'*	 *'eye'*
 *'fox'*	 *'mouse'*	 *'snail'*	 *'house'*
 *'camel'*	 *'pig'*	 *'pen'*	 *'comb'*

The pictures were presented two times in two different lists (categorized and randomized). Categorized lists of pictures were constructed such that each list included five categories (animals, birds, fruits, vegetables, and kitchen items). All of the members of a given category appeared in sequence within the list. Five lists of ten items each were generated for pictures. A set of randomized lists was constructed such that each random list of pictures contained exemplars from each of the semantic categories in a random order. The pictures were presented two times in two separate blocks. Each block included each picture only once. Block trials were randomized so that pictures of the same experimental condition appeared in no more than two consecutive trials. The order of list presentation was counterbalanced across participants.

Procedure. Participants were tested individually in a quiet environment. Instructions were administered in Assamese. Participants were instructed to name briefly presented pictures one at a time as rapidly and as accurately as possible in Assamese. The trial structure of the standard picture naming part of the experiment was the following (see Figure 5.6).

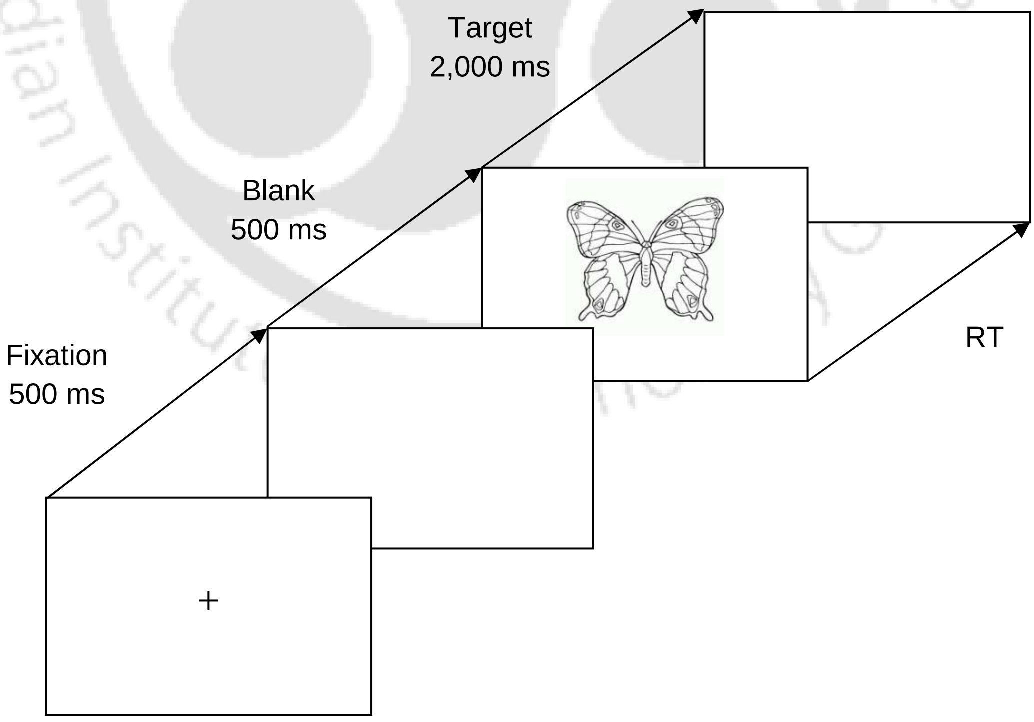


Figure 5.5 A schematic illustration of the procedure adopted for Experiment 9A.

First, a fixation point (a plus sign) was shown in the center of the screen for 500 ms. This was followed by a blank interval of 500 ms. Then, the picture was presented for 2,000 ms. If a response was not provided within 2,000 ms from the offset of the picture, the next trial started automatically. Naming latencies were measured from the onset of the stimulus to the beginning of the naming response.

5.5.2.2 Results

A mixed-effects analysis was run on the reaction time data and error data separately. Table 5.18 shows the mean reaction times and percentage of errors for the two types of words (cognates and non-cognates) in the two conditions (categorized and randomized) separately. The analysis of the reaction time data shows the following effects. There was no main effect of Cognate Status [$F < 1$], reflecting similar reaction times for cognate and non-cognate pictures. The main effect of List Type was not significant [$F < 1$]. A comparison of the two lists shows that there was no category interference as found in earlier studies. It took 10 ms longer to name pictures in the randomized lists than in the categorized list.

Table 5.18 Mean RTs (ms) and Percentage of Errors for Cognate and Non-cognate Targets in Experiment 9A

		Cognate Status		
	Overall	Cognate	Non-cognate	
List Type	RT (Error %)	RT (Error %)	RT (Error %)	**Cognate effect**
Categorized List	1214 (33.8)	1202 (28.3)	1227 (38.8)	**25**
Randomized List	1203 (38.6)	1220 (35.1)	1186 (41.9)	**−34**
Category interference	**11**	**−18**	**41**	

There was a significant effect of Bilingual Group [$F(2,54) = 14.413$, $p = .000$]. Of crucial interest in this experiment is the interaction between the variables group of

Cognate Status and Bilingual Group. This interaction was significant [$F(2,5087) = 25.170$, $p = .000$], suggesting that the difference between the cognate and non-cognate words depends on the type of bilinguals tested. The Cognate Status and List Type interaction also approached significance [$F(1,469) = 4.263$, $p = .039$]. Most critically, significant effects were observed for the three-way interaction [$F(2,5082) = 14.418$, $p = .000$].

Further analyses were carried out on the three bilingual groups separately in order to evaluate the effect of Cognate Status and List Type. Table 5.19 shows the mean reaction times and percentage of errors for the two types of words (cognates and non-cognates) in the two conditions (categorized and randomized) separately for the three groups of participants.

Table 5.19 Mean RTs (ms) and Percentage of Errors for Cognate and Non-cognate Targets For All Three Bilingual Groups in Experiment 9A

	Cognate Status/Bilingual Group					
	Cognate			Non-cognate		
	Early	Late high	Late low	Early	Late high	Late low
List Type	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)
Categorized	1241 (30)	1287 (40.4)	1078 (18.3)	1202 (36.2)	1266 (41.2)	1212 (42.9)
Randomized	1240 (34.3)	1268 (45.4)	1152 (30.1)	1181 (34.9)	1248 (54.5)	1129 (46.1)
Category interference	**1**	**19**	**−74**	**21**	**18**	**83**

The main effect of Cognate Status was not evident for the Early High Proficient and Late High Proficient Groups in both categorized and randomized conditions. However, a main effect of Cognate Status was observed for the Late Low Proficient bilinguals in the categorized condition. This 134 ms difference was very significant.

For the Early High Proficient group, the main effect of List Type was not significant in the cognate condition (1 ms), however, the effect was significant in the non-cognate condition (21 ms). For the Late Low Proficient group, the main effect of List Type was significant both in the cognate (19 ms) and non-cognate (18 ms) conditions. And finally, a significant main effect of List Type for the Late Low Proficient group was evident only in the non-cognate (83 ms) condition.

A mixed-effects analysis of the error data showed a main effect of Cognate Status [$F(1,321) = 10.627$, $p = .000$], in which cognates were responded to more accurately than non-cognates. The main effect of List Type was marginal [$F(1,6017) = 2.298$, $p = .042$]. Errors were numerous in the Randomized List than in the Categorized List. The main effect of Bilingual Group reached significance [$F(2,54) = 9.243$, $p = .000$]. Moreover, interaction between the variables group of Cognate Status and Bilingual Group was significant [$F(2,5087) = 8.295$,$p = .000$], suggesting that all three bilingual groups made more errors to cognate pictures than to non-cognate pictures. No other interactions were significant concerning error proportions [Fs < 1].

5.5.2.3 Discussion

The result of Experiment 9A shows that Bodo−Assamese bilinguals were faster to name cognate pictures than non-cognate pictures, suggesting that even when the bilingual’s two languages do not share script, there is activation of the phonology of the non-target language (L1). However, an important result in the L2 picture naming latency analyses is that cognate facilitation effect was observed only in the categorized list. Moreover, a significant interaction was observed between the cognate status of the word and the three groups of bilinguals. Only the Late Low Proficient group exhibited robust facilitation for cognates in the categorized list.. In Experiment 9A, the language of the response for the bilingual group was their second, non-dominant language. The cognate effect observed in that experiment reflects the influence of word properties of the dominant language on non-dominant language naming latencies. It has been argued (e.g., Kroll &Stewart, 1994) that the amounts of activation received by lexical items in dominant and in non-dominant languages are different—non-dominant language words are less strongly activated than their corresponding dominant-language words. We address this issue in the next experiment by investigating the naming performance of the three groups of Bodo−Assamese bilinguals in their dominant language.

5.5.3 Picture naming in L1 (Experiment 9B)

The goal of Experiment 9B was to explore whether the cognate status of pictures and the list in which pictures are present affects the performance of Bodo−Assamese bilingual speakers when naming in their dominant language, Bodo, and if so, whether the magnitude of the effect is comparable to that obtained when speakers are using their second language, Assamese. Based on the predictions of the cascaded activation models of lexical access regarding interaction between the language of the response and the cognate status of words, we assumed that cognate facilitation effect should be weak when naming in the dominant language, Bodo.

5.5.3.1 Method

Participants. As mentioned earlier, all participants performed the same simple picture naming task in their L1.

Stimuli. The picture stimuli used in Experiment 9A was used in this experiment as well.

Procedure. The procedure for this L1 simple picture naming task was identical to the previous L2 simple picture naming experiment other than the requirement that the picture names be spoken in the participants' L1 Bodo.

5.5.3.2 Results

Similar to Experiment 9A, a mixed-effects analysis was run on the reaction time data and error data separately. The results showed that there was a significant main effect of Cognate Status in this experiment [$F(1,321) = 13.627$, $p = .000$]. However, pictures whose names were cognates (1144 ms) were named slowly than those whose names were non-cognates (1066 ms), indicating inhibition rather than facilitation. There was also a significant effect of List Type [$F(1,6017) = 6.298$, $p = .012$]. However, no category interference was observed as the bilinguals named pictures faster in the categorized list (1096 ms) than in the randomized list (1114 ms). Table 5.20 shows the mean reaction times and percentage of errors for the two types of words (cognates and non-cognates) in the two experimental conditions (categorized and randomized).

Table 5.20 Mean RT (ms) and Percentage of Errors for Cognate and Non-cognate Targets in Experiment 9B

		Cognate Status		
	Overall	Cognate	Non-cognate	
List Type	RT (Error %)	RT (Error %)	RT (Error %)	**Cognate effect**
Categorized Lists	1096 (28.8)	1136 (23.8)	1057 (33.5)	**−79**
Randomized Lists	1114 (26.6)	1153 (27.9)	1076 (25.3)	**−77**
Category interference	**−18**	**−17**	**−19**	

The main effect of Bilingual Group [$F(2,54) = 141.950$, $p = .002$] approached significance. The interaction between Cognate Status and Bilingual Group was significant [$F(2,5918) = 20.865$, $p = .000$]. The Bilingual Group and List Type interaction also approached significance [$F(2,5925) = 3.432$, $p = .032$]. The three-way interaction was also significant [$F(2,5918) = 24.356$, $p = .000$]. To investigate the individual differences of the three bilingual groups separately, further analyses were carried out. Table 5.21 shows the mean reaction times and percentage of errors for the two types of words in the two experimental conditions separately for the three groups of participants.

Table 5.21 Mean RT (ms) and Percentage of Errors for Cognate and Non-cognate Targets for All Three Bilingual Groups in Experiment 9B

	Cognate Status/Bilingual Group					
	Cognate			Non-cognate		
	Early	Late high	Late low	Early	Late high	Late low
List Type	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)
Categorized	1163 (24.2)	1246 (40.4)	997 (12.7)	1140 (35.4)	1040 (33.3)	989 (31.2)
Randomized	1203 (30.6)	1186 (38.1)	1069 (17.1)	1115 (27.5)	1115 (32.7)	996 (17.1)
Category interference	**−40**	**60**	**−72**	**25**	**−75**	**−7**

Overall, the Late Low proficient bilinguals (1013 ms) named the cognate and non-cognate pictures faster than the Early High Proficient (1155 ms) and Late High Proficient bilinguals (1147 ms). The main effect of Cognate Status was not evident for any of the bilingual groups in both categorized and randomized lists. For the Early High Proficient group, the category interference effect was not significant in the cognate condition (−40 ms), however, the effect was significant in the non-cognate condition (25 ms). A significant main effect of category interference for the Late High Proficient group was evident only in the cognate condition (60 ms). And finally, for the Late Low Proficient group, the main effect of category interference was not significant both in the cognate (−72 ms) and non-cognate (−7 ms) conditions.

The error analysis showed a main effect of Cognate Status [$F(1,321) = 8.591$, $p = .000$]. Cognates were responded to correctly than non-cognates. The main effect of

List Type was not significant [$F < 1$]. The main effect of Bilingual Group reached significance [$F(2,54) = 11.203$, $p = .000$]. Errors were numerous for the high proficient bilinguals than the low proficient ones. No other interactions were significant concerning error proportions [Fs < 1].

5.5.3.3 Discussion

As mentioned earlier, in Experiment 9B all participants performed the same simple picture naming task in their L1. However, unlike Experiment 9A, no cognate facilitation effect was observed—Bodo−Assamese bilinguals named non-cognate pictures faster than cognate pictures. This finding was observed when the participants named the pictures in the categorized list and also when they named the pictures in the randomized list. This finding conforms to the past research which shows small or no cognate facilitation in L1 (e.g., Costa et al., 2000; Kroll et al., 2000), suggesting that semantic system activates the lexical representations in the non-dominant language to a lesser extent than their dominant language counterparts.

5.5.3.4 Combined Analysis of Experiment 9A and 9B

To further investigate the differential impact of L2 picture naming on L1 picture naming, the data of Experiment 9A was compared to the data of Experiment 9B. A mixed-effects analysis revealed that the main effect of Target Language was significant [$F(1,3076) = 218.344$, $p = .000$]. Naming was faster for Bodo (1106 ms) than for Assamese (1197 ms). The interaction between the variables Bilingual Group and Target Language was significant [$F(2,4536) = 21.419$, $p = .000$]. This interaction is shown in Figure 5.7. The three-way interaction between Cognate Status, Bilingual Group and Target Language was also significant [$F(2,11119) = 11.265$, $p = .000$].

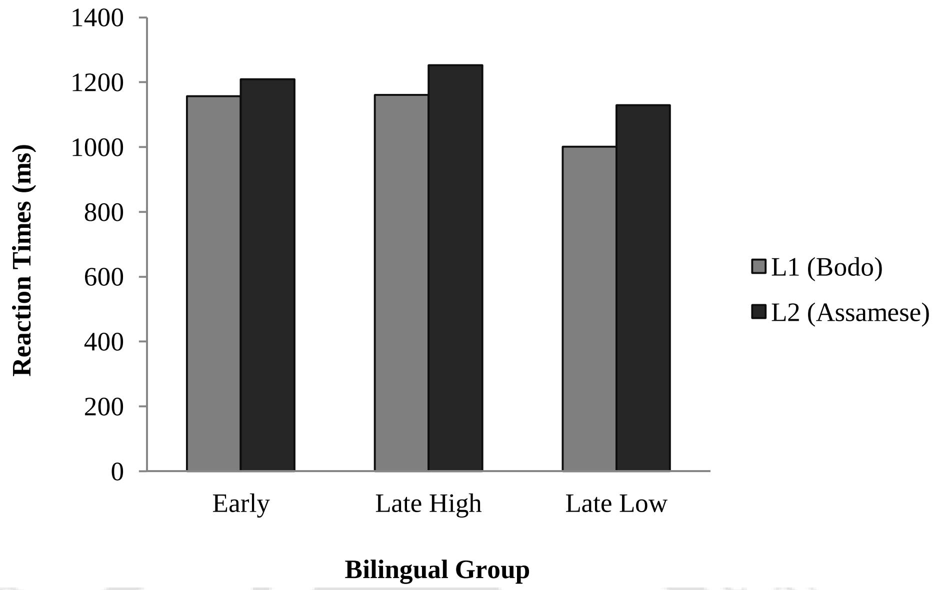


Figure 5.6 Mean RTs as a function of Bilingual Group and Target Language in Experiment 9A and 9B.

5.5.4 General Discussion

In Experiment 9A and 9B, the performance of three groups of Bodo−Assamese bilinguals was compared when they named pictures in their L2 and L1. The main theoretical issue addressed here is whether phonological encoding occurs for the translation of the picture's name in the non-response language. In order to experimentally detect phonological activation of a non-selected lexical item we exploited translation pairs that may or may not share phonology, i.e., cognates and non-cognates. Since Bodo and Assamese follows different writing systems, the study aimed to determine to what extent the degree of cross-language activation and the locus of language selection are modulated by script differences in the context where the written lexical form is not presented perceptually. Another goal of the present experiments was to replicate the category interference effect in picture naming and then to use it as a tool to investigate the structure of bilingual memory.

Three clear results were obtained from the results of the present study: (1) naming in L1 was faster than naming in L2; (2) bilingual speakers named the pictures with cognate names faster than the pictures with non-cognate names. However, the language of the response modulated the cognate facilitation effect. Bodo−Assamese bilinguals showed significant cognate facilitation effect only in their L2. The results of our study replicated previous studies using same-script bilinguals (Christoffels et al., 2006; Christoffels, De Groot, & Waldorp, 2003; Kroll et al., 2000; Hoshino & Kroll, 2008) and further extends our findings to studies using different-script bilinguals (Hoshino, 2006). This also finding suggests that cognate facilitation effect is not a contribution of the additional orthographic similarity of same-script cognates; (3) the response language as well the cognate status of the word modulates the category interference effect. This finding supports the claim of the RHM that the effect of meaning-related variables is usually observed in L1−L2, but not from L2−L1, or the latter to a lesser extent; (4) the L2 AoA and proficiency has a major impact on the processing of L1 and L2.

The cognate facilitation effect we have documented supports the notion that non-selected lexical items send activation to their phonological segments, and therefore we must assume that activation flows between stages in a cascaded fashion. However, the language of the response modulates the cognate facilitation effect. Although significant cognate facilitation effects were obtained in non-dominant language, Assamese, no facilitation was observed in the dominant language, Bodo. The lack of cognate facilitation effect in the dominant language reflects the fact that both cognate and non-cognate picture naming was not facilitated but rather was inhibited. The findings of our study support the claim of Peterson and Savoy (1998) and Costa and his colleagues that the level of activation of the phonological segments of a word depends on the level of activation of its corresponding lexical node. This indicates that the larger the activation of the lexical node, the larger the activation of its phonological segments. Based on this hypothesis, and following Kroll and Stewart's (1994) predictions that the strength of the connection between semantic representations and their corresponding lexical nodes is stronger for the dominant language than it is for the non-dominant language, the nodes of the dominant language were assumed to achieve higher levels of activation than the lexical nodes of the non-dominant language. Therefore, a significant cognate facilitation effect was observed when participants named pictures in their non-dominant language, since the cognate target's lexical nodes in the non-dominant language received relatively much activation from the lexical node of its translation equivalent in the dominant language which spreads to its phonological segments. This helps the retrieval of the target phonological units in the non-dominant language. However, when the participants named pictures in their dominant language Bodo, the cognate target's lexical nodes in the non-dominant language received a weak activation from the lexical node of its translation equivalent in the dominant language which spreads to its phonological segments, which resulted in no cognate facilitation effect.

Moreover, the category interference effect observed in our present study provides more compelling support for the RHM that suggests directionality effects of meaning variables. According to the predictions of the model, meaning-related variables affect translation from L1−L2, but not from L2−L1. Therefore, when the pictures were presented in a semantically organized list, reaction times were affected when naming in the non-dominant language Assamese, but not when naming in the dominant language Bodo. The findings of our study conform to the predictions of the RHM that L1−L2 is conceptually mediated, whereas, L2−L1 is lexically mediated.

Taken together, the results of our simple picture naming experiments support models of non-selective activation and language non-specific selection. This suggests that both languages are active to the level of phonology regardless of script differences and language backgrounds and that experience with different-script languages is not sufficient to limit activation during speech planning to the unintended language alone. In summary, we conclude that the cognate facilitation effect provides support for cascaded activation models and challenges the discrete serial activation models of lexical access. In the subsequent experiments, we investigate the role of cross-language activation by script when the written lexical form is present in the task. Previous studies shows that the presence of context word in picture naming either facilitates or interferes with the naming. In the next set of experiments, we will discuss the context effects in picture naming by examining two different paradigms: picture-word interference and primed picture naming to further investigate the degree of cross-language activation and the locus of language selection as a function of script. If the lack of the modulation of cross-language activation by script is due to the absence of the written lexical form in the task, then we should observe different patterns of results for Bodo−Assamese bilinguals in the picture-word interference and primed picture naming experiments where bilinguals name pictures in the L2 Assamese and L1 Bodo while ignoring L1 and L2 distracter/prime words.

5.6 Picture-Word Interference

Studies on context effects in naming tasks have been the focus of two distinct research fields: (1) the priming research of the early seventies, and (2) research on the Stroop phenomenon and picture-word interference paradigm. Research on these two distinct fields has produced different results but unfortunately, very few attempts have been made to reconcile the results obtained within both fields (La Heij, Dirkx, & Kramer, 1990).

Picture-word interference (PWI) paradigm, a modified version of the Stroop task, is one of the most frequently used methods in experimental psycholinguistic research on language production. In this paradigm, the picture is accompanied by a distracter word (either visual or auditory) and the influence of this distracter on picture naming performance is determined. Picture-word interference refers to the fact that when a picture (i.e., line drawing) is presented with a word superimposed, picture naming latency is longer than when the same picture is presented alone. Similar to the Stroop task, this phenomenon is strongly influenced by the nature of the superimposed word (Lupker, 1982). For example, naming a picture of a cat together with the word “dog” takes longer than naming that same picture without the word.

The PWI task was first used by Rosinski, Golinkoff, and Kukish (1975) to study automatic reading skills of children. Some other monolingual PWI studies, investigated the exact levels in the bilingual production system where co-activation of the non-target language occurred, by manipulating both the type of distracter words presented with the picture and the time interval between the presentation of distracter and picture. These studies showed that in comparison to neutral or unrelated distracters, semantic distracters slowed down the picture-naming response (e.g., Bajo, Puerta-Melguizo, & Macizo, 2003; Level et al., 1999; Roelofs, 1992; Schriefers et al., 1990; Starreveld & La Heij, 1995, 1996). Interestingly, phonological distracters showed facilitative rather than inhibitive effect. Moreover, these studies showed that the occurrence of these effects depend on the time relation between picture and distracter (Schriefers et al., 1990). In general, these effects hinted the competition between lemmas, therefore, provided evidence in support of language non-selective activation.

Following the footsteps of within-language production studies, many between-language production studies have also used the picture-word interference paradigm. In these studies, bilinguals name a picture in one language while ignoring a visually or auditorily presented distracter word in the same or other language. Ehri and Ryan (1980) showed that English−Spanish bilinguals named pictures more slowly, in both of their languages, when a word from the non-target language was superimposed over the picture than when a neutral distracter stimulus (a series of Xs) was superimposed. In a further study, Mägiste (1984b; see also Mägiste, 1985), testing German−Swedish bilinguals at various levels of proficiency in their L2, obtained this same interference effect and showed that its size depended on the learners' relative proficiency in the two languages—the stronger the non-target language, the larger the interference effect. Both these studies thus hinted at the occurrence of language non-selective activation in bilingual word production.More recent bilingual picture-naming studies, using both the distracter methodology (Costa & Caramazza, 1999; Costa et al., 1999; Hermans et al., 1998, Hoshino, 2006) and versions of the task in which pictures are presented without distracters (Colomé, 2001; Costa et al., 2000; Gollan & Acenas, 2004; Kroll, Dijkstra, Janssen, & Schriefers, 2000; Rodriguez-Fornelss, Van der Lugt, Rotte, Britti, Heinze, & Münte, 2005), focused on various aspects of the theoretical contrasts introduced earlier. However, with regard to the manner of language selection, there exists different interpretation in the literature. To illustrate, Hermans and his colleagues (1998) interpreted the findings of their study as support for a language non-specific model of bilingual production. Contrary to the interpretation of Hermans et al. (1998), Costa and his colleagues considered an alternative to language non-selective (or "language non-specific") selection, in which the selection mechanism ignores the activation in the non-target language (Costa et al., 1999; Costa & Caramazza, 1999; Costa, Colomé, Gómez, & Sebastián-Gallés, 2003).

To summarize, despite the frequent use of the picture-word interference paradigm, it is important to note that there has been criticism task. Although cross-language identity and semantic effects have been investigated in cross-language picture-word interference experiments, they do not allow strong conclusions since contrasting results were obtained across these studies. Moreover, all of this past research, except one (Hoshino, 2006) have examined bilingual performance for bilinguals whose languages are orthographically similar. Therefore, the issue of whether facilitation or inhibition is found with different-script bilinguals remains unresolved. This issue was investigated in the present series of experiments. The results provide useful information for determining whether lexical selection is language specific or non-specific.

5.6.1 The Present Study

The present study is an adaptation of Costa et al.'s (1999) study. Three experiments (Experiment 10A, 10B, and 10C) used a picture-word interference paradigm, in which Bodo−Assamese bilinguals named a picture in one language while ignoring a visually presented distracter word in the same or other language. In these experiments, the relation between the distracter word and the picture's name was varied along with the language of the distracter. However, it should be noted that our study was different from Costa et al.'s experiments in that, (1) different-script bilinguals were tested, (2) cognate status of the word was manipulated, and (3) three different groups of bilinguals participated in the study, (4) before the experiment proper, the pictures along with their names were not shown, and (5) in the mixed version of the task, the distracters from both languages were shown simultaneously. The primary goal of the study was to examine the time course of distracter effects as a way of identifying the activity of the non-target language during each stage of production (i.e., at the conceptual, lemma, and phonological levels).

Given the interpretation of cross-language facilitation and interference effects in previous studies discussed above, the hypothesis to be tested is that distracter words in a language whose script is different from the target language may provide a language cue to production that will inhibit the activation of cross-language competitors. In that case, the strongest prediction was that no identity and semantic effects would be observed for Bodo−Assamese bilinguals. However, a weaker version of this hypothesis predicts that the magnitude of identity and semantic effects would be smaller for Bodo−Assamese bilinguals (Hoshino, 2006). The distracter words can have an interfering or a facilitative effect on picture naming and the exact conditions under which such effects occur and the direction of the effects (facilitative or inhibitive) tell us something about the word production process. Reaction times and percentage of errors were measured and were assumed to vary as a function of the relationship between the distracter and the picture name.

5.6.2 Blocked Picture Naming in L2 (Experiment 10A)

In Experiment 10A, Bodo−Assamese bilinguals were asked to name a set of pictures in their L2, Assamese. Pictures were presented with a superimposed word, which could be written either in Assamese (*same-language* distracter) or in Bodo (*different-language* distracter). Three types of Assamese and Bodo distracters were used: picture names (*identity condition*), semantically related (*sematic condition*) and unrelated distracters (*control condition*). To illustrate, the picture donkey (গাধ [gadho] in Assamese) appeared with the following word distracters: গাধ [gadho], गादᐟ' [gado] ('*donkey*' in Bodo), ঘোঁৰা [ghura] ('*horse*' in Assamese), गराय [gorai]

(‘*horse*’ in Bodo),বাঁহী [bahi] (‘*flute*’ in Assamese) and सिफुं [siphung] (‘*flute*’ in Bodo).

5.6.2.1 Method

Participants. Participants in this and the following experiments were fifty-five Bodo−Assamese bilingual speakers with an average age 29.7 (*SD* = 4.3) years. They were recruited from Ganeshpara and Indian Institute of Technology Guwahati. All of the bilinguals who participated in this and the subsequent picture-word interference experiments were native speakers of Bodo and spoke Assamese as their second language. The participants were asked to rate (from 1 to 7) their abilities in speaking, reading, writing and comprehension in both languages. Table 5.22 reveals the mean ratings and language background data reported for the three groups of bilinguals.

Table 5.22 Self-Report Ratings in Bodo and Assamese for All Three Bilingual Groups in Experiment 10A

	Bodo (L1)			Assamese (L2)		
	Early (*n* = 21)	Late High (*n* = 18)	Late low (*n* = 16)	Early (*n* = 21)	Late High (*n* = 18)	Late Low (*n* = 16)
Age of acquisition (years)	2.3	2	3	3.3	11.2	12
Mean daily usage (%)	49.2 %	48.6 %	49.6 %	34.3 %	32.7 %	15.6 %
Self-ratings (7 point scale)						
Speaking	6.7 (0.5)	7 (0.2)	7 (0.2)	6.4 (0.9)	6.4 (0.5)	6 (1.3)
Reading	6.7 (0.6)	7 (0.1)	7 (0.2)	5.8 (0.2)	5.8 (0.5)	3.5 (2.1)
Writing	6.7 (0.6)	6.8 (0.3)	7 (0.5)	4.5 (0.5)	3.9 (1.0)	3 (2.6)
Comprehension	6.3 (0.2)	7 (0.2)	7 (0.1)	4.8 (0.3)	4.8 (0.3)	3.5 (0.9)

Analyses of the self-report data revealed that speaking, reading, writing, and comprehension skills were rated as being significantly better in Bodo than in Assamese. The ratings for Bodo on all four measures were similar for the Early High Proficient and the Late High Proficient groups, with no significant differences between high proficient group and low proficient groups. However, the Assamese ratings on all four proficiency measures were higher for the high proficient group than for the low proficient groups. In order to further assess the proficiency levels of the all the bilinguals, all participants took part in an objective naming test. Table 5.23 provides the mean scores on the Boston Naming Test in both Bodo and Assamese.

Table 5.23 Mean Scores on the Objective Naming Test in Bodo and Assamese for All Three Bilingual Groups in Experiment 10A

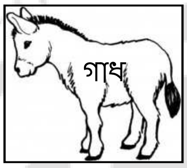
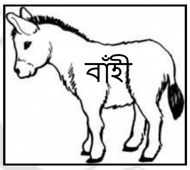
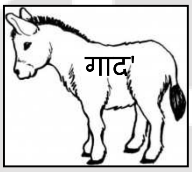
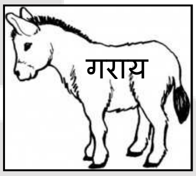
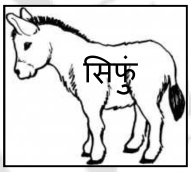
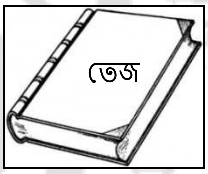
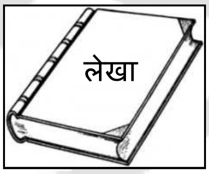
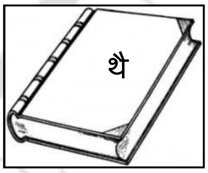
	Bodo	Assamese
Early High Proficient	53.8	49.3
Late High Proficient	52.2	50.3
Late Low Proficient	51.1	40.8

T-tests performed on the means of the Assamese scores provide statistical support for the proficiency and AoA manipulations. The results of the objective naming test shows that the Early High Proficient group's scores and the Late High Proficient group's scores did not yield a significant difference, indicating that the two groups were similar in L2 proficiency. However, the average L2 (Assamese) score for the Late High Proficient group is noticeably higher than the corresponding average for the Late Low Proficient group.

Stimuli. The stimuli consisted of twenty pictures with Assamese and Bodo cognate and non-cognate names. Each picture was paired with three distracter words: three Assamese words (same-language) and their Bodo translations (different-language). The Assamese and Bodo distracters paired with a given picture were of three types: (1) the picture name (identity), (2) categorically related (semantic) word, and an unrelated (control) word (see Appendix O). Distracters in the identical, related, and unrelated conditions were of similar length and frequency in both languages.

Moreover, they were of comparable frequency. Table 5.24 gives an example of distracter-target pairs.

Table 5.24 Examples of Distracter-Target Pairs for Experiment 10A

		Target Picture with Distracter Type		
Cognate Status	Distracter Language	Identity	Semantic	Unrelated
<u>Cognate</u>				
	Assamese			
	Bodo			
<u>Non-cognate</u>				
	Assamese			
	Bodo			

Note. *গাধ [gadho]; *गाद' [gado]; *ঘোঁৰা [ghura]; *गराय [gorai]; *বাঁহী [bahi]; *सिफुं [siphung]; *কিতাপ [kitap]; *बिजाब [bizab]; *বহী [bohi]; *लेखा [lekha]; *তেজ [tez]; *थै [thwi]

Procedure. Participants were instructed to name the pictures as fast and as accurately as possible in Assamese. They were informed that they would see picture-word pairs and were asked to ignore the words. Before the experiment proper, participants performed a training block of fifteen trials. Each trial had the following structure. First, a fixation point (a plus sign) was shown in the center of the screen for 500 ms, followed by a blank interval of 200 ms. Then the picture and the word were presented for 2,000 ms. If a response was not provided within 2,000 ms, the next trial started automatically (see Figure 5.8).

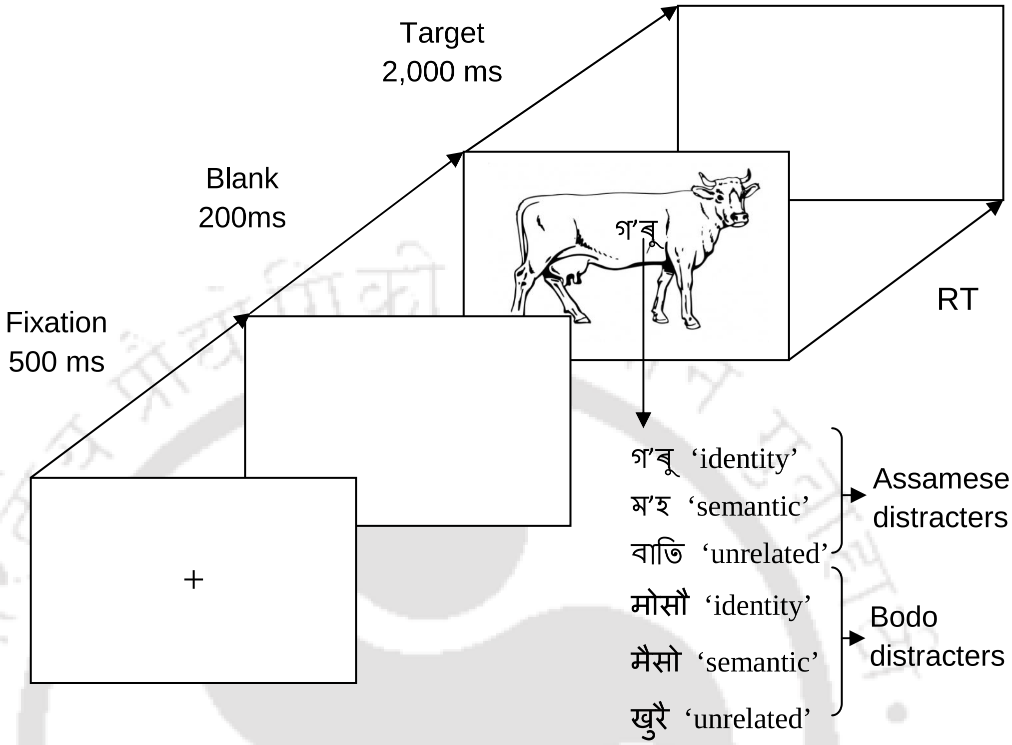


Figure 5.7 A schematic illustration of the procedure adopted for Experiment 10A. Here the same-language distracter in Assamese "গ'ৰু" [goru] (meaning 'cow') shares identity relation with the target picture.

5.6.2.2 Results

A mixed-effects analysis was run separately on the reaction time data and error data. Five independent variables were examined: Relatedness (related vs. unrelated), Cognate Status (cognate vs. non-cognate), Distracter Type (identity, semantic and unrelated), Distracter Language (same vs. different) and Bilingual Group (Early High Proficient, Late High Proficient and Late Low Proficient).

The analysis of the reaction times showed the following effects: A significant effect of Relatedness was observed [$F(1,110) = 19.193$, $p = .000$]. Participants named related distracters (1088 ms) slowly than unrelated distracters (980 ms). The main effect of Distracter Type was significant [$F(2,107) = 10.286$, $p = .000$].

Table 5.25 Mean RTs (ms) and Percentage of Errors for Cognate and Non-cognate Targets as a Function of Distracter Type and Distracter Language in Experiment 10A

		Distracter Language	
	Overall	Bodo	Assamese
Distracter	RT (Error %)	RT (Error %)	RT (Error %)
Cognate			
Identical	1076 (20)	1154 (24.4)	997 (15.7)
Semantically related	1102 (34)	1096 (38.2)	1108 (30.3)
Unrelated	989 (22.9)	1011 (21.3)	968 (24.7)
Identity effect (unrelated-identical)	**−87**	**−143**	**−29**
Semantic effect (unrelated-semantically related)	**−113**	**−85**	**−140**
Non-cognate			
Identical	1078 (21.5)	1168 (31.3)	989 (14.7)
Semantically related	1096 (26)	1114 (25.7)	1079 (26.6)
Unrelated	970 (11.9)	982 (11)	958 (12.8)
Identity effect (unrelated-identical)	**−108**	**−186**	**−31**
Semantic effect (unrelated-semantically related)	**−126**	**−132**	**−121**

There was also a significant main effect of Distracter Language [$F(1,107) = 9.655$, $p = .002$]. Naming latencies to same-language Assamese distracters (1017 ms) were faster than different-language Bodo distracters (1087 ms). No significant effects were observed for the variables Cognate Status and Bilingual Group [*F*s < 1]. Table 5.25 shows the mean reaction times and percentage of errors as a function of Cognate Status, Distracter Type, and Distracter Language. Of crucial interest in this experiment is the interaction between the variables Relatedness and Bilingual Group. This interaction was significant [$F(2,4804) = 52.675$, $p = .000$]. Another significant interaction was between the variables Distracter Type and Bilingual Group [$F(4,4789) = 28.456$, $p = .000$]. There was a marginally significant interaction between the variables Distracter Type and Distracter Language [$F(2,107) = 4.558$, $p = .013$] and between the variables Distracter Language and Bilingual Group [$F(2,4794) = 4.406$, $p = .012$]. Apart from the significant two-way interactions, the result of the present study also revealed some significant three-way interactions. The Relatedness, Distracter Language and Bilingual Group interaction was significant [$F(2,4799) = 17.528$, $p = .000$]. The interaction between Relatedness, Cognate Status and Bilingual Group approached significance [$F(2,4797) = 14.692$, $p = .000$]. The Distracter, Distracter Language and Bilingual Group interaction was also significant [$F(4,4796) = 12.510$, $p = .000$]. Finally, another significant interaction was observed between Cognate Status, Distracter Type and Bilingual Group [$F(4,4794) = 9.998$, $p = .000$].

Planned comparisons were conducted to examine the individual differences of the three groups of bilinguals. The results revealed that, the overall naming latencies of the Late Low Proficient bilinguals (1017 ms) were faster than the Early High Proficient (1056 ms) and Late High Proficient bilinguals (1083 ms). Table 5.26 shows the mean reaction times and percentage of errors of all three Bilingual Groups as a function of Cognate Status, Distracter Type, and Distracter Language.

The analysis of error data did not show a main effect of Relatedness [$F < 1$]. The main effect of Cognate Status was marginal [$F(1,107) = 2.115$, $p = .032$]. Participants made greater errors to cognate targets than to non-cognate targets. Moreover errors were numerous more for the different-language distracters than the same-language distracters. The main effect of Bilingual Group was not significant [$F < 1$]. There was no difference in errors between the bilingual groups. All other comparisons were non-significant (all *F*s < 1).

Table 5.26 Mean RTs (ms) and Percentage of Errors for Cognate and Non-cognate Targets for All Three Bilingual Groups as a Function of Distracter Type and Distracter Language in Experiment 10A

	Distracter Language					
	Bodo			Assamese		
	Early	Late high	Late low	Early	Late high	Late low
Distracter Type	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)
Cognate						
Identical	1147 (22.2)	1198 (28.9)	1116 (16.7)	968 (33.3)	1050 (11.1)	974 (0)
Semantically related	1061 (44.4)	1194 (37.8)	1032 (27.8)	1076 (33.3)	1109 (28.9)	1139 (27.8)
Unrelated	1031 (25.9)	987 (24.4)	1034 (5.6)	1060 (33.3)	992 (26.7)	852 (5.6)
Identity effect (unrelated−identical)	**−116**	**−211**	**−82**	**92**	**−58**	**−122**
Semantic effect (unrelated−semantically related)	**−30**	**−207**	**2**	**−16**	**−117**	**−287**
Non-cognate						
Identical	1124 (18.2)	1177 (36.4)	1201 (22.7)	972 (36.4)	988 (7.3)	1006 (0)
Semantically related	1092 (33.3)	1187 (21.8)	1061 (22.7)	1057 (30.3)	1101 (29)	1077 (13.6)
Unrelated	1045 (18.2)	1035 (7.3)	867 (9)	1055 (15.2)	979 (12.7)	840 (9)
Identity effect (unrelated−identical)	**−79**	**−142**	**−334**	**83**	**−9**	**−166**
Semantic effect (unrelated−semantically related)	**−47**	**−152**	**−194**	**−2**	**−122**	**−237**

To determine individual effects of identity and semantic primes, separate analyses were conducted. The following section discusses the result of each effect.

Identity effect. The main effect of Distracter Type was significant [$F(1,71) = 14.106$, $p = .000$]. Responses were faster for unrelated (980 ms) than identical (1078 ms) distracters which indicate interference rather than facilitation. Furthermore, there was a significant main effect of Distracter Language [$F(1,71) = 14.936$, $p = .000$]. Responses were faster for same-language (978 ms) as opposed to different-language (1079 ms) pairs. The interaction between the two variable Distracter Type and Bilingual Group was very significant [$F(2,3360) = 51.832$, $p = .000$].

A significant interaction was observed between Distracter Language and Bilingual Group [$F(2,3358) = 8.967$, $p = .000$]. The interaction between Distracter Type and Distracter Language was significant [$F(1,71) = 6.642$, $p = .012$], reflecting larger interference for different-language than same-language pairs. The significant three-way interactions were between the variables Cognate Status, Distracter Type, Bilingual Group [$F(2,3359) = 23.323$, $p = .000$] and between Distracter Type, Distracter Language and Bilingual Group [$F(2,3361) = 7.832$, $p = .000$]. All other interactions were not significant [Fs < 1].

Semantic effect. A significant effect of Distracter Type was observed [$F(1,72) = 17.339$, $p = .000$]. Responses were faster for unrelated (980 ms) than semantic (1097 ms) distracters. No main effects of Cognateness, Distracter Language and Bilingual Group were evident [$F < 1$]. However, there was a significant interaction between the between the variables Distracter Type and Bilingual Group [$F(2,3151) = 32.376$, $p = .000$]. The interaction between Cognate Status and Bilingual Group was also significant [$F(2,3140) = 6.393$, $p = .002$]. A reliable interaction was also observed between Distracter Language and Bilingual Group [$F(2,3137) = 5.204$, $p = .006$]. There was also a significant three-way interaction between the variables Distracter Type, Distracter Language and Bilingual Group [$F(2,3137) = 20.514$, $p = .000$].

5.6.2.3 Discussion

The results of Experiment 10A demonstrated interference in both identity and semantic conditions as compared to unrelated condition. The fact that interference was observed in the identity condition for both same-language and different-language distracters, is clearly compatible with the language non-selective hypothesis which predicts longer reaction times (that is, inhibition) in the cross-language identity condition. On the other hand, this finding has major implications for language selective hypothesis which predicts shorter latencies (facilitation) in the identity condition.

The finding of our study has major implications for previous study of Costa et al. (1999), where facilitation was observed in both same-language and different-language distracters in the identity condition. One reason for the difference between Costa et al. (1999) and our findings might be that in our study, the participants were different-script bilinguals. For the semantic condition however, the results of our study replicated the findings of previous studies by Hermans et al. (1998) and Costa et al. (1999). For both same- and different-language semantic distracters, our results demonstrated significant semantic interference. This finding of the inhibitive effect of semantic distracters can be attributed to the occurrence of co-activation of semantic competitors during lemma selection, which provides evidence for language non-selective hypothesis.

In Experiment 10A, the target language (Assamese) for the bilingual groups was their second, non-dominant language. The effect observed in that experiment reflects the influence of word properties of their dominant language (Bodo) on the non-dominant language (Assamese) naming latencies. In the next experiment, the naming performance of the three groups of Bodo−Assamese bilinguals was investigated when the target language was their dominant language (Bodo).

5.6.3 Blocked Picture Naming in L1 (Experiment 10B)

The goal of Experiment 10B was to explore lexical retrieval processes when Bodo−Assamese bilinguals performed a picture-word interference task in their native language, Bodo.

5.6.3.1 Method

Participants. Participants for Experiment 10B were the same participants who took part in Experiment 10A.

Stimuli. The picture targets utilized in Experiment 10A were used in this experiment as well.

Procedure. The procedure remained the same except that, in this experiment verbal and written instructions were provided to the participants in Bodo.

5.6.3.2 Results

Similar to Experiment 10A, a mixed-effects analysis was run separately on the reaction time data and error data. The result of the reaction time data did not reveal a main effect of Relatedness [$F < 1$]. No main effects of Cognate Status, Distracter Type and Bilingual Group were observed [Fs < 1]. However, a marginal effect of Distracter Language was observed [$F(1,105) = 4.026$, $p = .023$]. The interaction between Distracter Type and Bilingual Group approached significance [$F(4,4789) = 50.234$, $p = .000$]. The Cognate Status and Bilingual Group interaction approached significance [$F(2,5335) = 41.176$, $p = .000$]. The interaction between Distracter Language and Bilingual Group was also significant [$F(2,5331) = 6.629$, $p = .001$].The three-way interaction between Distracter Type, Distracter Language and Bilingual Group approached significance [$F(4,5332) = 10.762$, $p = .000$]. The Cognate Status, Distracter Language and Bilingual Group interaction was significant [$F(2,5332) = 7.755$, $p = .000$]. Finally, a significant interaction was observed between Cognate Status, Distracter Type and Bilingual Group [$F(4,5331) = 5.841$, $p = .000$]. Table 5.27 shows the mean reaction times and percentage of errors for cognate and non-cognate targets as a function of Distracter Type and Distracter Language.

Table 5.27 Mean RTs (ms) and Percentage of Errors for Cognate and Non-cognate Targets as a Function of Distracter Type and Distracter Language in Experiment 10B

		Distracter Language	
	Overall	Bodo	Assamese
Cognate Status/Distracter Type	RT (Error %)	RT (Error %)	RT (Error %)
Cognate			
Identical	949 (14.4)	974 (13.3)	925 (15.7)
Semantically related	977 (21.8)	1029 (24.7)	926 (19.1)
Unrelated	938 (18.9)	993 (23.6)	884 (14.6)
Identity effect (unrelated−identical)	**−11**	**19**	**−41**
Semantic effect (unrelated−semantically related)	**−79**	**−36**	**−42**
Non-cognate			
Identical	977 (6.4)	948 (10)	1006 (12.8)
Semantically related	1015 (15.9)	1027 (16.5)	1002 (15.6)
Unrelated	963 (12.7)	984 (11)	941 (14.7)
Identity effect (unrelated−identical)	**−14**	**36**	**−65**
Semantic effect (unrelated−semantically related)	**−52**	**−43**	**−61**

Planned comparisons were conducted to examine the individual differences of the three groups of bilinguals. The results revealed that, the overall reaction times of the Late Low Proficient bilinguals (946 ms) were faster than the Late High Proficient (976 ms) and Early High Proficient bilinguals (988 ms). Table 5.28 shows the mean reaction timess and percentage of errors of all three Bilingual Groups as a function of Cognate Status, Distracter Type, and Distracter Language.

Table 5.28 Mean Naming Latencies (ms) and Percentage of Errors for Cognate and Non-cognate Targets For All Three Bilingual Groups as a Function of Distracter Type and Distracter Language in Experiment 10B

	Distracter Language					
	Bodo			Assamese		
	Early	Late High	Late Low	Early	Late High	Late Low
Distracter Type	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)
Cognate						
Identical	909 (14.8)	1022 (15.6)	992 (5.6)	923 (14.8)	938 (17.8)	914 (11.1)
Semantically related	1122 (25.9)	1039 (28.9)	925 (11.1)	949 (29.6)	986 (15.6)	842 (11.1)
Unrelated	1014 (33.3)	1011 (22.2)	955 (11.1)	987 (22.2)	904 (13.3)	760 (5.6)
Identity effect (unrelated− identical)	**105**	**−11**	**−37**	**64**	**−34**	**−154**
Semantic effect (unrelated− semantically related)	**−108**	**−28**	**30**	**38**	**−82**	**−82**
Non-cognate						
Identical	841 (0)	991 (12.7)	1014 (13.6)	997 (9)	950 (16.4)	1070 (9)
Semantically related	1046 (27.3)	975 (12.7)	1059 (9)	1055 (24.2)	954 (10.9)	997 (13.6)
Unrelated	1056 (12.1)	1012 (9)	886 (13.6)	954 (21.2)	931 (10.9)	938 (13.6)
Identity effect (unrelated− identical)	**215**	**21**	**−128**	**−43**	**−19**	**−132**
Semantic effect (unrelated− semantically related)	**10**	**37**	**−173**	**−101**	**−23**	**−59**

A mixed-effects analysis of error data did not show a main effect of Relatedness [$F < 1$]. The main effect of Cognate Status was marginal [$F(1,107) = 2.734$, $p = .018$].

Participants made greater errors to cognate targets than to non-cognate targets. The main effect of Distracter Type was significant [$F(2,107) = 8.2472$, $p = .000$]. Greater errors were observed for semantic distracters than for identity and unrelated distracters. Moreover, errors were numerous more for the different-language distracters than the same-language distracters. This effect of Distracter Language was significant. The main effect of Bilingual Group was not significant [$F < 1$], indicating that there was no difference between the three bilingual groups. All other comparisons were non-significant (all Fs < 1). To determine individual effects of identity and semantic primes, separate analyses were conducted. The following section discusses the result of each effect.

Identity effect. The main effects of Cognate Status, Distracter Type, Distracter Language and Bilingual Group were not significant [Fs < 1]. However, there was a significant interaction between the variables Distracter Type and Bilingual Group [$F(2,3622) = 84.463$, $p = .000$]. The interaction between Distracter Language and Bilingual Group approached significance [$F(2,3620) = 18.894$, $p = .000$]. The Cognate Status and Bilingual Group interaction was also found to be significant [$F(2,3624) = 13.070$, $p = .000$]. The three-way interaction between Cognate Status, Distracter Language and Bilingual Group [$F(2,3621) = 18.151$, $p = .000$] approached significance. The Distracter Type, Distracter Language and Bilingual Group interaction also approached significance [$F(2,3620) = 9.316$, $p = .000$].

Semantic effect. A reliable effect of the variable Distracter Language was observed [$F(1,69) = 5.819$, $p = .018$], suggesting that the language of the distracter affects the magnitude of semantic interference. There was also a main of Bilingual Group [$F(2,51) = 4.713$, $p = .013$]. The interaction between Cognate Status and Bilingual Group approached significance [$F(2,3438) = 29.899$, $p = .000$]. A marginally significant interaction was observed between Distracter Type and Bilingual Group [$F(2,3436) = 4.444$, $p = .012$]. The three-way interaction between Cognate Status, Distracter Type and Bilingual Group approached significance [$F(2,3436) = 11.010$, $p = .000$]. The Cognate Status, Distracter Language and Bilingual Group was also found to be significant [$F(2,3436) = 5.916$, $p = .003$].

5.6.3.3 Discussion

The results of Experiment 10B produced results different from Experiment 10A. Unlike Experiment 10A, the present experiment produced significant facilitation in the identity condition for both cognate and non-cognate targets, only when the distracters were of the same-language. The inhibitive effects in the different-language identity condition has major implications for the findings of Costa et al. (1999), who found larger identity effect for both same- and different-language distracters, and therefore provided evidence in support of language-specific selection hypothesis. The findings of our study, on the other hand, is compatible with the language non-selective hypothesis, according to which the lexical nodes in the two languages of a bilingual compete for selection, and therefore pairs like (গাধ [gadho] *'donkey in Assamese'*− <picture of a donkey>) produces inhibition rather than facilitation. To sum up, the findings of the presents study provides evidence in support of the language non-specific selection hypothesis and indicates that the language of response modulates the activation, thereby producing either facilitation or inhibition. This finding indicates that the language of the target picture as well as the language of the distracter affects the magnitude of semantic interference.

5.6.3.4 Combined Analysis of Experiment 10A and 10B

In order to examine asymmetry, we analyzed the data from Experiments 10A and 10B in one design, using a mixed-effects analysis. The comparative analysis revealed a main effect of Target Language, [$F(1,10272) = 255.024$, $p = .000$]. Responses were faster when the target language was Bodo (970 ms) than when the target language was Assamese (1052 ms). The Bilingual Group and Target Language interaction approached significance [$F(2,10269) = 44.691$, $p = .000$]. This interaction is shown in Figure 5.9. The interaction between Distracter Type and Target Language approached significance [$F(2,10260) = 38.343$, $p = .000$].

The Distracter Language and Target Language interaction was significant [$F(1,10259) = 17.471$, $p = .000$]. There was another significant interaction between Cognate Status and Target Language [$F(1, 10260) = 15.271$, $p = .000$]. We also observed some significant three-way interactions such as, between Distracter Type, Distracter Language and Target Language [$F(2,10259) = 93.154$, $p = .000$], Cognate Status, Distracter Language and Target Language [$F(1,10259) = 30.555$, $p = .000$], Cognate Status, Bilingual Group and Target Language [$F(2,10256) = 23.156$, $p = .000$], and Distracter Type, Bilingual Group and Target Language [$F(4,10257) = 17.331$, $p = .000$].

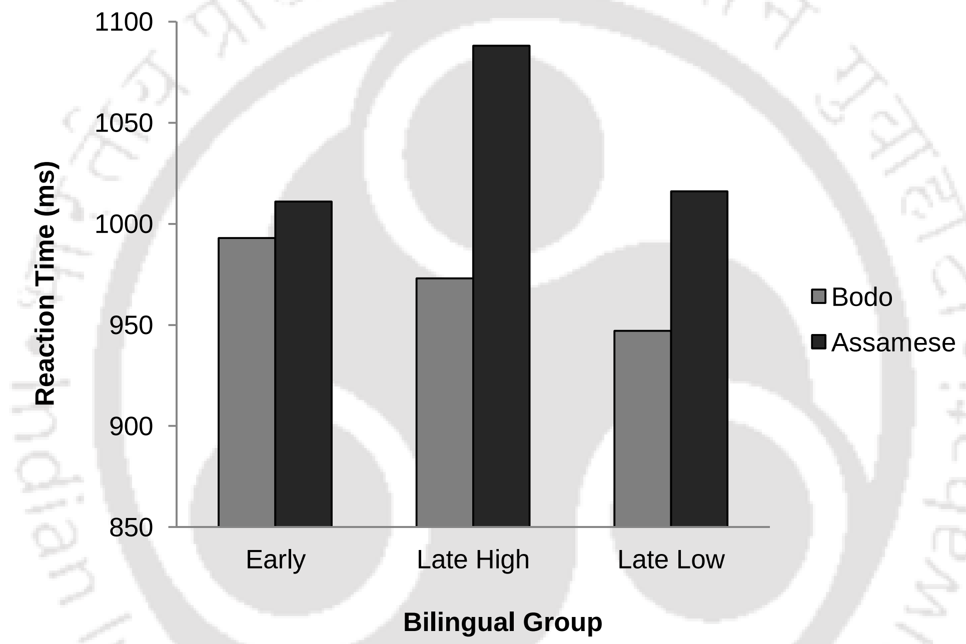


Figure 5.8 Mean RTs (ms) as a function of Bilingual Group and Target Language in Experiment 10A and 10B.

The blocked task might have allowed participants to focus their lexical search on one language and minimize the interfering effect of competing lexical nodes in the non-response lexicon (for a similar argument see Tzelgov, Henik, & Leiser, 1990) To assess whether the results obtained in Experiment 10A and 10B were due to the use of a blocked naming task, in Experiment 10C we compared the performance of three groups of Bodo−Assamese bilinguals when they named pictures both in Bodo (L1) and Assamese (L2) in the same task. If the absence of a cross-language inhibitive effect were an artifact of the use of a blocked task, it should not be reproduced with a mixed naming task.

5.6.4 Mixed Picture Naming in L1 and L2 (Experiment 10C)

The objective of Experiment 10C was to determine whether the cross-language identity effect and semantic effect can be replicated when both languages (Bodo and Assamese) are used for response. This mixed task presumably maximizes the opportunity of finding interference across languages, since in this experimental context it may not be possible to restrict selection to only one set of lexical nodes. This is because both lexicons are activated and used in the course of the experiment. In this experiment, participants were required to select lexical representations in the two languages depending on a cue. If the interference produced by different-language distracters increases when participants have to name the pictures in the two languages, we should expect more semantic interference in the mixed-language as opposed to the same-language naming task, at least for different-language semantically related distracters.

5.6.4.1 Method

Participants. The same participants who took part in the previous two experiments participated in this experiment.

Stimuli. As in the previous experiments, each picture was paired with three types of distracters: identity, semantic, and unrelated.

Procedure. The procedure of this experiment was identical to that of Experiment 10A and 10B. However, in this experiment, we introduced the following changes: (1) the distracters of both languages appeared simultaneously, (2) a colored (red or blue) dot was used as fixation point to cue the response language (*red* for Bodo and *blue* for Assamese); (3) participants named the experimental pictures in both Bodo and Assamese depending on the language cue (see Figure 5.10).

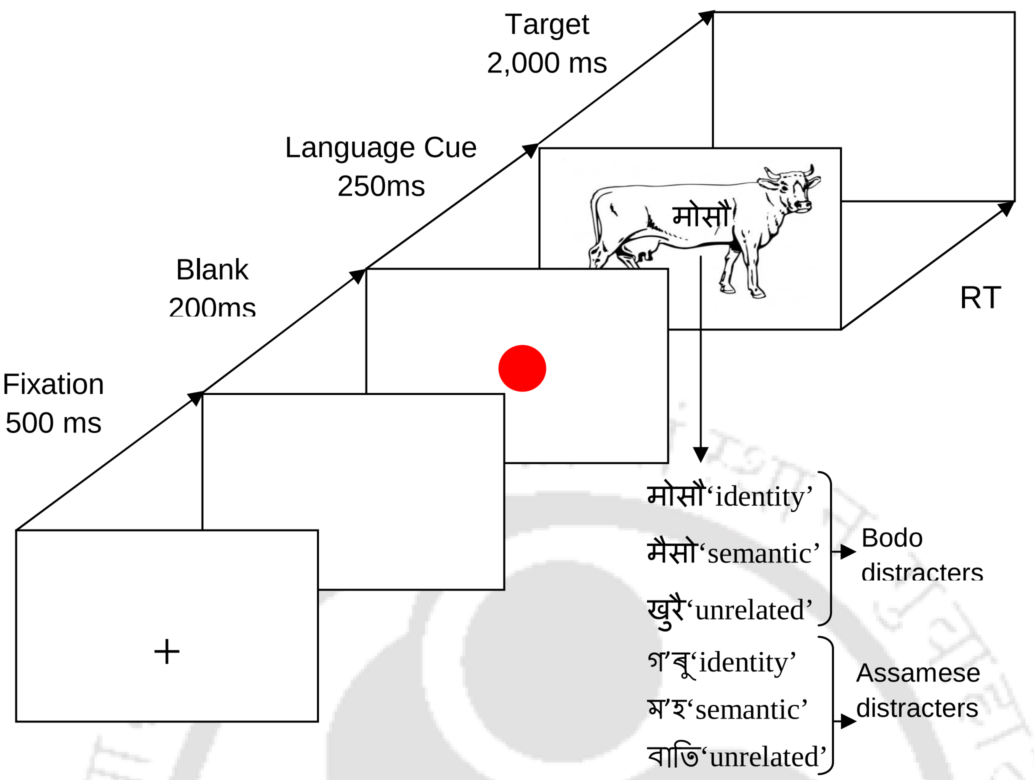


Figure 5.9 A schematic illustration of the procedure adopted for Experiment 10C.

5.6.4.2 Results

Similar to the previous experiments, a mixed-effects analysis was run separately on the reaction time data and error data. Table 5.29 shows the mean reaction times (ms) and percentage of errors for cognate and non-cognate targets as a function of Distracter Type and Target Language. The results of the Experiment 10C revealed a significant main effect of Target Language [*F*(1,5100) = 30.895, *p* = .000]. The main effect of Cognate Status approached significance [*F*(1,53) = 13.575, *p* = .001]. There was significant main effect of Bilingual Group [*F*(2,51) = 10.836, *p* = .000]. The interaction between Distracter Type and Bilingual Group reached significance [*F*(4,5101) = 5.895, *p* = .000].The Target Language and Bilingual Group interaction was also found to be significant [*F*(2,5097) = 7.285, *p* = .001]. The three-way interaction between Cognate Status, Distracter Type and Target Language approached significance [*F*(2,5098) = 13.686, *p* = .000]. The Distracter Type, Target Language and Bilingual Group was found to be significant [*F*(4,5094) = 12.920, *p* =

.000]. Finally, another significant interaction was observed between Cognate Status, Distracter Language and Bilingual Group [$F(4,5100) = 6.796$, $p = .000$].

Table 5.29 Mean Naming Latencies (ms) and Percentage of Errors for Cognate and Non-cognate Targets as a function of Distracter Type and Target Language in Experiment 10C

		Target Language	
	Overall	Bodo	Assamese
Distracter Type	RT (Error %)	RT (Error %)	RT (Error %)
Cognate			
Identical	983 (15.6)	999 (16.7)	968 (14.6)
Semantically related	1001 (22.3)	983 (26.9)	1019 (17.9)
Unrelated	995 (18.9)	996 (22.5)	995 (15.7)
Identity effect (unrelated−identical)	**12**	**−3**	**27**
Semantic effect (unrelated−semantically related)	**−6**	**13**	**−24**
Non-cognate			
Identical	1067 (18.6)	1023 (18.2)	1111 (19.3)
Semantically related	1074 (20.5)	1070 (19.3)	1079 (22)
Unrelated	1088 (21.9)	1033 (24.8)	1142 (19.3)
Identity effect (unrelated−identical)	**21**	**10**	**31**
Semantic effect (unrelated−semantically related)	**14**	**−37**	**63**

Planned comparisons were conducted to examine the individual differences of the three groups of bilinguals. Table 5.30 shows the mean reaction times and percentage of errors of all three Bilingual Groups as a function of Cognate Status, Distracter Type, and Distracter Language. As in the previous experiments, the results revealed that, the overall reaction times of the Late Low Proficient bilinguals (984 ms) were faster than the Late High Proficient (1018 ms) and Early High Proficient bilinguals (1103 ms).

Table 5.30 Mean Naming Latencies (ms) and Percentage of Errors for Cognate and Non-cognate Targets for All Three Bilingual Groups as Function of Distracter Type and Target Language in Experiment 10C

	Target Language					
	Bodo			Assamese		
Distracter Type	Early	Late high	Late low	Early	Late high	Late low
	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)
Cognate						
Identical	1049 (14.8)	1058 (20)	890 (11.1)	1032 (7.4)	986 (20)	887 (11.1)
Semantically related	1094 (33.3)	949 (28.9)	905 (11.1)	1184 (25.9)	996 (17.8)	877 (5.6)
Unrelated	1030 (25.9)	1022 (22.2)	936 (16.7)	1108 (22.2)	1006 (15.6)	871 (5.6)
Identity effect (unrelated−identical)	**−19**	**−38**	**46**	**76**	**20**	**−16**
Semantic effect (unrelated−semantically related)	**−64**	**73**	**31**	**−76**	**10**	**−6**
Non-cognate						
Identical	1085 (12.1)	1001 (23.6)	982 (13.6)	1145 (24.2)	1039 (16.4)	1149 (18.2)
Semantically related	1100 (24.2)	1008 (20)	1102 (9)	1154 (30.3)	1104 (16.4)	978 (22.7)
Unrelated	1056 (30.3)	983 (25.5)	1059 (13.6)	1196 (21.2)	1061 (16.4)	1170 (22.7)
Identity effect (unrelated−identical)	**−29**	**−18**	**77**	**51**	**22**	**21**
Semantic effect (unrelated−semantically related)	**−44**	**−25**	**−43**	**42**	**−43**	**192**

As in Experiment 10A and 10B, the analysis of the error data did not show a main effect of Relatedness [$F < 1$]. The main effect of Cognate Status did not reach significance [$F < 1$]. Participants made similar number of errors to cognate targets and non-cognate targets. The main effect of Distracter Type was not significant [$F < 1$]. However, errors were numerous for Bodo targets than for Assamese targets. This effect of Target Language was significant [$F(1,5100) = 10.783$, $p = .000$]. Moreover, the main effect of Bilingual Group was significant [$F(2,51) = 9.836$, $p = .001$]. Errors were numerous for the high proficient groups than the low proficient group. The interaction between Cognate Status and Bilingual Group approached significance [$F(2,5102) = 13.496$, $p = .000$]. All other comparisons were not significant (all Fs < 1). To determine individual effects of identity and semantic primes, separate analyses were conducted. The following section discusses the result of each effect.

Identity effect. The result of Experiment 10C did not reveal a main effect of Relatedness [$F < 1$] The main effect of Target Language approached significance [$F(1,3438) = 27.867$, $p = .000$]. The main effect of Cognate Status approached significance [$F(1,35) = 9.421$, $p = .004$]. The main effect of Bilingual Group was significant [$F(2,51) = 6.364$, $p = .003$]. The interaction between Cognate Status and Target Language approached significance [$F(1,3434) = 55.019$, $p = .000$]. The Cognate Status and Bilingual Group interaction was also found to be significant [$F(2,3439) = 51.231$, $p = .000$]. The Target Language and Bilingual Group interaction was marginally significant [$F(2,3436) = 4.907$, $p = .007$]. The three-way interaction between Relatedness, Target Language and Bilingual Group approached significance [$F(2,3432) = 8.208$, $p = .000$]. The Cognate Status, Target Language and Bilingual Group interaction was marginally significant [$F(2,3433) = 4.103$, $p = .017$].

Semantic effect. The result did not reveal a main effect of Relatedness [$F< 1$]. The main effect of Target Language approached significance [$F(1,3307) = 24.230$, $p = .000$]. The main effect of Bilingual Group was also found to be significant [$F(2,50) = 11.767$, $p = .000$]. A significant main effect of Cognate Status was also observed [$F(1,35) = 9.057$, $p = .005$]. The interaction between Cognate Status and

Bilingual Group approached significance [$F(2,3312) = 37.107$, $p = .000$]. The Target Language and Bilingual Group interaction approached significance [$F(2,3305) = 19.662$, $p = .000$]. Another significant interaction was observed between Relatedness and Bilingual Group [$F(2,3310) = 8.546$, $p = .000$]. The Cognate Status and Target Language interaction was also found to be significant [$F(1,3306) = 7.039$, $p = .008$]. The three-way interaction between Relatedness, Cognate Status and Target Language approached significance [$F(1,3305) = 18.633$, $p = .000$]. The Relatedness, Cognate Status, Bilingual Group approached significance [$F(2,3308) = 8.899$, $p = .000$]. Finally, the Relatedness, Target Language and Bilingual Group interaction was also found to be significant [$F(2,3303) = 6.316$, $p = .002$].

5.6.4.3 Discussion

The results of Experiment 10C demonstrated that mixed-language naming task affected the performance of participants in the critical conditions tested in the experiments. Overall, faster responses were observed for identical distracters. Of particular interest here is that the cross-language identity effect was observed when pictures were named in both Bodo and Assamese. The size of the effect was however, larger when the response language was the second language, Assamese. Another interesting observation in this experiment was that under certain conditions, the semantic distracters produced facilitation rather than inhibition. This observation was witnessed for both response languages.

5.6.4.4 Blocked vs. Mixed: A Comparative Analysis

The results of the Experiment 10A, 10B and 10C were further analyzed using a mixed-effects analysis to explore the processing dynamics of bilinguals in blocked versus mixed conditions. In general, the effect of both identity and semantic distracters was not the same for the blocked and mixed conditions. It could be argued that the inhibitive effects in the blocked condition might have been produced because the blocked task might have allowed participants to focus their lexical search on one language and minimize the interfering effect of competing lexical nodes in the non-response lexicon (Costa et al., 1999). On the other hand, participants were required to respond in both languages in the mixed condition, which might have caused the facilitative effect. Figure 5.11 shows the mean reaction times for identity and semantic distracters in blocked and mixed conditions.

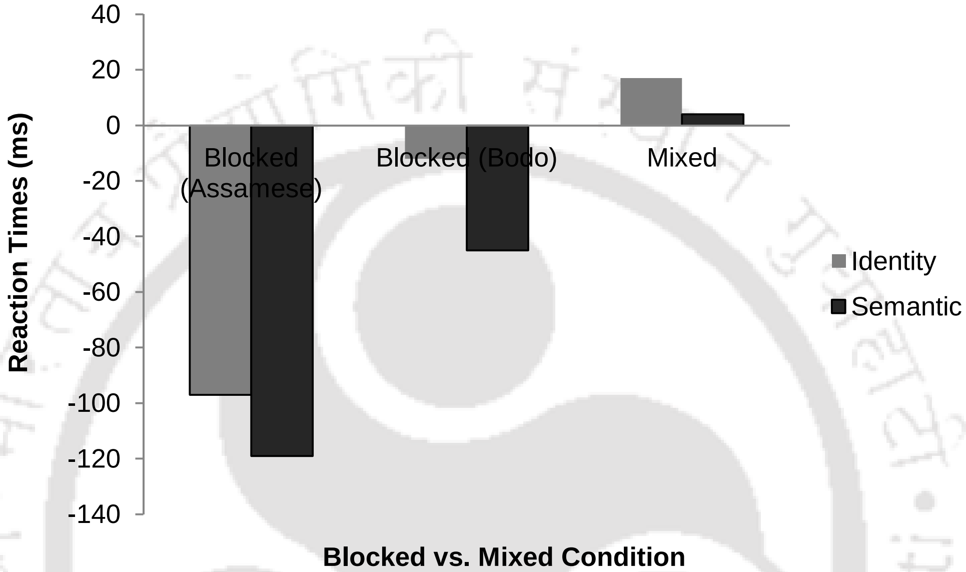


Figure 5.10 Magnitude of identity and semantic effects (ms) in Experiment 10A, 10B, and 10C.

5.6.5 General Discussion

In this study, a series of bilingual picture-word interference experiments were reported in which Bodo−Assamese speakers named pictures in Assamese (L2), Bodo (L1) and both, while ignoring visually presented L1 and L2 distracter words. The distracter words were manipulated in relation to the picture in three ways: identity, semantic, and unrelated. Experiment 10A investigated the performance of participants, who were asked to name cognate and non-cognate pictures of objects in their L2 while ignoring L1 and L2 distracter words. In Experiment 10B, the same paradigm was used, however, participants were asked to name cognate and non-cognates picture in their native language i.e., Bodo while ignoring L1 and L2 distracter words. In Experiment 10C, the language switching paradigm was used to investigate the process of inhibitive control and its consequences on word production in the first language, Bodo and second language, Assamese. The goal of these experiments was to determine whether the degree of cross-language activation and the locus of language selection can be modulated by script when the task includes an overt written lexical form. The following results were obtained:

The identity distracters exhibited different results for the blocked and mixed conditions. No facilitation was found in the Experiment 10A, when the target language was the second language, with one exception. Only the Early High Proficient group showed significant facilitation in the same-language distracter condition. In Experiment 10B, facilitation was found for only same-language identity distracters. Only Early High Proficient group exhibited significant facilitation for both cognate and non-cognate pictures. The results of Experiment 10C produced facilitative effect for identity distracters for both response languages. The identity effect observed only with the Early High Proficient group suggests that different types of bilinguals employ different processing mechanisms. The results of the semantic distracters demonstrated similar results in all three experiments. Semantic interference was obtained for both same-language and different-language distracters, replicating previous studies using high proficient bilinguals (e.g., Ehry & Ryan, 1980; Goodman, Haith, Guttentag, & Rao, 1985; Mägiste, 1984b; Potter, et al., 1984; Smith and Kisner, 1982). These effects are robust, having been replicated in the three experiments, in a variety of conditions (e.g., blocked vs. mixed language naming) and both response languages (Bodo and Assamese). However, two differences were observed for same- and different-language pairs. The facilitation effect was *larger* for same-language pairs than for different-language pairs. Furthermore, the results of our study demonstrate that the relative proficiency in the two languages influences the size of the facilitative or inhibitive effects, in accordance with the findings of Mägiste (1984b). The stronger the non-target language, the larger the chance it will permeate in processing the target language. We discuss the results in terms of three types of production models introduced earlier in Chapter 1. The results of the identity effect can be explained by the language non-specific selection hypothesis. To illustrate, we take the example of the Bodo−Assamese pair मोसौ 'cow'−গ'ৰু '*cow*'. In the identity condition, the picture *cow* will highly activate Assamese lexical node 'গ'ৰু', which would interfere with the selection of the target 'मोसौ' in the Bodo lexicon. The lexical node 'গ'ৰু' is highly activated, because it receives activation from the picture *cow*, and the written stimulus 'গ'ৰু', which results in interference.

The semantic interference found with bilingual picture–word naming tasks would seem to indicate that the lexical entries of two languages would compete for selection, and therefore, can also be explained by the language non-selective hypothesis. An example of this type of stimuli is given by the Bodo–Assamese pair मोसौ 'cow'−ম'হ 'buffalo'. In the semantic distracter condition, the picture of *cow* will activate its semantic representation and its associated lexical nodes in both languages ('मोसौ' and 'গ'ৰু'). Some activation is also sent to semantically related lexical nodes in the two languages ('मैसो' and 'ম'হ'). In the same way, the distracter word ম'হ also activates its semantic representation in and its associated lexical and semantically related nodes in both languages. Thus, the lexical node 'ম'হ' in the Assamese lexicon is highly activated. If lexical nodes in both the Bodo and the Assamese lexicons compete for selection, ম'হ would interfere with the selection of the Bodo response "मोसौ." Therefore, the finding of identity facilitation and semantic inhibition is consistent with the hypothesis of *language non-specific selection.*

To conclude, the findings of our study provide evidence for language non-selective activation. However, the evidence does not indicate whether only lemma selection or also phonological encoding is language non-selective. Moreover, previous research has shown that the manipulation of both the type of context words presented with the picture and the time interval between the presentation of context word and picture can have a significant effect on the outcome. For example, one of the questions which has received little attention is why the presence of a semantic relation between a context word and a target picture often facilitates the naming of the picture in priming experiments whereas such a relation hampers the naming of the picture in the picture-word interference task. We take up this issue in the following set of experiments.

5.7 Primed Picture Naming

As discussed in the previous picture-word interference experiments, a distracter word can have either facilitative or inhibitive effects on picture naming depending on the type of relationship it shares with the picture. Moreover, interaction between SOA and type of distracters can have a significant effect. For example, previous research shows that in priming experiments, when a context word shares semantic relation with a target picture, naming of the picture is facilitated. However, in picture-word interference experiments, such a relation hampers the naming of the picture. Similarly, when participants are presented with a context word that is identical to a target picture, they are typically able to name the picture faster than when the context word is unrelated to the target picture (Glaser & Dungelhoff, 1984; Rosinski et al., 1975; Rosinski, 1977; Smith & Magee, 1980). This facilitative effect is robust and has been observed at a variety of SOAs (Biggs & Marmurek, 1990). Moreover, even when other items intervene between the context word and the target word, robust facilitative effect has been observed (Durso & Johnson, 1979).

In contrast to the facilitative effects described above, the presence of a context word which is semantically related (versus unrelated) to the target picture have produced mixed results. Although some studies differing in their use of SOAs have shown semantic facilitation effect, these studies varied widely in terms of the size of the semantic facilitation effect. For example, in studies by Bajo (1988) and Carr, McCauley, Sperber, and Parmelee (1982), substantial semantic facilitation effects have been found; in the study of Sperber, McCauley, Ragain and Weil (1979), only a small but significant effect has been observed; and in the study by Irwin and Lupker (1983), the effect did not even reach significance.

The results of these studies indicate that the size of the SOA used cannot cause the inconsistency in the facilitative effect because semantic facilitation was obtained both with SOA values as small as approximately 200 ms (Carr et al., 1982) and with SOA values larger than 1000 ms (e.g. Bajo, 1988). Moreover, although the amount of processing of the prime word has been indicative of the respective priming effect as indicated by the results of a number of studies (e.g. Irwin & Lupker, 1983), a large facilitation effect has also been observed in the study by Bajo (1988) in a condition in which no reaction to the prime was required. Nor do the instructions concerning the processing of the prime word seem crucial. Furthermore, some studies using the naming procedure with masked priming and electrophysiological recordings also observed that the relationship between the prime word and the target picture affected the picture naming latencies (Blackford, Holcomb, Grainger, & Kuperberg, 2012; Chauncey, Holcomb, & Grainger, 2009).

5.7.1 The Present Study

The present study used a cross-representational priming paradigm in combination with behavioral measures in order to examine the time-course of facilitation and inhibition during primed picture naming task. Bodo−Assamese bilinguals were asked to name picture targets which were preceded by three types of word primes: identity, semantic and unrelated. Unlike the previous picture-word interference study, the context word disappeared with the onset of the target picture. The following predictions were made regarding the pattern of picture naming latencies. First, it was expected that naming times would be shorter to picture targets preceded by words that were identical (versus unrelated) to the picture's name. This would replicate previous findings of behavioral (Rosinski et al., 1975) identity priming during picture naming, and would indicate facilitation by overlapping activation from the prime word at multiple levels of representation – conceptual, lemma and phonological. Of most interest was the pattern of naming times to the picture targets preceded by semantically related words. Based on previously reported behavioral findings (Bloem et al., 2004; Mahon et al., 2007), we expected to see a semantic interference effect on naming times, i.e. we expected naming times of picture targets preceded by semantically related words to be longer than those preceded by semantically unrelated words.

5.7.2 Blocked Picture Naming in L2 (Experiment 11A)

In Experiment 11A Bodo−Assamese bilinguals were asked to name a set of pictures in Assamese. Pictures were preceded by a prime word, which could be written either in Assamese (*same-language* prime) or in Bodo (*different-language* prime). Three types of Assamese and Bodo primes were used: picture names (*identity condition*), semantically related (*semantic condition*) and unrelated (*unrelated condition*).

5.7.2.1 Method

Participants. Fifty-three Bodo−Assamese bilingual speakers (38 male and 15 female) from Bathoupuri School and Hagzer Bhawan participated in this and the following experiments. Participants ranged in age from 21 to 45 years (Mean age = 38 years, *SD* = 9.9). All of the participants were native speakers of Bodo and used Assamese as their second language. Table 5.31 presents the self-report ratings of the three types of bilinguals for both Bodo and Assamese. The results of the self-report ratings show that the Bodo ratings of the three groups of bilinguals on all four proficiency measures are similar. However, the Assamese ratings on all four proficiency measures are higher for the high proficient groups than for the low proficient group.

Table 5.31 Self-Report Ratings in Bodo and Assamese for All Three Bilingual Groups in Experiment 11A

	Bodo (L1)			Assamese (L2)		
	Early (*n* = 24)	Late High (*n* = 14)	Late low (*n* = 15)	Early (*n* = 24)	Late High (*n* = 14)	Late Low (*n* = 15)
Age of acquisition (years)	1.4	1	1.5	2.6	9	8.5
Mean daily usage (%)	51.6%	49.3%	50.8%	33.2%	33.6%	18.4%
Self-ratings (7 point scale)						
Speaking	6.6 (0.3)	7 (0.5)	6.5 (0.1)	6.8 (0.7)	6 (0.6)	4 (1.2)
Reading	6.6 (0.5)	7 (0.7)	7 (1.1)	6.4 (1.2)	6 (0.5)	4.5 (2.1)
Writing	6.4 (0.5)	7 (0.3)	6.5 (0.2)	4.4 (0.6)	4.2 (1.1)	3 (1.4)
Comprehension	5.8 (0.1)	7 (0.3)	5.5 (0.3)	4.4 (0.6)	4.1 (0.9)	1 (0.9)

In order to further assess the proficiency levels of the bilinguals, all participants took part in an objective naming test. Table 5.32 provides the mean scores on the objective naming test in both Bodo and Assamese.

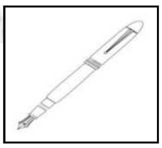
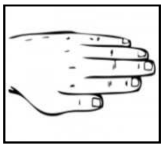
Table 5.32 Mean Scores on the Objective Naming Test in Bodo and Assamese for All Three Bilingual Groups in Experiment 11A

Bilingual Group	Bodo	Assamese
Early High Proficient	49.1	47.2
Late High Proficient	51.2	48.1
Late Low Proficient	48.2	36.3

The results of the Objective Naming Test show that the average L1 score for all three bilingual groups is similar. In case of L2, the average score for the Late High Proficient group matches the average score for the Early High Proficient group (48.1 vs. 47.2 respectively) and the scores do not yield a significant difference [$t(50)$ = 1.09, p = .412]. This indicates that the proficiency level of the two groups is similar. However, the average score of the Late High Proficient group is noticeably higher than the average score of the Late Low Proficient group (48.1 vs. 36.3) and the scores yielded a significant difference [$t(48)$ = 11.53, p = .000].

Stimuli. The stimuli used in this experiment consisted of twenty pictures as targets. Half of the picture targets were cognates and the other half were non-cognates. Each picture in this set of twenty pictures was paired with a word prime to construct word-picture pairs. These pairs had one of three types of relationship: identity, semantically related and unrelated. Identity pairs consisted of a context word that corresponded to the name of the picture, semantically related pairs consisted of words and target pictures that were both co-category exemplars, and unrelated pairs consisted of words and target pictures that were not related to each other. Moreover, each picture was paired with both Assamese word primes (same-language) and their Bodo counterparts (different-language) (see Appendix O). To illustrate, the following word primes preceded the picture hand (হাত [hat] in Assamese): হাত [hat], आखाइ [akhai] (‘*hand*’ in Bodo), আঙুলী [anguli] (‘*finger*’ in Assamese), आसि [asi] (‘*finger*’ in Bodo), পানী [pani] (‘*water*’ in Assamese) and दै [dwi] (‘*water*’ in Bodo). There was no significant difference in, number of letters, or number of syllables of the names of target pictures across the three types of primes. An example of each type of relationship is given in Table 5.33.

Table 5.33 Examples of Prime-Target Pairs for Experiment 11A

Cognate Status	Prime Language	Prime: Identical	Prime: Semantically related	Prime: Unrelated	Target Picture
Cognate	Assamese	কলম *‘pen’*	পেঞ্চিল *‘pencil’*	ভালুক *‘bear’*	
	Bodo	खोलोम *‘pen’*	पेन्सिल *‘pencil’*	मुफुर *‘bear’*	
Non-cognate	Assamese	হাত *‘hand’*	আঙুলী *‘finger’*	পানী *‘water’*	
	Bodo	आखाइ *‘hand’*	आसि *‘finger’*	दै *‘water’*	

Note. কলম [kolom]; खोलोम [khwlwm]; পেঞ্চিল [pensil]; पेन्सिल [pensil]; ভালুক [bhaluk]; मुफुर [muphur]; হাত [hat]; आखाइ [akhai]; আঙুলী [anguli]; आसि [asi]; পানী [pani]; दै [dwi]

Procedure. Participants were tested individually. Verbal and written instructions were administered in Assamese. Participants were informed that they would see words followed by pictures and were asked to ignore the words and name the picture as fast and as accurately as possible in Assamese. Each trial had the following structure. First, a fixation point (a plus sign) was shown in the center of the screen for 500 ms, followed by a blank interval of 200 ms. Then the prime word was presented for 250 ms followed by the target picture for a maximum of 2,000 ms. If a response was not provided within 2,000 ms, the next trial started automatically. Response latencies were measured from the onset of the stimulus to the beginning of the naming response. Before the experiment proper, the participants performed a training block of fifteen trials. Figure 5.12 shows a schematic illustration of the procedure adopted for this experiment.

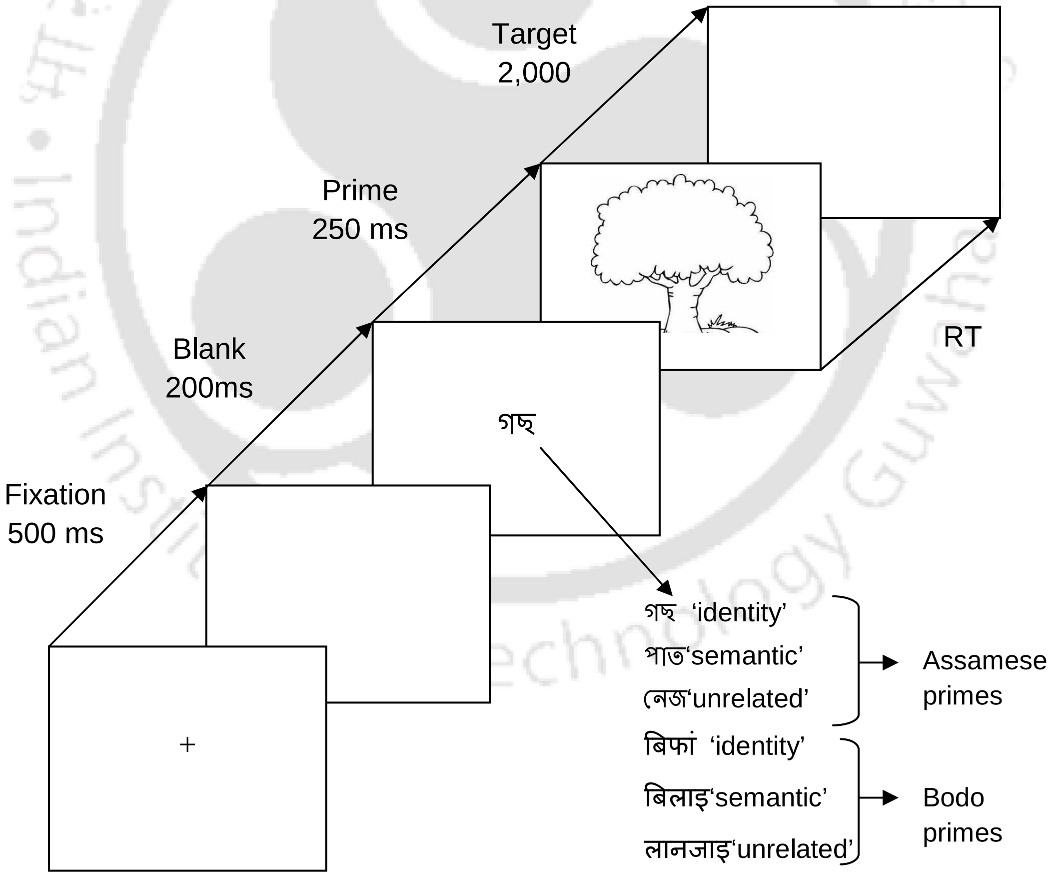


Figure 5.11 A schematic illustration of the procedure adopted for Experiment 11A. Here the same-language prime in Assamese "গছ" (meaning 'tree') shares identity relation with the target picture.

5.7.2.2 Results

A mixed-effects analysis was run separately on the reaction time data and error data. The results of the reaction time analysis did not reveal a main effect of Relatedness [$F < 1$]. A significant main effect of Cognate Status was observed [$F(1,107) = 9.491$, $p = .003$]. Pictures with cognate names were responded to 61 ms faster than non-cognates. The main effect of Bilingual Group approached significance [$F(2,49) = 8.264$, $p = .001$]. The main effect of Prime Type was also significant [$F(2,107) = 40.643$, $p = .000$], with the shortest latencies in the identity condition (831 ms), followed by the unrelated condition (967 ms) and the longest naming latencies was observed in the semantically related condition (1046 ms). There was also a significant main effect of Prime Language [$F(1,107) = 67.124$, $p = .000$]. Of most interest, however, there was a significant interaction between Prime Type and Prime Language [$F(2,107) = 10.354$, $p = .000$]. The two-way interaction between Cognate Status and Bilingual Group approached significance [$F(2,5215) = 27.626$, $p = .000$]. The Prime Type and Prime Language interaction was found to be significant [$F(2,107) = 10.354$, $p = .000$]. The Prime Type and Bilingual Group approached significance [$F(4,5210) = 44.199$, $p = .000$]. A significant interaction was observed between Prime Language and Bilingual Group [$F(2,5205) = 35.201$, $p = .000$]. The Relatedness and Bilingual Group interaction also approached significance [$F(2,5199) = 8.210$, $p = .000$].

The three-way interaction between Cognate Status, Prime Type and Bilingual Group was found to be significant [$F(4,5204) = 11.224$, $p = .000$]. The Prime Type, Prime Language and Bilingual Group interaction approached significance [$F(4,5205) = 25.030$, $p = .000$]. The Relatedness, Prime Language and Bilingual Group interaction approached significance [$F(2,5198) = 38.239$, $p = .000$]. Finally, the Relatedness, Cognate Status and Bilingual Group interaction was also found to be significant [$F(2,5198) = 6.981$, $p = .001$]. Table 5.34 shows the mean reaction times and percentage of errors as a function of Cognate Status (cognate vs. non-cognate), Prime Type (identical, semantically related, and unrelated) and Prime Language (Assamese vs. Bodo).

Table 5.34 Mean RTs (ms) and Percentage of Errors for Cognate and Non-cognate Targets as a Function of Prime Type and Prime Language in Experiment 11A

		Prime Language	
	Overall	Bodo	Assamese
Prime Type	RT (Error %)	RT (Error %)	RT (Error %)
Cognate			
Identical	792 (9)	917 (10.9)	667 (7.1)
Semantically related	1006 (25.9)	1023 (21.4)	989 (31.4)
Unrelated	955 (19.6)	1014 (20)	896 (20)
Identity effect (unrelated−identical)	**163**	**97**	**229**
Semantic effect (unrelated−semantically related)	**−51**	**−9**	**−93**
Non-cognate			
Identical	870 (10.2)	1032 (14.8)	708 (5.7)
Semantically related	1085 (18.8)	1152 (17.2)	1019 (20.6)
Unrelated	980 (9.7)	1035 (11.5)	925 (8)
Identity effect (unrelated−identical)	**110**	**3**	**217**
Semantic effect (unrelated−semantically related)	**−105**	**−117**	**−94**

Planned comparisons were conducted to examine the individual differences of the three groups of bilinguals. The results revealed that, the overall reaction times of the Late High Proficient bilinguals (906 ms) were faster than the Early High Proficient (946 ms) and Late Low Proficient (991 ms) bilinguals. The pattern of results of this study is different from the results of the blocked picture-word interference experiments, in which the Late Low Proficient bilinguals produced the fastest naming latencies. Table 5.35 shows the mean reaction times and percentage of errors of all three Bilingual Groups as a function of Cognate Status, Prime Type, and Prime Language.

Table 5.35 Mean RTs (ms) and Percentage of Errors for Cognate and Non-cognate Targets for All Three Bilingual Groups as a Function of Prime Type and Prime Language in Experiment 11A

	Prime Language/Bilingual Group					
	Bodo			Assamese		
	Early	Late high	Late low	Early	Late high	Late low
Prime Type	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)
Cognate						
Identical	936 (4.2)	880 (11.1)	934 (22.2)	759 (2.9)	491 (11.1)	751 (11.1)
Semantically related	1032 (13)	996 (11.1)	1041 (22.2)	1006 (20.3)	947 (11.1)	1016 (38.9)
Unrelated	1004 (10.1)	936 (0)	1101 (38.9)	904 (10.1)	879 (11.1)	906 (33.3)
Identity effect (unrelated−identical)	**68**	**56**	**167**	**145**	**388**	**155**
Semantic effect (unrelated−semantically related)	**−28**	**−60**	**60**	**−102**	**−68**	**−110**
Non-cognate						
Identical	987 (12.7)	1004 (9)	1104 (22.7)	761 (5.5)	551 (0)	813 (9)
Semantically related	1067 (14.5)	1274 (18.2)	1114 (22.7)	1008 (27.3)	1054 (9)	995 (9)
Unrelated	973 (9)	969 (0)	1163 (22.7)	921 (1.8)	893 (0)	960 (27.2)
Identity effect (unrelated−identical)	**−14**	**−35**	**59**	**160**	**342**	**147**
Semantic effect (unrelated−semantically related)	**−94**	**−305**	**49**	**−87**	**−161**	**−35**

The analyses of the error data did not show a main effect of Relatedness [$F < 1$]. The main effect of Cognate Status was marginal [$F(1,107) = 3.491$, $p = .003$].

Participants made greater errors to cognate targets than to non-cognate targets. Moreover the main effect of Prime Type reached significance [$F(2,107) = 9.643$, $p = .000$]. Errors were numerous more for the semantic primes than the identity and unrelated primes. The main effect of Distracter Language was not significant [$F < 1$]. However, the main effect of Bilingual Group approached significance [$F(2,49) = 8.264$, $p = .001$]. Greater errors were observed for the low proficient group than for the high proficient groups. All other comparisons were not significant (all Fs < 1). To determine individual effects of identity and semantic primes, separate analyses were conducted. The following section discusses the result of each effect.

Identity effect. There was a significant effect of Prime Type [$F(1,71) = 35.710$, $p = .000$]. Responses were 136 ms faster for identity than unrelated primes. Furthermore, the main effect of Prime Language also reached significance [$F(1,71) = 76.079$, $p = .000$]. Responses were faster for same-language (800 ms) as opposed to different-language pairs (999 ms). Finally there was a significant interaction between the variables Prime Type and Prime Language [$F(1,71) = 14.301$, $p = .000$]. This interaction shows that the identity effect was larger for same-language vs. different-language pairs.

Semantic effect. The main effect of Prime Type reached significance [$F(1,72) = 12.478$, $p = .001$]. Responses were faster for unrelated (967 ms) than related primes (1050 ms) which indicate that there was semantic interference rather than facilitation. A significant effect of Prime Language was also observed [$F(1,72) = 17.355$, $p = .000$]. However, we did not observe any interaction between the variables Prime Type and Prime Language [$F < 1$].

5.7.2.3 Discussion

The result of Experiment 11A showed significant facilitation in both the same-language and different-language identity condition and significant inhibition in both same-language and different-language semantic condition.

5.7.3 Blocked Picture Naming in L1 (Experiment 11B)

In Experiment 11B Bodo−Assamese bilingual participants were presented with a set of pictures and were instructed to name them in their L1, i.e., Bodo. The goal of this Experiment was to further explore how primes which share different relationship with the target picture affect the performance of Bodo−Assamese bilinguals when naming in their dominant language, Bodo.

5.7.3.1 Method

Participants. The participants of this experiment were the same Bodo−Assamese bilinguals who took part in Experiment 11A.

Stimuli. The picture stimuli used in Experiment 11A were used in this experiment as well.

Procedure. The exact same procedure adopted for Experiment 11A was used in this experiment. The only exception was that in this experiments participants had to name picture targets in their native language, Bodo. Therefore, verbal and written instructions were provided in Bodo.

5.7.3.2 Results

Similar to Experiment 11A, a mixed-effects analysis was run on the reaction time and error data of Experiment 11B. Table 5.36 shows the mean reaction times and percentage of errors as a function of Cognate Status (cognate vs. non-cognate), Prime Type (identical, semantically related, and unrelated) and Prime Language (Assamese vs. Bodo). The results of the reaction time data revealed a significant main effect of Prime Type [$F(2,107) = 26.798$, $p = .000$].

Table 5.36 Mean RTs (ms) and Percentage of Errors for Cognate and Non-cognate Targets as a Function of Prime Type and Prime Language in Experiment 11B

		Prime Language	
	Overall	Bodo	Assamese
Prime Type	RT (Error %)	RT (Error %)	RT (Error %)
Cognate			
Identical	769 (2.8)	798 (2.7)	740 (2.9)
Semantically related	909 (5.6)	937 (5.7)	880 (5.7)
Unrelated	886 (4.9)	927 (1.8)	845 (5.7)
Identity effect (unrelated−identical)	**117**	**129**	**105**
Semantic effect (unrelated−semantically related)	**−23**	**−10**	**−35**
Non-cognate			
Identical	766 (3.9)	701(0)	831 (8)
Semantically related	982 (8.6)	1019 (11.5)	946 (5.7)
Unrelated	901 (4)	914 (2.3)	888 (5.7)
Identity effect (unrelated−identical)	**135**	**213**	**57**
Semantic effect (unrelated−semantically related)	**−81**	**−105**	**−58**

The main effect of Prime Language was not significant [$F < 1$]. The main effect of Bilingual Group reached significance [$F(2,50) = 8.104$, $p = .001$]. The interaction between Prime Type and Bilingual Group approached significance [$F(4,5830) = 20.772$, $p = .000$]. The Relatedness and Bilingual Group interaction was significant [$F(2,5835) = 29.063$, $p = .000$]. The three-way interaction between Relatedness, Prime Language and Bilingual Group approached significance [$F(2,5835) = 24.246$, $p = .000$]. There was another significant interaction between Prime Type, Prime Language and Bilingual Group [$F(4,5829) = 32.229$, $p = .000$]. The Cognate Status, Prime Language and Bilingual Group interaction also approached significance [$F(2,5831) = 28.473$, $p = .000$].

As in the previous experiments, planned comparisons were conducted to examine individual differences of the three groups of bilinguals. Table 5.37 shows the mean reaction times and percentage of errors of all three Bilingual Groups as a function of Cognate Status, Prime Type, and Prime Language.

Table 5.37 Mean RTs (ms) and Percentage of Errors for Cognate and Non-cognate Targets for All Three Bilingual Groups as a Function of Prime Type and Prime Language in Experiment 11B

	Prime Language					
	Bodo			Assamese		
	Early	Late high	Late low	Early	Late high	Late low
Prime Type	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)
Cognate						
Identical	728 (2.8)	802 (0)	864 (0)	703 (1.4)	689 (0)	828 (5.6)
Semantically related	895 (4.3)	903 (0)	1014 (5.6)	860 (4.3)	894 (0)	885 (5.6)
Unrelated	884 (2.9)	961 (0)	936 (5.6)	888 (2.9)	801 (11.1)	847 (5.6)
Identity effect (unrelated−identical)	**156**	**159**	**72**	**185**	**112**	**19**
Semantic effect (unrelated−semantically related)	**−11**	**58**	**−78**	**28**	**−93**	**−38**
Non-cognate						
Identical	744 (0)	622 (0)	739 (0)	722 (1.9)	823 (0)	949 (27.3)
Semantically related	977 (9)	967 (18.2)	1110 (13.6)	941 (0)	955 (9)	943 (18.2)
Unrelated	913 (0)	911 (0)	918 (9)	895 (3.6)	851 (0)	916 (13.6)
Identity effect (unrelated-identical)	**169**	**289**	**179**	**173**	**28**	**−33**
Semantic effect (unrelated-semantically related)	**−64**	**−56**	**−192**	**−46**	**−104**	**−27**

The overall results revealed faster naming latencies for the Early High Proficient (846 ms) and Late High Proficient (848 ms) bilinguals than Late Low Proficient (912 ms) bilinguals.

In the error analyses, no main effect of Relatedness was observed [$F < 1$]. The main effect of Cognate Status was marginal [$F(1,107) = 2.638$, $p = .002$]. Participants made greater errors to non-cognate targets than to cognate targets. The main effect of Prime Type was significant [$F(2,107) = 7.734$, $p = .000$]. Errors were numerous more for the semantic and unrelated primes than for the identity primes. However, the main effect of Prime Language was not significant. The percentage of errors was similar for primes from both languages. The main effect of Bilingual Group was significant [$F(2,50) = 9.216$, $p = .001$]. Moreover, the interaction between Prime Type and Bilingual Group approached significance [$F(4,5830) = 6.524$, $p = .000$]. All other comparisons were not significant (all Fs < 1). To determine individual effects of identity and semantic primes, separate analyses were conducted. The following section discusses the result of each effect.

Identity effect. The results revealed a significant main effect of Prime Type [$F(1,71) =33.841$, $p = .000$]. The main effect of Bilingual Group was found to be significant [$F(2,50) = 8.515$, $p = .001$]. The two-way interaction between Prime Type and Bilingual Group approached significance [$F(2,3925) = 41.362$, $p = .000$]. The Prime Language and Bilingual Group interaction approached significance [$F(2,3924) = 7.721$, $p = .000$]. The interaction between Cognate Status and Prime Language was also found to be significant [$F(1,71) = 7.792$, $p = .007$]. The three-way interaction between Cognate Status, Prime Language and Bilingual Group approached significance [$F(2,3925) = 47.511$, $p = .000$]. The interaction between Prime Type, Prime Language and Bilingual Group was also found to be significant [$F(2,3924) = 30.923$, $p = .000$].

Semantic effect. A marginally significant effect of Cognate Status was observed [$F(1,71) = 3.019$, $p = .087$]. The main effect of Prime Type was marginally significant [$F(1,71) = 4.066$, $p = .047$]. A reliable main effect of Prime Language was observed [$F(1,71) = 5.317$, $p = .024$]. The two-way interaction between Prime

Language and Bilingual Group approached significance [$F(2,3827) = 20.145$, $p = .000$]. The Prime Type and Bilingual Group interaction was found to be significant [$F(2,3826) = 12.572$, $p = .000$]. The three-way interaction between Prime Type, Prime Language and Bilingual Group approached significance [$F(2,3827) = 29.052$, $p = .000$].

5.7.3.3 Discussion

In Experiment 11B, the goal was to investigate the performance of Bodo−Assamese bilinguals when they named pictures in their dominant language and to explore whether the results are comparable to that obtained in Experiment 11A. The results of the experiments showed results similar to Experiment 11A, i.e., facilitation for identity primes and inhibition for semantic primes.

5.7.3.4 Combined Analysis of Experiment 11A and 11B

In order to investigate the effect of the target language, a comparative analysis was conducted between the data of Experiment 11A and 11B using a mixed-effects analysis. The result revealed a significant main effect of Target Language [$F(1,11173) = 487.160$, $p = .000$]. Responses were faster when the target language was Bodo (868 ms) than when the target language was Assamese (949 ms). There was a significant interaction between Cognate Status and Target Language [$F(1,11174) = 14.834$, $p = .000$]. The Prime Type and Target Language interaction was found to be significant [$F(2,11172) = 10.289$, $p = .000$]. The Prime Language and Target Language interaction approached significance [$F(2,11171.181) = 308.468$, $p = .000$]. Another significant interaction was observed between Bilingual Group and Target Language [$F(2,11170) = 11.160$, $p = .000$]. This interaction is shown in Figure 5.13. Moreover, the three-way interaction between Cognate Status, Prime Language and Target Language approached significance [$F(1,11174) = 71.143$, $p = .000$]. The Cognate Status, Bilingual Group and Target Language interaction approached significance [$F(2,11170) = 21.209$, $p = .000$]. A very significant interaction was observed between Prime Type, Prime Language and Target Language [$F(2,11171) = 160.922$, $p = .000$]. The interaction between Prime Type, Bilingual Group and Target Language was found to be significant [$F(4,11169) = 30.365$, $p = .000$]. Finally, another significant interaction was observed between Prime Language, Bilingual Group and Target Language [$F(2,11167) = 16.920$, $p = .000$].

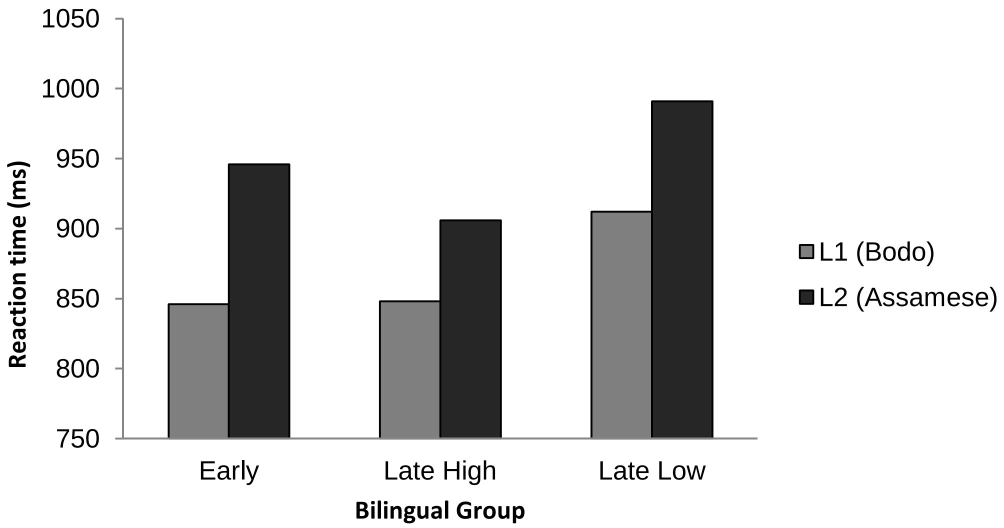


Figure 5.12 Mean RTs (ms) as a function of Bilingual Group and Target Language in Experiment 11A and 11B.

Thus, the overall pattern of results of the Experiment 11A and 11B suggest that bilingual language production is non-selective in nature. However, the blocked naming task might allow participants to focus their lexical search on the target language only. To further test the issue of language selectivity we investigated primed picture naming in a mixed context.

5.7.4 Mixed Picture Naming in L1 and L2 (Experiment 11C)

In Experiment 11C, the goal was to further test whether the cross-language identity effect and semantic effect observed in Experiment 11A and 11B can be replicated when both languages (Bodo and Assamese) are used for response.

5.7.4.1 Method

Participants. The same participants who took part in the previous two experiments participated in this experiment as well.

Stimuli and Design. The stimuli for the mixed-language naming task consisted of the same word–picture pairs used in Experiment 11A and 11B.

Procedure. The procedure of the mixed-language picture naming task was identical to that of Experiment 10C, with the exception that in this task the context words preceded the pictures. Each trial began with a brief fixation point of 500 ms, which was followed by a blank of 200 ms. The language cue (a red or blue dot) then appeared on the screen for 250 ms. Next two strings of letters in Bodo and Assamese appeared simultaneously, one above the other followed by the target picture for a maximum of 2,000 ms.

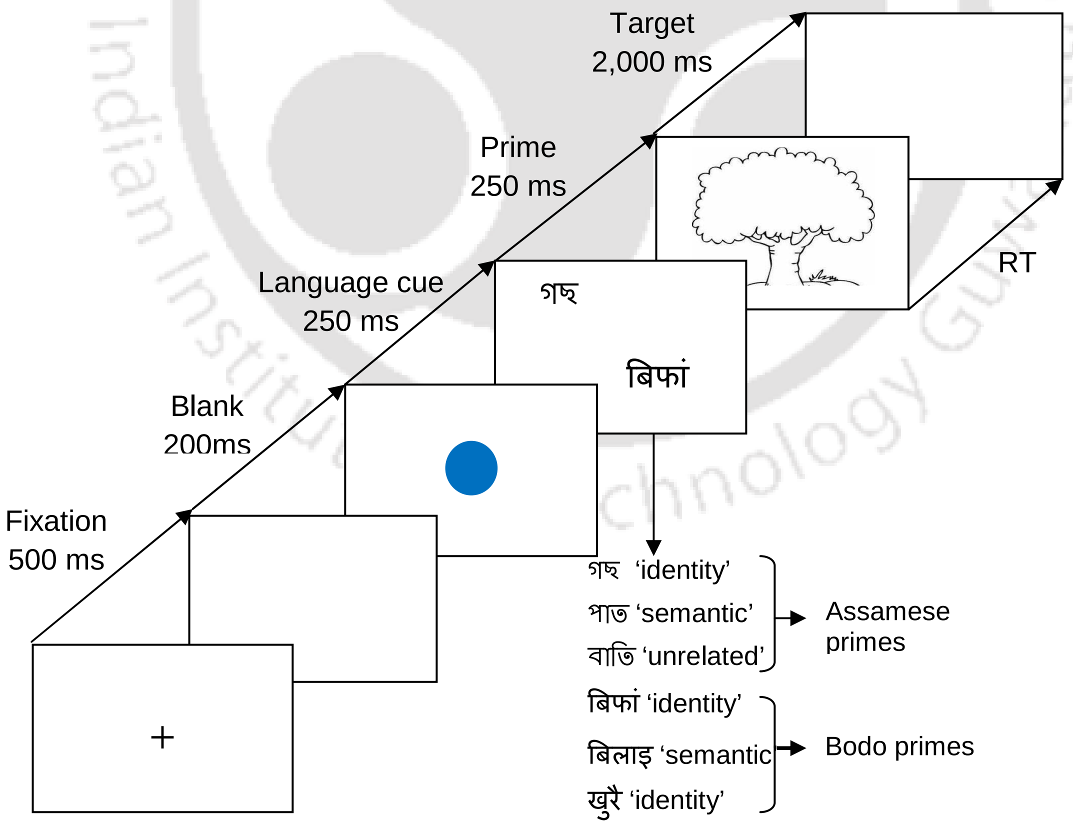


Figure 5.13 An illustration of the procedure adopted for Experiment 11C.

5.7.4.2 Results

Similar to the previous experiments, a mixed-effects analysis was run on the reaction time data and error data separately. Table 5.38 shows the mean reaction times and percentage of errors as a function of Cognate Status, Prime Type, and Target Language.

Table 5.38 Mean RTs (ms) and Percentage of Errors for Cognate and Non-cognate Targets as a Function of Prime Type and Target Language in Experiment 11C

		Target Language	
	Overall	Bodo	Assamese
Prime Type	RT (Error %)	RT (Error %)	RT (Error %)
Cognate			
Identical	997 (13.8)	967 (13.1)	1027 (14.5)
Semantically related	1034 (14.4)	977 (14.5)	1090 (14.5)
Unrelated	1049 (14.4)	1020 (15.7)	1078 (13.2)
Identity effect (unrelated-identical)	**52**	**53**	**51**
Semantic effect (unrelated-semantically related)	**15**	**43**	**−12**
Non-cognate			
Identical	1036 (13)	1121 (9)	949 (17.2)
Semantically related	1190 (14.9)	1171 (16)	1209 (13.8)
Unrelated	1049 (16)	997 (18.4)	1100 (13.8)
Identity effect (unrelated-identical)	**13**	**−124**	**151**
Semantic effect (unrelated-semantically related)	**−141**	**−174**	**−109**

The result of the reaction time analysis revealed a significant main effect of Cognate Status [$F(1,54) = 6.643$, $p = .013$]. Cognate pictures (1027 ms) were named faster than non-cognate pictures (1092 ms). A reliable effect of Prime Type was observed [$F(2,54) = 4.997$, $p = .010$]. The main effect of Target Language approached significance [$F(1,5283) = 25.097$, $p = .000$]. The main effect of Bilingual Group was also found to be significant [$F(2,51) = 30.761$, $p = .000$]. The two-way interaction between Cognate Status and Target Language approached significance [$F(1,5280) = 43.393$, $p = .000$]. The Cognate Status and Bilingual Group interaction approached significance [$F(2,5275) = 10.844$, $p = .000$]. The interaction between Prime Type and Target Language was also found to be significant [$F(2,5280) = 45.603$, $p = .000$]. The Prime Type and Bilingual Group interaction approached significance [$F(4,5268) = 18.970$, $p = .000$]. Another significant two-way interaction was observed between Target Language and Bilingual Group [$F(2,5265) = 49.163$, $p = .000$]. The three-way interaction between Cognate Status, Prime Type and Bilingual Group approached significance [$F(4,5269) = 22.761$, $p = .000$]. The Cognate Status, Prime Type and Target Language interaction approached significance [$F(2,5280) = 36.561$, $p = .000$]. Another significant interaction was observed between Cognate Status, Target Language and Bilingual Group [$F(2,5262) = 6.925$), $p = .001$]. Finally, the Prime Type, Target Language and Bilingual Group also approached significance [$F(4,5262) = 9.145$, $p = .000$].

Planned comparisons were conducted to examine the individual differences of the three groups of bilinguals. The results revealed a pattern different than the blocked picture naming experiments. The overall naming latencies of the Early High Proficient (1022 ms) and Late Low Proficient bilinguals (1020 ms) were faster than the Late High Proficient (1135 ms). Table 5.39 shows the mean reaction times and percentage of errors of all three Bilingual Groups as a function of Cognate Status, Prime Type, and Target Language.

A mixed-effects analysis of the error data did not show a main effect of Relatedness [$F < 1$]. The main effect of Cognate Status did not reach significance [$F < 1$]. Participants made similar number of errors to cognate targets and non-cognate targets. The main effect of Prime Type was not significant [$F < 1$]. The main effect of Target Language also did not reach significant [$F < 1$]. However, the main effect of Bilingual Group approached significance [$F(2,51) = 11.761$, $p = .000$]. Errors were numerous more for the low proficient group than the high proficient groups. Moreover, the interaction between Prime Type and Target Language was also found to be significant [$F(2,5280) = 8.034$, $p = .000$]. All other comparisons were not significant (all Fs < 1).

Table 5.39 Mean RTs (ms) and Percentage of Errors for Cognate and Non-cognate Targets for All Three Bilingual Groups as a Function of Prime Type and Target Language in Experiment 11C

	Target Language					
	Bodo			Assamese		
	Early	Late high	Late low	Early	Late high	Late low
Prime Type	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)	RT (Error %)
Cognate						
Identical	971 (7.4)	1033 (15)	896 (17.5)	1030 (8.6)	1032 (5)	1019 (25)
Semantically related	991 (8.6)	1066 (20)	875 (17.5)	1048 (7.2)	1149 (20)	1074 (22.5)
Unrelated	989 (6.5)	1148 (20)	922 (30)	1025 (7.2)	1107 (10)	1102 (22.5)
Identity effect (unrelated−identical)	**18**	**115**	**26**	**−5**	**75**	**83**
Semantic effect (unrelated−semantically related)	**−2**	**82**	**117**	**−23**	**−42**	**28**
Non-cognate						
Identical	1062 (5.5)	1304 (0)	998 (22.7)	1003 (10.6)	932 (9)	913 (31.8)
Semantically related	969 (10.6)	1394 (18.2)	1150 (22.7)	1095 (6)	1268 (18.2)	1263 (27.3)
Unrelated	1041 (7.6)	1028 (27.3)	924 (36.4)	1042 (9)	1154 (9)	1104 (22.7)
Identity effect (unrelated−identical)	**−21**	**−276**	**−74**	**39**	**222**	**191**
Semantic effect (unrelated−semantically related)	**72**	**−366**	**−226**	**−53**	**−114**	**−159**

To determine individual effects of identity and semantic primes, separate analyses were conducted. The following section discusses the result of each effect.

Identity effect. No main effects of Relatedness, Cognateness, and Target Language were found [all *F*s < 1]. However, the main effect of Bilingual Group was found to be significant [$F(2,51) = 18.633$, $p = .000$]. The two-way interaction between Relatedness and Target Language approached significance [$F(1,3524) = 66.276$, $p = .000$]. The Cognate Status and Target Language interaction approached significance [$F(1,3523) = 31.104$, $p = .000$]. The interaction between Target Language and Bilingual Group was also found to be significant [$F(2,3514) = 29.908$, $p = .000$]. The three-way interaction between Relatedness, Cognate Status and Target Language approached significance [$F(1,3525) = 67.762$, $p = .000$]. The Relatedness, Target Language and Bilingual Group was significant [$F(2,3510) = 16.496$, $p = .000$]. Another reliable interaction was observed between Relatedness, Cognate Status and Bilingual Group [$F(2,3516) = 5.995$, $p = .003$].

Semantic effect. The results did not reveal a main effect of Relatedness [$F < 1$]. The main effect of Cognate Status was reliable [$F(1,36) = 5.686$, $p = .022$]. Of crucial interest was the main effect of Target Language which approached significance [$F(1,3473) = 104.380$, $p = .000$]. The main effect of Bilingual Group was also found to be significant [$F(2,51) = 31.100$, $p = .000$]. The two-way interaction between Relatedness and Bilingual Group approached significance [$F(2,3467) = 21.347$, $p = .000$].

The Cognate Status and Bilingual Group interaction approached significance [$F(2,3470) = 15.906$, $p = .000$]. The Target Language and Bilingual Group interaction was also found to be significant [$F(2,3467) = 33.649$, $p = .000$]. The three-way interaction between Relatedness, Cognate Status and Bilingual Group approached significance [$F(2,3468) = 41.581$, $p = .000$]. The Relatedness, Cognate Status and Target Language interaction approached significance [$F(1,3471) = 15.600$, $p = .000$]. The interaction between Relatedness, Target Language and Bilingual Group was also found to be significant [$F(2,3464) = 8.544$, $p = .000$].

5.7.4.3 Discussion

The results of Experiment 11C revealed that when the primes appeared simultaneously and when the task was not blocked by the language of response, then more cross-language interaction was observed. The interpretation of the data emerging from the experiment is complex as well and equivocal at times. At this point, it is difficult to ascertain precisely how the different factors interact.

5.7.4.4 Blocked vs. Mixed: A Comparative Analysis

The results of Experiment 11A, 11B and 11C were further analyzed using a mixed-effects analysis to explore the processing dynamics of bilinguals in blocked versus mixed conditions. Figure 5.15 shows the distribution of mean reaction times as a function of three naming tasks (blocked Assamese, blocked Bodo, and mixed-language) and type of effects (identity and semantic).

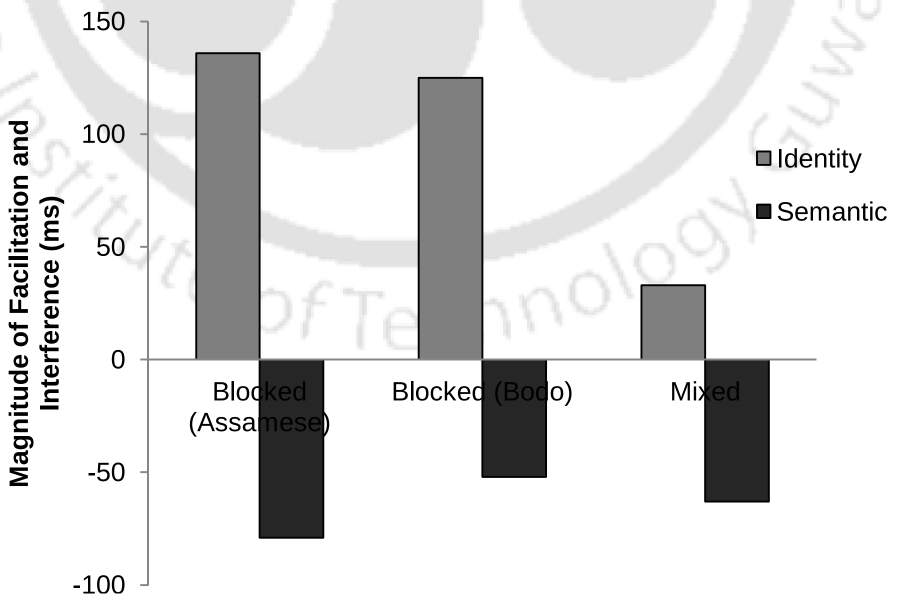


Figure 5.14 Magnitude of identity and semantic effects (ms) in Experiment 11A, 11B, and 11C.

5.7.5 General Discussion

The aim of the present study was to investigate how manipulations of content at different levels of representation influence word production by measuring naming latencies to pictures preceded by words primes. In Experiment 11A, 11B, and 11C, Bodo−Assamese speakers named pictures in Assamese (L2) and Bodo (L1) while ignoring visually presented L1 and L2 prime words which had different types of relationships to the names of the pictures (identity, semantic, and unrelated).

Experiment 11A and 11B employed a blocked picture naming paradigm in which participants were asked to name cognate and non-cognate pictures in their L2 (Assamese) and L1 (Bodo) respectively, while ignoring prime words in both L1 and L2. On the other hand, Experiment 11C employed a mixed picture naming paradigm, where participants named pictures in L2 and L1, depending on a language cue, ignoring prime words in L1 and L2 presented simultaneously. The following results were obtained:

In Experiment 11A, when pictures were preceded by words that were identical to their names, reaction times of the participants were faster for both same-language and different-language pairs. That is, identity priming was found for both same-language and different-language pairs when pictures were preceded by words that were identical (versus unrelated) to their names. However, facilitation effect was larger for same-language pairs. On the other hand, participants showed longer reaction times when pictures were preceded by semantically related (versus unrelated) words.

Experiment 11B showed results similar to Experiment 11A, i.e., facilitation for identity primes and inhibition for semantic primes. Experiment 11C, however, showed mixed results. Although an overall identity effect was observed, it was not consistent in all conditions. Moreover, what came as a surprise to us was that the semantic effect was found to be modulated by the cognate status of the pictures—

facilitation was observed for cognate pictures, whereas, inhibition was found for non-cognate pictures. Another interesting observation of our study was that the size of the facilitation or interference effects was found to be modulated by the age of acquisition and proficiency of the bilinguals. We now turn to the interpretation of the results in terms of production models.

The facilitation for the identity primes, when the prime was the name of the picture in both same- and different-language pairs can be interpreted within a lexical model that assumes that words of both the target and non-target language are considered for lexical selection and can, therefore, compete for selection. Moreover, the interference effect observed for semantically related primes in the same-language vs. different-language conditions can also be interpreted with a model that supports language non-selective access. However, the results of the mixed condition produced complex results which make it difficult to ascertain at this point.

Taken together, although the results of the present study provides evidence in support of language non-selective lexical access, the findings suggest that there are complex interactions among second language age of acquisition and proficiency level, form similarity across languages (i.e. cognate status), and relationship between words. To conclude, we discussed context effects in picture naming by examining two different paradigms: picture-word interference and primed picture naming and found that these two tasks are complex paradigms, and, consequently, the interpretation of the data emerging from these tasks is complex as well and equivocal at times. It is for similar reasons that Starreveld (2000) concluded that:

> In order to understand the origin of distracter effects in picture-naming studies, a theory of how the distracter is perceived and processed is as indispensable as a theory of how the picture is perceived and processed. According to him, both such a theory of perception and of production specify an interval in which the distracter manipulation is potentially effective. He then concludes that: “It is only when these two intervals overlap that a specific context effect [=distracter effect] can be found”. (p. 521)

5.8 Chapter Summary

In this chapter, many different types of tasks have been used to investigate the nature of the bilingual representation and processing in language production. The five different paradigms reported here compared the performance of Bodo−Assamese bilinguals at different stages of L2 AoA and proficiency and the concepts of language selective and language non-selective lexical access are discussed in light of the research findings. The overall results of the production experiments postulate that any one of the two languages of bilinguals co-activates information in both languages of the bilingual.

6

CONCLUSION

This chapter presents a summary of the main research questions and motivation that prompted the present study. A set of concluding statements and recommendations are also presented based on the findings of the study.

Main Contents

6.1 Introduction

Psycholinguistic research on bilingualism is mostly centered around an important question on how words in one language are cognitively organized and processed in relation to words in the other language. Although there has been extensive research in this area, there are many conflicting findings, making it difficult to reach firm conclusions even in areas where much research has been done. Moreover, most of the previous work differed in various experimental manipulations. It has been suggested in the past (e.g., Grosjean, 1998a) that variation in selection of participants, stimuli, tasks and models may all influence the pattern of results and be responsible for differences in outcomes.

In this thesis, we examined two major areas of research activity in experimental psycholinguistics—representation and processing. Chapter 4 examined the way in which bilinguals recognize words when they are written in each language and Chapter 5 addressed the way in which bilingual’s two languages are processed when they are produced in the language in which they intend to speak. The series of experiments reported in this thesis was aimed at refining our understanding of mechanisms in the way bilinguals process language comprehension and production.

6.2 Chapter Overview

This chapter draws together the results from Chapter 4 and 5, and refers to the research questions and hypotheses of the present study to address the key focus of the study. The chapter first summarizes the major findings of each experiment. Next, a summary of the main research questions is outlined with discussion of the implications that these findings have for models of bilingual language representation and processing. Finally, the thesis concludes by identifying the limitations of this study and enumerates some suggestions for future research.

6.3 Summary of Findings for Word Recognition Experiments

The word recognition tasks discussed in this study include visual lexical decision, semantic categorization, and translation recognition. In the visual lexical decision task, participants decided if the target word was a word or not; in the semantic categorization task, participants decided if the target word was a member of a specific semantic category and in the translation recognition task, participants were shown word pairs and they decided whether the second word in a pair was a correct translation of the first. In all the experiments, we manipulated the cognate status of the word. Moreover, we compared the performance of three groups of Bodo−Assamese bilinguals who differed on their L2 AoA and proficiency.

The visual lexical decision task tested two different priming paradigms—unmasked and masked. The experiments were designed to examine meaning and form by focusing on “semantic” relatedness (translation equivalents, semantic similarity, and associative relatedness) and “form” relatedness (phonological relatedness). This resulted in four different experiments, each having four sub-experiments—translation priming (Experiment 1A, 1B, 1C, and 1D), cross-language semantic priming (Experiment 2A, 2B, 2C and 2D), cross-language associative priming (Experiment 3A, 3B, 3C and 3D), and cross-language phonological priming (Experiment 4A, 4B, 4C and 4D).

Experiment 1A replicated facilitative translation priming effect from L1−L2 and Experiment 1B showed a reliable facilitative translation priming effect from L2−L1, in contrast with a number of previous studies that failed to find such effects. However, inhibitive rather than facilitative priming effects were observed in Experiment 1C and 1D which used a masked priming paradigm. This finding contradicts previous findings in which robust facilitative translation priming effect has been observed in both L1−L2 and L2−L1 direction under masked condition. For the unmasked translation priming experiments, we tested a 400 ms SOA condition (pilot study), as well as a shorter 100 ms SOA condition. Overall, we found clear unmasked facilitative translation priming effects in both the 400 ms and the 100 ms SOA conditions. The longer SOA boosted the priming effects but did not change the overall pattern of effects.

Experiment 2A added to the small literature on cross-language facilitative semantic priming effect. However, inhibitive semantic priming effect was observed in Experiment 2B, in which primes were in L2 and targets in L1. The presence of significant facilitative priming effects in the L1–L2 direction and inhibitive priming effects in the L2–L1 direction indicates that presentation of a word in the L1 would activate more conceptual information and, thus, allow a greater amount of conceptual activation to spread to the L2. Moreover, Experiment 2C and 2D also failed to show facilitative semantic priming effects when a masked paradigm was used. Therefore, although facilitation was also observed when both words were semantically related, priming between translation equivalents was greater than that between just semantically related words, indicating that translation word pairs elicited more activation than do semantically related word pairs. This suggests that strict semantic processing may not be capable of producing cross-language semantic priming effects when the experimental design is highly constrained.

Experiment 3A showed reliable facilitative associative priming in the absence of semantic relation. However, Experiment 3B, 3C, and 3D failed to produce facilitative associative priming effects. The overall findings of the experiments indicated that associative priming arises not, or at least not principally, through shared modal semantic representations but via language-specific knowledge of familiar word combinations. The overall results of the translation priming, cross-language semantic priming and cross-language associative priming experiments showed that facilitative priming effects can be observed only when an unmasked paradigm is used.

Finally, facilitative phonological priming effects were observed only from L2−L1 for both unmasked and masked conditions—Experiment 4B and 4D exhibited significant phonological priming effects, with the magnitude of the effect being larger in the latter experiment. On the other hand, in Experiment 4A and 4C, the phonological priming effects were inhibitive in nature. The findings of the study indicated that phonological priming may be automatic rather than strategic.

Although there was a consistent trend for larger priming effects with cognate words than with non-cognate words, none of the cross-language priming experiments except the phonological priming experiments, showed cognate facilitation effect. The different effects of processing for cognates in translation priming and phonological priming suggest that the simple phonological overlap between two languages and the conceptual overlap for translation equivalents have somewhat different impacts on bilingual word recognition. The visual lexical decision experiments thus offered important insights into the facilitative/inhibitive processes underlying the masked and unmasked priming technique. To sum up, we have demonstrated that masked priming effects with different primes and different tasks are a combination of both facilitative and inhibitive effects.

The semantic categorization task (Experiment 5A and 5B) was conducted to account for the *translation asymmetry* and *task effect* in the masked priming literature—the asymmetry observed in L2−L1 lexical decision task becomes symmetrical when the task is changed to a semantic categorization task. The results of the two experiments revealed that facilitative translation priming effect could not be obtained for exemplars when the word type was controlled in both directions. The findings of the study conform to the results of the masked lexical decision task using translation primes. Therefore, it was shown that the priming asymmetry in lexical decision was not due to differential degrees of semantic activation of the prime in L1 and L2. Moreover, the results revealed that categorical priming is not sensitive to the language asymmetry often reported in the bilingual semantic priming literature.

In the translation recognition task (Experiment 6A and 6B), the critical focus concerned those trials on which the two words were not translation equivalents (i.e. the *no* trials). The results of the two experiments showed that the two types of related trials produced different results for different groups of bilinguals. For low proficient bilinguals, there was significant interference for form related pairs, but little effect for semantically related pairs. For high proficient bilinguals, the pattern was reversed—form related pairs produced inconsistent effects in performance but semantically related pairs produced significant interference. The overall pattern of results provides support for the hypothesis that early in second language learning, lexical form relations between L2 and L1 provide the basis of inter-language connection.

6.4 Summary of Findings for Production Experiments

The production tasks discussed in this study include word naming, word translation, simple picture naming, picture-word interference and primed picture naming. In the word naming task, participants named words in their L1 and L2. In the word translation task, participants translated words from their L1−L2 and vice versa. In the simple picture naming task, participants named pictures presented on their own. In the picture-word interference task, participants named pictures superimposed with distracter words. In the primed picture naming task, participants named picture targets that were preceded by word primes. The stimuli in all the tasks included cognate and non-cognate targets.

The word naming task (Experiment 7A and 7B) investigated the role of Cognate Status, List Type, and Bilinguals Group, when three groups of Bodo-Assamese bilinguals named cognate and non-cognate words in L1 and L2, which were presented in categorized and randomized lists. Experiment 7A demonstrated significant category interference for both cognate and non-cognate words, whereas, in Experiment 7B, category interference was observed only in case of cognate words. The findings of the two experiments revealed that naming in L1 was sensitive to the lexical effect, whereas naming in L2 was prone to semantic effects.

The word translation task investigated whether forward translation (L1−L2) exploits a different mental process from backward translation (L2−L1). Two experiments

(Experiment 8A and Experiment 8B) were reported in which word translation was performed in the context of semantically categorized or randomized lists. The experiments also manipulated the cognate status of the target words. In general, translation from L2−L1 was faster than translation from L1−L2. In Experiment 8A, non-cognates words produced category interference when they were translated in a semantically organized list from L1−L2. Moreover, robust cognate facilitation effects were observed in both categorized and randomized list for all three bilingual groups. In Experiment 8B, non-cognate word translation was slower in the categorized than randomized conditions. However, cognate facilitation effect was observed only in the categorized list. The results of the two experiments further showed that category interference in bilingual translation occurred only with non-cognate words and when translation was performed from the second language to the first language, suggesting that the two directions of translation engage different inter-language connections.

The simple picture naming task (Experiment 9A and 9B) investigated whether cognate facilitation and category interference in simple picture naming would be obtained for bilinguals whose two languages differ in script. Picture naming was performed in the context of semantically categorized or randomized lists. Experiment 9A showed significant cognate facilitation effect, whereas no such facilitation was observed in Experiment 9B. The results suggest that there is cross-language activation of phonology even for different-script bilinguals.

The results of the word naming, word translation and simple picture naming experiments confirm that translating a word or naming a picture were quite similar and took much longer than reading a word. Since picture naming is believed to require concept mediation, the resemblance of word translation to picture naming provides evidence that it too is conceptually mediated. Significant category interference found in word translation further supports the exploitation of meaning representations, which is, in fact, a debated issue in the form-to-meaning mapping studies. Another clear observation in our study is that backward translation (L2−L1) was faster than forward translation (L1−L2). Although, this finding hinted the use of lexical route as suggested by the RHM, the evidence for category interference in the

L2−L1 direction supports a weaker version of the model, which holds that L2 words may also access conceptual memory directly but do so less often (or less often quickly enough) than L1 words (De Groot, 2011). The overall effects, therefore, suggest that word translation (mostly in the forward direction) requires lexicalization in a form that appears similar to other production tasks such as picture naming. That is, when a word is presented in one language for translation into the other language, the meaning of the word is accessed before a lexical candidate is chosen and its phonology specified (e.g., De Groot, 1992b; Sánchez-Casas et al., 1992; Kroll and Stewart, 1994; Sholl et al., 1995; La Heijet al., 1996). Moreover, the results of the word naming task revealed that naming in both L1 and L2 was subject to semantic (conceptual) processing, as reflected in the significant interference produced in the semantically categorized list. This suggests that it took advantage of the semantic processing requirements, refuting pervious research on word naming which suggests that it primarily involves lexical-level processing.

In the next two paradigms, we investigated the processes involved in bilingual picture-word interference studies by manipulating both the type of visual context words (three types of visual context words have been used: identity, semantic, and unrelated) presented with the picture and the time interval between the presentation of context word and picture. In the picture-word interference experiments, the distracter and pictures were presented simultaneously (SOA of 0 ms), whereas in the primed picture naming experiments the prime preceded the picture (SOA of 250 ms).

The picture-word interference task (Experiment 10A, 10B, and 10C) was used to determine whether the degree of cross-language activation and the locus of language selection can be modulated by script when the task includes an overt written lexical form. Experiment 10A and 10B employed a blocked language paradigm and Experiment 10C used a mixed language switching paradigm. Experiment 10A showed no identity effect when the distracter was the name of the picture in both same-language and different-language pairs. However, in Experiment 10B naming was facilitated when the distracter was the name of the picture in the same-language pairs. It was also observed that semantically related distracters in the same-language vs. different-language conditions were similarly interfering in Experiment 10A and 10C. Experiment 10C produced facilitative effect for identity distracters for both response languages.

The primed picture naming task (Experiment 11A, 11B and 11C) was used to further investigate how manipulations of content at different levels of representation influence word production. The overall results of Experiment 11A and 11C demonstrated shorter naming times (facilitation) to pictures preceded by identity words and longer naming times (interference) to pictures preceded by semantically related words. However, Experiment 11C showed mixed results: although an overall identity effect was observed, it was not consistent in all conditions. Moreover, semantic effect was found to be modulated by the cognate status of the pictures—facilitation was observed for cognate pictures, whereas, interference was found for non-cognate pictures.

To sum up, we obtained semantic interference effect not only when the semantic distracter coincided with the picture, but also when the semantic prime preceded the picture. Interestingly, the same two studies showed completely different results for identity condition. The effect of this identity distracter was inhibitive when the distracter was superimposed with the picture. On the other hand, the effect of the identity prime which preceded the picture was facilitative rather that inhibitive, i.e., they speeded up the picture naming response. Thus, the interaction between SOA and the type of distracter/prime can be understood if we consider the various processing stages, and their order, in the two processes that operate in parallel in the both the tasks—processing the context word and naming the picture.

6.5 Discussion of Findings

The key findings from the research are best examined by returning to the purpose and questions underpinning the research. The overall purpose of the research was to determine how bilinguals represent and process their two languages and the nature and extent of the factors that influence the representation and processing of the two languages. We began our study with the primary goal of finding out whether lexical access in bilinguals would look language selective or language non-selective under processing circumstances. To achieve this, we used priming methodology and manipulated the cognate status of target words as well as the relationship between words. Based upon this broader overall purpose, the key questions for the research were identified and findings for each are discussed. We will take up these issues, in turn, in the following sections.

1) Is lexical access selective or non-selective?

As mentioned, a major discovery in the past decade is that when bilinguals use one language, information in the other language is also being accessed. Experimental psychology has established this phenomenon, known as cross-language interaction, during reading, listening, and speaking in bilinguals with various language combinations and levels of proficiency.

In our study, we found evidence for cross-language interaction, either in the form of facilitation or inhibition. This pattern of results was echoed in the numeric differences found in the data for our Bodo−Assamese bilingual participants. Our result is consistent with the current position in cognitive science that word recognition and production, in general, involves parallel activation mechanism. However, the data of our study presents us with certain factors that can have an impact on the time-course of the selectivity of language (see sections below).

2) Are cognates represented and processed differently from non-cognates? If yes, is the difference task-specific?

Our study was designed to examine cognate status with Bodo−Assamese bilinguals in different paradigms. A large number of studies have focused on cognate and non-cognate words, and there is overwhelming evidence in support of both language selective and language non-selective access. Facilitation effects for cognates are thought to arise because lexical activation of target and non-target language representations converges onto the same meaning and form, and thus speed up comprehension or production. With respect to cognates, if access is language selective, reaction times should not be affected by words being either cognates or non-cognates. However, if access is non-selective, ensuing competition between candidates from both languages will again lead to either facilitation or inhibition.

Different theoretical accounts give different explanation on cognate representation and processing. The link account attributes the facilitation effect to stronger link at the lexical level and thus predicts cognate facilitation regardless of task. On the other hand, the form overlap account predicts that cognate facilitation is the result of the fact that cognates share many overlapping features in L1 and L2 (shared meaning as well as form) than non-cognates. In order to test these predictions with Bodo−Assamese materials, thirty-two experiments were conducted in which the semantic and phonological overlaps between the prime and target were manipulated so that we could see if different degrees of semantic and form relatedness can influence the processing of cognates and non-cognates. Moreover, different tasks were used to see if cognate facilitation can be found regardless of task.

The present study which have made use of multifarious paradigms have illustrated that words that share similar form and meaning in two languages (cognates) behaved in a qualitatively different manner from words which share only meaning in the two languages (non-cognates), robustly throughout the series of experiments. This indicates that bilingual individuals activate lexical items in their first language and their second language, simultaneously. When cognate facilitation is considered to explore language co-activation, the results of our study show that this effect is robust in the production tasks than in the comprehension tasks.

To illustrate, in the three visual lexical decision experiments (translation priming, semantic priming, and associative priming), both cognates and non-cognates produced priming effects, but no cognate facilitation was observed. The absence of robust cognate facilitation effects in these lexical decision experiments, while a clear advantage for cognate over non-cognate words in previous studies was surprising. However, a significant cognate priming as well as facilitation effect was observed in the phonological priming experiments. The stronger effects of cognate translations compared to non-cognate translations in the phonological priming experiments can be interpreted as an added advantage of form overlap in combination of meaning and form priming effects. Moreover, as can be seen in all production experiments, cognate facilitation effect was observed when phonological information was clearly used to make a response. Hence, differences in language requirements imposed by the two tasks seem to be the critical factor determining the presence of robust cognate facilitation effects only in the production tasks.

Another interesting finding of our study was an observed asymmetry in the cognate facilitation effect. In semantic categorization task, significant cognate facilitation effect was observed only in the L2−L1 direction. Moreover, in the production tasks, cognate facilitation was robust when the target language was the L2, as compared to the L1, in which weak or null effects were observed. A further interesting observation of our study was that, the three groups of bilinguals produced different patterns of results regarding what lexical codes are needed in different response tasks. We will discuss the implications of these results with theoretical explanations.

As can be seen in our study, cognate facilitation effect was mostly observed when phonological information was clearly used to make a response. This pattern of results provides evidence in support of the form overlap account of the cognate facilitation effect, which argues that the cognate facilitation is due to the additional form overlap. Therefore, the larger priming effect is caused by the additional form priming and when form priming is not observed, the facilitation will disappear. Furthermore, the lack of cognate facilitation in lexical decision task but its existence in semantic categorization task and other production tasks indicates that the effect is task-dependent, which is another evidence against the link account. To sum up, our study with Bodo−Assamese bilinguals observed cognate facilitation effect, but the finding of this effect was dependent on some restraints, like task type, language direction, and bilingual group.

3) To what extent is the co-activation of languages modulated by differences in age of acquisition and proficiency in the second language?

A primary motivation of the current study was to explore whether the underlying processes of lexical processing during word recognition and production may be distinct, depending on the age of acquisition and proficiency level in the second language. As noted in Chapter 1 and 2, a number of studies claim that bilinguals who differ in their L2 AoA and proficiency have different architectures as well as distinct processing mechanisms. The RHM permits a number of interesting predictions to be made about changes in performance with increasing fluency in L2. Therefore, based on previous findings and the predictions of the RHM, it was hypothesized that the locus of selection would be at a different level for the three groups of Bodo−Assamese bilinguals. This was assumed because the three groups of bilinguals were different in terms of their L2 AoA and proficiency. Moreover, proficiency, more than AoA, was hypothesized to be a deciding factor for the locus of selection.

The results of our study demonstrated different findings for the three bilingual groups throughout the experiments. The implication is that L2 AoA and proficiency does have a major influence on how bilinguals represent and access words in their second language. Moreover, we noticed that proficiency rather than age of acquisition has a major role, in that, the Early High Proficient and the Late High Proficient bilinguals showed similar results in various processing tasks as compared to the Late Low Proficient bilinguals. Our results are consistent with the predictions of the RHM in some ways, but not in others. The core idea of this model is that initially bilinguals map a newly learned L2 word onto its L1 translation, with conceptual access based on the L1 linkage between the lexical representation and its conceptual representation. With increasing proficiency, bilinguals can instead, directly map a word in L2 to a conceptual representation, without any need for the L1 mediation. Our results are consistent with the notion that high proficient bilinguals can have direct conceptual access, in ways that other bilinguals cannot. For example, in the translation priming experiments, only the high proficient bilinguals demonstrated robust priming effects. However, some of our experiments showed disparate results. For example, in the semantic priming experiments, a strong version of the RHM would predict strong effects for the high proficient bilinguals and null effects for the low proficient bilinguals. However, in our study, only the Late Low Proficient bilinguals showed significant priming effects. Another instance in which disparate result was observed was the word translation experiments. As per the predictions of the RHM, reaction times for the low proficient bilinguals were hypothesized to be shorter when translating from L2−L1, due to strong direct connections from the L2−L1 lexical representations, whereas, reaction times for the high proficient bilinguals were hypothesized to be longer, because they are assumed to primarily exploit indirect connections through the conceptual representations shared by L1 and L2. However, to our surprise, the low proficient bilinguals showed longer reaction times as compared to the high proficient bilinguals in our study. We therefore, interpret the observed change with increasing proficiency to indicate that early in acquisition, direct connections between translation equivalents across the two languages are salient until the ability to directly conceptually mediate L2 develops. However, an alternative account of the combined data suggests that low proficient bilinguals can also access conceptual memory directly in all cases but that, due to the relatively weak links, the access point is too slow so that by the time the target is presented, it has not yet not been successfully completed (De Groot, 2011). Moreover, as far as language selectivity is concerned, the results of the experimental procedures support the notion that the type of bilingual does not determine language selectivity or how competition is resolved during lexical selection, based on how the L2 was acquired or what history the bilingual may have with it.

4) Does a language-specific difference, such as script, modulate cross-language activation, the locus of language selection, and the manner of language/lexical selection during bilingual word recognition and production?

The present study investigated the role of script in the recognition and production of visually presented words and pictures. If different scripts function as a language cue to direct lexical access selectively, the strongest prediction was that Bodo−Assamese bilinguals will switch off the unintended language and there will be no cross-language activation. In contrast, a weaker version of this hypothesis was that Bodo−Assamese bilinguals will also show cross-language activation but can select the response language earlier than the same script bilinguals. Given the findings from the experiments described thus far, it may be reasonable to conclude that the non-selective access view is still supported even if the writing systems of the two languages are completely different. Moreover, the three groups of bilinguals performed similarly when the script (a language cue) was absent in the task and also when the script was present. To sum up, the overall pattern of our experiments replicated previous findings, indicating that script alone cannot be a motivating factor in the selection of language.

5) Is lexical processing asymmetrical?

The present study has examined bilinguals' processing in both L1 and L2. Overview of the previous studies revealed that asymmetry is a well-observed fact in bilingual language processing. The evidence provided by these studies usually concerns the RHM's predictions that ensue from the assumed asymmetries in the strengths of the connections between the lexical and conceptual nodes within a single developmental stage (De Groot, 2011). The overall findings of our study clearly demonstrated that language of response has an impact on language processing. For example, in the lexical decision task, cross-language priming effect was, in fact, larger from L1−L2 than from L2−L1. Moreover, reaction time for L2−L1 processing was shorter than in the reverse direction across different tasks. For example, backward translation was faster than forward translation. The results of the production experiments further reveals that word naming in L1 was faster than word naming in L2.

The data of our experiments, together with the overview of the previous studies, revealed some of the factors that might cause the asymmetry in processing language. For example, previous research shows that one of the variables influencing the asymmetry in the bilingual lexical processing is the cognate status of words and pictures. In our study, we compared the reaction times for cognates and non-cognates and the comparison yielded the following results: reaction times were shorter for cognates in the L2−L1 direction. Moreover, as regards to L2 AoA and proficiency, the overall experiments showed mixed results. Furthermore, no task difference was observed. The contradicting results found in these experiment call for further examination of the word type effect and its relation to L2 AoA and proficiency, experimental task and/or typological closeness of the two languages of a bilingual. To conclude, the findings of our study clearly demonstrated a well-known asymmetry. However, what clearly emerges from the pattern of results is that, none of the factors involves a qualitative difference; rather the difference seems to be quantitative.

6.6 Implications for Models of Bilingual Language Representation and Processing

Each experiment in this thesis provided an account of empirical research that challenges aspects of accepted models and widely accepted theories about bilingual word recognition and production. The extensive literature review in Chapter 1 and 2 outlined the existing models and theories relating to bilingual language representation and processing. While providing a useful framework for beginning the discussion about language processing, these existing theories relating to bilingual language representation and processing are not adequate to explain how the process of comprehension and production occurs as a whole and what may impact these processes. Moreover, current models of bilingual language processing have not yet been aimed at testing competing hypotheses of bilingual language representation and processing:

a) Does a bilingual have two conceptual stores and two lexicons that receive simultaneous inputs from shared conceptual and lexical items?

b) Or does a bilingual have one conceptual store and one lexicon, and its partially active conceptual and lexical items from two different languages directly compete with one another?

As regards the representation of a bilingual's languages, our study sought to determine the extent to which language subsystems for a bilingual's two languages are shared, or are separate. We noted in Chapter 1 that if an interactive activation architecture is assumed then a model should specify whether there are separate representations for the two languages at each of the three levels of such an architecture—conceptual, lexical, and form. Although the results of our study are in some ways, consistent with the basic architecture of hierarchical models (like RHM) and interactive activation models (like BIA+), they are not clear in explicitly formulating the hypothesis of separate versus shared conceptual and lexical representations of the two languages separately.

Moreover, as reviewed in Chapter 2, a number of studies suggest that age of L2 acquisition, as well as level of L2 proficiency, determine the particular architecture for a given bilingual. Our study demonstrated different results for the three bilingual groups, indicating a clear impact of L2 AoA and proficiency. However, the observed pattern was not consistent throughout the experiments, and therefore, it seems unclear whether different architectures are involved for the three bilingual groups.

As far as the processing of languages is concerned, the findings of our study provide evidence in support of parallel activation of two languages. However, the parallel activation can be interpreted by two different models of parallel language processing in bilinguals—one model would assume two separate lexical stores, one for each language, and the other model would assume a single lexical store for both languages. One way to go about asking this would be to design two different models having different interpretations of parallel activation and examine how these models accommodate the parallel activation phenomena mentioned above.

Furthermore, the relation between comprehension and production and the underlying architecture of the language system have been studied thoroughly since the second half of the last century. The multitude of studies that have been carried out in the present study suggests that the recognition and production tasks might subsume different cognitive processes and might differ in the extent to which the non-target language influences processing in the target language. However, it also suggests that comprehension and production are highly connected, and as such, visual word recognition and production may exploit one and the same underlying processing system with components that are either fully shared or highly interconnected between production and recognition. This view is in line with the proposed model of De Groot (2011) that incorporates both comprehension and production in one (see Figure 6.2).

Moreover, the model includes bidirectional connections between the different types of nodes in the system. Moreover, this model hypothesizes that to feed a node, a node does not have to go via some other node. For example, orthographic nodes can feed phonological nodes indirectly, via semantic nodes, but also directly. However, the proposed model is in its preliminary stages, and therefore, each component of the multifaceted hypothesis must be validated empirically. An interchange between computational modeling and empirical research may in the long run provide conclusive answers to many important questions within bilingualism research. Moreover, as bilingualism is a complex process, and therefore, any theory aimed at explaining bilingual language processing must be able to take into account the dynamics and changes that take place over time.

6.7 Research Limitations and Directions for Future Research

The present study had added to theory by providing not only a more detailed explanation of how language processing in bilinguals happens, but has also attempted to explain the discrepancy in the results of the previous studies, by controlling for various experimental manipulations. The most important characteristic about this study is that it is based on a population that has not been studied before.

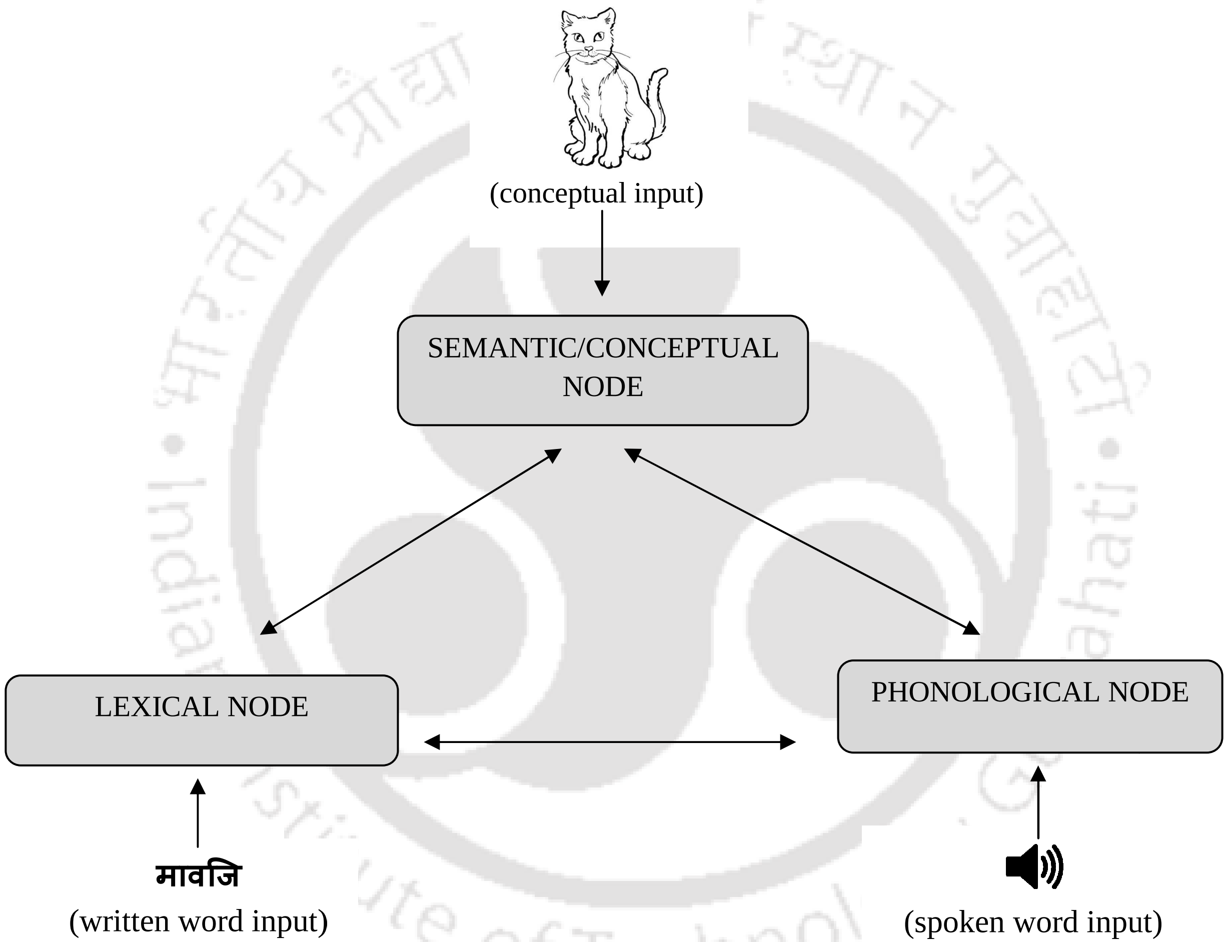


Figure 6.1 A visual illustration of language-processing system for both word recognition and production which highlights the component structures and processes involved (adapted and modified from De Groot, 2011).

Some of the experiments of our study are simple replication of published studies (with some modifications) which attempted to extend the findings of the previous studies to this new population and new languages. For now, it suffices to say that bilinguals can and do experience competition from both languages and into both languages, although the magnitude of the effect changes under different circumstances. However, as with any study, this study has its own limitations that must be acknowledged when interpreting the reported results. Overall, some results of our experiments were far from straightforward, making it difficult to draw many firm conclusions. In that sense, the studies should be considered exploratory ventures into the workings of bilingual lexical representation and processing. Indeed, although many papers have been published in the field of bilingual visual word recognition and production, no work has been done on this population. Although not yielding simple conclusions, the use of convergent paradigms has demonstrated the importance of studying bilingual processing in a range of experimental contexts. The results caution against making generalizations based on a single paradigm or stimulus class.

The work reported in this thesis offers some promising directions that could be taken for future research on the topic. The focus of the study was on the lexico-conceptual representation and processing in Bodo−Assamese bilinguals. That is, we have only considered the question of how a bilingual's languages are represented at word and meaning levels. Therefore, all of the experiments that we covered in this study have utilized the isolated word as the experimental unit. Of course, being a bilingual is more than just understanding and producing words in another language. It also entails having knowledge of the second language's syntax and being able to construct sentences using the appropriate syntactic rules.

Recent developments in the field also suggest that bilingual research is beginning to move away from the isolate-word level and to address the other general language processing issues such as bilingual sentence processing and figurative language processing (e.g. Heredia & Altarriba, 2002). In the future, research focusing on the syntactical aspect of being a bilingual will be able to answer to explore whether language non-selective access generalizes more contextualized language use, for example when words are part of meaningful sentences, or when words are spoken aloud and so reveal information about the word's language.

6.8 Thesis Summary

This study extracted the key theoretical points of the theoretical assumptions, the methods adopted, and the results and their interpretation. The primary goal of this study was to offer an insight into the processing mechanisms of the bilingual mental lexicon. More specifically, it focused on the empirical investigations of the storage and retrieval of cognates and non-cognates in a bilingual mind. All the aspects, analyzed in the experiments reported in the Chapter 4 and 5, are part of a broader question of how do bilinguals represent and process their two languages. In order to place the investigations in a larger context, the thesis was divided into six chapters.

The preliminary theoretical considerations referring to a plethora of bilingual issues included in Chapter 1 provided a relevant background against which most important review of literature concerning bilingual language representation and processing was presented in Chapter 2. In Chapter 3, the focus of attention was shifted to the overall research design and methodology of the experiments. Chapter 4 and 5 offered a detailed account of a series of experiments conducted, in order to verify the assumptions concerning the representation and processing of cognates and non-cognates in the context of the Bodo−Assamese lexicon.

In a variety of experiments, Bodo−Assamese bilinguals were asked to make lexical decisions, categorize words, recognize word translations, read words aloud, translate words, name pictures, and name pictures in presence of distracter words. In the present study, participants with different AoA and degrees of proficiency in their non-native language were used (i.e., Early High Proficient, Late High Proficient, and Late Low Proficient bilinguals). To sum up, it appears that both recognition and production processes in bilinguals proceed in parallel, with information from the non-target language activated during a target language task. Overall, the results highlight the flexibility of the bilingual system, which adapts readily to range of different tasks demands. In other words, it may be that the utility of the selective/non-selective access dichotomy, while important for the research it has stimulated, may have run its course and may be replaced by a view of bilingual lexical access in which lexical, contextual, and criterial factors flexibly interact to either facilitate or inhibit access to lexical representations in both of a bilingual's languages. A more detailed examination of the characteristics of the experimental paradigms in future studies is required to understand the complex nature of these tasks.

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APPENDICES

APPENDIX A.

Pilot Study Fieldwork Locations and Participants.

Participation in the pilot study was voluntary. All participants were native speakers of Bodo and speakers of Assamese as a second language. Few of them were even reported being more proficient in Assamese, and used it as their mother tongue, and therefore, removed from the analysis. The participants from the pilot study were not included in the main study because they have already been exposed to a set of experiments and, therefore, may respond differently from those who have not previously experienced it. The selection of the participants consisted of students and staff from university and colleges of Guwahati, Assam.

1. Indian Institution of Technology Guwahati: Participants included eight Bodo−Assamese bilinguals. They were students and staff of the institute. All participants were male and ranged in age from 21−43 years.

2. **Gauhati University:** Participants included twenty-one students from Bodo Department and two project staff from Computer Science Department. They ranged in age from 21−32 years.

3. **Cotton College:** Participants included four students from Geography Department.

4. **Pandu College:** Participants included one student and four teachers.

APPENDIX B.

Main Fieldwork Locations and Participants.

1. Bathoupuri Bodo M.E. and H.E. School

Number of participants: 9

Male: 8

Female: 1

Age group: 29–45 years

Bathoupuri Bodo M.E. School and Bathoupuri Bodo H.E. School is located in Garchuk, Guwahti. The M.E. section was set up in 1985 and three years later, the H.E. section was incorporated in 1988. The school has completed 25 years of glorious existence in the year 2013. It is a co-educational school. Eleven teachers, in total, from the M.E. and H.E. sections of the school participated in few of the comprehension and production experiments.

Figure 1 Front view of Bathoupuri Bodo M.E. and H.E. School

2. J. B. Hagzer Bhawan

Number of participants: 10
Male: 10
Female: 0
Age group: 21−43 years

J.B. Hagjer Bhawan, situated at Narayanpur, Ganeshguri, Guwahati housed the sub-office of the Bodo Sahitya Sabha. The foundation stone of the building was laid by Late Shri Hiteswar Saikia, ex- Chief Minister of Assam, in 1994. The bhawan is named after Joy Bhadra Hagjer who became the president of the sixth Bodo Sahitya Sabha session during 1964 and in 1965. The bhawan functions as a meeting point for Bodo littérateurs and academicians and is used as a base in the city for the furtherance of scope and reach of Bodo language.

Figure 2 Office building of J. B. Hagzer Bhawan

3. Bathoupuri

Number of participants: 43

Male: 32

*Female:*11

Age group: 22-45 years

Bathoupuri is located to the south of Guwahati. This area is surrounded by Assamese speaking localities. The closest Boro-speaking locality is Ahomgaon, which is one and a half kilometers to the west of Bathoupuri. The most dominant language in this area is Bodo, and the second is Assamese. The Bodo people in this area are bilingual in Boro and Assamese, and some are multilingual. Most young people understand Hindi, and some can even read and write Hindi. However, no one uses Hindi in daily life. A few understand and can speak a bit of English. The language is being passed to the new generations, and most children are learning Bodo as their first language. However, there are a few who are acquiring Assamese rather than Bodo, and prefer to speak to everyone in Assamese. Most children are sent to Bodo-medium schools. However, a few are sent to English-medium schools.

Figure 3 Few participants from Bathoupuri

4. Ganeshpara

Number of participants: 36

Male:15

Female: 21

Age group: 23-43 years

Ganeshpara is located around 10 km from Bathoupuri. This place is surrounded by Assamese speaking localities. The closest Bodo speaking area is Dhirenpara. The Bodo people of this area are one with the surrounding Assamese people, from dawn to dusk. Their interaction pervades all spheres of daily life. The most dominant language in this area is Bodo, and the second is Assamese. The Bodo people in this area are bilingual in Boro and Assamese, and some are multilingual. However, there are a few who are acquiring Assamese rather than Boro, and prefer to speak to everyone in Assamese.

Figure 4 Bathou Temple, Ganeshpara

5. Champavati Higher Secondary School

Number of participants: 3
Male: 3
Female: 0
Age group: 32−45 years

Champavati Higher Secondary School, located in Fatasil Ganeshpara, Guwahati, is a Upper Primary with Secondary School in Guwahati. It was established in the year 1961 and the school management is Department of Education. It is an Assamese-medium co-educational school. The school runs in a government school building. The school has total ten classrooms. The lowest class is six and the highest class in the school is ten. This school has thirteen male teachers and twelve female teachers. The school does not provide any residential facility.

Figure 5 Main gate of Champavati Higher Secondary School.

6. Indian Institute of Technology Guwahati

Number of participants: 6

Male: 3

Female: 3

Age group: 23-38 years

Established in 1994, Indian Institute of Technology Guwahati is the sixth member of the IIT fraternity. The campus is situated on the north bank of the river Brahmaputra around 20 km from the heart of Guwahati city. The Institute has eleven departments and three inter-disciplinary academic centres covering all the major engineering, science and humanities disciplines. Since a number of people from the institute already participated in the pilot study, only six Bodo-Assamese bilinguals voluntarily took part in two experiments of the main study. They included three research scholars from the Department of Humanities and Social Sciences and three lady security guards from Subansiri Hostel of the institute.

Figure 6 Photograph of a participant of Subansiri Hostel, IIT Guwahati, performing the picture-word interference experiment.

APPENDIX C (i)

Language Background Questionnaire in English.

Date: ____________

1. Name: ____

2. Place: ____

3. Age: ____________

4. Sex: ☐ male ☐ female

5. At what age you were first exposed to Bodo? _______

6. At what age you were first exposed to Assamese? _______

7. Where did you learn Bodo? ☐ at home ☐ at school

8. Where did you learn Assamese? ☐ at home ☐ at school

9. What language(s) does/do your mother speak **with you**?

☐ Bodo
☐ Assamese
☐ other _____________

10. What language(s) does/do your father speak **with you**?

☐ Bodo
☐ Assamese
☐ other _____________

11. Indicate other languages you speak in addition to Bodo and Assamese and your proficiency in each.

a) ______ ☐ excellent ☐ good ☐ ok ☐ weak ☐ very poor
b) ______ ☐ excellent ☐ good ☐ ok ☐ weak ☐ very poor
c) ______ ☐ excellent ☐ good ☐ ok ☐ weak ☐ very poor

12. Educational Background (check **all** that apply):

a) Elementary school: ☐ in Bodo ☐ in Assamese ☐ other _________
b) Middle school: ☐ in Bodo ☐ in Assamese ☐ other _________
c) High school: ☐ in Bodo ☐ in Assamese ☐ other ________
d) College: ☐ in Bodo ☐ in Assamese ☐ other ________
e) Graduate school: ☐ in Bodo ☐ in Assamese ☐ other ________

13. Rate your language use with the following people:

a) At home to your parents

- [ ] always Bodo
- [ ] Bodo more than Assamese
- [ ] Bodo and Assamese equally
- [ ] Assamese more than Bodo
- [ ] always Assamese
- [ ] does not apply

b) At home with your brothers or sisters

- [ ] always Bodo
- [ ] Bodo more than Assamese
- [ ] Bodo and Assamese equally
- [ ] Assamese more than Bodo
- [ ] always Assamese
- [ ] does not apply

c) With your friends

- [ ] always Bodo
- [ ] Bodo more than Assamese
- [ ] Bodo and Assamese equally
- [ ] Assamese more than Bodo
- [ ] always Assamese
- [ ] does not apply

d) with your co-workers

- [ ] always Bodo
- [ ] Bodo more than Assamese
- [ ] Bodo and Assamese equally
- [ ] Assamese more than Bodo
- [ ] always Assamese
- [ ] does not apply

14. Rate the language use of the following people when speaking to you:

a) your parents

- [ ] always Bodo
- [ ] Bodo more than Assamese
- [ ] Bodo and Assamese equally
- [ ] Assamese more than Bodo
- [ ] always Assamese
- [ ] does not apply

b) your brothers or sisters

- [ ] always Bodo
- [ ] Bodo more than Assamese
- [ ] Bodo and Assamese equally
- [ ] Assamese more than Bodo
- [ ] always Assamese
- [ ] does not apply

c) your friends

- [ ] always Bodo
- [ ] Bodo more than Assamese
- [ ] Bodo and Assamese equally
- [ ] Assamese more than Bodo
- [ ] always Assamese
- [ ] does not apply

d) your co-workers

- [ ] always Bodo
- [ ] Bodo more than Assamese
- [ ] Bodo and Assamese equally
- [ ] Assamese more than Bodo
- [ ] always Assamese
- [ ] does not apply

15. Rate the relative frequency with which you do the following in Bodo and Assamese:

a) read

- ☐ always Bodo
- ☐ Bodo more than Assamese
- ☐ Bodo and Assamese equally
- ☐ Assamese more than Bodo
- ☐ always Assamese
- ☐ does not apply

b) write

- ☐ always Bodo
- ☐ Bodo more than Assamese
- ☐ Bodo and Assamese equally
- ☐ Assamese more than Bodo
- ☐ always Assamese
- ☐ does not apply

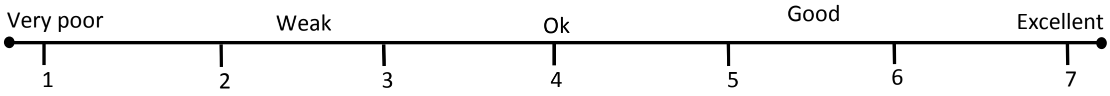
c) speak

- ☐ always Bodo
- ☐ Bodo more than Assamese
- ☐ Bodo and Assamese equally
- ☐ Assamese more than Bodo
- ☐ always Assamese
- ☐ does not apply

d) hear (TV, radio, teachers, parents, etc)

- ☐ always Bodo
- ☐ Bodo more than Assamese
- ☐ Bodo and Assamese equally
- ☐ Assamese more than Bodo
- ☐ always Assamese
- ☐ does not apply

16. Rate your abilities in the following languages according to the 7 point scale given below:



a) Rate your abilities in **Bodo** for the following categories:

i) **speaking**	1	2	3	4	5	6	7
ii) **reading**	1	2	3	4	5	6	7
iii) **writing**	1	2	3	4	5	6	7
iv) **comprehension**	1	2	3	4	5	6	7

b) Rate your abilities in **Assamese** for the following categories:

i) **speaking**	1	2	3	4	5	6	7
ii) **reading**	1	2	3	4	5	6	7
iii) **writing**	1	2	3	4	5	6	7
iv) **comprehension**	1	2	3	4	5	6	7

17. How many hours a week do you do the following activities in Bodo and Assamese:

a) speak: _____ Bodo _____ Assamese

b) read: _____ Bodo _____ Assamese

c) write: _____ Bodo _____ Assamese

d) listen: _____ Bodo _____ Assamese

18. Could you pass off as a monolingual speaker when talking with someone who doesn't know you?

In Bodo:

- ☐ always
- ☐ almost always
- ☐ sometimes
- ☐ almost never
- ☐ never

In Assamese:

- ☐ always
- ☐ almost always
- ☐ sometimes
- ☐ almost never
- ☐ never

19. Which language do you feel most comfortable speaking?

☐ Bodo ☐ Assamese ☐ other __________

20. Which language do you use to do simple arithmetic (counting, adding, etc)?

☐ Bodo ☐ Assamese ☐ other __________

21. Do you use Assamese while speaking Bodo?

- ☐ always
- ☐ almost always
- ☐ sometimes
- ☐ almost never
- ☐ never

22. Do you use Bodo while speaking Assamese?

- ☐ always
- ☐ almost always
- ☐ sometimes
- ☐ almost never
- ☐ never

23. Which language do you use the most except Bodo? ________________________

24. Do you have any other comments on your language use/background that you think are important, but which you were not asked about in the questionnaire?

25. Contact Details:

Present/ Address (include phone number/email id if possible):

Permanent Address:

APPENDIX C (ii)

Language Background Questionnaire in Bodo (रावनि सोमोन्दै सोंलुफोर).

अक्ट': ____________

1. मुं: ____

2. थावनि: ____

3. बैसो: ____________

4. आथोन: ☐ हौवा ☐ हिनजाव

5. मा बैसोआव नोंथाङा गिबियै बर' राव रोंदोंमोन? ___________

6. मा बैसोआव नोंथाङा गिबियै असमीया राव रोंदोंमोन? ___________

7. बबेयाव नोंथाङा गिबियै बर' राव सोलोंदोंमोन? ☐ नआव ☐ फरायसालियाव

8. बबेयाव नोंथाङा गिबियै असमीया राव सोलोंदोंमोन ☐ नआव ☐ फरायसालियाव

9. आइआ नोंथांजों मा राव (फोर) जों नआव रायज्लायो?

☐ बर'

☐ असमीया

☐ गुबुन गुबुन _____________

10. आफाया नोंथांजों मा राव (फोर) जों नआव रायज्लायो?

☐ बर'

☐ असमीया

☐ गुबुन गुबुन _____________

11. बर'' आरो असमीया रावफोरनि अनगायै गुबुन रावफोर रोंबावोब्ला नोंथांनि हारोंथाइखौ दिन्थि

a) ____ ☐ मोजांथार ☐ मोजां ☐ जासाबो ☐ लोरबां ☐ जोबोद लोरबां

b) ____ ☐ मोजांथार ☐ मोजां ☐ जासाबो ☐ लोरबां ☐ जोबोद लोरबां

c) ____ ☐ मोजांथार ☐ मोजां ☐ जासाबो ☐ लोरबां ☐ जोबोद लोरबां

12. सोलोंथाइयारि फारिलाइ (बाहायजाथावफोरखौ सायख):

a) गुदि फरायसालि:	☐ बर’आव	☐ असमीयायाव	☐ गुबुन ______
b) गेजेर फरायसालि:	☐ बर’आव	☐ असमीयायाव	☐ गुबुन _____
c) गोजौ फरायसालि:	☐ बर’आव	☐ असमीयायाव	☐ गुबुन ______
d) फरायसालिमा:	☐ बर’आव	☐ असमीयायाव	☐ गुबुन ______
e) आरिमु जालिया फरायसालि:	☐ बर’आव	☐ असमीयायाव	☐ गुबुन ______

13. गाहायनि सुबुंफोरजों नोंथांनि राव बाहायनायखौ फोरमाय:

a) न’आव नोंथांनि बिमा बिफाजों

- ☐ जेब्लाबो बर’
- ☐ असमीयानिख्रुय बर’ बांसिन
- ☐ बर’निख्रुय असमीया बांसिन
- ☐ बर’ आरो असमीया समानै
- ☐ जेब्लायबो असमीया
- ☐ बाहायजाया

b) न'आव नांथांनि बिदा फंबाय आरो बिब बिनानावजों

- ☐ जेब्लाबो बर’
- ☐ असमीयानिख्रुय बर’ बांसिन
- ☐ बर’निख्रुय असमीया बांसिन
- ☐ बर’ आरो असमीया समानै
- ☐ जेब्लायबो असमीया
- ☐ बाहायजाया

c) नोंथांनि लोगोफोरजों

- [ ] जेब्लाबो बर'
- [ ] असमीयानिख्रुय बर' बांसिन
- [ ] बर'निख्रुय असमीया बांसिन
- [ ] बर' आरो असमीया समानै
- [ ] जेब्लायबो असमीया
- [ ] बाहायजाया

d) नोंथांजों खामानि मावफाग्राफोरजों

- [ ] जेब्लाबो बर'
- [ ] असमीयानिख्रुय बर' बांसिन
- [ ] बर'निख्रुय असमीया बांसिन
- [ ] बर' आरो असमीया समानै
- [ ] जेब्लायबो असमीया
- [ ] बाहायजाया

14. गाहायनि सुबुंफोरा नोंथांजों राव बाहायनायखौ बुंफोर हो:

a) नोंथांनि बिमा बिफाजों

- [ ] जेब्लाबो बर'
- [ ] असमीयानिख्रुय बर' बांसिन
- [ ] बर'निख्रुय असमीया बांसिन
- [ ] बर' आरो असमीया समानै
- [ ] जेब्लायबो असमीया
- [ ] बाहायजाया

b) नोंथांनि बिदा फंबाय आरो बिब बिनानावजों

- [ ] जेब्लाबो बर'
- [ ] असमीयानिखुय बर' बांसिन
- [ ] बर'निखुय असमीया बांसिन
- [ ] बर' आरो असमीया समानै
- [ ] जेब्लायबो असमीया
- [ ] बाहायजाया

c) नोंथांनि लोगोफोरजों

- [ ] जेब्लाबो बर'
- [ ] असमीयानिखुय बर' बांसिन
- [ ] बर'निखुय असमीया बांसिन
- [ ] बर' आरो असमीया समानै
- [ ] जेब्लायबो असमीया
- [ ] बाहायजाया

d) नोंनि लेङाइ लोगो

- [ ] जेब्लाबो बर'
- [ ] असमीयानिखुय बर' बांसिन
- [ ] बर'निखुय असमीया बांसिन
- [ ] बर' आरो असमीया समानै
- [ ] जेब्लायबो असमीया
- [ ] बाहायजाया

15. बर’ आरो असमीयाखौ नोंथांङा मा बेलायाव बांसिन बाहायो बेसेन हो:

a) फरायनाय

- [ ] जेब्लाबो बर’
- [ ] असमीयानिख्रुय बर’ बांसिन
- [ ] बर’निख्रुय असमीया बांसिन
- [ ] बर’ आरो असमीया समानै
- [ ] जेब्लायबो असमीया
- [ ] बाहायजाया

b) लिरनाय

- [ ] जेब्लाबो बर’
- [ ] असमीयानिख्रुय बर’ बांसिन
- [ ] बर’निख्रुय असमीया बांसिन
- [ ] बर’ आरो असमीया समानै
- [ ] जेब्लायबो असमीया
- [ ] बाहायजाया

c) बुंनाय

- [ ] जेब्लाबो बर’
- [ ] असमीयानिख्रुय बर’ बांसिन
- [ ] बर’निख्रुय असमीया बांसिन
- [ ] बर’ आरो असमीया समानै
- [ ] जेब्लायबो असमीया
- [ ] बाहायजाया

d) खोनासंनाय (टि.भि., रेडिअ, फोरोंगिरि, बिमा बिफा बायदि बायदि)

- ☐ जेब्लाबो बर'
- ☐ असमीयानिख्रुय बर' बांसिन
- ☐ बर'निख्रुय असमीया बांसिन
- ☐ बर' आरो असमीया समानै
- ☐ जेब्लायबो असमीया
- ☐ बाहायजाया

16. नोंथांनि रावफोरनि हारोंथाइखौ गाहायाव होनाय मोनस्नि जखाजों सु:.........................

जोबोद लोरबां		लोरबां	जागोन	मोजां	जोबोद मोजां	
1	2	3	4	5	6	7

a) **बर'आव** नोंथांनि हारोंथाइखौ गाहायनि थाखोफोराव बेसेन हो:

i) **बुंनाय**	1	2	3	4	5	6	7
ii) **फरायनाय**	1	2	3	4	5	6	7
iii) **लिरनाय**	1	2	3	4	5	6	7
iv) **बेखेवनाय**	1	2	3	4	5	6	7

b) **असमीयाआव** नोंथांनि हारोंथाइखौ गाहायनि थाखोफोराव बेसेन हो:

i) **बुंनाय**	1	2	3	4	5	6	7
ii) **फरायनाय**	1	2	3	4	5	6	7
iii) **लिरनाय**	1	2	3	4	5	6	7
iv) **बेखेवनाय**	1	2	3	4	5	6	7

17. बर' आरो असमीया रावआव नोंथांङा सानसेयाव बेसेबां घन्टा सम बाहायो:

a) बुंनाय: _____ बर' _____ असमीया

b) फरायनाय: _____ बर' _____ असमीया

c) लिरनाय: _____ बर' _____ असमीया

d) खोनासंनाय: _____ बर' _____ असमीया

18. नोंथांखौ मिथियै सासे सुबुङा नोंथांजों रायज्लायोब्ला नोंथांङा गावखौनो मोनसे रावारि सुबुं होनना सिनायथि होनो नाजायोनामा?

बर'आव:

☐ सानफ्रोमबो

☐ सानफ्रोमबोफ्राम

☐ माब्लाबा

☐ बाहायबांथ्रा

☐ बाहायथारा

असमीयाआव:

☐ सानफ्रोमबो

☐ सानफ्रोमबोफ्राम

☐ माब्लाबा

☐ बाहायबांथ्रा

☐ बाहायथारा

19. नोंथांङा मा रावजों रायज्लायनो साबसिन मोनो?

☐ बर'   ☐ असमीया   ☐ गुबुन गुबुन __________

20. नोंथाङा गोरलै सानखान्थि बानायनो मा राव बाहायो (साननाय, दाजाब, दानख' बायदि बायदि)??

☐ बर'   ☐ असमीया   ☐ गुबुन गुबुन __________

21. बर' बुंनाय समाव नोंथाङा असमीया बाहायोनामा?

☐ सानफ्रोमबो

☐ सानफ्रोमबोफ्राम

☐ माब्लाबा

☐ बाहायबांश्रा

☐ बाहायथारा

22. असमीया बुंनाय समाव नोंथाङा बर' बाहायोनामा?

☐ सानफ्रोमबो

☐ सानफ्रोमबोफ्राम

☐ माब्लाबा

☐ बाहायबांश्रा

☐ बाहायथारा

23. बर' रावनि अनगा नोंथाङा मा रावखऔ बांसिन बाहायो?______________________

24. नोंथाङ गावनि राव बाहायनायनि सोमोन्दै माबाफोर बिबुंथि होगोन नामा/ जायफोरखौ नोंथाङ गोनां होननाा सानो/जायफोर सोंलुवा बेयाव होजायाखै?

25. नोंथांनि आबुं थं:

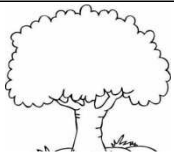
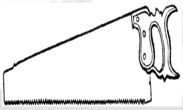
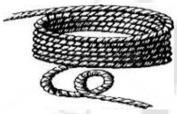
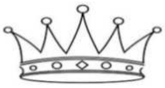
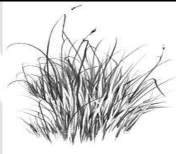
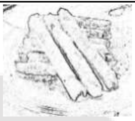
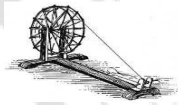
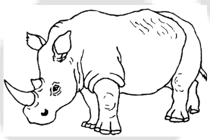
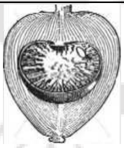
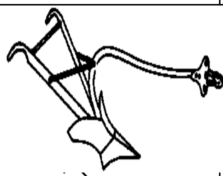
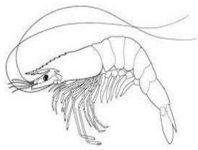
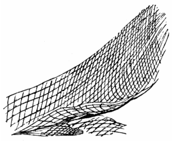
आथिखालनि थं (फन नं एबा इमेइल आइ डि दंब्ला हो):

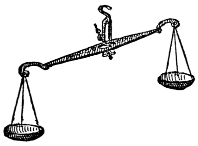
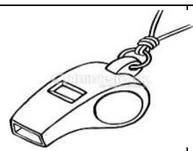
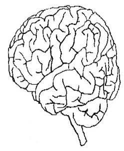
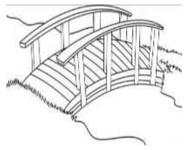
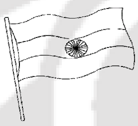
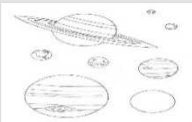
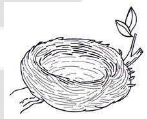
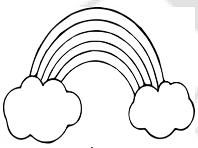
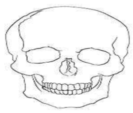
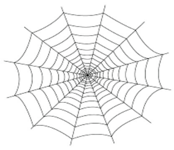
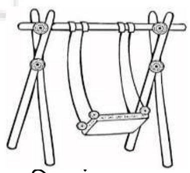
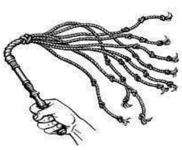
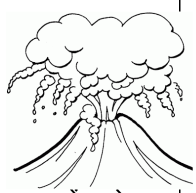
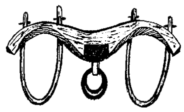
गागि थं:

APPENDIX D.

Pictures Used in Objective Naming Test

(Pictures are not to scale, for ease of presentation here.)

 एम/বিছনা [em/bisona] *‘bed’*	 बिफां/গছ [biphang/gos] *‘tree’*	 पेन्सिल/পেঞ্চিল [pensil/pensil] *‘pencil’*	 न’/ঘৰ [no/ghor] *‘house’*	 खेमसि/কেঁচি [khemsi/kesi] *‘scissor’*
 खानजुं/ফণি [khanzung/phoni] *‘comb’*	 बिबार/ফুল [bibar/phul] *‘flower’*	 करत/কৰত [korot/korot] *‘saw’*	 खानाइ/চুলি [khanai/suli] *‘hair’*	 जौ/মদ [zwu/mod] *‘alcohol’*
 दिरु/ৰছী [diru/rosi] ‘rope’	 मुकुट/মুকুট [mukut/mukut] ‘crown’	 गांसो/ঘাঁহ [gangsw/ghah] *‘grass’*	 फिथा/পিঠা [phitha/pitha] *‘pancake’*	 जेनथेर/যঁতৰ [zenther/zotor] *‘spinning wheel’*
 रां/টকা [rang/toka] *‘money’*	 गान्दा/গঁড় [ganda/gor] *‘rhinoceros’*	 गनथं/নাক [gonthong/nak] *‘nose’*	 सामु/শামুক [samu/xamuk] *‘snail’*	 रोदा/শিপা [rwda/xipa] *‘root’*
 खामफ्लाइ/পিৰা [khamphlai/pira] *‘stool’*	 गइ/তামোল [goi/tamul] *‘betel nut’*	 हासिब/ঝাড়ু [hasib/jharu] *‘broom’*	 बाथुल/গুল্টি [bathul/gulti] *‘catapult’*	 पदुम/পদুম [podum/podum] *‘lotus’*
 खनथा/কোৰ [khontha/kur] *‘hoe’*	 नांगोल/নাঙল [nangol/nangol] *‘plough’*	 नाथुर/মিছা মাছ [nathur/misa mas] *‘prawn’*	 जे/জাল [ze/zal] *‘net’*	 बोरला/धनु [bwrla/dhonu] *‘bow’*

 मुखा/মুখা [mukha/mukha] *‘mask’*	 फारला/পাল্লা [pharla/palla] *‘balance’*	 सु/কাঁইট [su/kait] *‘thorn’*	 हुसेल/সুহুৰি [husel/xuhuri] *‘whistle’*	 साथि/চাকি [sathi/saki] *‘lamp’*
 लाइजाम/চিঠি [laizam/sithi] *‘letter’*	 लावाथ/লাঠি [lauthi/lathi] *‘stick’*	 खुसेर/কুঁহিয়াৰ [khuser/kuhiyar] *‘sugarcane’*	 मलम/মগজ [melem/mogoz] *‘brain’*	 दालां/দলং [dalang/dolong] *‘bridge’*
 दाउगां/পাখি [daugang/pakhi] *‘feather’*	 फिरफिला/পতাকা [phirphali/potaka] *‘flag’*	 आसि/আঙুলী [asi/anguli] *‘finger’*	 खुनदुं/সূতা [khundung/xuta] *‘thread’*	 बादाम/বাদাম [badam/badam] *‘peanut’*
 मैखुन/কাঠফুলা [mwikhun/kathphula] *‘mushroom’*	 गामब्ला/গামলা [gambla/gamla] *‘tub’*	 ग्रह/গ্ৰহ [groho/groho] *‘planet’*	 दावबासा/বাহ [daubasa/bah] *‘nest’*	 मानसावगारि/মান চিত্ৰ [mansaugiri/ mansitro] *‘map’*
 जाइख्लं/ৰামধেনু [zaikhlong/ramdhenu] *‘rainbow’*	 लाउख'ला/লাওখোলা [laukhola/laukhula] *‘skull’*	 बेमाजे/মকৰা জাল [bemaze/mokora zal] *‘web’*	 हांथा/টোপা [hangtha/tupa] *‘hook’*	 दिनदां/ঝুলনা [dindang/jhulna] *‘swing’*
 साबुक/চাবুক [sabuk/sabuk] *‘knout’*	 हासुं/চুপি [hasung/supi] *‘funnel’*	 दौलें/চিপজৰী [dwuleng/sipzori] *‘noose’*	 अरगेंहाजो/ আগ্নেয়গিৰি [orgenghazw/ agneogiri] *‘volcano’*	 जुंगाल/যুঁৱলি [zungal/zuwoli] *‘yoke’*

APPENDIX E (i)

Norming Experiment for Translation Equivalency Ratings.

The aim of this experiment was to achieve different language versions of the stimuli and to achieve this we used a well-established method of forward-translation and backward-translation. In order to ensure translation equivalency for each Bodo–Assamese word pair, five high proficient Bodo–Assamese bilinguals (from the same population as the participants in the experiments) were asked to translate a list of 200 items from Bodo to Assamese (L1–L2) as a first step. Participants were instructed to consider the definition of the original term and attempt to translate it in the most relevant way. They were also asked to give the conceptual equivalent of a word, not a word-for-word translation, i.e. not a literal translation. Using the same approach as that outlined in the first step, another group of five high proficient bilinguals who had no knowledge of the stimuli was asked to translate the same items in the opposite direction, i.e., Assamese to Bodo (L2–L1). As in the initial translation, emphasis in the back-translation was on conceptual and cultural equivalence and not linguistic equivalence.

Only those words that maintained translation consistency in both directions of translation by all of the participants were considered for this study. The criterion for selection was based on Bodo−Assamese bilinguals' familiarity with both of the category norms and vocabulary in two languages, plus the translation consistency among these bilingual participants. In total, hundred fifty cross-language word pairs met this criterion and therefore, selected as critical items in the experiments, namely, *Translation priming* (Experiment 1A, 1B, 1C, and 1D), *Semantic Categorization* (Experiment 5A and 5B), *Translation Recognition* (Experiment 6A and 6B) and *Word Translation* (Experiment 8A and 8B). Half of these word-pairs were cognates and the other half were non-cognates. The critical items belonged to eleven different semantic categories (animals, birds, insects, fish, fruits, vegetables, body parts, kinship, unit of time).

APPENDIX E (ii)

Norming Experiment for Semantic Similarity Ratings.

The goal of this experiment was to determine the semantic similarity between Bodo and Assamese words. The word trials for this study consisted of the list of item selected from the translation equivalency ratings. Ten high proficient Bodo−Assamese bilinguals from Bathoupuri participated in this task. Each individual had a rating sheet to indicate the range of similarity between words. Thereafter, a Latent Semantic Analysis (LSA) (Landauer & Dumais, 1997) was used to confirm semantic relatedness between primes and target word. We obtained pairwise comparison values for primes and targets. All semantically related word pairs had a minimum correlation value of 0.10 (M = 0.422, SD = 0.193).

APPENDIX E (iii)

Norming Experiments for Associative Relatedness Ratings.

The word trials for the associative norming study came from the set of target words developed for translation priming and semantic priming experiments. Half of these words were cognates and the other half were non-cognates. In order to determine the associative strength of the words, five Bodo−Assamese bilinguals were asked to give the first Assamese word that comes to mind upon hearing the stimulus word in Bodo. On the other hand, other five Bodo−Assamese bilinguals were asked to do the same in the opposite direction. For example, on hearing the Bodo word खानाइ [khanai] ‘*hair*’ from the list of words, participants had answered खानजुं [khanjung] ‘*comb*’ or ফণি [phoni] ‘*comb*’ on hearing the Assamese word চুলি [suli] ‘*hair*’. A set of hundred fifty words with the most frequent associates were selected from the list of words. Association was determined by selecting context words that elicited the name of the target word during free association. Prime words were at least the third most common associate of the target word, with a mean association value of 0.12.

APPENDIX E (iv)

Norming Experiments for Phonological Similarity and Phonological Translation Similarity Ratings.

The phonological relatedness between Bodo and Assamese words was also assessed in a norming study. The construction of the experimental materials for this experiment was done in various stages. First, the stimuli consisting of 150 cross-language word pairs developed for the translation equivalency norming study were chosen. These 150 words consisted of two word types: 50 cognate words and fifty non-cognate words. Thereafter, phonologically similar words were chosen for each words. Phonological relatedness of each word was operationalised as onset plus rhyme when possible. To illustrate, for the Assamese word আই [ai] '*mother*', words like माइ [mai], दाय [dai], लाइ [lai] were selected.

The materials were then arranged as pairs of items and subjected to a group of 10 bilinguals from Bathoupuri who were Bodo−Assamese bilinguals and did not participate in the previous experiments. The participants rated all of the pairs on a 7-point scale, where 1 was ''not at all similar'' and 7 was the ''very similar''. Items with a rating of 1 were eliminated. Thus, only those pairs that were judged to be highly phonologically similar were included in the final pool of possible. Pairs that were rated on average 4 or higher were used. The mean rating for each word pair was calculated and analyzed by condition. As expected, Bodo−Assamese bilinguals perceived the phonological similarity of cognates to be greater than non-cognates for the Bodo pairs. These phonologically related pairs were also used for the experiments utilizing phonological translation pairs in which a word in a pair was phonologically related to the second item of the pair, i.e., the translation equivalent. For example, for the Bodo word आखाइ [akhai] *'hand'*, the phonological translation equivalent is the word পাত [pat] *'leaf'*, which sounds like the translation equivalent in Assamese হাত [hat] *'hand'*.

APPENDIX F.

Word Targets and Corresponding Primes Used in Translation Priming Experiments of Pilot Study.

Target			Translation Prime		Control Prime		
Assamese	Bodo	Meaning	Bodo	Assamese	Bodo	Assamese	Meaning
আম [am]	थायजौ [thaizwu]	*'mango'*	थायजौ [thaizwu]	আম [am]	बार [bar]	বতাহ [botah]	*'wind'*
আনাৰস [anarox]	रायमालि [raimali]	*'pineapple'*	रायमालि [raimali]	আনাৰস [anarox]	सिफुं [siphung]	বাঁহি [bahi]	*'flute'*
মধুৰি [modhuri]	सेंफ्रेम [sengfrem]	*'guava'*	सेंफ्रेम [sengfrem]	মধুৰি [modhuri]	मोदोम [mwdwm]	শৰীৰ [xorir]	*'body'*
কল [kol]	थालिर [thalir]	*'banana'*	थालिर [thalir]	কল [kol]	दाव [dau]	চৰাই [sorai]	*'bird'*
পখিলা [pokhila]	सिखिरि [sikhiri]	*'butterfly'*	सिखिरि [sikhiri]	পখিলা [pokhila]	दैखर [dwikhor]	কুঁৱা [kuwa]	*'well'*
অমিতা [omita]	मोदोम फुल [mwdwm phul]	*'papaya'*	मोदोम फुल [mwdwm phul]	অমিতা [omita]	थै [thwi]	তেজ [tez]	*'blood'*
জলকীয়া [zolokia]	बानलु [banlu]	*'chilli'*	बानलु [banlu]	জলকীয়া [zolokia]	दै [dwi]	পানী [pani]	*'water'*
বেঙেনা [bengena]	फान्थाव [phanthau]	*'aubergine'*	फान्थाव [phanthau]	বেঙেনা [bengena]	एमफौ [emphwu]	পোক [puk]	*'insect'*
ৰঙালাও [rongalau]	जोगोनार [zwgwnar]	*'pumpkin'*	जोगोनार [zwgwnar]	ৰঙালাও [rongalau]	अखा [okha]	বৰষুণ [boroxun]	*'rain'*
আদা [ada]	हायजें [haizeng]	*'ginger'*	हायजें [haizeng]	আদা [ada]	थिमा [thima]	ওকণি [ukoni]	*'louse'*
কচু [kosu]	मानथास' [manthaso]	*'arum'*	मानथास' [manthaso]	কচু [kosu]	हौवासा [hwuasa]	ল'ৰা [lora]	*'boy'*
কুকুৰ [kukur]	सैमा [swima]	*'dog'*	सैमा [swima]	কুকুৰ [kukur]	खानजुं [khanzung]	ফণী [phoni]	*'comb'*
মেকুৰী [mekuri]	मावजि [mauzi]	*'cat'*	मावजि [mauzi]	মেকুৰী [mekuri]	रुवा [ruwa]	কুঠাৰ [kuthar]	*'axe'*
ছাগলী [sagoli]	बोरमा [bwrma]	*'goat'*	बोरमा [bwrma]	ছাগলী [sagoli]	सि [si]	কাপোৰ [kapur]	*'cloth'*
গ'ৰু [goru]	मोसौ [mwswu]	*'cow'*	मोसौ [mwswu]	গ'ৰু [goru]	मासि [masi]	চকী [soki]	*'chair'*
বান্দৰ [bandor]	मोख्रा [mwkhra]	*'monkey'*	मोख्रा [mwkhra]	বান্দৰ [bandor]	दिरु [diru]	ৰছী [rosi]	*'rope'*

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Target			Translation Prime		Control Prime		
Assamese	Bodo	Meaning	Bodo	Assamese	Bodo	Assamese	Meaning
হৰিণ [horin]	मै [mwi]	*‘deer’*	मै [mwi]	হৰিণ [horin]	बिगुर [bigur]	ছাল [sal]	*‘skin’*
বাঘ [bagh]	मोसा [mwsa]	*‘tiger’*	मोसा [mwsa]	বাঘ [bagh]	हाथरखि [hathorkhi]	তৰা [tora]	*‘star’*
সাপ [xap]	जिबौ [zibwu]	*‘snake’*	जिबौ [zibwu]	সাপ [xap]	गइ [goi]	তামোল [tamul]	*‘betel nut’*
ঘঁৰিয়াল [ghoriyal]	गोलेर [gwler]	*‘crocodile’*	गोलेर [gwler]	ঘঁৰিয়াল [ghoriyal]	दैहु [dwihu]	কলহ [koloh]	*‘pitcher’*
গাহৰি [gahori]	अमा [oma]	*‘pig’*	अमा [oma]	গাহৰি [gahori]	हा [ha]	মাটি [mati]	*‘soil’*
ভেকুলী [bhekuli]	एम्बु [embu]	*‘frog’*	एम्बु [embu]	ভেকুলী [bhekuli]	दनदर [dondor]	গুহা [guha]	*‘cave’*
কাছ [kaso]	खासेव [khaseu]	*‘tortoise’*	खासेव [khaseu]	কাছ [kaso]	बिफां [biphang]	গছ [gos]	*‘tree’*
ভালুক [bhaluk]	मुफुर [muphur]	*‘bear’*	मुफुर [mufur]	ভালুক [bhaluk]	संख्रि [songkhri]	নিমখ [nimokh]	*‘salt’*
কেঁকোৰা [kekura]	खांख्राय [khangkhrai]	*‘crab’*	खांख्राय [khangkhrai]	কেঁকোৰা [kekura]	बिबार [bibar]	ফুল [phul]	*‘flower’*
হাতী [hati]	मैदेर [mwider]	*‘elephant’*	मैदेर [mwider]	হাতী [hati]	सामब्राम [sambram]	পিঁয়াজ [piyaz]	*‘onion’*
ম’হ [moh]	थाम्फै [thamphwi]	*‘mosquito’*	थाम्फै [thamphwi]	ম’হ [moh]	थोरसि [thwrsi]	কাঁহি [kahi]	*‘plate’*
পৰুৱা [poruwa]	मोस्रोम [mwsrwm]	*‘ant’*	मोस्रोम [mwsrwm]	পৰুৱা [poruwa]	सामब्राम गुफुर [sambram gufur]	নহৰু [nohoru]	*‘garlic’*
কেঁচু [kesuwa]	खानस्रि [khansri]	*‘earthworm’*	खानस्रि [khansri]	কেঁচু [kesu]	गोखै फानथाव [gwkhwi phanthau]	বিলাহী [bilahi]	*‘tomato’*
কাউৰী [kauri]	दावखा [daukha]	*‘crow’*	दावखा [daukha]	কাউৰী [kauri]	खुन [khun]	কপাহ [kopah]	*‘cotton’*
চকু [soku]	मेगन [megon]	*‘eye’*	मेगन [megon]	চকু [soku]	बोरमा मेनदा [bwrma menda]	ভেৰা [bhera]	*‘sheep’*
কাণ [kan]	खोमा [khwma]	*‘ear’*	खोमा [khwma]	কাণ [kan]	थामफै [thamphwi]	মাখি [makhi]	*‘fly’*
নাক [nak]	गन्थं [gonthong]	*‘nose’*	गन्थं [gonthong]	নাক [nak]	दावखा [daukha]	কাউৰী [kauri]	*‘crow’*

Target			Translation Prime		Control Prime		
Assamese	Bodo	Meaning	Bodo	Assamese	Bodo	Assamese	Meaning
হাত [hat]	आखाय [akhai]	*‘hand’*	आखाय [akhai]	হাত [hat]	मोसा [mwsa]	বাঘ [bagh]	*‘tiger’*
ভৰি [bhori]	आथिं [athing]	*‘leg’*	आथिं [athing]	ভৰি [bhori]	थिक-थिका [thikthika]	জেঠি [zethi]	*‘lizard’*
ওঁঠ [uth]	गुसुथि [gusuthi]	*‘lip’*	गुसुथि [gusuthi]	ওঁঠ [uth]	थायसुम [thaisum]	তিঁয়হ [tiyoh]	*‘cucumber’*
দাঁত [dat]	हाथाय [hathai]	*‘teeth’*	हाथाय [hathai]	দাঁত [dat]	जोमै [zwmwi]	ডাৱৰ [dawor]	*‘cloud’*
মূৰ [mur]	खर’ [khoro]	*‘head’*	खर’ [khoro]	মূৰ [mur]	हाजो [hazw]	পাহাৰ [pahar]	*‘mountain’*
নখ [nokh]	आसुगुर [asugur]	*‘nail’*	आसुगुर [asugur]	নখ [nokh]	अख्रां [okhrang]	আকাশ [akax]	*‘sky’*
মুখ [mukh]	खुगा [khuga]	*‘mouth’*	खुगा [khuga]	মুখ [mukh]	दैमा [dwima]	নদী [nodi]	*‘river’*
জিভা [zibha]	सालाय [salai]	*‘tongue’*	सालाय [salai]	জিভা [zibha]	दावदै [daudwi]	কণী [koni]	*‘egg’*
চুলি [suli]	खानाय [khanai]	*‘hair’*	खानाय [khanai]	চুলি [suli]	खांख्राय [khangkhrai]	কেকোঁৰা [kekura]	*‘crab*
ডিঙি [dingi]	गोदोना [gwdwna]	*‘neck’*	गोदोना [gwdwna]	ডিঙি [dingi]	गिसिब [gisib]	বিছনী [bisoni]	*‘fan’*
বুকু [buku]	बिखा [bikha]	*‘chest’*	बिखा [bikha]	বুকু [buku]	बिलाइ बायदि [bilai baidi]	শাক [xak]	*‘leafy vegetables’*
স্তন [ston]	आबु [abu]	*‘breast’*	आबु [abu]	স্তন [ston]	फिथाइ [phithai]	ফল [phol]	*‘fruit’*
কান্ধ [kandho]	फाफ्लि [phaphli]	*‘shoulder’*	फाफ्लि [phaphli]	কান্ধ [kandho]	ना [na]	মাছ [mas]	*‘fish’*
পেত [pet]	उदै [udwi]	*‘stomach’*	उदै [udwi]	পেত [pet]	बिजाब [bizab]	কিতাপ [kitap]	*‘book’*
কঁকাল [kokal]	जान्जि [zanzi]	*‘waist’*	जान्जि [zanzi]	কঁকাল [kokal]	न’ [no]	ঘৰ [ghor]	*‘house’*
পিঠি [pithi]	बिखुं [bikhung]	*‘back’*	बिखुं [bikhung]	পিঠি [pithi]	ओंखाम [wngkham]	ভাত [bhat]	*‘rice’*
আঙুলি [anguli]	आसि [asi]	*‘finger’*	आसि [asi]	আঙুলি [anguli]	एन्जर [enzor]	নিগনি [nigoni]	*‘mouse’*

APPENDIX G.

Word Targets and Corresponding Primes Used in Translation Priming Experiments (1A, 1B, 1C, & 1D).

Cognate Targets

Target			Translation Prime		Control Prime		
Assamese	Bodo	Meaning	Bodo	Assamese	Bodo	Assamese	Meaning
বেৰা [bera]	बेरा [bera]	*‘fence’*	बेरा [bera]	বেৰা [bera]	थुनलाइ [thunlai]	সাহিত্য [xahityo]	*‘literature’*
টিভি [tibhi]	ति.भि. [tibhi]	*‘television’*	ति.भि. [tibhi]	টিভি [tibhi]	गइ [goi]	তামোল [tamul]	*‘betel nut’*
বেমাৰ [bemar]	बेराम [beram]	*‘disease’*	बेराम [beram]	বেমাৰ [bemar]	थाइजौ [thaizwu]	আম [am]	*‘mango’*
পুখুৰী [pukhuri]	फुख्रि [phukhri]	*‘pond’*	फुख्रि [phukhri]	পুখুৰী [pukhuri]	खावलाय [khaulai]	গাল [gal]	*‘cheek’*
হাঁহ [hah]	हांसो [hangsw]	*‘duck’*	हांसो [hangsw]	হাঁহ [hah]	दिरु [diru]	ৰছী [rosi]	*‘rope’*
দাড়ি [dari]	दारि [dari]	*‘beard’*	दारि [dari]	দাড়ি [dari]	जोमै [zwmwi]	ডাৱৰ [dawor]	*‘cloud’*
কপাল [kopal]	खाफाल [khaphal]	*‘forehead’*	खाफाल [khaphal]	কপাল [kopal]	जोगोनार [zwgwnar]	ৰঙালাও [rongalau]	*‘pumpkin’*
গাধ [gadho]	गाद’ [gado]	*‘donkey’*	गाद’ [gado]	গাধ [gadho]	सिफुं [siphung]	বাঁহী [bahi]	*‘flute’*
বতৰ [botor]	बोथोर [bwthwr]	*‘weather’*	बोथोर [bwthwr]	বতৰ [botor]	दैहु [dwihu]	কলহ [koloh]	*‘pitcher’*
ফেঁচা [phesa]	फेसा [phesa]	*‘owl’*	फेसा [phesa]	ফেঁচা [phesa]	रुवा [ruwa]	কুঠাৰ [kuthar]	*‘axe’*
চেকেণ্ড [sekend]	सेकेण्ड [sekend]	*‘second’*	सेकेण्ड [sekend]	চেকেণ্ড [sekend]	थै [thwi]	তেজ [tez]	*‘blood’*

Target			Translation Prime		Control Prime		
Assamese	Bodo	Meaning	Bodo	Assamese	Bodo	Assamese	Meaning
চাহ [sah]	साहा [saha]	*‘tea’*	साहा [saha]	চাহ [sah]	खांख्राय [khangkhrai]	কেকোঁৰা [kekura]	*‘crab’*
গীটাৰ [gitar]	गिटार [gitar]	*‘guitar’*	गिटार [gitar]	গীটাৰ [gitar]	बिबार [bibar]	ফুল [phul]	*‘flower’*
কলম [kolom]	खोलोम [khwlwm]	*‘pen’*	खोलोम [khwlwm]	কলম [kolom]	गोलेर [gwler]	ঘঁৰিয়াল [ghoriyal]	*‘crocodile’*
সিংহ [xingho]	सिंह [singho]	*‘lion’*	सिंह [singho]	সিংহ [xingho]	संख्रि [songkhri]	নিমখ [nimokh]	*‘salt’*
জুতা [zuta]	जुथा [zutha]	*‘shoe’*	जुथा [zutha]	জুতা [zuta]	गिसिब [gisib]	বিছনী [bisoni]	*‘fan’*
চিলিং [siling]	सिलिं [siling]	*‘ceiling’*	सिलिं [siling]	চিলিং [siling]	गुसुथि [gusuthi]	ওঁঠ [uth]	*‘lip’*
গজাল [gozal]	गाजोल [gazwl]	*‘nail’*	गाजोल [gazwl]	গজাল [gozal]	मोनाबिलि [mwnabili]	সন্ধিয়া [xondhiya]	*‘evening’*
গাজৰ [gazor]	गाजर [gazor]	*‘carrot’*	गाजर [gazor]	গাজৰ [gazor]	सखा [sokha]	ঘনচিৰিকা [ghonsirika]	*‘sparrow’*
আটা [ata]	आटा [ata]	*‘flour’*	आटा [ata]	আটা [ata]	अमा [oma]	গাহৰি [gahori]	*‘pig’*
গোলাপ [gulap]	गलाब [golab]	*‘rose’*	गलाब [golab]	গোলাপ [gulap]	मै [mwi]	হৰিণ [horin]	*‘deer’*
আঁঠু [athu]	हानथु [hanthu]	*‘knee’*	हानथु [hanthu]	আঁঠু [athu]	सेसा [sesa]	শহাপহু [xohapohu]	*‘rabbit’*
আঙুৰ [angur]	आंगुर [angur]	*‘grape’*	आंगुर [angur]	আঙুৰ [angur]	दाओबो [daobw]	বগলী [bogoli]	*‘crane’*
নাও [lau]	नाउ [nau]	*‘boat’*	नाउ [nau]	নাও [nau]	मोदोम [mwdwm]	শৰীৰ [xorir]	*‘body’*
সোণা [xuna]	सना [sona]	*‘gold’*	सना [sona]	সোণা [xuna]	आसुगुर	নখ [nokh]	*‘nail’*

Target			Translation Prime		Control Prime		
Assamese	Bodo	Meaning	Bodo	Assamese	Bodo	Assamese	Meaning
নিজৰা [nizora]	निजोरा [nizwra]	*'spring'*	निजोरा [nizwra]	নিজৰা [nizwra]	मानथास' [manthaso]	কচু [kosu]	*'arum'*
গাখীৰ [gakhir]	गाइखेर [gaikher]	*'milk'*	गाइखेर [gaikher]	গাখীৰ [gakhir]	गोदोना [gwdwna]	ডিঙি [dingi]	*'neck'*
চেনি [seni]	चिनि [sini]	*'sugar'*	चिनि [sini]	চেনি [seni]	सैमा [swima]	কুকুৰ [kukur]	*'dog'*
আলু [alu]	आलु [alu]	*'potato'*	आलु [alu]	আলু [alu]	आरसि [arsi]	আইনা [aina]	*'mirror'*
দৰ্জা [dorza]	दरजा [dorza]	*'door'*	दरजा [dorza]	দৰ্জা [dorza]	हायजें [haizeng]	আদা [ada]	*'ginger'*
মটৰ [motor]	मटर [motor]	*'pea'*	मटर [motor]	মটৰ [motor]	हौवासा [hwuasa]	ল'ৰা [lora]	*'boy'*
কমলা [komola]	खमला [khomla]	*'orange'*	खमला [khomla]	কমলা [komola]	खोमा [khwma]	কাণ [kan]	*'ear'*
ৰজা [roza]	राजा [raza]	*'king'*	राजा [raza]	ৰজা [roza]	थिमा [thima]	ওকণি [ukoni]	*'louse'*
মাখন [makhon]	माखन [makhon]	*'butter'*	माखन [makhon]	মাখন [makhon]	मोस्रोम [mwsrwm]	পৰুৱা [poruwa]	*'ant'*
পিঠা [pitha]	फिथा [phitha]	*'pancake'*	फिथा [phitha]	পিঠা [pitha]	सानजा [sanza]	পূব [pub]	*'east'*
আই [ai]	आइ [ai]	*'mother'*	आइ [ai]	আই [ai]	रायमालि [raimali]	আনাৰস [anarox]	*'pineapple'*
গিলাচ [gilas]	गिलाच [gilas]	*'glass'*	गिलाच [gilas]	গিলাচ [gilas]	सोनाब [swnab]	পশ্চিম possim]	*'west'*
নিয়ৰ [niyor]	निहिर [nihir]	*'dew'*	निहिर [nihir]	নিয়ৰ [niyor]	खानस्रि [khansri]	কেঁচু [kesu]	*'earthworm'*
বালি [balu]	बाला [bala]	*'sand'*	बाला [bala]	বালি [balu]	मोदोम फुल [mwdwm phul]	অমিতা [omita]	*'papaya'*
তুছক [tusok]	तसक [tosok]	*'mattress'*	तसक [tosok]	তুছক [tusok]	सेंफ्रेम [sengfrem]	মধুৰি [modhuri]	*'guava'*

Non-Cognate Targets

Target			Translation Prime		Control Prime		
Assamese	Bodo	Meaning	Bodo	Assamese	Bodo	Assamese	Meaning
মুৰ্গী [murgi]	दावजो [dauzw]	*‘hen’*	दावजो [dauzw]	মুগী [mugi]	खुरै [khurwi]	বাতি [bati]	*‘bowl’*
চুলি [suli]	खानाइ [khanai]	*‘hair’*	खानाइ [khanai]	চুলি [suli]	बैसो [bwisw]	বয়স [boyox]	*‘age’*
ঘৰ [ghor]	न’ [no]	*‘house’*	न’ [no]	ঘৰ [ghor]	मुफुर [muphur]	ভালুক [bhaluk]	*‘bear’*
মাছ [mas]	ना [na]	*‘fish’*	ना [na]	মাছ [mas]	फरायसा [phoraisa]	ছাত্র [satro]	*‘student’*
পেত [pet]	उदै [udwi]	*‘belly’*	उदै [udwi]	পেত [pet]	राव [rau]	ভাষা [bhaxa]	*‘language’*
হাত [hat]	आखाइ [akhai]	*‘hand’*	आखाइ [akhai]]	হাত [hat]	भेण्डि [bhendi]	ভেণ্ডি [bhendi]	*‘lady’s finger’*
ভাত [bhat]	ओंखाम [wngkham]	*‘rice’*	ओंखाम [wngkham]	ভাত [bhat]	बिगुर [bigur]	ছাল [sal]	*‘skin’*
কুঁৱা [kuwa]	दैखर [dwikhor]	*‘well’*	दैखर [dwikhor]	কুঁৱা [kuwa]	फानथाव [phanthau]	বেঙেনা [bengena]	*‘brinjal’*
সূৰ্য্য [xurjyo]	सान [san]	*‘sun’*	सान [san]	সূৰ্য্য [xurjyo]	लानजाइ [lanzai]	নেজ [nez]	*‘tail’*
ৰাতি [rati]	हर [hor]	*‘night’*	हर [hor]	ৰাতি [rati]	रोदा [rwda]	শিৰ [xir]	*‘nerve’*
বন্দুক [bonduk]	सिलाइ [silai]	*‘gun’*	सिलाइ [silai]	বন্দুক [bonduk]	गोलोमदै [gwlwmdwi]	ঘাম [gham]	*‘sweat’*
ভেকুলী [bhekuli]	एमबु [embu]	*‘frog’*	एमबु [embu]	ভেকুলী [bhekuli]	खुन [khun]	কপাহ [kopah]	*‘cotton’*
পাহাৰ [pahar]	हाजो [hazw]	*‘mountain’*	हाजो [hazw]	পাহাৰ [pahar]	सानखानथि [sankhanthi]	অঙ্ক [zontu]	*‘mathematics’*

Target			Translation Prime		Control Prime		
Assamese	Bodo	Meaning	Bodo	Assamese	Bodo	Assamese	Meaning
কাপোৰ [kapur]	सि [si]	*‘cloth’*	सि [si]	কাপোৰ [kapur]	गाराय [garai]	ঘাঁ [gha]	*‘wound’*
বটল [botol]	दिंग्रि [dingri]	*‘bottle’*	दिंग्रि [dingri]	বটল [botol]	सावगारि [saugiri]	ছবি [sobi]	*‘picture’*
ছাগলী [sagoli]	बोरमा [bwrma]	*‘goat’*	बोरमा [bwrma]	ছাগলী [sagoli]	खनथाय [khonthai]	কবিতা [kobita]	*‘poem’*
সূতা [xuta]	खुनदुं [khundung]	*‘thread’*	खुनदुं [khundung]	সূতা [xuta]	सामब्राम गुफुर [sambram gufur]	নহৰু [nohoru]	*‘garlic’*
বৰষুণ [boroxun]	अखा [okha]	*‘rain’*	अखा [okha]	বৰষুণ [boroxun]	बानलु [banlu]	জলকীয়া [zolokiya]	*‘chilli’*
বান্দৰ [bandor]	मोख्रा [mukhra]	*‘monkey’*	मोख्रा [mwkhra]	বান্দৰ [bandor]	गुदुं [gudung]	তাপ [tap]	*‘heat’*
চকী [soki]	मासि [masi]	*‘chair’*	मासि [masi]	চকী [soki]	गाब [gab]	ৰং [rong]	*‘colour’*
ফুল [phul]	बिबार [bibar]	*‘flower’*	बिबार [bibar]	ফুল [phul]	बिखुं [bikhung]	পিঠি [pithi]	*‘back’*
চৰাই [sorai]	दाव [dau]	*‘bird’*	दाव [dau]	চৰাই [sorai]	बेसर [besor]	সৰিয়হ [xoriyoh]	*‘mustard’*
মকৰা [mokora]	बेमा [bema]	*‘spider’*	बेमा [bema]	মকৰা [mokora]	बन [bon]	খৰি [khori]	*‘firewood’*
গ’ৰু [goru]	मोसौ [mwswu]	*‘cow’*	मोसौ [mwswu]	গ’ৰু [goru]	बोरला [bwrla]	ধনু [dhonu]	*‘bow’*
সাপ [xap]	जिबौ [zibwu]	*‘snake’*	जिबौ [zibwu]	সাপ [xap]	खदाल [khodal]	কোৰ [kur]	*‘spade’*
টকা [toka]	रां [rang]	*‘money’*	रां [rang]	টকা [toka]	मानसि [mansi]	মানুহ [manuh]	*‘human’*
বিদ্যালয় [bidyaloi]	फरायसालि [phoraisali]	*‘school’*	फरायसालि [phoraisali]	বিদ্যালয় [bidyaloi]	हा [ha]	মাটি [mati]	*‘soil’*

Target			Translation Prime		Control Prime		
Assamese	Bodo	Meaning	Bodo	Assamese	Bodo	Assamese	Meaning
মহ [moh]	थामफै [thamphwi]	*'mosquito'*	थामफै [thamphwi]	মহ [moh]	हाब्रु [habru]	বোকা [buka]	*'mud'*
কিতাপ [kitap]	बिजाब [bizab]	*'book'*	बिजाब [bizab]	কিতাপ [kitap]	मैखुन [mwikhun]	কাঠফুলা [kathphula]	*'mushroom'*
ধান [dhan]	माइ [mai]	*'paddy'*	माइ [mai]	ধান [dhan]	दावखा [daukha]	কাউৰী [kauri]	*'crow'*
বতাহ [botah]	बार [bar]	*'wind'*	बार [bar]	বতাহ [botah]	जानजि [zanzi]	কঁকাল [kokal]	*'back'*
কটাৰী [kotari]	दाबा [daba]	*'knife'*	दाबा [daba]	কটাৰী [kotari]	लुवार [luwar]	জোক [zuk]	*'leech'*
বানপানী [banpani]	दैबाना [dwibana]	*'flood'*	दैबाना [dwibana]	বানপানী [banpani]	फिथाइ [phithai]	ফল [phol]	*'fruit'*
চকু [soku]	मेगन [megon]	*'eye'*	मेगन [megon]	চকু [soku]	अखां [okhrang]	আকাশ [akax]	*'sky'*
গছ [gos]	बिफां [biphang]	*'tree'*	बिफां [biphang]	গছ [gos]	खुगा [khuga]	মুখ [mukh]	*'mouth'*
ৰাস্তা [rasta]	लामा [lama]	*'road'*	लामा [lama]	ৰাস্তা [rasta]	थोरसि [thwrsi]	কাঁহী [kahi]	*'plate'*
কাঠ [kath]	दंफां [dongphang]	*'wood'*	दंफा [dongphang]	কাঠ [kath]	खिबु [khibu]	তপিনা [topina]	*'buttock'*
নিগনি [nigoni]	एनजर [enzor]	*'rat'*	एनजर [enzor]	নিগনি [nigoni]	बेगर [begor]	গুটি [guti]	*'seed'*
পোহৰ [puhor]	सोरां [swrang]	*'light'*	सोरां [swrang]	পোহৰ [puhor]	दावस्रि [dausri]	শালিকা [xalika]	*'sparrow'*
আইতা [aita]	आबै [abwi]	*'grandmother'*	आबै [abwi]	আইতা [aita]	अर [or]	জুই [zui]	*'fire'*

APPENDIX H.

Word Targets and Corresponding Primes Used in Semantic Priming Experiments (2A, 2B, 2C, & 2D).

Cognate Targets

Target			**Semantic Prime**			**Control Prime**		
Assamese	Bodo	Meaning	Bodo	Assamese	Meaning	Bodo	Assamese	Meaning
বেৰা [bera]	बेरा [bera]	*‘fence’*	इन्जुर [inzur]	দেৱাল [dewal]	*‘wall’*	थुनलाइ [thunlai]	সাহিত্য [xahityo]	*‘literature’*
টিভি [tibhi]	ति.भि. [tibhi]	*‘television’*	रेडिअ [redio]	ৰেডিঅ’ [redio]	*‘radio’*	गइ [goi]	তামোল [tamul]	*‘betel nut’*
বেমাৰ [bemar]	बेराम [beram]	*‘disease’*	गोबादै [gwbadwi]	বমি [bomi]	*‘vomit’*	थाइजौ [thaizwu]	আম [am]	*‘mango’*
পুখুৰী [pukhuri]	फुख्रि [phukhri]	*‘pond’*	बिलोमा [bilwma]	বিল [bil]	*‘lake’*	खावलाय [khaulai]	গাল [gal]	*‘cheek’*
হাঁহ [hah]	हांसो [hangsw]	*‘duck’*	हांसोराजा [hangswraza]	ৰাজহাঁহ [razhah]	*‘swan’*	दिरु [diru]	ৰছী [rosi]	*‘rope’*
দাড়ি [dari]	दारि [dari]	*‘beard’*	गफ [goph]	গোফ [guph]	*‘moustache’*	जोमै [zwmwi]	ডাৱৰ [dawor]	*‘cloud’*
কপাল [kopal]	खाफाल [khaphal]	*‘forehead’*	खर’ [khoro]	মূৰ [mur]	*‘head’*	जोगोनार [zwgwnar]	ৰঙালাও [rongalau]	*‘pumpkin’*
গাধ [gadho]	गाद’ [gado]	*‘donkey’*	गराय [gorai]	ঘোঁৰা [ghura]	*‘horse’*	सिफुं [siphung]	বাঁহী [bahi]	*‘flute’*
বতৰ [botor]	बोथोर [bwthwr]	*‘weather’*	बारहावा [barhawa]	জলবায়ু [zolobayu]	*‘climate’*	दैहु [dwihu]	কলহ [koloh]	*‘pitcher’*
ফেঁচা [phesa]	फेसा [phesa]	*‘owl’*	बादामालि [badamali]	বাদুলী [baduli	*‘bat’*	रुवा [ruwa]	কুঠাৰ [kuthar]	*‘axe’*
চেকেণ্ড [sekend]	सेकेण्ड [sekend]	*‘second’*	मिनिट [minit]	মিনিট [minit]	*‘minute’*	थै [thwi]	তেজ [tez]	*‘blood’*
চাহ [sah]	साहा [saha]	*‘tea’*	क’फि [kophi]	কফি [kophi]	*‘coffee’*	खांख्राय [khangkhrai]	কেকোঁৰা [kekura]	*‘crab’*

Target			Semantic Prime			Control Prime		
Assamese	Bodo	Meaning	Bodo	Assamese	Meaning	Bodo	Assamese	Meaning
গীটাৰ [gitar]	गिटार [gitar]	*'guitar'*	सिटार [sitar]	চেতাৰ [setar]	*'sitar'*	बिबार [bibar]	ফুল [phul]	*'flower'*
কলম [kolom]	खोलोम [khwlwm]	*'pen'*	पेन्सिल [pensil]	পেঞ্চিল [pensil]	*'pencil'*	गोलेर [gwler]	ঘঁৰিয়াল [ghoriyal]	*'crocodile'*
সিংহ [xingho]	सिंह [singho]	*'lion'*	मोसा [mwsa]	বাঘ [bagh]	*'tiger'*	संख्रि [songkhri]	নিমখ [nimokh]	*'salt'*
জুতা [zuta]	जुथा [zutha]	*'shoe'*	चेनडाल [sendal]	চেণ্ডেল [sendel]	*'sandal'*	गिसिब [gisib]	বিচনী [bisoni]	*'fan'*
চিলিং [siling]	सिलिं [siling]	*'ceiling'*	उखुम [ukhum]	চাল [sal]	*'roof'*	गुसुथि [gusuthi]	ওঁঠ [uth]	*'lip'*
গজাল [gozal]	गाजोल [gazwl]	*'nail'*	स्क्रु [skru]	স্ক্ৰু [skru]	*'screw'*	मोनाबिलि [mwnabili]	সন্ধিয়া [xondhiya]	*'evening'*
গাজৰ [gazor]	गाजर [gazor]	*'carrot'*	मुला [mula]	মূলা [mula]	*'radish'*	सखा [sokha]	ঘনচিৰিকা [ghonsirika]	*'sparrow'*
আটা [ata]	आटा [ata]	*'flour'*	मैदा [mwida]	মৈদা [moida]	*'corn flour'*	अमा [oma]	গাহৰি [gahori]	*'pig'*
গোলাপ [gulap]	गलाब [golab]	*'rose'*	नारजि [narzi]	নাৰ্জী [narzi]	*'marigold'*	मै [mwi]	হৰিণ [horin]	*'deer'*
আঁঠু [athu]	हानथु [hanthu]	*'knee'*	खिलाखुनथि [khilakhunthi]	কিলাকুটি [kilakuti]	*'elbow'*	सेसा [sesa]	শহাপহু [xohapohu]	*'rabbit'*
আঙুৰ [angur]	आंगुर [angur]	*'grape'*	किच्-मिच् [kismis]	কিচমিচ [kismis]	*'raisin'*	दाओबो [daobw]	বগলী [bogoli]	*'crane'*
নাও [lau]	नाउ [nau]	*'boat'*	जाहाज [zahaz]	জাহাজ [zahaz]	*'ship'*	मोदोम [mwdwm]	শৰীৰ [xorir]	*'body'*
সোণ [xuna]	सना [sona]	*'gold'*	रुफा [rupha]	ৰূপ [rup]	*'silver'*	आसुगुर [asugur]	নখ [nokh]	*'nail'*

Target			Semantic Prime			Control Prime		
Assamese	Bodo	Meaning	Bodo	Assamese	Meaning	Bodo	Assamese	Meaning
নিজৰা [nizora]	निजोरा [nizwra]	*'spring'*	दै बाजुम [dwi bazrum]	জলপ্ৰপাত [zolopropat]	*'waterfall'*	मानथास' [manthaso]	কচু [kosu]	*'arum'*
গাখীৰ [gakhir]	गाइखेर [gaikher]	*'milk'*	दाखा [dakha]	দৈ [doi]	*'curd'*	गोदोना [gwdwna]	ডিঙি [dingi]	*'neck'*
চেনি [seni]	चिनि [sini]	*'sugar'*	गुर [gur]	গুৰ [gur]	*'jaggery'*	सैमा [swima]	কুকুৰ [kukur]	*'dog'*
আলু [alu]	आलु [alu]	*'potato'*	गोदै आलु [gwdwi alu]	মিঠা আলু [mitha alu]	*'sweet potato'*	आरसि [arsi]	আইনা [aina]	*'mirror'*
দৰ্জা [dorza]	दरजा [dorza]	*'door'*	खिरकि [khirki]	খিৰিকী [khiriki]	*'window'*	हायजें [haizeng]	আদা [ada]	*'ginger'*
মটৰ [motor]	मटर [motor]	*'pea'*	लेसेरा [lesera]	লেচেৰা [lesera]	*'bean'*	हौवासा [hwuasa]	ল'ৰা [lora]	*'boy'*
কমলা [komola]	खमला [khomla]	*'orange'*	लेबु [lebu]	নেমু [nemu]	*'lemon'*	खोमा [khwma]	কাণ [kan]	*'ear'*
ৰজা [roza]	राजा [raza]	*'king'*	रानि [rani]	ৰাণী [rani]	*'queen'*	थिमा [thima]	ওকণি [ukoni]	*'louse'*
মাখন [makhon]	माखन [makhon]	*'butter'*	गिहि [gihi]	ঘিউ [ghiu]	*'ghee'*	मोस्रोम [mwsrwm]	পৰুৱা [poruwa]	*'ant'*
পিঠা [pitha]	फिथा [phitha]	*'pancake'*	लारु [laru]	লাৰু [laru]	*'laddu'*	सानजा [sanza]	পূব [pub]	*'east'*
আই [ai]	आइ [ai]	*'mother'*	आफा [apha]	দেউতা [deuta]	*'father'*	रायमालि [raimali]	আনাৰস [anarox]	*'pineapple'*
গিলাচ [gilas]	गिलाच [gilas]	*'glass'*	काप [kap]	কাপ [kap]	*'cup'*	सोनाब [swnab]	পশ্চিম possim]	*'west'*
নিয়ৰ [niyor]	निहिर [nihir]	*'dew'*	खुवा [khuwa]	কুঁৱলী [kuwoli]	*'fog'*	खानस्रि [khansri]	কেঁচু [kesu]	*'earthworm'*
বালু [balu]	बाला [bala]	*'sand'*	हाद्रि [hadri]	ধূলি [dhuli]	*'dust'*	मोदोम फुल [mwdwm phul]	অমিতা [omita]	*'papaya'*

Non-Cognate Targets

Target			Semantic Prime			Control Prime		
Assamese	Bodo	Meaning	Bodo	Assamese	Meaning	Bodo	Assamese	Meaning
তুহুক [tusok]	तसक [tosok]	*'mattress'*	गानदु [gandu]	গাৰু [garu]	*'pillow'*	सेंफ्रेम [sengphrem]	মধুৰি [modhuri]	*'guava'*
মুৰ্গী [murgi]	दावजो [dauzw]	*'hen'*	दावज्ला [dauzla]	কুকুৰা [kukura]	*'cock'*	खुरै [khurwi]	বাতি [bati]	*'bowl'*
চুলি [suli]	खानाइ [khanai]	*'hair'*	खोमोन [khwmwn]	নোম [num]	*'hair'*	बैसो [bwisw]	বয়স [boyox]	*'age'*
ঘৰ [ghor]	न' [no]	*'house'*	देरा [dera]	কুটীৰ [kutir]	*'cottage'*	मुफुर [muphur]	ভালুক [bhaluk]	*'bear'*
মাছ [mas]	ना [na]	*'fish'*	मागुर [magur]	মাগুৰ [magur]	*'Magur'*	फरायसा [phoraisa]	ছাত্ৰ [satro]	*'student'*
পেত [pet]	उदै [udwi]	*'belly'*	उथुमाय [uthumai]	নাভি [navi]	*'navel'*	राव [rau]	ভাষা [bhaxa]	*'language'*
হাত [hat]	आखाइ [akhai]	*'hand'*	आसि [asi]	আঙুলি [anguli]	*'finger'*	भेण्डि [bhendi]	ভেণ্ডি [bhendi]	*'lady's finger'*
ভাত [bhat]	ओंखाम [wngkham]	*'rice'*	ओंख्रि [wngkhri]	তৰকাৰী [torkari]	*'curry'*	बिगुर [bigur]	ছাল [sal]	*'skin'*
কুঁৱা [kuwa]	दैखर [dwikhor]	*'well'*	दमकल	দমকল [domkol]	*'tube well'*	फानथाव [phanthau]	বেঙেনা [bengena]	*'brinjal'*
সূৰ্য্য [xurjyo]	सान [san]	*'sun'*	अखाफोर [okhaphwr]	চন্দ্ৰ [sondro]	*'moon'*	लानजाइ [lanzai]	নেজ [nez]	*'tail'*
ৰাতি [rati]	हर [hor]	*'night'*	सान [san]	সূৰ্য্য [xurjyo]	*'sun'*	रोदा [rwda]	শিৰ [xir]	*'nerve'*
বন্দুক [bonduk]	सिलाइ [silai]	*'gun'*	पिष्टल [pistol]	পিস্তল [pistol]	*'gun'*	गोलोमदै [gwlwmdwi]	ঘাম [gham]	*'sweat'*
ভেকুলী [bhekuli]	एमबु [embu]	*'frog'*	एमबु बंगा [embu bonga]	বেং [beng]	*'toad'*	खुन [khun]	কপাহ [kopah]	*'cotton'*

Target			Semantic Prime			Control Prime		
Assamese	Bodo	Meaning	Bodo	Assamese	Meaning	Bodo	Assamese	Meaning
পাহাৰ [pahar]	हाजो [hazw]	*'mountain'*	हाफाव [haphau]	টিলা [tila]	*'hill'*	सानखानथि [sankhanthi]	অঙ্ক [ongko]	*'mathematics'*
কাপোৰ [kapur]	सि [si]	*'cloth'*	फालि [phali]	ৰুমাল [rumal]	*'handkerchief'*	गाराय [garai]	ঘাঁ [gha]	*'wound'*
বটল [botol]	दिंग्रि [dingri]	*'bottle'*	जाग [zag]	জগ [zog]	*'jug'*	सावगारि [saugiri]	ছবি [sobi]	*'picture'*
ছাগলী [sagoli]	बोरमा [bwrma]	*'goat'*	बोरमा मेनदा [bwrma menda]	ভেৰা [bhera]	*'sheep'*	खनथाय [khonthai]	কবিতা [kobita]	*'poem'*
সূতা [xuta]	खुनदुं [khundung]	*'thread'*	ऊल [ul]	উণ [un]	*'wool'*	सामब्राम गुफुर [sambram gufur]	নহৰু [nohoru]	*'garlic'*
বৰষুণ [boroxun]	अखा [okha]	*'rain'*	सानदुं [sandung]	ৰ'দ [rod]	*'sunlight'*	बानलु [banlu]	জলকীয়া [zolokiya]	*'chilli'*
বান্দৰ [bandor]	मोख्रा [mukhra]	*'monkey'*	गरिला [gorila]	গৰিলা [gorila]	*'gorilla'*	गुदुं [gudung]	তাপ [tap]	*'heat'*
চকী [soki]	मासि [masi]	*'chair'*	सफा [sofa]	চোফা [sofa]	*'sofa'*	गाब [gab]	ৰং [rong]	*'colour'*
ফুল [phul]	बिबार [bibar]	*'flower'*	फुलि [phuli]	পুলি [puli]	*'sapling'*	बिखुं [bikhung]	পিঠি [pithi]	*'back'*
চৰাই [sorai]	दाव [dau]	*'bird'*	गां [gang]	পাখি [pakhi]	*'wing'*	बेसर [besor]	সৰিয়হ [xoriyoh]	*'mustard'*
মকৰা [mokora]	बेमा [bema]	*spider*	थिक-थिका [thikthika]	জেঠী [zethi]	*'lizard'*	बन [bon]	খৰি [khori]	*'firewood'*
গ'ৰু [goru]	मोसौ [mwswu]	*cow*	मैसो [mwisw]	ম'হ	*'buffalo'*	बोरला [bwrla]	ধনু [dhonu]	*'bow'*
সাপ [xap]	जिबौ [zibwu]	*snake*	अजगर [ozogor]	অজগৰ	*'cobra'*	खदाल [khodal]	কোৰ [kur]	*'spade'*
টকা [toka]	रां [rang]	*money*	फैसा	পেচা	*'owl'*	मानसि [mansi]	মানুহ [manuh]	*'human'*

Target			Semantic Prime			Control Prime		
Assamese	Bodo	Meaning	Bodo	Assamese	Meaning	Bodo	Assamese	Meaning
বিদ্যালয় [bidyaloi]	फरायसालि [phoraisali]	*school*	फरायसालिमा [phoraisalima]	মহাবিদ্যালয় [mohabidyaloi]	*‘college’*	हा [ha]	মাটি [mati]	*‘soil’*
মহ [moh]	थामफै [thamphwi]	*mosquito*	थामफै [thamphwi]	মাখি [makhi]	*‘fly’*	हाब्रु [habru]	বোকা [buka]	*‘mud’*
কিতাপ [kitap]	बिजाब [bizab]	*book*	लेखा [lekha]	বহী [bohi]	*copy’*	मैखुन [mwikhun]	কাঠফুলা [kathphula]	*‘mushroom’*
ধান [dhan]	माइ [mai]	*paddy*	माइरं [mairong]	চাউল [saul]	*‘rice’*	दावखा [daukha]	কাউৰী [kauri]	*‘crow’*
বতাহ [botah]	बार [bar]	*wind*	बारहुंखा [barhungkha]	ধুমুহা [dhumuha]	*‘storm’*	जानजि [zanzi]	কঁকাল [kokal]	*‘back’*
কটাৰী [kotari]	दाबा [daba]	*knife*	सिखा [sikha]	দা [da]	*‘broadsword’*	लुवार [luwar]	জোক [zuk]	*‘leech’*
বানপানী [banpani]	दैबाना [dwibana]	*flood*	बांग्रि [bangri]	ভূমিকম্প [bhumikompo]	*‘earthquake’*	फिथाइ [phithai]	ফল [phol]	*‘fruit’*
চকু [soku]	मेगन [megon]	*eye*	मुसुगुर [musugur]	ভ্ৰু [bhru]	*‘eyebrow’*	अखां [okhrang]	আকাশ [akax]	*‘sky’*
গছ [gos]	बिफां [biphang]	*tree*	बिलाइ [bilai]	পাত [pat]	*‘leaf’*	खुगा [khuga]	মুখ [mukh]	*‘mouth’*
ৰাস্তা [rasta]	लामा [lama]	*road*	फुतपाथ [phutpath]	ফুটপাথ [phutpath]	*‘footpath’*	थोरसि [thwrsi]	কাঁহী [kahi]	*‘plate’*
কাঠ [kath]	दंफां [dongphang]	*‘wood’*	तक्टा [tokta]	তক্তা [tokta]	*‘plank’*	खिबु [khibu]	তপিনা [topina]	*‘buttock’*
নিগনি [nigoni]	एनजर [enzor]	*rat*	एनजर सिखा [enzor sikha]	চিকা [sika]	*‘shrew’*	बेगर [begor]	গুটি [guti]	*‘seed’*
পোহৰ [puhor]	सोरां [swrang]	*light*	खोमसि [khemsi]	অন্ধকাৰ [ondhokar]	*‘darkness’*	दावस्रि [dausri]	শালিকা [xalika]	*‘sparrow’*
আইতা [aita]	आबै [abwi]	*grandmother*	आबौ [abwu]	ককা [koka]	*‘grandfather’*	अर [or]	জুই [zui]	*‘fire’*

APPENDIX I.

Word Targets and Corresponding Primes Used in Associative Priming Experiments (3A, 3B, 3C, & 3D).

Cognate Targets

Target			**Associative Prime**			**Control Prime**		
Assamese	Bodo	Meaning	Bodo	Assamese	Meaning	Bodo	Assamese	Meaning
বেৰা [bera]	बेरा [bera]	*‘fence’*	औवा [wuwa]	বাঁহ [bah]	*‘bamboo’*	थुनलाइ [thunlai]	সাহিত্য [xahityo]	*literature*
টিভি [tibhi]	ति.भि. [tibhi]	*‘television’*	सावथुन [sauthun]	চলচিত্ৰ [solositro]	*‘cinema’*	गइ [goi]	তামোল [tamul]	*betel nut*
বেমাৰ [bemar]	बेराम [beram]	*‘disease’*	मुलि [muli]	ঔষধ [ouxodh]	*‘medicine’*	थाइजौ [thaizwu]	আম [am]	*mango*
পুখুৰী [pukhuri]	फुख्रि [phukhri]	*‘pond’*	पदुम [podum]	পদুম [podum]	*‘lotus’*	खावलाय [khaulai]	গাল [gal]	*cheek*
হাঁহ [hah]	हांसो [hangsw]	*‘duck’*	बेदर [bedor]	মাংস [mangxo]	*‘meat’*	दिरु [diru]	ৰছী [rosi]	*rope*
দাড়ি [dari]	दारि [dari]	*‘beard’*	खुर [khur]	ক্ষুৰ khur]	*‘razor’*	जोमै [zwmwi]	ডাৱৰ [dawor]	*cloud*
কপাল [kopal]	खाफाल [khaphal]	*‘forehead’*	फोथा [phwtha]	ফোঁট [phut]	*‘bindi’*	जोगोनार [zwgwnar]	ৰঙালাও [rongalau]	*pumpkin*
গাধ [gadho]	गाद’ [gado]	*‘donkey’*	गांसो [gangsw]	ঘাঁহ [ghah	*‘grass’*	सिफुं [siphung]	বাঁহী [bahi]	*flute*
বতৰ [botor]	बोथोर [bwthwr]	*‘weather’*	सानदुं [sandung]	ৰ’দ [rod]	*‘sunshine’*	दैहु [dwihu]	কলহ [koloh]	*pitcher*
ফেঁচা [phesa]	फेसा [phesa]	*‘owl’*	हर [hor]	ৰাতি [rati]	*‘night’*	रुवा [ruwa]	কুঠাৰ [kuthar]	*axe*
চেকেণ্ড [sekend]	सेकेण्ड [sekend]	*‘second’*	घड़ी [ghori]	ঘড়ী [ghori]	*‘watch’*	थै [thwi]	তেজ [tez]	*blood*
চাহ [sah]	साहा [saha]	*‘tea’*	बिस्कुट [biskut]	বিস্কুট [biskut]	*‘biscuit’*	खांख्राय [khangkhrai]	কেকোঁৰা [kekura]	*crab*

Target			Associative Prime			Control Prime		
Assamese	Bodo	Meaning	Bodo	Assamese	Meaning	Bodo	Assamese	Meaning
গীটাৰ [gitar]	गिटार [gitar]	*‘guitar’*	मेथाय [methai]	গান [gan]	*‘song’*	बिबार [bibar]	ফুল [phul]	*flower*
কলম [kolom]	खोलोम [khwlwm]	*‘pen’*	खालि [khali]	চিয়াঁহী [siyahi]	*‘ink’*	गोलेर [gwler]	ঘঁৰিয়াল [ghoriyal]	*crocodile*
সিংহ [xingho]	सिंह [singho]	*‘lion’*	हाग्रामा [hagrama]	জঙ্ঘল [zonghol]	*‘jungle’*	संख्रि [songkhri]	নিমখ [nimokh]	*salt*
জুতা [zuta]	जुथा [zutha]	*‘shoe’*	आथिं [athing]	ভৰি [bhori]	*‘leg’*	गिसिब [gisib]	বিচনী [bisoni]	*fan*
চিলিং [siling]	सिलिं [siling]	*‘ceiling’*	फांखा [phangkha]	পাংখা [pangkha]	*‘fan’*	गुसुथि [gusuthi]	ওঁঠ [uth]	*lip*
গজাল [gozal]	गाजोल [gazwl]	*‘nail’*	हाथुरा [hathura]	হাতুৰী [haturi]	*‘hammer’*	मोनाबिलि [mwnabili]	সন্ধিয়া [xondhiya]	*evening*
গাজৰ [gazor]	गाजर [gazor]	*‘carrot’*	साटनि [satni]	ছাটনি [satni]	*‘salad’*	सखा [sokha]	ঘনচিৰিকা [ghonsirika]	*sparrow*
আটা [ata]	आटा [ata]	*‘flour’*	रुटि [ruti]	ৰুটি [ruti]	*‘chapati’*	अमा [oma]	গাহৰি [gahori]	*pig*
গোলাপ [gulap]	गलाब [golab]	*‘rose’*	सु [su]	কাঁইট [kait]	*‘thorn’*	मै [mwi]	হৰিণ [horin]	*deer*
আঁঠু [athu]	हानथु [hanthu]	*‘knee’*	बिस [bis]	বিষ [bix]	*‘pain’*	सेसा [sesa]	শহাপহু [xohapohu]	*rabbit*
আঙুৰ [angur]	आंगुर [angur]	*‘grape’*	जौ [zwu]	মদ [mod]	*‘wine’*	दाओबो [daobw]	বগলী [bogoli]	*crane*
নাও [lau]	नाउ [nau]	*‘boat’*	दैमा [dwima]	নদী [nodi]	*‘river’*	मोदोम [mwdwm]	শৰীৰ [xorir]	*body*
সোণা [xuna]	सना [sona]	*‘gold’*	गहेना [gohena]	গহনা [gohona]	*‘jewellery’*	आसुगुर	নখ [nokh]	*nail*
নিজৰা [nizora]	निजोरा [nizwra]	*‘spring’*	दै [dwi]	পানী [pani]	*‘water’*	मानथास’ [manthaso]	কচু [kosu]	*arum*

Target			Associative Prime			Control Prime		
Assamese	Bodo	Meaning	Bodo	Assamese	Meaning	Bodo	Assamese	Meaning
গাখীৰ [gakhir]	गाइखेर [gaikher]	*'milk'*	फायस [phayos]	পায়স [payox]	*'kheer'*	गोदोना [gwdwna]	ডিঙি [dingi]	*neck*
চেনি [seni]	चिनि [sini]	*'sugar'*	मिथाइ [mithai]	মিঠাই [mithai]	*'sweet'*	सैमा [swima]	কুকুৰ [kukur]	*dog*
আলু [alu]	आलु [alu]	*'potato'*	सामब्राम [sambram]	পিঁয়াজ [piyaz]	*'onion'*	आरसि [arsi]	আইনা [aina]	*mirror*
দর্জা [dorza]	दरजा [dorza]	*'door'*	फैसालि [phwisali]	পর্দা [porda]	*'curtain'*	हायजें [haizeng]	আদা [ada]	*ginger*
মটৰ [motor]	मटर [motor]	*'pea'*	घुगनि [ghugni]	ঘুগনি [ghugni]	*'ghugni'*	हौवासा [hwuasa]	ল'ৰা [lora]	*boy*
কমলা [komola]	खमला [khomla]	*'orange'*	रोसि [rwsi]	ৰস [rox]	*'juice'*	खोमा [khwma]	কাণ [kan]	*ear*
ৰজা [roza]	राजा [raza]	*'king'*	राजमहल [razmohol]	ৰাজপ্ৰাসাদ [razpraxad]	*'palace'*	थिमा [thima]	ওকণি [ukoni]	*louse*
মাখন [makhon]	माखन [makhon]	*'butter'*	लफ [loph]	লোফ [loph]	*'bread'*	मोस्रोम [mwsrwm]	পৰুৱা [poruwa]	*ant*
পিঠা [pitha]	फिथा [phitha]	*'pancake'*	बैसागु [bwisagu]	বিহু [bihu]	*'Bihu'*	सानजा [sanza]	পূব [pub]	*east*
আই [ai]	आइ [ai]	*'mother'*	गथ' [gotho]	সন্তান [xontan]	*'child'*	रायमालि [raimali]	আনাৰস [anarox]	*pineapple*
গিলাচ [gilas]	गिलाच [gilas]	*'glass'*	चर्बत [sorbot]	চৰ্বত [sorbot]	*'sherbet'*	सोनाब [swnab]	পশ্চিম possim]	*west*
নিয়ৰ [niyor]	निहिर [nihir]	*'dew'*	गोजां बोथोर [gwzang bwthwr]	শীতকাল [xitkal]	*'winter'*	खानस्रि [khansri]	কেঁচু [kesu]	*earthworm*
বালু [balu]	बाला [bala]	*'sand'*	लैथो [lwithw]	সাগৰ [xagor]	*'sea'*	मोदोम फुल [mwdwm phul]	অমিতা [omita]	*papaya*
তুহক [tusok]	तसक [tosok]	*'mattress'*	एम [em]	বিছনা [bisona]	*'bed'*	सेंफ्रेम [sengphrem]	মধুৰি [modhuri]	*guava*

Non-cognate Targets

Target			Associative Prime			Control Prime		
Assamese	Bodo	Meaning	Bodo	Assamese	Meaning	Bodo	Assamese	Meaning
মুৰ্গী [murgi]	दावजो [dauzw]	*'hen'*	दावदै [daudwi]	কণী [koni]	*'egg'*	खुरै [khurwi]	বাতি [bati]	*'bowl'*
চুলি [suli]	खानाइ [khanai]	*'hair'*	खानजुं [khanzung]	ফণি [phoni]	*'comb'*	बैसो [bwisw]	বয়স [boyox]	*'age'*
ঘৰ [ghor]	न' [no]	*'house'*	खामसालि [khamsali]	চোতাল [sutal]	*'courtyard'*	मुफुर [muphur]	ভালুক [bhaluk]	*'bear'*
মাছ [mas]	ना [na]	*'fish'*	जे [ze]	জাল [zal]	*'net'*	फरायसा [phoraisa]	ছাত্ৰ [satro]	*'student'*
পেত [pet]	उदै [udwi]	*'belly'*	मेजेम [mezem]	চৰ্বি [sorbi]	*'fat'*	राव [rau]	ভাষা [bhaxa]	*'language'*
হাত [hat]	आखाइ [akhai]	*'hand'*	आसान [asan]	খাৰু [kharu]	*'bangle'*	भेण्डि [bhendi]	ভেণ্ডি [bhendi]	*'lady's finger'*
ভাত [bhat]	ओंखाम [wngkham]	*'rice'*	भ'ज [bhoz]	ভোজ [bhuz]	*'feast'*	बिगुर [bigur]	ছাল [sal]	*'skin'*
কুঁৱা [kuwa]	दैखर [dwikhor]	*'well'*	बालथिं [balthing]	বাল্টিং [balting]	*'bucket'*	फानथाव [phanthau]	বেঙেনা [bengena]	*'brinjal'*
সূৰ্য্য [xurjyo]	सान [san]	*'sun'*	ग्रह [groho]	গ্ৰহ [groho]	*'planet'*	लानजाइ [lanzai]	নেজ [nez]	*'tail'*
ৰাতি [rati]	हर [hor]	*'night'*	हाथरखि [hathorkhi]	তৰা [tora]	*'star'*	रोदा [rwda]	শিৰ [xir]	*'nerve'*
বন্দুক [bonduk]	सिलाइ [silai]	*'gun'*	दावहा [dauha]	যুদ্ধ [zuddho]	*'war'*	गोलोमदै [gwlwmdwi]	ঘাম [gham]	*'sweat'*
ভেকুলী [bhekuli]	एमबु [embu]	*'frog'*	खासेव [khaseu]	কাছ [kaso]	*'tortoise'*	खुन [khun]	কপাহ [kopah]	*'cotton'*
পাহাৰ [pahar]	हाजो[hazw]	*'mountain'*	दनदर [dondor]	গুহা [guha]	*'cave'*	सानखानथि [sankhanthi]	অঙ্ক [zontu]	*'mathematics'*

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Target			Associative Prime			Control Prime		
Assamese	Bodo	Meaning	Bodo	Assamese	Meaning	Bodo	Assamese	Meaning
কাপোৰ [kapur]	सि [si]	*‘cloth’*	दरजि [dorzi]	দর্জি [dorzi]	*‘tailor’*	गाराय [garai]	ঘাঁ [gha]	*wound*
বটল [botol]	दिंग्रि [dingri]	*‘bottle’*	दै [dwi]	পানী [pani]	*‘water’*	सावगारि [saugiri]	ছবি [sobi]	*picture*
ছাগলী [sagoli]	बोरमा [bwrma]	*‘goat’*	बेदर [bedor]	মাংস [manxo]	*‘meat’*	खनथाय [khonthai]	কবিতা [kobita]	*poem*
সূতা [xuta]	खुनदुं [khundung]	*‘thread’*	बेजि [bezi]	বেজী [bezi]	*‘needle’*	सामब्राम गुफुर [sambram gufur]	নহৰু [nohoru]	*garlic*
বৰষুণ [boroxun]	अखा [okha]	*‘rain’*	बोथोर [bwthwr]	বতৰ [botor]	*‘weather’*	बानलु [banlu]	জলকীয়া [zolokiya]	*chilli*
বান্দৰ [bandor]	मोख्रा [mukhra]	*‘monkey’*	थालिर [thalir]	কল [kol]	*‘banana’*	गुदुं [gudung]	তাপ [tap]	*heat*
চকী [soki]	मासि [masi]	*‘chair’*	गादि [gadi]	গাদী [gadi]	*‘cushion’*	गाब [gab]	ৰং [rong]	*colour*
ফুল [phul]	बिबार [bibar]	*‘flower’*	बिबारबारि [bibarbari]	বাগান [bagan]	*‘garden’*	बिखुं [bikhung]	পিঠি [pithi]	*back*
চৰাই [sorai]	दाव [dau]	*‘bird’*	दावबासा [daubasa]	বাঁহ [bah]	*‘nest’*	बेसर [besor]	সৰিয়হ [xoriyoh]	*mustard*
মকৰা [mokora]	बेमा [bema]	*spider*	बेमाजे [bemaze]	মকৰা জাল [mokora jal]	*‘web’*	बन [bon]	খৰি [khori]	*firewood*
গ’ৰু [goru]	मोसौ [mwswu]	*cow*	गोबोर [gwbwr]	গোবৰ [gubor]	*‘cow dung’*	बोरला [bwrla]	ধনু [dhonu]	*bow*
সাপ [xap]	जिबौ [zibwu]	*snake*	नेवलाय [neulai]	নেউল [neul]	*‘mongoose’*	खदाल [khodal]	কোৰ [kur]	*spade*
টকা [toka]	रां [rang]	*money*	बेसेन [besen]	দাম [dam]	*‘price’*	मानसि [mansi]	মানুহ [manuh]	*human*
বিদ্যালয় [bidyaloi]	फरायसालि [phoraisali]	*school*	फोरोंगिरि [phwrwnggiri]	শিক্ষক [xikkhok]	*‘teacher’*	हा [ha]	মাটি [mati]	*soil*

Target			Associative Prime			Control Prime		
Assamese	Bodo	Meaning	Bodo	Assamese	Meaning	Bodo	Assamese	Meaning
মহ [moh]	थामफै [thamphwi]	*mosquito*	मुस्रि [musri]	আঁঠুৱা [athuwa]	*'mosquito net'*	हाब्रु [habru]	বোকা [buka]	*mud*
কিতাপ [kitap]	बिजाब [bizab]	*book*	बुहुम [buhum]	পৃথিৱী [prithibi]	*'earth'*	मैखुन [mwikhun]	কাঠফুলা [kathphula]	*mushroom*
ধান [dhan]	माइ [mai]	*paddy*	आबाद [abad]	খেতি [kheti]	*'cultivation'*	दावखा [daukha]	কাউৰী [kauri]	*crow*
বতাহ [botah]	बार [bar]	*wind*	बारदैसिखला [bardwisikhla]	বৰদৈচিলা [bordoisila]	*'Bordoichilla'*	जानजि [zanzi]	কঁকাল [kokal]	*back*
কটাৰী [kotari]	दाबा [daba]	*knife*	खेमसि [khemsi]	কেঁচি [kesi]	*'scissor'*	लुवार [luwar]	জোক [zuk]	*leech*
বানপানী [banpani]	दैबाना [dwibana]	*flood*	बानदो [bandw]	বান্ধ [bandh]	*'dam'*	फिथाइ [phithai]	ফল [phol]	*fruit*
চকু [soku]	मेगन [megon]	*eye*	ससमा [sosma]	চছমা [sosma]	*'spectacle'*	अख्रां [okhrang]	আকাশ [akax]	*sky*
গছ [gos]	बिफां [biphang]	*tree*	साया [saya]	ছাঁ [sa]	*shadow'*	खुगा [khuga]	মুখ [mukh]	*mouth*
ৰাস্তা [rasta]	लामा [lama]	*road*	गारि [gari]	গাড়ী [gari]	*'car'*	थोरसि [thwrsi]	কাঁহী [kahi]	*plate*
কাঠ [kath]	दंफां [dongphang]	*'wood'*	आरांगा [arangga]	মেজ [mez]	*'table'*	खिबु [khibu]	তপিনা [topina]	*buttock*
নিগনি [nigoni]	एनजर [enzor]	*rat*	मावजि [mauzi]	মেকুৰী [mekuri]	*'cat'*	बेगर [begor]	গুটি [guti]	*seed*
পোহৰ [puhor]	सोरां [swrang]	*light*	साथि [sathi]	ছাতি [sati]	*'umbrella'*	दावस्रि [dausri]	শালিকা [xalika]	*sparrow*
আইতা [aita]	आबै [abwi]	*grandmother*	सल' [solo]	কাহিনী [kahini]	*'story'*	अर [or]	জুই [zui]	*fire*

APPENDIX J.

Word Targets and Corresponding Primes Used in Phonological Priming Experiments (4A, 4B, 4C, & 4D).

Cognate Targets

Target			Phonological Prime				Control Prime		
Assamese	Bodo	Meaning	Bodo	Meaning	Assamese	Meaning	Bodo	Assamese	Meaning
বেৰা [bera]	बेरा [bera]	*‘fence’*	देरा [dera]	*‘cottage’*	কেঁৰা [kera]	*‘squint eyed’*	थुनलाइ [thunlai]	সাহিত্য [xahityo]	*‘literature’*
হাঁহ [hah]	हांसो [hangsw]	*‘duck’*	हान [han]	*‘lift’*	মাংস [mangxo]	*‘meat’*	दिरु [diru]	ৰছী [rosi]	*‘rope’*
দাড়ি [dari]	दारि [dari]	*‘beard’*	गारि [gari]	*‘car’*	বাৰি [bari]	*‘stick’*	जोमै [zwmwi]	ডাৱৰ [dawor]	*‘cloud’*
বতৰ [botor]	बोथोर [bwthwr]	*‘weather’*	बोसोर [bwswr]	*‘year’*	বছৰ [bosor]	*‘year’*	दैहु [dwihu]	কলহ [koloh]	*‘pitcher’*
আলু [alu]	आलु [alu]	*‘potato’*	आलि [ali]	*‘road’*	আঁঠু [athu]	*‘knee’*	आरसि [arsi]	আইনা [aina]	*‘mirror’*
ৰজা [roza]	राजा [raza]	*‘king’*	रोदा [rwda]	*‘nerve’*	গাজা [gaza]	*‘joke’*	थिमा [thima]	ওকণি [ukoni]	*‘louse’*
পিঠা [pitha]	फिथा [phitha]	*‘pancake’*	चिता [sita]	*‘pyre’*	ফিতা [phita]	*‘ribbon’*	सानजा [sanza]	পূব [pub]	*‘east’*
আই [ai]	आइ [ai]	*‘mother’*	दाय [dai]	*‘crime’*	গাই [gai]	*‘cow’*	रायमालि [raimali]	আনাৰস [anarox]	*‘pineapple’*
নিয়ৰ [niyor]	निहिर [nihir]	*‘dew’*	निजोम [nizwm]	*‘silence’*	নিবিড় [nibir]	*‘intimate’*	खानस्रि [khansri]	কেঁচু [kesu]	*‘earthworm’*
বালু [balu]	बाला [bala]	*‘sand’*	थालो [thalw]	*‘hard palate’*	মালা [mala]	*‘garland’*	मोदोम फुल [mwdwm phul]	অমিতা [omita]	*‘papaya’*

Non-cognate Targets

Target			Phonological Prime				Control Prime		
Assamese	Bodo	Meaning	Bodo	Meaning	Assamese	Meaning	Bodo	Assamese	Meaning
মাছ [mas]	ना [na]	*'fish'*	बास [bas]	*'bus'*	দা [da]	*'broadsword'*	फरायसा [phoraisa]	ছাত্ৰ [satro]	*'student'*
পেত [pet]	उदै [udwi]	*'belly'*	पेन्ट [pent]	*'pant'*	উদয় [udoi]	*'rise'*	राव [rau]	ভাষা [bhaxa]	*'language'*
হাত [hat]	आखाइ [akhai]	*'hand'*	हार [har]	*'rate'*	আখৈ [akhoi]	*'puffed rice'*	भेण्डि [bhendi]	ভেণ্ডি [bhendi]	*'lady's finger'*
বন্দুক [bonduk]	सिलाइ [silai]	*'gun'*	बनदु [bondu]	*'friend'*	চিলাই [silai]	*'stitching'*	गोलोमदै [gwlwmdwi]	ঘাম [gham]	*'sweat'*
কাপোৰ [kapur]	सि [si]	*'cloth'*	मुफुर [muphur]	*'bear'*	ঘি [ghi]	*'ghee'*	गाराय [garai]	ঘাঁ [gha]	*'wound'*
ছাগলী [sagoli]	बोरमा [bwrma]	*'goat'*	फागलि [phagli]	*'mad (fem)'*	বৰমা [borma]	*'aunt'*	खनथाय [khonthai]	কবিতা [kobita]	*'poem'*
চৰাই [sorai]	दाव [dau]	*'bird'*	गराय [gorai]	*'horse'*	লাউ [lau]	*'gourd'*	बेसर [besor]	সৰিয়হ [xoriyoh]	*'mustard'*
মকৰা [mokora]	बेमा [bema]	*spider*	मोख्रा [mwkhra]	*'monkey'*	টেমা [tema]	*'can'*	बन [bon]	খৰি [khori]	*'firewood'*
ধান [dhan]	माइ [mai]	*paddy*	दान [dan]	*'alms'*	ছাই [sai]	*'ash'*	दावखा [daukha]	কাউৰী [kauri]	*'crow'*
কাঠ [kath]	दंफां [dongphang]	*'wood'*	पाथ [path]	*'text'*	ডাঠ [dath]	*'thick'*	खिबु [khibu]	তপিনা [topina]	*'buttock'*

APPENDIX K (i).

Word Targets and Corresponding Primes Used in Semantic Categorization Experiments (5A).

Cognate words

Examplars				Non-exemplars			
Assamese Target	Meaning	Bodo Translation Prime	Bodo Form Control	Assamese Target	Meaning	Bodo Translation Prime	Bodo Form Control
গাধ [gadho]	*'donkey'*	गाद' [gado]	लाद' [lado]	মদ [mod]	*'wine'*	जौ [zwu]	बौ [bwu]
সিং [xingho]	*'lion'*	सिंह [singho]	मिंह [mingho]	গছ [gos]	*'tree'*	बिफां [biphang]	रिफां [riphang]
শিয়াল [xiyal]	*'fox'*	सियाल [siyal]	बियाल [biyal]	ফণি [phoni]	*'comb'*	खानजुं [khanzung]	बानजुं [banzung]
ঘোঁৰা [ghura]	*'horse'*	गराय [gorai]	मराय [morai]	বিছনা [bisona]	*'bed'*	एम [em]	उम [um]
উট [ut]	*'camel'*	उट [ut]	एट [et]	পানী [pani]	*'water'*	दै [dwi]	है [hwi]
আপেল [apel]	*'apple'*	आफेल [aphel]	गाफेल [gaphel]	ঘৰ [ghor]	*'house'*	न' [no]	फ' [pho]
আঙুৰ [angur]	*'grape'*	आंगुर [angur]	इंगुर [ingur]	সূতা [xuta]	*'thread'*	खुनदुं [khundung]	लुनदुं [lundung]
কঁঠাল [kothal]	*'jackfruit'*	खानथाल [khanthal]	गानथाल [ganthal]	বৰষুণ [boroxun]	*'rain'*	अखा [okha]	इखा [ikha]
নাচপতি [naspoti]	*'pear'*	नाचपति [naspoti]	माचपति [maspoti]	তেজ [tez]	*'blood'*	थै [thwi]	रै [rwi]
তৰমুজ [tormuz]	*'watermelon'*	तरमुज [tormuz]	गरमुज [gormuz]	কটাৰী [kotari]	*'knife'*	दाबा [daba]	साबा [saba]

Non-cognate words

Examplars				**Non-examplars**			
Assamese Target	Meaning	Bodo Translation Prime	Bodo Form Control	Assamese Target	Meaning	Bodo Translation Prime	Bodo Form Control
কুকুৰ [kukur]	*‘dog’*	सैमा [swima]	गैमा [gwima]	কুঠাৰ [kuthar]	*‘axe’*	रुवा [ruwa]	बुवा [buwa]
গৰু [goru]	*‘cow’*	मोसौ [mwswu]	जोसौ [zwswu]	পাহাৰ [pahar]	*‘mountain’*	हाजो [hazw]	नाजो [nazw]
বান্দৰ [bandor]	*‘monkey’*	मोखा्र [mwkhra]	जोख्रा [zwkhra]	ৰছী [rosi]	*‘rope’*	दिरु [diru]	जिरु [ziru]
হৰিণ [horin]	*‘deer’*	मै [mwi]	जै [zwi]	টকা [toka]	*‘money’*	रां [rang]	बां [bang]
হাতী [hati]	*‘elephant’*	मैदेर [mwider]	सैदेर [swider]	আদা [ada]	*‘ginger’*	हायजें [haizeng]	लायजें [laizeng]
আম [am]	*‘mango’*	थाइजौ [thaizwu]	नाइजौ [naizwu]	বুকু [buku]	*‘chest’*	बिखा [bikha]	लिखा [likha]
কল [kol]	*‘banana’*	थालिर [thalir]	गालिर [galir]	কিতাপ [kitap]	*‘book’*	बिजाब [bizab]	खिजाब [khizab]
আনাৰস [anarox]	*‘pineapple’*	रायमालि [raimali]	दायमालि [daimali]	বাঁহী [bahi]	*‘flute’*	सिफुं [siphung]	निफुं [niphung]
মধুৰি [modhuri]	*‘guava’*	सेंफ्रेम [sengfrem]	देंफ्रेम [dengfrem]	সূৰ্য্য [xurzyo]	*‘sun’*	सान [san]	नान [nan]
অমিতা [omita]	*‘papaya’*	मोदोम फुल [mwdwm phul]	रोदोम फुल [rwdwm phul]	বিছনী [bisoni]	*‘fan’*	गिसिब [gisib]	मिसिब [misib]

APPENDIX K (ii).

Word Targets and Corresponding Primes Used in Semantic Categorization Experiments (5B).

Cognate words

Examplars				Non-examplars			
Bodo Target	Meaning	Assamese Translation Prime	Assamese Form Control	Bodo Target	Meaning	Assamese Translation Prime	Assamese (L2) Form Control
गाद' [gado]	*'donkey*	গাধ [gadho]	লাধ [ladho]	जौ [zwu]	*'wine'*	মদ [mod]	জদ [zod]
सिंह [singho]	*'lion'*	সিংহ [xingho]	মিংহ [mingho]	बिफां [biphang]	*'tree'*	গছ [gos]	নছ [nos]
सियाल [siyal]	*'lion'*	শিয়াল [xiyal]	বিয়াল [biyal]	खानजुं [khanzung]	*'comb'*	ফণি [phoni]	ঘণি [ghoni]
गराय [gorai]	*'horse'*	ঘোঁৰা [ghura]	নোঁৰা [nura]	एम [em]	*'bed'*	বিছনা [bisoni]	কিছনা [kisona]
उट [ut]	*'camel'*	উট [ut]	ইট [it]	दै [dwi]	*'water'*	পানী [pani]	গানী [gani]
आफेल [aphel]	*'apple'*	আপেল [apel]	লাপেল [lapel]	न' [no]	*'house'*	ঘৰ [ghor]	ফৰ [phor]
आंगुर [angur]	*'grape'*	আঙুৰ [angur]	এঙুৰ [engur]	खुनदुं [khundung]	*'thread'*	সূতা [xuta]	হূতা [huta]
खानथाल [khanthal]	*'jackfruit'*	কঁঠাল [kothal]	মঁঠাল [mothal]	अखा [okha]	*'rain'*	বৰষুণ [boroxun]	জৰষুণ [zoroxun]
नाचपति [naspoti]	*'pear'*	নাচপতি [naspoti]	লাচপতি [laspoti]	थै [thwi]	*'blood'*	তেজ [tez]	ফেজ [phez]
तरमुज [tormuz]	*'watermelon'*	তৰমুজ [tormuz]	ইনাৰস [inarox]	दाबा [daba]	*'knife'*	কটাৰী [kotari]	মটাৰী [motari]

Non-cognate words

Examplars				Non-examplars			
Bodo Target	Meaning	Assamese Translation Prime	Assamese Form Control	Bodo Target	Meaning	Assamese Translation Prime	Assamese Form Control
सैमा [swima]	*'dog'*	কুকুৰ [kukur]	লুকুৰ [lukur]	रुवा [ruwa]	*'axe'*	কুঠাৰ [kthar]	বুঠাৰ [buthar]
मोसौ [mwswu]	*'cow'*	গৰু [goru]	হৰু [horu]	हाजो [hazw]	*'mountain'*	পাহাৰ [pahar]	কাহাৰ [kahar]
मोख्रा [mwkhra]	*'monkey'*	বান্দৰ [bandor]	গান্দৰ [gandor]	दिरु [diru]	*'rope'*	ৰছী [rosi]	জছী [zosi]
मै [mwi]	*'deer'*	হৰিণ [horin]	মৰিণ [morin]	रां [rang]	*'money'*	টকা [toka]	নকা [noka]
मैदेर [mwider]	*'elephant'*	হাতী [hati]	লাতী [lati]	हायजें [haizeng]	*'ginger'*	আদা [ada]	লাদা [lada]
थाइजौ [thaizwu]	*'mango'*	আম [am]	অম [om]	बिखा [bikha]	*'chest'*	বুকু [buku]	জুকু [zuku]
थालिर [thalir]	*'banana'*	কল [kol]	খল [khol]	बिजाब [bizab]	*'book'*	কিতাপ [kitap]	মিতাপ [mitap]
रायमालि [raimali]	*'pineapple'*	আনাৰস [anarox]	ইনাৰস [inarox]	सिफुं [siphung]	*'flute'*	বাঁহী [bahi]	জাঁহী [zahi]
सेंफ्रेम [sengfrem]	*'guava'*	মধুৰি [modhuri]	দধুৰি [dodhuri]	सान [san]	*'sun'*	সূৰ্য্য [xurzyo]	মূৰ্য্য [murjyo]
मोदोम फुल [mwdwm phul]	*'papaya'*	অমিতা [omita]	ইমিতা [imita]	गिसिब [gisib]	*'fan'*	বিছনী [bisoni]	গিছনী [gisoni]

APPENDIX L (i).

Word Targets and Corresponding Primes Used in Translation Recognition Experiments (6A).

Cognate

L1 Target	**Semantic**	**Control**	**Associative**	**Control**	**Phonological**	**Control**	**Phono-trans**	**Control**
बेरा [bera] *‘fence’*	দেৱাল [dewal] *‘wall’*	কলহ [koloh] *‘pitcher’*	বাঁহ [bah] *‘bamboo’*	নিমখ [nimokh] *‘salt’*	বেঁকা [beka] *‘bent’*	চিঠি [sithi] *‘letter’*	কেঁৰা [kera] *‘squint eyed’*	বাতি [bati] *‘bowl’*
दारि [dari] *‘beard’*	গোফ [guph] *‘moustache’*	হৰিণ [horin] *‘deer’*	ক্ষুৰ [khur] *‘razor’*	জুই [zui] *‘fire’*	দামী [baki] ‘expensive’	কপাহ [kopah] *‘cotton’*	মাৰি [mari] ‘bar’	গুটি [guti] *‘seed’*
आलु [alu] *‘potato’*	মিঠা আলু [mitha alu] *‘sweet potato’*	সন্ধিয়া [xondhiya] *‘evening’*	পিঁয়াজ [piyaz] *‘onion’*	পৰুৱা [poruwa] *‘ant’*	আফু [aphu] *‘poppy seed’*	কান্ধ [kandho] *‘shoulder’*	আৰু [aru] *‘and’*	কঁকাল [kokal] *‘back’*
राजा [raza] *‘king’*	ৰাণী [rani] *‘queen’*	গাহৰী [gahori] *‘pig’*	ৰাজপ্ৰাসাদ [razproxad] *‘palace’*	ডিঙি [dingi] *‘neck’*	গাজা [gaza] *‘joke’*	চৰ্বি [sorbi] *‘fat’*	সঁজা [xoza] *‘cage’*	ছাল [sal] *‘skin’*
आइ [ai] *‘mother’*	দেউতা [deuta] *‘father’*	ঘনচিৰিকা [ghonsirika] *‘sparrow’*	সন্তান [xontan] *‘child’*	ওকণি [ukoni] *‘louse’*	গাই [gai] *‘cow’*	ৰান্দা [randa] *‘adze’*	খাই [khai] *‘ditch’*	ৰং [rong] *‘color’*
निहिर [nihir] *‘dew’*	কুঁৱলী [kuwoli] *‘fog’*	ৰছী [rosi] *‘rope’*	শীতকাল [xitkal] *‘winter’*	অমিতা [omita] *‘papaya’*	নিবিড় [nibir] *‘intimate’*	শিকল [xikol] *‘chain’*	চিঞৰ [siyor] *‘scream’*	মুখ [mukh] *‘face’*
बाला [bala] *‘sand’*	ধূলি [dhuli] *‘dust’*	কেকোঁৰা [kekura] *‘crab’*	সাগৰ [xagor] *‘sea’*	পূব [pub] *‘east’*	মালা [mala] *‘necklace’*	চৰাই [sorai] *‘bird’*	তালু [talu] *‘hard palate’*	পিঠি [pithi] *‘back’*
हांसो [hangsw] *‘duck’*	ৰাজহাঁহ [razhah] *‘swan’*	ৰঙালাও [rongalau] *‘pumpkin’*	পুখুৰী [pukhuri] *‘pond’*	আদা [ada] *‘ginger’*	মঞ্চ [monso] *‘stage’*	কাঁইট [kait] *‘thorn’*	কাঁহ [kah] *‘bell metal’*	কাঁহী [kahi] *‘plate’*
फिथा [phitha] *‘pancake’*	লাৰু [laru] *‘laddu’*	বাঁহী [bahi] *‘flute’*	বিহু [bihu] *‘Bihu’*	পখিলা [pokhila] *‘butterfly’*	ফিতা [phita] *‘ribbon’*	গঁড় [gor] *‘rhinoceros’*	পিপা [pipa] ‘barrel’	তপিনা [topina] *‘buttock’*
जुथा [jutha] *‘shoe’*	चेनडाल [sendal] *‘sandal’*	ফুল [phul] *‘flower’*	ভৰি [bhori] *‘leg’*	তামোল [tamul] *‘betel nut’*	জুঠা [zutha] *‘ort’*	মুখা [mukha] *‘mask’*	খুটা [khuta] *‘pillar’*	আকাশ [akax] *‘sky’*

Non-Cognate

L1 Target	Semantic	Control	Associative	Control	Phonological	Control	Phono-trans	Control
ना [na] *'fish'*	মাগুৰ [magur] *'Magur fish'*	ডাৱৰ [dawor] *'cloud'*	জাল [zal] *'net'*	ৰাতিপুৱা [ratipuwa] *'morning'*	ঘাঁ [gha] *'wound'*	চাকি [saki] *'lamp'*	পাচ [pas] *'five'*	খৰি [khori] *'firewood'*
उदै [udwi] *'stomach'*	নাভি [nabhi] *'navel'*	শ্ৰেণী [sreni] *'class'*	চৰ্বি [sorbi] *'fat'*	মধুৰি [modhuri] *'guava'*	উদয় [udoi] *'rise'*	লাঠি [lathi] *'stick'*	বেত [bet] 'cane'	ঔষধ [ouxodh] *'medicine'*
सिलाइ [silai] *'gun'*	পিস্তল [pistol] *'pistol'*	গাল [gal] *'cheek'*	যুদ্ধ [zuddho] *'war'*	নেজ [nez] *'tail'*	চিলাই [silai] *'stitching'*	হাতী [hati] *'elephant'*	ছন্দুক [sonduk] *'trunk'*	পশ্চিম [possim] *'west'*
सि [si] *'cloth'*	ৰুমাল [rumal] *'handkerchief'*	শৰীৰ [xorir] *'body'*	দৰ্জি [dorzi] *'tailor'*	কুঠাৰ [kuthar] *'axe'*	ঘি [ghi] *'ghee'*	চুপি [supi] *'funnel'*	কামোৰ [kamur] 'bite'	পানী pani] *'water'*
बेमा [bema] *'spider'*	জেঠী [zethi] *'lizard'*	নখ [nokh] *'nail'*	মকৰাজাল [mokorazal] *'web'*	তিল [til] *'sesame'*	টেমা [tema] *'can'*	সুহুৰি [xuhuri] *'whistle'*	চকৰা [sokora] *'silk moth'*	বৌ [bou] *'sister-in-law'*
माइ [mai] *'paddy'*	চাউল [saul] *'rice'*	আম [am] *'mango'*	খেতি [kheti] *'cultivation'*	কাণ [kan] *'ear'*	ছাই [sai] *'ash'*	শিং [xing] *'horn'*	গান [gan] *'song'*	নাক [nak] *'nose'*
दंफां [dongphang] *'wood'*	তক্তা [tokta] *'plank'*	পৃথিৱী [prithibi] *'earth'*	মেজ [mez] *'table'*	কান্ধ [kandho] *'shoulder'*	ফুংফাং [phungphang] *'insincere'*	নাঙল [nangol] *'plough'*	ডাঠ [dath] *'thick'*	কেঁচু [kesu] *'worm'*
दाव [dau] *'bird'*	পাখি [pakhi] *'wing'*	জোক [zuk] *'leech'*	বাহ [bah] *'nest'*	আনাৰস [anarox] *'pineapple'*	লাউ [lau] *'gourd'*	কৰত [korot] *'saw'*	শৰাই [xorai] 'xorai'	কবিতা [kobita] *'poem'*
आखाइ [akhai] *'hand'*	আঙুলি [anguli] *'finger'*	বিছনী [bisoni] *'fan'*	খাৰু [kharu] *'bangle'*	সভাপতি [xobhapoti] *'president'*	আখৈ [akhoi] *'puffed rice'*	জাল [zal] *'net'*	পাত [pat] *'leaf'*	শালিকা [xalika] *'Indian Myna'*
बोरमा [bwrma] *'goat'*	ভেৰা [bhera] *'sheep'*	জ্বৰ [zor] *'fever'*	মাংস [mangxo] *'meat'*	ফৰিং [phoring] *'grasshopper'*	বৰমা [borma] *'aunt'*	পৃথিৱী [prithibi] *'earth'*	পাগলী [pagoli] *'mad (fem)'*	তিয়ঁহ [tiyoh] *'cucumber'*

APPENDIX L (ii).**Word Targets and Corresponding Primes Used in Translation Recognition Experiments (6B).**

Cognates

L2 Target	Semantic	Control	Associative	Control	Phonological	Control	Phono-trans	Control
বেৰা [bera] *'fence'*	इन्जुर [inzur] *'wall'*	दैहु [dwihu] *'pitcher'*	औवा [wuwa] *'bamboo'*	संख्रि [songkhri] *'salt'*	देरा [dera] *'cottage'*	लाइजाम [laizam] *'letter'*	खेरा [khera] *'squint eyed'*	खुरै [khurwi] *'bowl'*
দাড়ি [dari] *'beard'*	गफ [goph] *'moustache'*	मै [mwi] *'deer'*	खुर [khur] *'razor'*	अर [or] *'fire'*	गारि [gari] *'beard'*	खुन [khun] *'cotton'*	बारि [bari] *'garden'*	बेगर [begor] *'seed'*
আলু [alu] *'potato'*	गोदै आलु [gwdwi alu] *'sweet potato'*	मोनाबिलि [mwnabili] *'evening'*	सामब्राम [sambram] *'onion'*	मोस्रोम [mwsrwm] *'ant'*	आबु [abu] *'breast'*	फाफलि [phaphli] *'shoulder*	आरो [arw] *'and'*	बिखुं [bikhung] *'back'*
ৰজা [roza] *'king'*	रानि [rani] *'queen'*	अमा [oma] *'pig'*	राजमहल [razmohol] *'palace'*	गोदोना [gwdwna] *'neck'*	दरजा [dorza] *'door'*	मेजेम [mezem] *'fat'*	सानजा [sanza] *'east'*	बिगुर [bigur] *'skin'*
আই [ai] *'mother'*	आफा [apha] *'father'*	सखा [sokha] *'sparrow'*	गथ' [gotho] *'child'*	थिमा [thima] 'louse'	लाइ [lai]	रान्दा [randa] *'adze'*	राय [rai] 'scold'	गाब [gab] *'color'*
নিয়ৰ [niyor] *'dew'*	निहिर [nihir] *'fog'*	दिरु [diru] *'rope'*	गोजां बोथोर [gwzang bwthwr] *'winter'*	मोदोम फुल [mwdwm phul] *'papaya'*	नोगोर [nwgwr] *'city'*	जिनिज़्रि [zinizri] *'chain'*	दिहिर [dihir] *'mansion'*	मोखां [mwkhang] *'face'*
বালু [balu] *'sand'*	हाद्रि [hadri] *'dust'*	खांख्राय [khangkhrai] *'crab'*	लैथो [lwthw] *'sea'*	सानजा [sanza] *'east'*	थालो [thalw] *'hard palate'*	दाव [dau] *'bird'*	ताला [tala] *'lock'*	बिखुं *'back'*
হাঁহ [hah] *'duck'*	हांसोराजा [hangswraza] *'swan'*	जोगोनार [zwgwnar] *'pumpkin'*	फुख्रि [phukhri] *'pond'*	हायजें [haizeng] *'ginger'*	हान [han] *'pick up'*	सु [su] *'thorn'*	गांसो [gangsw] *'grass'*	थोरसि [thwrsi] *'plate'*
পিঠা [pitha] *'pancake'*	लारु [laru] *'laddu'*	सिफुं [siphung] *'flute'*	बैसागु [bwisagu] *'Bihu'*	सिखिरि [sikhiri] *'butterfly'*	फिता [phita] *'ribbon'*	गानदा [ganda] *'rhinoceros'*	फिसा [phisa] *'child'*	खिबु [khibu] *'buttock'*
জুতা [zuta] *'shoe'*	चेनडाल [sendal] *'sandal'*	बिबार [bibar] *'flower'*	आथिं [athing] *'leg'*	गइ [goi] *'betel nut'*	खुनथा [khuntha] *'pillar'*	मुखा [mukha] *'mask'*	खथा [khotha] *'room'*	अख्रां [okhrang] *'sky'*

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Non-cognates

L2 Target	Semantic	Control	Associative	Control	Phonological	Control	Phono-trans	Control
মাছ [mas] *'fish'*	मागुर [magur] *'Magur fish'*	जोमै [zwmwi] *'cloud'*	जे [ze] *'net'*	फुं [phung] *'morning'*	बास [bas] *'bus'*	साथि [sathi] *'lamp'*	हा [ha] *'soil'*	बन [bon] *'firewood'*
পেত [pet] *'stomach'*	उथुमाय [uthumai] *'navel'*	थाखो [thakhw] *'class'*	मेजेम [mezem] *'fat'*	सेंफ्रेम [sengphrem] *'guava'*	बेट [bet] *'bat'*	लावथि [lauthi] *'stick'*	खुदै [khudwi]	मुलि [muli] *'medicine'*
বন্দুক [bonduk] *'gun'*	पिष्टल [pistol] *'pistol'*	खावलाय [khaulai] *'cheek'*	दावहा [dauha] *'war'*	लानजाइ [lanzai] *'tail'*	बन्दु [bondu] *'friend'*	मैदेर [mwider] *'elephant'*	बिलाइ [bilai] *'leaf'*	सोनाब [swnab] *'west'*
কাপোৰ [kapur] *'cloth'*	फालि [phalli] *'handkerchief'*	मोदोम [mwdwm] *'body'*	दरजी [dorzi] *'tailor'*	रुवा [ruwa] *'axe'*	नाथुर [nathur] *'prawn'*	हासुं [hasung] *'funnel'*	जि [zi]	दै [dwi] *'water'*
মকৰা [mokora] *'spider'*	थिकथिका [thikthika] *'lizard'*	आसुगुर [asugur] *'nail'*	बेमा जे [bema ze] *'web'*	सिबिं [sibing] *'sesame'*	मोख्रा [mwkhra] *'monkey'*	हुसेल [husel] *'whistle'*	सैमा [swima] *'dog'*	बाजै [bazwi] *'sister-in-law'*
ধান [dhan] *'paddy'*	ओंखाम [wngkham] *'rice'*	थाइजौ [thaizwu] *'mango'*	आबाद [abad] *'field'*	खोमा *'ear'*	दान [dan] 'alms'	गं [gong] *'horn'*	दाय [dai]	गन्थं [gonthong] *'nose'*
কাঠ [kath] *'wood'*	तक्टा [tokta] *'plank'*	बुहुम [buhum] *'earth'*	आरांगा [arangga] *'table'*	फाफलि [phaphli] *'shoulder'*	पाथ [path] *'text'*	नांगोल [nangwl] *'plough'*	थंफां [thongphang] *'big tree'*	खानस्रि [khansri] *'worm'*
চৰাই [sorai] *'bird'*	गां [gang] *'wing'*	लुवार [luwar] 'leech'	दावबासा [daubasa] *'nest'*	रायमालि [raimali] *'pineapple'*	गराय [gorai] *'horse'*	करत [korot] *'saw'*	लाउ [lau] *'bottle gourd'*	खनथाय [khonthai] *'poem'*
হাত [hat] *'hand'*	आसि [asi] *'finger'*	गिसिब [gisib] *'fan'*	आसान [asan] *'bangle'*	आफादगिरि [aphadgiri] *'president'*	हार [har] *'enter'*	जे [ze] *'net'*	आमाइ [amai] *'maternal uncle'*	सखा [sokha] *'Indian Myna'*
ছাগলী [sagoli] *'goat'*	बोरमा मेनदा [bwrma menda]	लोमजानाय [lwmzanai]	बेदर [bedor] *'meat'*	गुमा [guma] *'grasshopper'*	फागलि [phagli] *'mad (fem)'*	बुहुम [buhum] *'earth'*	बोरला [bwrla] *'bow'*	थायसुम [thaisum] *'cucumber'*

	'sheep'	*'fever'*

APPENDIX M (i).

Word Targets Used in Word Naming and Word Translation Experiments (Categorized List).

Cognate words

Fruit	Vegetable	Animal	Bird	Kitchen Item
आफेल [aphel]/আপেল [apel] *'apple'*	आलु [alu]/আলু [alu] *'potato'*	गाद' [gado]/গাধ [gadho] *'donkey'*	फेसा [phesa]/ফেঁচা [phesa] *'owl'*	सामुस [samus]/চামুচ [samus] *'spoon'*
आंगुर [angur]/আঙুৰ [angur] *'grape'*	गाजर [gazor]/গাজৰ [gazor] *'carrot'*	सिंह [singho]/সিংহ [xingho] *'lion'*	बादामालि [badamali]/বাদুলি [baduli] *'bat'*	केटली [ketli]/কেটলি [ketli] *'kettle'*
खानथाल [khanthal]/কঁঠাল [kothal] *'jackfruit'*	मुला [mula]/মূলা [mula] *'radish'*	सियाल [siyal]/শিয়াল [xiyal] *'fox'*	बाथ' [batho]ভাটৌ [bhatou] *'parrot'*	गिलाच [gilas]/গিলাচ [gilas] *'glass'*
नाचपति [naspoti]/নাচপতি [naspoti] *'pear'*	मटर [motor]/মটৰ [motor] *'pea'*	गराय [gorai]/ঘোঁৰা [ghura] *'horse'*	हांसो [hangsw]/হাঁহ [hah] *'duck'*	जाग [zag]/জগ [zog] *'jug'*
तरमुज [tormuz]/তৰমুজ [tormuz] *'watermelon'*	फुलकबि [phulkobi]/ফুলকবি [phulkobi] *'cauliflower'*	उट [ut]/উট [ut] *'camel'*	फारौ [pharwu]/পাৰ [paro] *'pigeon'*	उवाल [uwal]/উৰাল [ural] *'mortar'*

Non-cognate words

Fruit	Vegetable	Animal	Bird	Kitchen Item
थाइजौ [thaizwu]/আম [am] *'mango'*	बानलु [banlu]/জলকীয়া [zolokiya] *'chilli'*	सैमा [swima]/কুকুৰ [kukur] *'dog'*	दावखा [daukha]/কাউৰী [kauri] *'crow'*	दैहु [dwihu]/কলহ [koloh] *'pitcher'*
थालिर [thalir]/কল [kol] *'banana'*	फानथाव [phanthau]/বেঙেনা [bengena] *'brinjal'*	मोसौ [mwswu]/গৰু [goru] *'cow'*	सखा [sokha]/ঘনচিৰিকা [ghonsirika] *'sparrow'*	थोरसि [thwrsi]/কাঁহী [kahi] *'plate'*
रायमालि [raimali]/আনাৰস [anarox] *'pineapple'*	ৰঙালাও [rongalau]/जोगोनार [zwgwnar] *'pumpkin'*	मोखा [mwkhra]/বান্দৰ [bandor] *'monkey'*	दाओबो [daobo]/বগলী [bogoli] *'crane'*	खुरै [khurwi]/বাতি [bati] *'bowl'*
सेंफ्रेम [sengfrem]/মধুৰি [modhuri] *'guava'*	मानथास' [manthaso]/কচু [kosu] *'arum'*	मोसा [mwsa]/বাঘ [bagh] *'tiger'*	दावराइ [daurai]/ময়ূৰ [moyur] *'peacock'*	साराइ [sarai]/কেৰাহী [kerahi] *'pan'*
मोदोमफुल [mwdwm phul]/অমিতা [omita] *'papaya'*	सामब्राम [sambram]/পিঁয়াজ [piyaz] *'onion'*	मैदेर [mwider]/হাতী [hati] *'elephant'*	दावसि्र [dausri]/শালিকা [xalika] *'myna'*	खामफ्लाइ [khamphlai]/পিৰা [pira] *'stool'*

APPENDIX M(ii).

Word Targets Used in Word Naming and Word Translation Experiments (Randomized List).

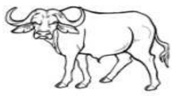
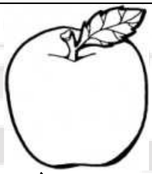
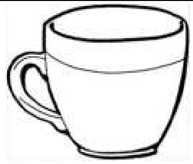
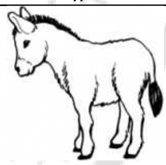
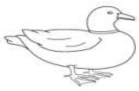
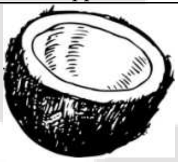
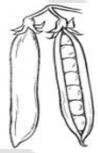
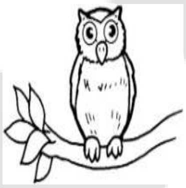
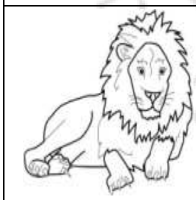
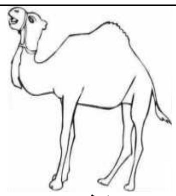
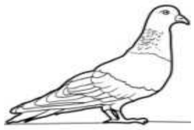
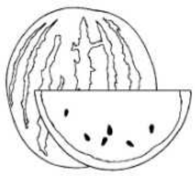
Cognate words				**Non-cognate words**			
गसला/চোলা [gosla/sula] *‘shirt’*	दारि/দাড়ি [dari]/[dari] *‘beard’*	बिगियान/বিজ্ঞান [bigiyan]/[bigyan] *‘science’*	गामसा/গামোছা [gamsa]/[gamusa] *‘towel’*	थाखो/শ্রেণী [thakhw]/[sreni] *‘class’*	हर/ৰাতি [hor]/[rati] *‘night’*	उदै/পেট [udwi]/[pet] *‘stomach’*	सि/কাপোৰ [si]/[kapur] *‘cloth’*
हारा/হাড় [hara/har] *‘bone’*	गेनजि/গেঞ্জি [genzi]/[genzi] *‘vest’*	फुख्रि/পুখুৰী [phukhri]/[pukhuri] *‘pond’*	निब/নিব [nib]/[nib] *‘nib’*	ओंखाम/ভাত [wngkham]/[bhat] *‘rice’*	संख्रि/নিমখ [songkhri]/[nimokh] *‘salt’*	दै/পানী [dwi]/[pani] *‘water’*	जौ/মদ [zwu]/[mod] *‘wine’*
सेकेण्ड/চেকেণ্ড [sekend]/[sekend] *‘second’*	हाबथा/সপ্তাহ [habtha]/[xoptah] *‘week’*	गुदाम/বুটাম [gudam]/[butam] *‘button’*	निहिर/নিয়ৰ [nihir]/[niyor] *‘dew’*	फुं/ৰাতিপুৱা [phung]/[ratipuwa] *‘morning’*	गोदोनाডিঙি [dingi]/[gwdwna] *‘neck’*	दान/মাহ [dan]/[mah] *‘month’*	गनथं/নাক [gonthong]/[nak] *‘nose’*
खाफाल/কপাল/ [khaphal]/[kopal] *‘forehead’*	सादोर/চাদৰ [sadwr]/[sador] *‘sador’*	घन्टा/ঘণ্টা [ghonta]/[ghonta] *‘hour’*	फिथा/পিঠা [phitha]/[pitha] *‘pancake’*	मेगन/চকু [megon]/[soku] *‘eye’*	हाजो/পাহাৰ [hazw]/[pahar] *‘mountain’*	आथिं/ভৰি [athing]/[bhori] *‘leg’*	राव/ভাষা [rau]/[baxa] *‘language’*
बिलोमा/বিল [bilwma]/[bil] *‘lake’*	गाइखेर/গাখীৰ [gaikher]/[gakhir] *‘milk’*	माखन/মাখন [makhon]/[makhon] *‘butter’*	चिनि/চেনি [sini]/[seni] *‘sugar’*	मोनाबिलि/সন্ধিয়া [mwnabili]/[xondhiya] *‘evening’*	फालि/ৰুমাল [phali]/[rumal] *‘handkerchief’*	खनथाय/কবিতা [khonthai]/[kobita] *‘poem’*	थाव/তেল [thau]/[tel] *‘oil’*
मोखां/মুখ [mwkhang]/[mukh] *‘face’*	बोसोर/বছৰ [bwswr]/[bosor] *‘year’*	पेन्सिल/পেঞ্চিল [pensil]/[pensil] *‘pencil’*	दालां/দলং [dalang]/[dolong] *‘bridge’*	आखाइ/হাত [akhai]/[hat] *‘hand’*	सियाहि/চিয়াঁহী [siyahi]/[siyahi] *‘ink’*	दैमा/নদী [dwima]/[nodi] *‘river’*	अख्रां/আকাশ [okhrang]/[akax] *‘sky’*
सारि/শাৰী [sari]/[xari] *‘saree’*	बरफ/বৰফ [boroph]/[boroph] *‘snow’*	थुफि/টুপী [thuphi]/[tupi] *‘cap’*		फरायसा/ছাত্ৰ [phoraisa]/[satro] *‘student’*	अखा/বৰষুণ [okha]/[boroxun] *‘rain’*	थै/তেজ [thwi]/[tez] *‘blood’*	
खोलोम/কলম [khwlwm]/[kolom] *‘pen’*	साहा/চাহ [saha]/[sah] *‘tea’*	हानथु/আঁঠু [hanthu]/[athu] *‘knee’*		खोमा/কাণ [khwma]/[kan] *‘ear’*	अकट’/তাৰিখ [okto]/[tarikh] *‘date’*	बिजाब/কিতাপ [bizab]/[kitap] *‘book’*	

APPENDIX N (i).

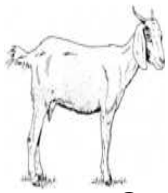
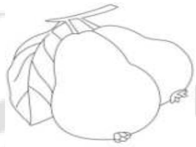
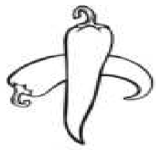
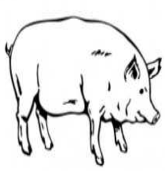
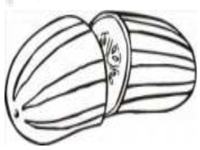
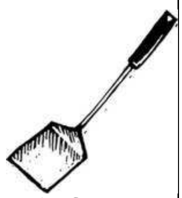
Picture Targets Used in Simple Picture Naming Experiments (Categorized List).

(Pictures are not to scale, for ease of presentation here)

Cognate Pictures

Animal	Bird	Fruit	Vegetable	Kitchen Item
 मैसो/ম'হ [mwisw]/[moh] *'buffalo'*	 बादामालि/বাদুলী [badamali]/[baduli] *'bat'*	 आफेल/আপেল [aphel]/[apel] *'apple'*	 गाजर/গাজৰ [gazor]/[gazor] *'carrot'*	 काप/কাপ [kap]/[kap] *'cup'*
 गादʼ/গাধ [gado]/[gadho] *'donkey'*	 हांसो/হাঁহ [hangsw]/[hah] *'duck'*	 नालेंखर/নাৰিকল [nalengkhor]/[narikol] *'coconut'*	 मटर/মটৰ [motor]/[motor] *'pea'*	 गिलाच/গিলাচ [gilas]/[gilas] *'glass'*
 सियाल/শিয়াল [siyal]/[xiyal] *'fox'*	 फेसा/ফেঁচা [phesa]/[phesa] *'owl'*	 आंगुर/আঙুৰ [angur]/[angur] *'grape'*	 आलु/আলু [alu]/[alu] *'potato'*	 जाग/জগ [zag]/[zog] *'jug'*
 सिंह/সিংহ [singho]/[xingho] *'lion'*	 बाथʼ/ভাটৌ [batho]/[bhatou] *'parrot'*	 खानथाल/কঁঠাল [khanthal]/[kothal] *'jackfruit'*	 लाउ/লাউ [lau]/[lau] *'bottle gourd'*	 केटलि/কেটলি [ketli]/[ketli] *'kettle'*
 उट/উট [ut]/[ut] *'camel'*	 फारौ/পাৰ [pharwu]/[paro] *'pigeon'*	 तरमुज/তৰমুজ [tormuz]/[tormuz] *'watermelon'*	 अलकबि/ওলকবি [olkobi]/[ulkobi] *'turnip'*	 सामुस/চামুচ [samus]/[samus] *'spoon'*

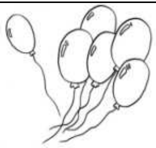
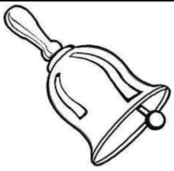
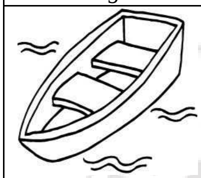
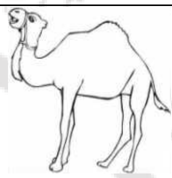
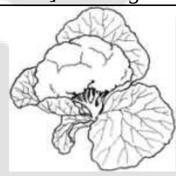
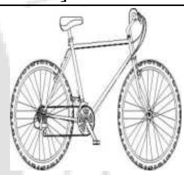
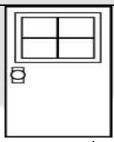
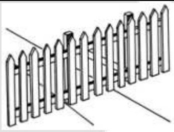
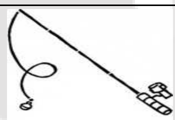
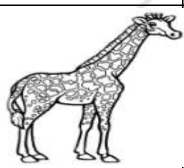
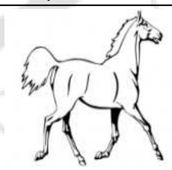
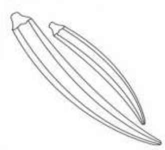
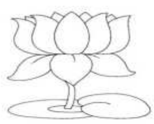
Non-cognate Pictures

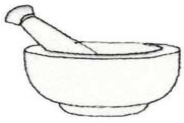
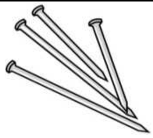
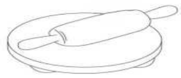
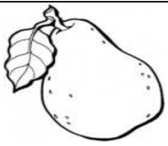
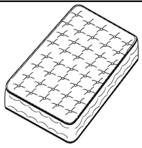
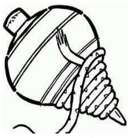
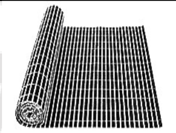
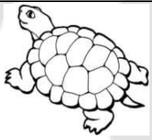
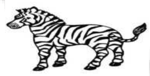
Animal	Bird	Fruit	Vegetable	Kitchen
 मुफुर/ভালুক [muphur]/[bhaluk] *'bear'*	 दावजो/मूर्गी [dauzw]/[murgi] *'hen'*	 थालिर/কল [thalir]/[kol] *'banana'*	 फानथाव/বেঙেনা [phanthau]/[bengena] *'brinjal'*	 खुरै/বাতি [khurwi]/[bati] *'bowl'*
 बोरमा/ছাগলী [bwrma]/[sagoli] *'goat'*	 दाओबो/বগলী [daobw]/[bogoli] *'crane'*	 सेंफ्रेम/মধুৰি [sengfrem]/[modhuri] *'guava'*	 जोगोनार/ৰঙালাউ [zwgwnar]/[rongalau] *'pumpkin'*	 दाबा/কটাৰী [daba]/[kotari] *'knife'*
 मोखा/বান্দৰ [mwkhra]/[bandor] *'monkey'*	 दावखा/কাউৰী [daukha]/[kauri] *'crow'*	 थाइजौ/আম [thaizwu]/[am] *'mango'*	 बानलु/জলকীয়া [banlu]/[zolokiya] *'chilli'*	 साराइ/কেৰাহি [sarai]/[kerahi] *'pan'*
 एनजर/নিগনি [enzor]/[nigoni] *'mouse'*	 दावराइ/ময়ূৰ [daurai]/[moyur] *'peacock'*	 मोदोम फुल/অমিতা [mwdwm phul]/[omita] *'papaya'*	 सामब्राम/পিঁয়াজ [sambram]/[piyaz] *'onion'*	 दैहु/কলহ [dwihu]/[koloh] *'pitcher'*
 अमा/গাহৰি [oma]/[gahori] *'pig'*	 दावस्रि/শালিকা [dausri]/[xalika] *'myna'*	 रायमालि/আনাৰস [raimali]/[anarox] *'pineapple'*	 थायसुम/তিয়ঁহ [thaisum]/[tiyoh] *'cucumber'*	 खोसलि/হেতা [khwsli]/[heta] *'ladle'*

Appendix N (ii).

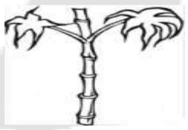
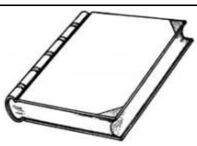
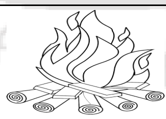
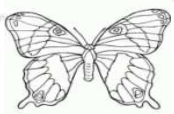
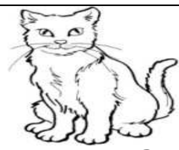
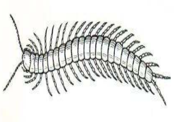
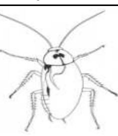
Picture Targets Used in Simple Picture Naming Experiments (Randomized List).

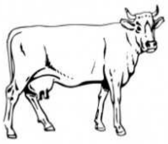
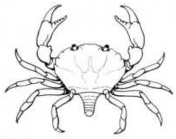
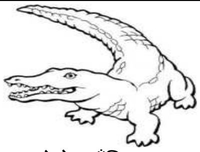
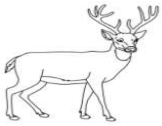
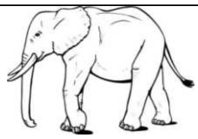
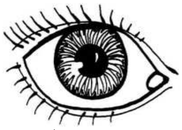
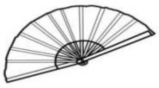
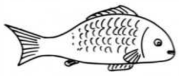
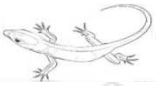
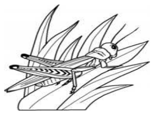
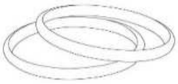
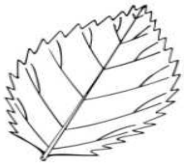
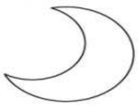
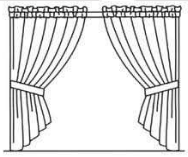
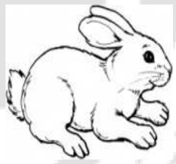
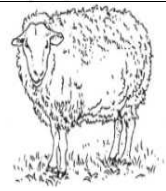
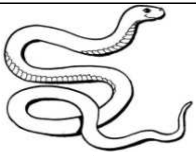
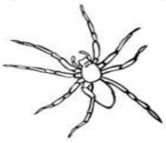
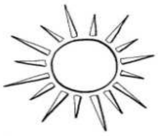
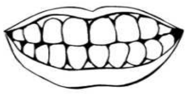
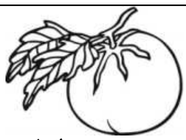
Cognate Pictures

 म'ना/মোনা [mona]/[muna] *'bag'*	 बेलुन/বেলুন [belun]/[belun] *'balloon'*	 गसला/চোলা [gosla]/[sula] *'basket'*	 घन्टा/ঘন্টা [ghonta]/[ghonta] *'bell'*	 बेल/বেল্ট [bel]/[belt] *'belt'*
 नाव/নাও [nau]/[nau] *'boat'*	 बालथिं/বাল্টিং [balthing]/[balthing] *'bucket'*	 बान्दाकबि/বন্ধাকবি [bandakobi]/[bandhakobi] *'cabbage'*	 उट/উট [ut]/[ut] *'camel'*	 ममबाथि/মমবাতি [mombathi]/[mombati] *'candle'*
 थुफि/টুপী [thuphi]/[tupi] *'cap'*	 गारि/গাড়ী [gari]/[gari] *'car'*	 फुलकबि/ফুলকবি [phulkobi]/[phulkobi] *'cauliflower'*	 घड़ी/ঘড়ী [ghori]/[ghori] *'clock'*	 साइकेल/চাইকেল [saikel]/[saikel] *'cycle'*
 पुतला/পুতলা [putola]/[putola] *'doll'*	 दरजा/দৰ্জা [[dorza]/[dorza] *'door'*	 बेरा/বেৰা [bera]/[bera] *'fence'*	 बोरसि/বৰশী [bwrsi]/[boroxi] *'fishhook'*	 भुत/ভূত [bhut]/[bhut] *'ghost'*
 जिराफ/জিৰাফ [ziraph]/[ziraph] *'giraffe'*	 गिटार/গীটাৰ [gitar]/[gitar] *'guitar'*	 हाथुरा/হাতুৰী [hathura]/[haturi] *'hammer'*	 गराय/ঘোঁৰা [gorai]/[ghura] *'horse'*	 साबि/চাবি [sabi]/[sabi] *'key'*
 सिला/চিলা [sila]/[sila] *'kite'*	 जांख्ला/জখলা [zangkhla]/[zokhola] *'ladder'*	 भेण्डि/ভেন্দি [bhendi]/[bhendi] *'lady's finger'*	 ताला/তলা [tala]/[tola] *'lock'*	 पदुम/পদুম [podum]/[podum] *'lotus'*

 नेवलाय/নেউল [neulai]/[neul] *'mongoose'*	 उवाल/উৰাল [uwal]/[ural] *'mortar'*	 गाजोल/গজাল [gazwl]/[gozal] *'nail'*	 हार/হাৰ [har]/[har] *'necklace'*	 बेलना/বেলনা [belna]/[belna] *'pastry board'*
 नाचपति/নাচপতি [naspoti]/[naspoti] *'pear'*	 खोलोम/কলম [kolom]/[kolom] *'pen'*	 तसक/তুচ্ছক [tosok]/[tusok] *'mattress'*	 दालिम/ডালিম [dalim]/[dalim] *'pomegranate'*	 गलाप/গোলাপ [golap]/[gulap] *'rose'*
 लाटुम/লাটুম [latum]/[latum] *'top'*	 जुता/জুতা [juta]/[juta] *'shoe'*	 पाटि/পাটি [pati]/[pati] *'mat'*	 मुजा/মুজা [muza]/[muza] *'sock'*	 ससमा/চছমা [sosma]/[sosma] *'spectacles'*
 थिंख्लि/তেঁতেলী [thingkhli]/[teteli] *'tamarind'*	 खासेव/কাছ [khaseu]/[kaso] *'tortoise'*	 साथा/ছাতি [satha]/[sati] *'umbrella'*	 खिरकि/খিৰিকী [khirki]/[khiriki] *'window'*	 जेब्रा/জেব্ৰা [zebra]/[zebra] *'zebra'*

Non-cognate Pictures

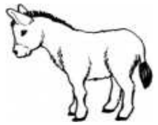
 रुवा/কুঠাৰ [ruwa]/[kuthar] 'axe'	 उनदै/কেঁচুৱা [undwi]/[kesuwa] *'baby'*	 औवा/বাঁহ [wua]/[bah] *'bamboo'*	 थोरसि/কাঁহী [thwrsi]/[kahi] *'plate'*	 बेरे/মৌমাখি [bere]/[moumakhi] *'bee'*
 बिजाब/কিতাপ [bizab]/[kitap] *'book'*	 दिंग्रि/বটল [dingri]/[botol] *'bottle'*	 अर/জুই [or]/[zui] *'fire'*	 सिखिरि/পখিলা [sikhiri]/[pokhila] *'butterfly'*	 मावजि/মেকুৰী [mauzi]/[mekuri] *'cat'*
 बिसा/চেলা [bisa]/[sela] *'centipede'*	 मासि/চকী [masi]/[soki] *'chair'*	 खांख'मा/পঁইতাচোৰা [khangkhoma]/[poitasura] *'cockroach'*	 बुहुम/পৃথিৱী [buhum]/[pritibi] *'earth'*	 माय/গোম-ধান [mai]/[gumdhan] *'corn'*

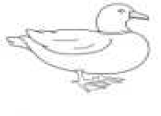
 मोसौ/গৰু [mwswu]/[goru] *‘cow’*	 खांख्राय/কেঁকোৰা [khangkhrai]/[kekura] *‘crab’*	 गोलेर/ঘঁৰিয়াল [gwler]/[ghoriyal] *‘crocodile’*	 मै/হৰিণ [mwi]/[horin] *‘deer’*	 सैमा/কুকুৰ [swima]/[kukur] *‘dog’*
 खोमा/কাণ [khwma]/[kan] *‘ear’*	 मैदेर/হাতী [mwider]/[hati] *‘elephant’*	 मेगन/চকু [megon]/[soku] *‘eye’*	 गिसिब/বিচনী [gisib]/[bisoni] *‘fan’*	 ना/মাছ [na]/[mas] *‘fish’*
 थिकथिका/জেঠী [thikthika]/[zethi] *‘lizard’*	 सिफुं/বাঁহী [siphung]/[bahi] *‘flute’*	 एमबु/ভেকুলী [embu]/[bhekuli] *‘frog’*	 सामब्राम गुफुर/ নহৰু [sambram guphur]/[nohoru] *‘garlic’*	 गुमा/ফৰিং [guma]/[phoring] *‘grasshopper’*
 आखाइ/হাত [akhai]/[hat] *‘hand’*	 आसान/খাৰু [asan]/[kharu] *‘bangle’*	 बिलाइ/পাত [bilai]/[pat] *‘leaf’*	 आथिं/ভৰি [athing]/[bhori] *‘leg’*	 गुसुथि/ওঁঠ [gusuthi]/[uth] *‘lip’*
 अखाफोर/চন্দ্ৰ [okhaphwr]/ [sondro] *‘moon’*	 थामफै/মহ [thamphwi]/[moh] *‘mosquito’*	 फैसालि/পৰ্দা [phwisali]/[porda] *‘curtain’*	 सेसा/শহাপহু [sesa]/[xohapohu] *‘rabbit’*	 बोरमा मेनदा /ভেৰা [bwrma menda]/[bhera] *‘sheep’*
 जिबौ/সাপ [zibwu]/[xap] ‘snake’	 बेमा/মকৰা [bema]/[mokora] *‘spider’*	 हाथरखि/তৰা [hathorkhi]/[tora] *‘star’*	 सान/সূৰ্য্য [san]/[xurjyo] *‘sun’*	 आरांगा/মেজ [arangga]/[mez] *‘table’*
 हाथाइ/দাঁত [hathai]/[dat] *‘teeth’*	 मोसा/বাঘ [mwsa]/[bagh] *‘tiger’*	 गोखै फानथाव/ বিলাহী [gwkhwi phanthau]/[bilahi] *‘tomato’*	 हाजो/পাহাৰ [hazw]/[pahar] *‘mountain’*	 खानस्रि/কেঁচু [khansri]/[kesu] ‘worm’

APPENDIX O.

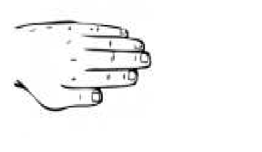
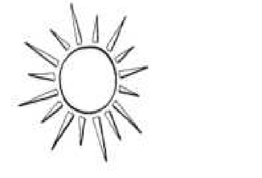
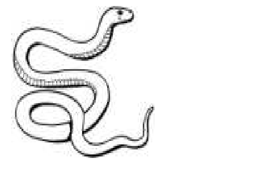
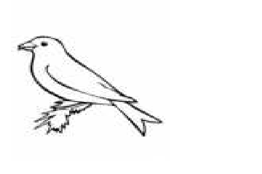
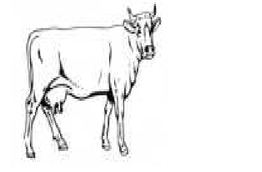
Picture Targets and Corresponding Distracters and Primes Used in Picture-Word Interference Experiments (10A, 10B, and 10C)and Primed Picture Naming Experiments (11A, 11B, and 11C).

Cognate picture targets

	Identity			Semantically related			Control		
Picture	Bodo	Assamese	Meaning	Bodo	Assamese	Meaning	Bodo	Assamese	Meaning
	गाद’ [gado]	গাধ [gadho]	*‘donkey’*	गराय [gorai]	ঘোঁৰা [ghura]	*‘horse’*	सिफुं [siphung]	বাঁহী [bahi]	*‘flute’*
	ताला [tala]	তলা [tola]	*‘lock’*	साबि [sabi]	চাবি [sabi]	*‘key’*	दैहु [dwihu]	কলহ [koloh]	*‘pitcher’*
	फेसा [phesa]	ফেঁচা [phesa]	*‘owl’*	बादामालि [badamali]	বাদুলী [baduli]	*‘bat’*	रुवा [ruwa]	কুঠাৰ [kuthar]	*‘axe’*
	गिटार [gitar]	গীটাৰ [gitar]	*‘guitar’*	सिटार [sitar]	চেতাৰ [setar]	*‘sitar’*	बिबार [bibar]	ফুল [phul]	*‘flower’*
	खोलोम [khwlwm]	কলম [kolom]	*‘pen’*	पेन्सिल [pensil]	পেঞ্চিল [pensil]	‘pencil’	मुफुर [muphur]	ভালুক [bhaluk]	*‘bear’*

	Identity			Semantically related			Control		
Picture	Bodo	Assamese	Meaning	Bodo	Assamese	Meaning	Bodo	Assamese	Meaning
	सिंह [singho]	সিংহ [xingho]	*'lion'*	मोसा [mwsa]	বাঘ [bagh]	*'tiger'*	संख्रि [songkhri]	নিমখ [nimokh]	*'salt'*
	जुथा [jutha]	জুতা [juta]	*'shoe'*	चेनडाल [sandal]	চেণ্ডেল [sendel]	*'sandal'*	गिसिब [gisib]	বিছনী [bisoni]	*'fan'*
	गाजर [gazor]	গাজৰ [gazor]	*'carrot'*	मुला [mula]	মূলা [mula]	*'radish'*	अमा [oma]	গাহৰি [gahori]	*'pig'*
	गिलाच [gilas]	গিলাচ [gilas]	*'glass'*	काप [kap]	কাপ [kap]	*'cup'*	सैमा [swima]	কুকুৰ [kukur]	*'dog'*
	हांसो [hangsw]	হাঁহ [hah]	'duck'	दावजो [dauzw]	মুৰ্গী [murgi]	*'hen'*	दिरु [diru]	ৰছী [rosi]	*'rope'*

Non-cognate picture targets

	Identity			Semantically related			Control		
Picture	Bodo	Assamese	Meaning	Bodo	Assamese	Meaning	Bodo	Assamese	Meaning
	आखाइ [akhai]	হাত [hat]	*‘hand’*	आसि [asi]	আঙুলী [anguli]	*‘finger’*	दै [dwi]	পানী [pani]	*‘water’*
	सान [san]	সূৰ্য্য [xurzyo]	*‘sun’*	अखाफोर [okhaphwr]	চন্দ্ৰ [sondro]	*‘moon’*	हा [ha]	মাটি [mati]	*‘soil’*
	जिबौ [zibwu]	সাপ [xap]	*‘snake’*	अजगर [ozogor]	অজগৰ [ozogor]	*‘cobra’*	फानथाव [phanthau]	বেঙেনা [bengena]	*‘aubergine’*
	दाव [dau]	চৰাই [sorai]	*‘bird’*	गां [gang]	পাখি [pakhi]	*‘wing’*	गइ [goi]	তামোল [tamul]	*‘betel nut’*
	मोसौ [mwswu]	গ’ৰু [goru]	*‘cow’*	मैसो [mwisw]	ম’হ [moh]	*‘buffalo’*	खुरै [khuwi]	বাটি [bati]	*‘bowl’*

Identity				Semantically related			Control		
Picture	Bodo	Assamese	Meaning	Bodo	Assamese	Meaning	Bodo	Assamese	Meaning
	बिजाब [bizab]	কিতাপ [kitap]	*‘book’*	लेखा [lekha]	বহী [bohi]	*‘copy’*	थै [thwi]	তেজ [tez]	*‘blood’*
	बिफां [biphang]	গছ [gos]	*‘tree’*	बिलाइ [bilai]	পাত [pat]	*‘leaf’*	लान्जाइ [lanzai]	নেজ [nez]	*‘tail’*
	दाबा [daba]	কটাৰী [kotari]	*‘knife’*	सिखा [sikha]	দা [da]	*‘broadsword’*	हाजो [hazw]	পাহাৰ [pahar]	*‘mountain’*
	मोख्रा [mwkhra]	বান্দৰ [bandor]	*‘monkey’*	गरिला [gorila]	গৰিলা [gorilla]	*‘gorilla’*	अख्रां [okhrang]	আকাশ [akax]	*‘sky’*
	न’ [no]	ঘৰ [ghor]	*‘house’*	देरा [dera]	কুটীৰ [kutir]	*‘cottage’*	बेगर [begor]	গুটি [guti]	*‘seed’*

PUBLICATIONS AND PRESENTATIONS

Publication

- **Kaur, S.** & Som, B. (2013). Priming effects across Bodo−Assamese Bilinguals: The effect of age of acquisition and level of proficiency. *International Journal of Mind, Brain and Cognition, 4 (1-2),* 87−112.

Presentations

- **Kaur, S**. (2016). *Bilingual language representation and processing: Evidence from simple picture naming*. Paper presented at the 38th International Conference of Linguistic Society of India (ICOLSI38), November 10−12, Indian Institute of Technology Guwahati, Guwahati.

- **Kaur, S.** (2016). *Translation priming with cognates and non-cognates in Bodo−Assamese bilinguals*. The Third Annual Linguistics Conference at the University of Georgia (LCUGA 3), University of Georgia, Athens, Georgia, October 7−9, 2016. (accepted to be presented).

- **Kaur, S.** & Som, B. (2016). *The role of script in speech production: A study with Bodo−Assamese bilinguals*. The Architecture and Mechanism of Language Processing (AMLaP) Conference, BCBL, Bilbao, Spain, September 1−3, 2016. (accepted to be presented).

- **Kaur, S.** (2016). *The role of semantic context, cognate status, age of acquisition and proficiency in bilingual word translation: Evidence from Bodo−Assamese bilinguals*. The 22nd Himalayan Languages Symposium, June 8−10, 2016, Indian Institute of Technology Guwahati, Guwahati.

- **Kaur, S.** (2014). *Priming effects across Bodo–Assamese bilinguals: Evidence from translation priming and masked translation priming tasks*. Paper presented at the 30th South Asian Languages Analysis Roundtable (SALA Roundtable–30), February 6-8, University of Hyderabad, Hyderabad.