

# **Influence of Anthropomorphic Product Appearance on Purchase Intention: A Cognitive Ergonomics Perspective**

*A Thesis*

*Submitted in Partial Fulfillment of the Requirements for the Degree of*

*Doctor of Philosophy*

*By*

**Anirban Chowdhury**

(Roll No.: 126105003)

*Under supervision of*

**Dr. Sougata Karmakar**



**Department of Design**

**Indian Institute of Technology Guwahati**

**Guwahati-781039, Assam, India.**

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Department of Design

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Guwahati-781039, Assam, India.

**Date:**

## **Certificate**

**(To Whom It May Concern)**

This is to certify that the thesis work presented herein by Mr. Anirban Chowdhury was undertaken under my guidance and supervision. The volume of work presented here, for the award of Doctor of Philosophy (PhD) in Design of Indian Institute of Technology (IIT) Guwahati, was not submitted by him earlier for any other degree or diploma.

He has undergone six specified/ suggested courses and fulfilled all the requirements of rules and regulations as mentioned in the PhD ordinance for submitting the thesis for PhD degree of Indian Institute of Technology (IIT) Guwahati.

(Dr. Sougata Karmakar)

**Assistant Professor**

**Department of Design**

**Indian Institute of Technology (IIT) Guwahati**

**Guwahati-781039, Assam, India.**

## Preface

Product design is an important domain of industrial design. Global scenarios of user centered design approach state that designers need to evaluate the designed product with users for better market outcome. In highly competitive market of India as well as abroad there is always a need of uniqueness in product design. Designers are always thinking to bring newness in product in any context of their use. This novelty in product design leads to success of a company. In this context, many companies take approaches to bring newness in product through different product appearance design.

Around eighty percent of total human sensory information is processed through visual channels. Even, in many cases consumers decide to purchase a product based on the visual appearance of the product (e.g. in case of well packaged product, online purchase etc.). Therefore, the strategy may be fruitful to create product unique and visually attractive through anthropomorphic product appearance design. Furthermore, according to theories of product semantics, it is possible to communicate different positive messages (e.g. emotional message) through product appearance.

In this thesis work an attempt has been made to enhance market acceptance of the product through anthropomorphic product appearance design. The research work stated in this thesis, undertaken evaluation of anthropomorphic product appearances from cognitive ergonomics perspective. This study considers three cognitive human factors (viz. perceived attractiveness, perceived apparent usability and perceived pleasure) to explain probable influence of anthropomorphic product appearance on its purchase intention.

## Acknowledgement

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Anirban Chowdhury

## Summary of the Thesis

### 1. Overview

Many anthropomorphic products (which express humanlike appearances) are nowadays found in the market. Due to incorrect/ improper use of anthropomorphic attributes in product appearance, all anthropomorphic products are not accepted by the market though anthropomorphic look is intended for better visual attraction and market acceptance. Present study aims to discover the influence of anthropomorphic appearance on product purchase intention considering three cognitive human factors viz. visual attractiveness, perceived pleasure and apparent usability. In the first phase of the thesis work, three (03) different products were evaluated through standard questionnaires. Second phase of the study intended to evaluate three (03) products (among these three, two were same as in first phase of evaluation) using eye-tracking (for visual attractiveness evaluation) and facial EMG (for evaluation of perceived pleasure) paradigms. Results of preset thesis work suggest that anthropomorphic product attributes have potentials to improve product purchase intention; provided these attributes do not negatively influencing visual attractiveness, perceived pleasure and apparent usability. In addition, eye-tracking and facial EMG experiments are beneficial for evaluation of attractiveness and pleasant appearance of anthropomorphic products, respectively. Thus, it could be concluded that designers need to consider these cognitive human factors (viz. visual attractiveness, perceived pleasure and apparent usability) while designing anthropomorphic appearance of the product to expedite its acceptance in market.

#### *1.1. Brief of Chapter 1*

Anthropomorphic products are generally attributed with human-like appearance or human like behaviour. It is observed that anthropomorphism (attribution of humanness) was applied in many design contexts such as human computer interaction (HCI), interaction design (beyond HCI), robotics, automobile design, household product design, graphic design, animation design etc. Very few reports

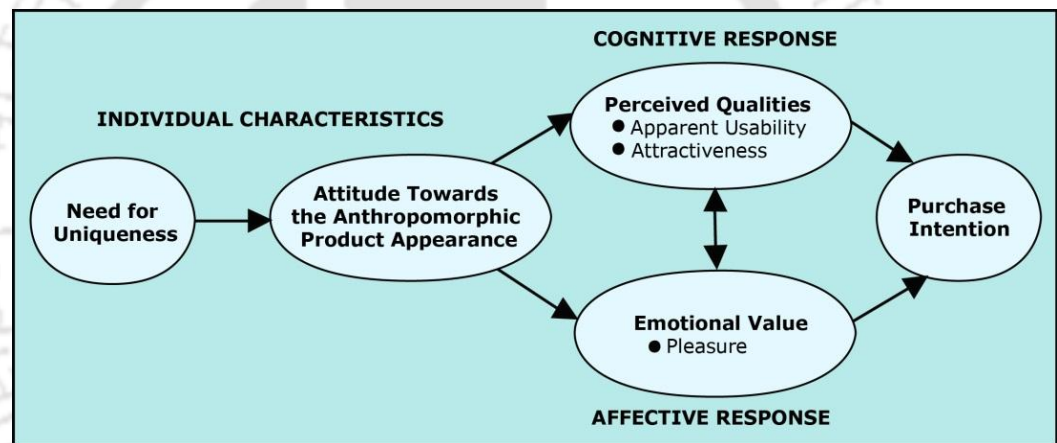
have highlighted about the negative and positive consequences of anthropomorphic attributes in product selection behaviour. There are no published reports specifically on an anthropomorphic product choice study on Indian consumers/ users. As the Indian market is one of the biggest consumer markets in the world, there is scope to study the consequences of anthropomorphic product appearance on product purchase. Moreover, cognitive and affective aspects of the anthropomorphic appearance of product design are less evident in literature. These facts were identified in ‘**Chapter-1**’ of this thesis.

### ***1.2. Brief of Chapter 2***

Cognitive ergonomics studies the cognitive and affective behaviour of users in different context of product uses. Human cognitive and affective systems may interplay role in evaluation of product quality and product value, and thus, these human systems helps in decision making on product/ brand choice. Sheth-Newman-Gross (SNG) model states that different product values (*Functional, Social, Emotional, Epistemic, and Conditional*) have influence on product choice behaviour (Sheth, Newman, & Gross, 1991). Among these product values, functional and emotional values are important from the perspective of cognitive ergonomics. Furthermore, Creusen and Schoormans (2005) elaborated the role of product appearance on perceptions of functional, aesthetic and ergonomics values; and they stated that these product appearance related values in turn helps in product choice. According to the theories on semantic and emotional design, users’ emotion could be evoked by product attributes related to its appearance. Therefore, anthropomorphic attributes in product appearance may affect the perception of aesthetic, functional and ergonomics values.

According to the tri-component attitude model of cognition; product/ brand attributes influence the affection (feelings) towards the brand/ product and this affection ultimately leads to a conative attitude of consumers/ users (purchase intention and brand interest) (Majumdar, 2011; Morris et al., 2002). Levi’s model of consumer attitude demonstrates that perceived qualities and emotional values of the product influences the purchase intention if there is a need for uniqueness

(Kumar, Lee, & Kim, 2009; Majumdar, 2011). It is now clear that cognitive and affective systems are involved in product purchase behaviour. Based on the literatures of first chapter, it might be proclaimed that anthropomorphism may be helpful to bring newness in appearance of products in the market. Further, anthropomorphic forms may influence product quality and emotional value perceived by users, thereby influence the product purchase intention. Similar to Levi's model of consumer attitude, a conceptual model was built upon the consumers' attitude towards an anthropomorphic product for the present thesis work (**Figure 1**). This conceptual model was helpful to propose hypotheses for present research and to follow subsequent steps towards proving of them empirically.



**Figure 0.1 Conceptual model for users' attitude towards an anthropomorphic product purchase intention.**

In '**Chapter-2**', detailed literature review which covered different models and theories of cognitive and affective product design were carried out, before any hypothesis statement. Famous models and theories studied for this dissertation included *Theories of anthropomorphism*; *James-Lange Theory of Emotion*; *Cannon-Bard Theory of Emotion*; *Schachter-Singer Theory of Emotion*; *Cognitive-Appraisal Theory of Emotion*; *Action-readiness Theory*; *Core-affect theory of emotion*; *Communicative theory*; *Circumplex Model of Emotion*; *theories of Emotion Recognition Through Facial Expression*; *Theories of Kansei*

*Engineering; Theories of product personality; Pleasure Model; Basic Model of Product Appraisal; Emotional Design Model; Technology as Experience Framework; Theories of Usability Perception, Theories of Attractiveness and Visual Attention, Wicken's Information processing model; The Sheth-Newman-Gross Model of Consumer Choice Behaviour; The Engel-Kollat-Blackwell Model of Decision Making etc.* After a detailed literature survey, following key observations were put forth:

- a) *The cognitive and affective theories imply that visual attractiveness, apparent usability and perceived pleasure may be the determinants of anthropomorphic product choice.*
- b) *The evaluation of the anthropomorphic product appearance could be possible through questionnaire study, eye-movement study and facial EMG study.*
- c) *The eye-movement study and facial EMG study might be useful for validation of product evaluation results obtained from questionnaire based study.*

To conduct the present study, total five variables were identified to find out the basis of anthropomorphic product choice decision. These were anthropomorphism, visual attractiveness, perceived pleasure, apparent usability and product purchase intention. In this thesis, an attempt has been made to establish relationships among these variables.

Total four hypotheses were stated in this chapter based on theories related to cognitive ergonomics and anthropomorphic product design. These hypotheses are as follows:

**H<sub>a1</sub>:** Visual attractiveness and perceived pleasure (due to anthropomorphic product appearance) significantly affects the anthropomorphic product purchase intention.

**H<sub>a2</sub>:** Apparent usability and visually perceived pleasantness (due to anthropomorphic product appearance) significantly affects the anthropomorphic purchase intention.

**H<sub>a3</sub>:** Activity (electrical potential) of facial muscles (viz. corrugator supercilii and zygomaticus major) significantly varies with levels (or extent) of pleasant look of anthropomorphic products.

**H<sub>a4</sub>:** Anthropomorphic appearance of the product significantly affects the visual attention which in turn affects the anthropomorphic product purchase intention during in shop/ on shelf visual search behaviour.

### **1.3. Brief of Chapter 3**

The '**Chapter-3**' of the thesis discussed about the establishment of relationships among anthropomorphic appearance, visual attractiveness, perceived pleasure and product purchase intention. Appearances of two different products (tiffin box and chair) were tested and results were reported in this chapter. Key findings mentioned in this chapter were as follows:

- a) *Level of anthropomorphism significantly varied with number and type of anthropomorphic attributes incorporated in product appearance.*
- b) *Anthropomorphic appearance had significant effect on perception of both visual attractiveness and visually perceived pleasure.*
- c) *Level of anthropomorphism, visual attractiveness and visually perceived pleasure were significantly correlated among each other.*
- d) *Visual attractiveness and visually perceived pleasure might be affected by the anthropomorphic product appearance.*
- e) *Though visual attractiveness and visually perceived pleasure had significant solitary influence on 'anthropomorphic product purchase intention', the influence of visual attractiveness on anthropomorphic product purchase intention was mediated through visually perceived pleasure.*

#### **1.4. Brief of Chapter 4**

This chapter dealt with the establishment of inter relationships among anthropomorphic appearance, apparent usability, perceived pleasure and product purchase intention. To establish these relationships, appearances of watch and chair were assessed through a questionnaire to measure the above mentioned variables. Salient observations of user testing were as follows:

- a) *Anthropomorphic attributes significantly influenced both the perception of apparent usability and visually perceived pleasure.*
- b) *The strategy of incorporation of anthropomorphic attributes in product appearance was found to be crucial in terms of its impact on purchase intension.*
- c) *There might be a chance of low market acceptance of an anthropomorphic product if humanlike attributes used in the product negatively affect apparent usability and visually perceived pleasure.*
- d) *Designers should give due consideration on apparent usability and visually perceived pleasure while designing anthropomorphic appearance.*
- e) *Designers should emphasize more on apparent usability than visually perceived pleasure as users prioritise the apparent usability over the perceived pleasure.*

#### **1.5. Brief of Chapter 5**

The research work described in ‘**Chapter-5**’ elaborated the neurocognitive basis of anthropomorphic product choice. Two sensitive neurocognitive techniques viz. facial EMG and eye-tracking techniques were employed to evaluate impact of anthropomorphic product appearance on users/ consumers. The facial EMG study was conducted to estimate the perceived pleasure caused by a particular anthropomorphic appearance, whereas eye-tracking study was conducted to analyse the attention grabbing power of anthropomorphic products when

presented in a virtual shop environment. Later, in this chapter, a relationship between attention and pleasure was established in the context of anthropomorphic product choice. In addition, results of questionnaire based studies of ‘**Chapter-3**’ and ‘**Chapter-4**’ were validated with the results of facial EMG and eye-tracking experiments. Important observations of this chapter were as follows:

- a) *Facial EMG study might be applicable for anthropomorphic and pleasurable product design.*
- b) *Zygomaticus and corrugator activities were found to be sensitive markers for pleasurable anthropomorphic product appearance design.*
- c) *The eye-tracking technique could fruitfully be applied to evaluate visual attractiveness of anthropomorphic product.*
- d) *There were similarities between the observations of questionnaire based studies and neurocognitive techniques (facial EMG and eye-tracking) based experiments.*
- e) *Facial EMG and eye-tracking techniques could be very sensitive neurocognitive markers for anthropomorphic product appearance design and validation of concept model.*

### **1.6. Brief of Chapter 6**

Last chapter of this thesis (**Chapter-6**) brought about an overview of all observations presented in earlier chapters. This dissertation established a model of ‘The consumer process for anthropomorphic product purchase’ and came up with a framework for anthropomorphic product appearance evaluation considering cognitive human factors. Finally, a design guideline was proposed based on all the study results of this thesis. Following conclusions were drawn at the end of ‘**Chapter-6**’:

- a) *Questionnaire technique along with eye movement study and facial EMG study would be beneficial for anthropomorphic product design evaluation and for the prediction of anthropomorphic product purchase intention.*
- b) *Product designer needs to follow design strategies (which considered visual attractiveness, apparent usability and perceived pleasure) noted in this chapter for better market acceptance.*

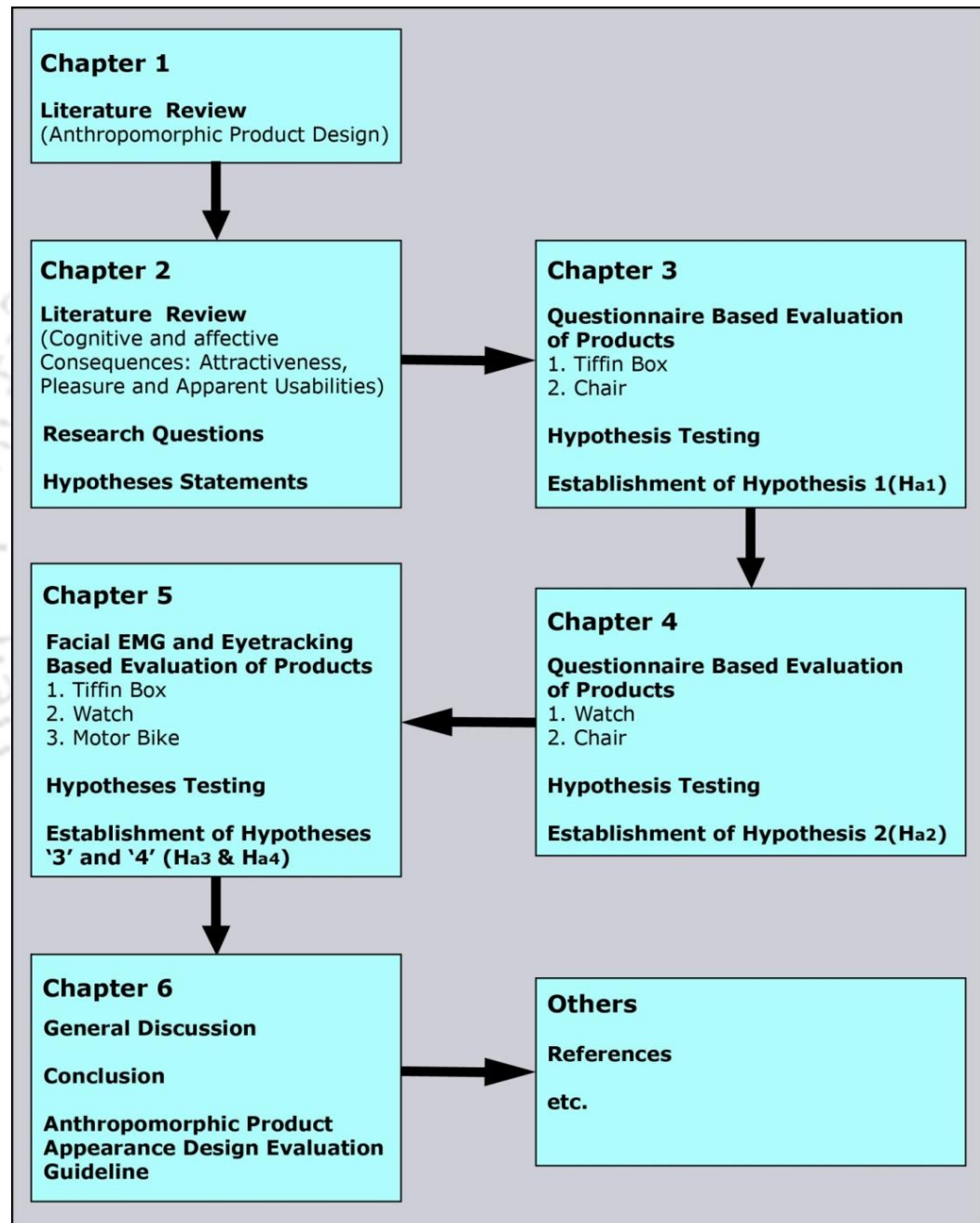
## **2. Salient features and findings of the present thesis work**

The following features and findings are unique in the present thesis work

- a) *Relationships among cognitive human factors (viz. visual attractiveness, perceived pleasure and apparent usability) were established in the context of anthropomorphic product appearance design.*
- b) *The purchase intention of anthropomorphic product among consumers was also predicted on the basis of the aforesaid three cognitive human factors.*
- c) *The similar study on cognitive ergonomics perspective in the Indian context is not available in literature before this work.*
- d) *The present thesis employed the eye-tracking technique for the evaluation of visual attractiveness of anthropomorphic products.*
- e) *Facial EMG technique was employed for the evaluation of pleasure due to anthropomorphic product appearance.*
- f) *The protocol followed for facial EMG evaluation was new as it was established in the laboratory during this thesis work.*
- g) *A causal relationship was established between visual attention and pleasure. It indicated that the more visual attention toward an anthropomorphic product could be gained through pleasant anthropomorphic appearance than a neutral one.*

h) A framework and an anthropomorphic product evaluation strategy were established considering three cognitive human factors (viz. visual attractiveness, perceived pleasure and apparent usability).

The flow of whole thesis work was systematically presented in ‘**Figure 2**’.



**Figure 0.2 Thesis work flow.**

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## Chapter-1: Introduction to anthropomorphic product design

### Abstract

Anthropomorphic products either reflect humanlike appearance and or humanlike behavior. Present chapter of the thesis discusses on impact of anthropomorphic appearance of product in relation to its acceptance in the market, considering its influence on cognitive ergonomics related factors such as visual attractiveness, apparent usability and perceived pleasure. Available literatures suggest that anthropomorphism having been applied in product design from the ancient time of human civilization but designers' knowledge is limited about roles of cognitive or emotional consequences on product acceptance in case of anthropomorphic product appearance. Fewer reports have highlighted on the negative impact of anthropomorphic attributes in product selection while most of the literatures demonstrate only positive consequences.. However, few researches have been conducted on the effect of anthropomorphic product appearance on affect (pleasure as positive affect); and, how people are able to perceive human schema in anthropomorphic products. Even, there is no mention in literature about the influence of anthropomorphic attributes on visual attractiveness and apparent usability perception. Therefore, it is envisaged that there is scope of research work in the area of anthropomorphic product appearance design. This chapter concludes if anthropomorphic attributes in product appearance interfere with perception of visual attractiveness; apparent usability; and pleasure; there is a chance of less product acceptance. With this background, present thesis aims to evaluate the influence of anthropomorphic attributes (in product appearance) on cognitive human factor issues (visual attractiveness, apparent usability, and perceived pleasure) and thus on purchase intention of anthropomorphic product.

**Keywords:** *anthropomorphism; attractiveness; cognition; emotion; perception*

### 1. Introduction

Product design is a very challenging job for designers in the present highly competitive commercial environment. Companies generally try to communicate a certain meaning (e.g. prestige) through product appearance; and; hence they are trying to enhance competitive advantage in the market for product's success (Lewalski, 1988; Bloch, 1995; Hertenstein et al., 2005; Yamamoto & Lambert, 1994; Chang & Wu, 2007). In addition, consumers' behaviors are also changing day by day with their requirements and adaptation to new trends. According to the present scenario, designers and design researchers should think about the creation of novelty in product design (Mugge & Schoormans, 2012).

Cognitive ergonomics deals with perception, cognition, information processing and decision making (according to 'International Ergonomics Association') during the product selection process. From the cognitive ergonomics perspective, aesthetics/ attractiveness, functionality, usability and safety are important criteria for enhancing the product value in the market through product's appearance (Creusen & Schoormans, 2005; Creusen et al., 2010). The visual appearance of a product plays an important role in product selection process; because in many cases consumers are unable to evaluate products physically (e.g. by means of touch) before purchase. So, it can be assumed that visual appearance of the product should be designed in such a way that it would reflect all cognitive factors related to product value and thus positively influence the consumers' decision during product purchase. It has been observed from previous studies that consumers can perceive the personality of different products (which basically depends on product appearance); and, the product which has strong personality also has positive influence on product choice (Govers & Schoormans, 2005). According to Jordan (2000), product personality assignment is a technique to make a product pleasurable. In contrast, the appearance of a product may reflect the anthropomorphism. Commonly, anthropomorphic products reflect different degrees of humanness, either through their appearances and or through interaction patterns (Preece, 2012). The current chapter of the thesis discusses about possibilities of variations of visual attractiveness, pleasure and apparent usability due to degrees of humanness (anthropomorphism) and types of anthropomorphic attributes in product appearance.

## **2. Anthropomorphism and anthropomorphic product design**

Product form may convey the function of the product, semantics/ different meanings and emotion such as pleasure. In product design, there are three common principles with respect to the form of the product (Demirbilek and Sener, 2003; Wake and Das, 2000). These laws are -

- a) Form follows function
- b) Form follows meaning
- c) Form follows emotion

Designers generally take advantages of these principles in product form design as it is related to behavioural responses (e.g. attitude towards product purchase) of users/ consumers. Thus, the form of a product can contribute to its success in numerous ways. In markets, form helps to gain customers' attention and it is important for communicating information to customers. Product form sometimes portrays a metaphor in order to improve the experiential properties of the product and these properties may be very dominating on users (Desmet and Hekkert, 2002; Desmet and Hekkert, 2007). In this context anthropomorphic product forms are very relevant.

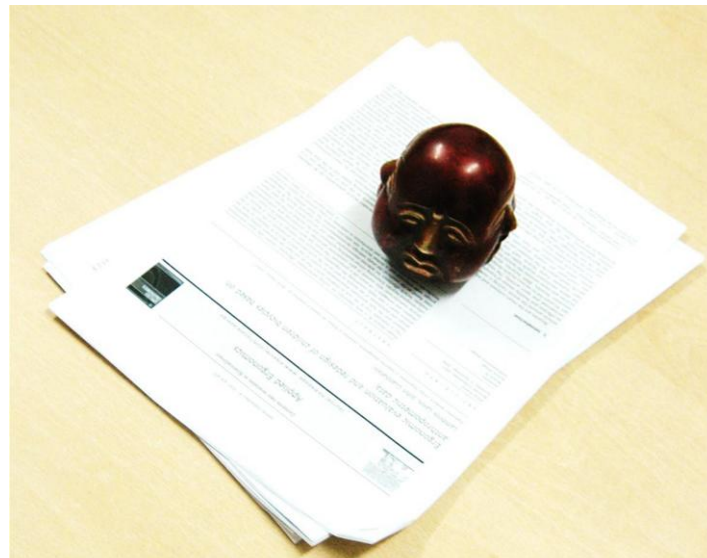
Now-a-days, anthropomorphism is a new way of smart product design. In several cases, it is found that there are humanlike attributes present in many non-human objects. Anthropomorphism may be attributed through humanlike forms and other characteristics (such as human like interaction styles, behavior etc.) into the non-human objects (Preece, Sharp, and Rogers, 2012). Thus, the product which has a humanlike form /characteristics is known as anthropomorphic product. Though the presence of anthropomorphism are found in the number of cases from the ancient time, recently anthropomorphism are being studied from new viewpoints and under different disciplines, such as psychology, engineering/ industrial design, ergonomics and human factors engineering, human computer interaction (HCI), interaction design beyond HCI, computer sciences, robotics etc.

### *2.1. History of anthropomorphism*

The essence of anthropomorphism comes from the instillation of the imagined or real behavior of nonhuman agents with humanlike characteristics (such as motivations, intentions, and emotions). A range of these nonhuman agents may include anything that act with apparent independence, including nonhuman animals, natural forces, religious deities, and mechanical or electronic devices etc. A simple definition of anthropomorphism found in the Oxford Dictionary (Soanes & Stevenson, 2005, p. 66) states that “the anthropomorphism is the attribution of human characteristics or behavior to a god, animal, or object”. The word ‘Anthropomorphism’ is derived from the Greek words *anthropos* (meaning

“human”) and *morphe* (meaning “shape” or “form”). Anthropomorphic forms are found in many cases of our everyday life, starting from our imagination of a face from moon by means of its black spots, well seen at full the moon night. Even anthropomorphism has its long history in ancient India and Egyptian culture. There are many sculptures found on the wall of pyramids with anthropomorphic forms; for instance, human figures of many Egyptian kings having dog or cat like faces. Anthropomorphic forms are also seen in many Indian gods like ‘Narashimha’ (an avatar of good Vishnu), ‘Ganeshha’ (Son of the goddess Parvati and the god Shiva), Hanuman (Son of god Pavana), all these gods have animal like faces but humanlike body.

Most existing research addresses the actual mental states and abilities of nonhuman agents by detailing the extent to which these agents really are humanlike and the extent to which anthropomorphism represents accurate insight versus fanciful illusion (e.g., Cheney & Seyfarth, 1990; Hauser, 2000). Very little of the existing research on anthropomorphism in product design tried to provide a cognitive ergonomics account of ‘when and why people would like to buy anthropomorphic products’, but rather most of these studies investigated the accuracy and functionality of products.



**Figure 1.1 Anthropomorphic paper-weight.**

## *2.2. Anthropomorphism in the context of product design*

Many products have been seen to be designed with anthropomorphic appearance (either with similar form or interaction style) in different context. Anthropomorphisms are found in 'Human Computer Interaction (HCI)', interaction design (beyond HCI), robotics, automobile design, house hold product design (e.g. pot design, chair design etc.), graphic design, animation design etc. **Figure 1.1** is presenting a product (paper weight) with anthropomorphic appearance.

### *2.1.1. Anthropomorphism in Interaction design including HCI*

Many human computer interfaces have been designed with the approach of anthropomorphism. One classical example of anthropomorphism in HCI is voice instruction facility of the computer for differently abled persons. Reeves and Nass (1996) identified some benefits of anthropomorphic approach in HCI. Their results demonstrate that computers, designed to flatter and praise users when they did something right had a positive influence on how they felt about themselves. For instance, an educational programme was designed to say, "Your question makes an interesting and useful distinction. Great job!" (a message) after a user had contributed a new question to it. Students enjoyed such experiences and were more willing to continue working with the computer than students who were not praised by the computer for doing same job.

Woggles are the agents that were designed to appear on the screen and play games with one another, such as hide and seek (Bates, 1994). These agents are nothing but coloured bouncing balls with cute facial expressions. Users would like to play this kind of games and it could change their moods.

Many efforts are required for the development of life like virtual agents exhibiting human like movements, walking and running, and having distinct personality traits. One example of such agent is Rea who was developed as an embedded real-estate agent with a human like conversation style (Cassell, 2000). Baylor (2009) reported about avatars which are more anthropomorphic in nature.

These agents can serve as powerful technological mediators to impact motivational outcomes such as self-efficacy and attitude change.

Duffy (2003) highlighted that it is the obvious designing of anthropomorphic features, such as a human like head with eyes and a mouth may facilitate social interaction, but, a balance is needed while conveying anthropomorphic features to hint at certain capabilities that meet our expectations of a socially intelligent entity. Recently, Gong (2008) tested the assumption that more anthropomorphic (human-like) computer representations elicit more social responses from people. In this study, it was proved that more social responses (e.g. perception of trustworthiness of virtual agents) from users were received as the agent became more anthropomorphic to being human.

### *2.2.2. Anthropomorphism in robotics*

Anthropomorphism shows beneficial effects on the artificial intelligence design based on users' perception. Higher user ratings have been found for robots that appear to exhibit playful behavior, more extroverted and outgoing than robots that appeared more serious. It was found that people were more likely to cooperate and work with playful robots than the serious robots (Kiesler & Goetz, 2002). The nature of anthropomorphic traits projected onto these robots significantly influenced subsequent interactions. In a recent study on robotics, authors emphasized over the need for standardized measurement tools for 'Human Robot Interaction (HRI)' (Bartneck et al., 2009). They performed some tests with measurements of five key concepts of HRI: anthropomorphism, animacy, likeability, perceived intelligence, and perceived safety. With their contributions they made it easy to evaluate HRI with the help of scales including these five constructs.

### *2.2.3. Anthropomorphism in car design*

Effectiveness and consequences of anthropomorphism on automobiles were empirically studied by Aggarwal and McGill (2007). This research proposed that schema congruity as a theoretical basis for examining the effectiveness and

consequences of anthropomorphism. In this study, consumers were able to find out similarity between anthropomorphized product and the proposed human schema characteristics. In addition, the influence of featured type on product evaluation was mediated via consumers' perception of the product as human. It was also reported that specific affective human schema moderates the evaluation but not the successful anthropomorphizing of the product (Aggarwal & McGill, 2007).

It is established that anthropomorphic automotive features are co-varying with trait perception in a manner similar to that found with human faces (Windhager et al., 2008). Eye movement patterns revealed that people could perceive humanlike facial features in cars, such as headlights as eyes or grille as a nose. A predominance of attraction was found on headlights as people's gaze was guided towards headlights irrespective of the feature they were asked to compare. Such a phenomenon was equivalent to the role of the eyes during face perception (Windhager et al., 2010).

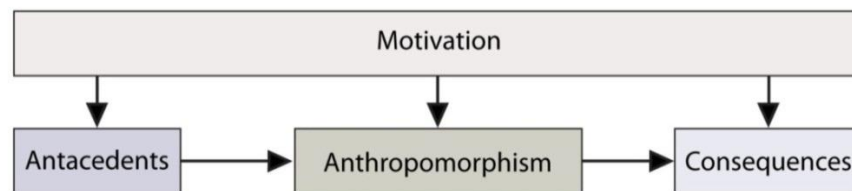
Following the facial electromyographic approach along with cuteness ratings Miesler, Leder, and Herrmann (2011) found that participants showed more positive affective responses to the baby faced car fronts than non-baby faced car fronts. It was observed that the effect of such baby-schema features on positive affect was stable over two repeated exposures (Miesler, Leder, & Herrmann, 2011).

#### *2.2.4. Anthropomorphism in other design related fields*

Other applications of anthropomorphism includes animation characters design such as Mickey Mouse (a cartoon character of World Disney) (Hosany et al., 2013); toy design for children (Lanier Jr et al., 2013; Veer, 2013); the household product design (e.g. chair design; pillow design (Gemperle et al., 2003; DiSalvo et al., 2003) etc.); graphic design (signage design with anthropometric form (Dorris et al., 2004); but, there are very less reports available from literature on these above mentioned fields.

### 3. Probable consequences of anthropomorphic product appearance

It is being a long time when researchers, especially experts of consumer behavior thought about the consequences of anthropomorphism in product choice. In 2006, consequences of anthropomorphism were first addressed by Kiesler in a general framework for anthropomorphism research (**Figure 1.2**). Kiesler (2006), highlighted the consequences of anthropomorphism might be positive (for instance, increased attachment to anthropomorphized entity) or negative (as it might occur if one perceived negative affect towards an anthropomorphized product due to a negative humanlike characteristics). Consequences of anthropomorphized products can also be gender (male vs. female) or age group (children vs. adult) specific.



**Figure 1.2** A general framework for anthropomorphism research (Adapted from Kiesler, 2006).

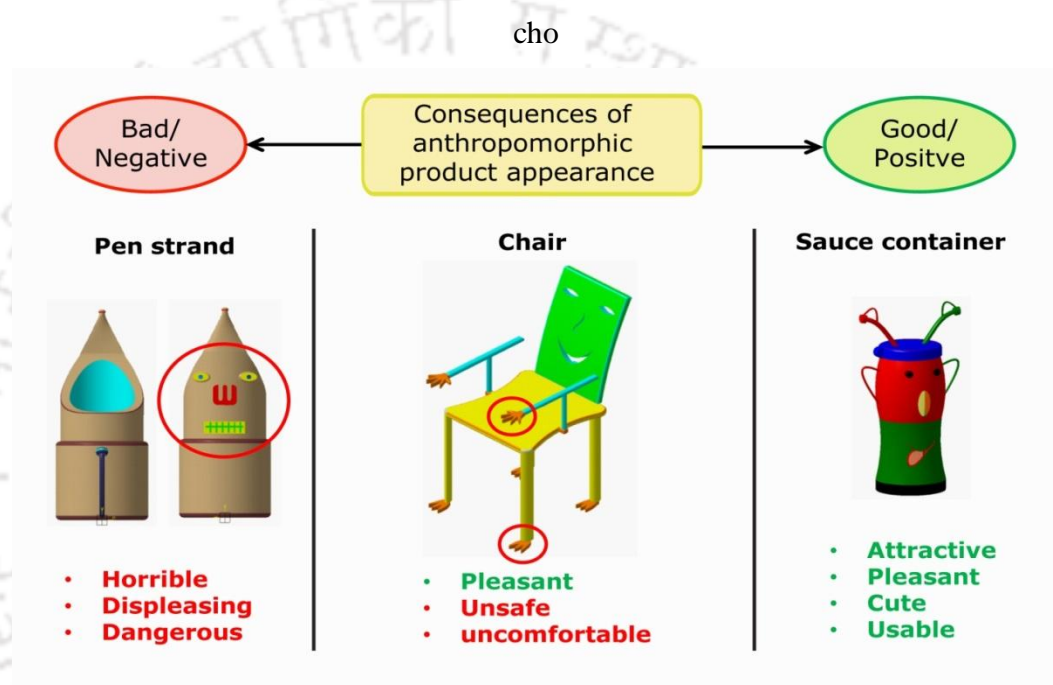
### 4. Cognitive ergonomics in the context of anthropomorphic product design

Cognitive ergonomics is a domain of ergonomics which investigates human cognitive processes, such as sensation, perception, attention, cognition, emotion, memory, motor skills and decision making process for a particular task including product choice. Most of the literatures related to cognitive ergonomics cover the roles of different cognitive factors on different physical and mental task contexts, but cognitive ergonomics of product purchase decision is less discussed in literature. Specifically, the roles of apparent usability, visual attractiveness and pleasure (as a positive affect) on the anthropomorphic product choice remain not discovered. Probable influence of anthropomorphic product attributes on these cognitive ergonomics related factors have been described in the following paragraphs.

A product can be anthropomorphized through the incorporation of humanlike attributes in product form. If humanlike attributes are wrongly incorporated in product appearance this may negatively be impacted on the perception of attractiveness, apparent usability and pleasure. Visual attractiveness of a product/object can be defined as the visual attraction towards a product/object. Recently scholars are referring physical beauty of the product as attractiveness of the product as beauty is related to attractiveness (Hekkert, Snelders, and VanWieringen, 2003; Mugge and Schoormans, 2012). In addition, Khan and Sutcliffe (2014) reported that humanlike agent was more attractive as it was beautiful. Hence, it can also be said that if a product is beautiful it will be attractive. According to aesthetic principle, if a product is aesthetically good then it would be visually attractive/ appealing; and, thus it would be accepted in the market (Dion, 1972). The anthropomorphic appearance of a product may either be attractive or not be attractive. Therefore, attractiveness of product may depend on the kind of anthropomorphic attributes used in the product appearance. For example, the pen stand presented in **Figure 1.3** may not be attractive due to its unpleasant appearance though it is anthropomorphic in nature. Aesthetic design principle says that a design is considered beautiful or pleasing when a great effect is attained with only a minimum of means (Hekkert, 2006). Therefore, the perception of attractiveness may depend on minimalistic use of anthropomorphic attributes in product appearance. For instance, people may perceive the low level of anthropomorphism due to less number/ types of humanlike attributes used in product appearance but may perceive the product more attractive.

Apparent usability is another important factor in the context of anthropomorphic product design. Consumers can perceive a product apparently usable by seeing a product itself before using it. Apparent usability and inherent usability are different from each other. Inherent usability is the actual usability of the product and it is only perceived after product use; whereas, apparent usability of a product is defined as perceived usability before product use involving different sensory modalities such as vision, audition etc. For example, one can perceive a product more usable if the product appearance is aesthetically good

(Mugge & Schoormans, 2012a). Even, apparent usability is important for purchase decision, especially when the user can't access the product before its purchase. Therefore, if anthropomorphic attributes causes perception of low apparent usability among users/consumers; there may be a chance of less product acceptance. For instance in case of the chair (presented in **Figure 1.3**), user may apparently perceive the chair as less usable due to the sharp human fingerlike attributes used in chair appearance design.



**Figure 1.3 Anthropomorphic attributes play a crucial role in perception of attractiveness, apparent usability and pleasure.**

According to Jordan (2000), pleasure may be perceived through visual appearance of the products. Demirbilek and Sener (2003) stated that pleasure can be best defined as the agreeable emotion accompanying the expectation, acquisition, or possession of something good or desirable. According to them pleasure can be represented by related words happiness, joy, satisfaction etc. According to circumplex model of emotion, pleasure is a positive valance of emotion (Russell, 1980; Yik, Russell, and Steiger, 2011). Psycho physiologists believe that pleasure is an emotional state and can be measured through physiological changes such as facial electromyography (Fujimura, Sato, and Suzuki, 2010; Sato, Fujimura, and Suzuki, 2008). Therefore, pleasure has both

subjective and objective measures. For instance, consumer may perceive pleasure to see a product / object as it product is looking good and may rate this product as pleasant in semantic differential scale. On the other side, pleasure (as a subjective measure) could be measured by measuring bodily changes (e.g. facial EMG, heart rate changes etc.) of consumer who is exposed to a pleasant product.

There may be a chance of displeasure (dissatisfaction) due to less apparent usability perceived through product appearance (as in case of chair in **Figure 1.3**). Thus, inappropriately used anthropomorphic attributes in product appearance may lead to displeasure (as in case of the pen strand in **Figure 1.3**), whereas proper use of anthropomorphic attributes in a product appearance may contribute pleasure (as in case of dual sauce container in **Figure 1.3**).

From the literature survey on anthropomorphic product design it is clear that only few studies have been reported about cognitive and affective consequences of anthropomorphized products. However, cognitive and emotional processes related to product choice decision have been less explored in the context of anthropomorphic product. It can be reasonable to argue that there are only few studies which aim to find out cognitive and affective consequences of anthropomorphic appearance (Aggarwal & McGill, 2007; Miesler, Leder, & Herrmann, 2011; Windhager et al., 2008; Windhager et al., 2010). Even, very fewer studies have elaborated about the design strategies required for anthropomorphic product design specifically considering some important cognitive ergonomics related factors such as visual attractiveness, apparent usability, and pleasure. Moreover, influence of these factors altogether on anthropomorphic product purchase intention is less reported. Therefore, there is a scope for establishment of strategy to design and evaluation of the anthropomorphic product appearance considering the cognitive human factors (visual attractiveness, apparent usability, and pleasure). It would be good to have some insights regarding theories of cognition and affective product design which are related to visual attractiveness, apparent usability, and pleasure; before hypotheses were stated for the present thesis work. Therefore, available literatures

surveyed on cognitive and affective theories related to these human factors are presented in the next chapter (**Chapter-2**).

*Key points*

- ☞ Consequences of anthropomorphic product appearance may be positive or negative.
- ☞ Design strategy for anthropomorphic appearance design is less discussed.
- ☞ Fewer empirical evidences were available on anthropomorphic product design.
- ☞ Visual attractiveness, apparent usability and pleasure perception may be affected by anthropomorphic product appearance.



## Chapter-2: Cognitive and emotional consequences of anthropomorphic product appearance

### Abstract

This chapter of the thesis covers detailed literature review on cognitive and affective theories of product choice decisions. Probable consequences of anthropomorphic appearance on product purchase intention have been covered here. Scopes of research on anthropomorphic appearance design considering cognitive ergonomics related factors such as visual attractiveness, apparent usability and pleasure was described in this chapter. Few broad research questions have been raised based on literature review, preliminary study results and earlier identified (chapter-1) research scopes on anthropomorphic product appearance design. Four hypotheses have been formulated for the present thesis work. Definitions of variables under study (anthropomorphism, visual attractiveness, apparent usability, pleasure and purchase intention) and their measurement or assessment techniques have been discussed in this chapter. It has been concluded that chances of product acceptance are high if the anthropomorphic product is attractive, apparently usable and pleasurable.

*Keywords: apparent usability, attractive, cognition, emotion, pleasure*

### 1. Introduction

In general, cognition directs the emotions found in many daily life scenarios though there are different causes of emotion other than the cognition. Actually, cognition and emotions are closely related with each other and cognition of an object/ stimulus may lead to generation of different basic emotions. For example, fear can be generated due to paying sudden attention to a man with a gun in a dark road without any other crowd. In other case, one student may be happy or pleased when a reward is given to him for securing top score in a design course. Similar to these incidents, it is possible to generate positive emotions among consumers or users through product design. Since last three decades, designers and human factor researchers are more concerned about the development of design theories based on human cognition and emotion. Some theories and practices regarding cognitive theories of emotions are going on/ running in the design related industries in India as well as abroad. They are trying to build different strategies for emotional product design. But, only few emotion related theories has been studied in product/ service design context such as 'Emotional Design Model'; 'Pleasure Model'; 'Technology as Experience Framework'; 'Basic Appraisal

Model'; and, Attention and Emotion related theories. Though there are many appreciable theories of emotional product design which being taken to develop products, there is a need to study more theories related to cognition and emotion for better emotional product design and service outcomes. In this context, the detail knowledge about the theories of cognition and emotions are necessary. In present chapter an attempt has been taken to collect information about cognitive theories of emotion and its probable applications in anthropomorphic product design. A theoretical model was also developed for better emotional design outcome. Before going into details about cognitive theories of emotion we need to know about the basics of cognition and emotion.

## **2. Definitions of cognition and emotion**

'*Cognition*' is the mental process which includes series of sensory events such as perception, attention, use of short term memory/ working memory, exploration of long term memory, information processing, identification and classification of objects, reasoning, decision making etc. (Prinz, 2012; Wickens and Hollands, 2000) In other words, cognition is the mental process underlying our ability to perceive the world, remember, talk about and learn from our experiences, and modify our behavior accordingly. The concept and meanings of cognition may be stated from various perspectives:

- a) Understanding about objects/ events/ surrounding environment
- b) Perception and consequent acceptance of meaning of objects
- c) Thought/ Thinking process
- d) Reasoning and interpretation
- e) Initiator of emotion(s)

'*Emotion*' can be defined as different mental and bodily changes with specific features (Ekman, 1992; Lazarus, 1991). It is widely agreed that emotions have subjective, behavioral, cognitive and internal/peripheral physiological components (Norman, 2004; Picard and Picard, 1997). Cognitive processes are

also associated with emotional responses. Emotions may vary from time to time or place to place either consciously or unconsciously. In his great philosophical path breaking work “On the Origin of species” (1859, 1872), Charles Darwin was one of the first who proposed that there are a limited number of basic and universal emotions. Ekman and Friesen (1971) have suggested that there are six basic emotions corresponding to anger, disgust, fear, happiness, sadness, and surprise. It is possible to conceptualize the emotion from several different perspectives:

- a) May be both conscious and unconscious
- b) Originates from different part of the brain
- c) Combines both mental and bodily changes
- d) Affects attention and processing of information in a predictable way
- e) May influence motivation and behavior
- f) One type of “affective state” (Emotions, moods, sentiments and personality traits)

### **3. Causes of human emotions:**

Emotions can be distinguished by their causes; different emotions are caused by different things. It is very useful to categorize the causes of emotion as the origins are different: cognitive and non-cognitive.

#### *3.1. Cognitive causes:*

Prinz (2012) highlighted that cognitive events can be understood in terms of a pre-theoretical umbrella term “Thoughts”. Thoughts can be defined as mental episodes that require concepts which human beings can build through their experience. Thoughts may be an automatic mental episode that may not be the copy of stimuli that affect our senses. They may go beyond ordinary sensation and present the world being a certain way. “Thoughts can occur through the process of deliberation and can be affected by many causes, at least by reasoning”. In this section, cognitive causes of emotion refer to how a thought causes emotion.

Cognitive scientists have widely accepted that thoughts can cause emotions but it depends on what kind of thought it is. Many thoughts such as rose is red, ice is cold etc. may have little impact on most people. Thoughts which are evoking emotion, likely to be evaluative thoughts: thoughts that assess things in way that reflects our attitudes towards them. For example, one may not have any emotional response to the thought that kitchen knife is sharp, but emotion will likely follow the thought that kitchen knife is dangerous. The concept of more dangerous or less dangerous is directly related to the degree of well-beings. Many emotion researchers use the term appraisal to denote evaluation of well-being-ness (Arnold, 1960; Desmet, 2002). An appraisal refers to a thought representing an organism-environment relationship that bears on well-being (Lazarus, 1991). It is well documented fact that appraisal may affect emotions. In 1964, Lazarus and Alfert conducted a study in which they used same film clip with different narratives. Their study reveals that different narratives generate different appraisals. In another study, Smith and Lazarus (1993) gave vignettes with different contents to manipulate appraisals and got different emotional responses e.g. if participants invited to construe an event as a loss, they might feel sad. According to their view, there are several appraisal dimensions trigger every emotion. That means if we ask these questions about a situation: is it goal-congruent or incongruent? Who deserves blame or credits? What coping strategies are available to me? In such situations every answer to these questions corresponds to every emotion. For example, happiness is goal-congruent, anger involves placing blame on others and fear involves coping strategies. This theory is known a *dimensional appraisal theory*. This theory is not universally accepted as some researchers think that emotions are elicited by thoughts such as ‘I am in danger’, ‘I have been wronged’ etc.

Researches on molecular appraisals were designed to show how changing thoughts in fine grain scale can influence our emotions (e.g. a shift from other blame to self-blame can make a shift from anger to guilt). It may be due to the fact that these cognitive changes influence emotions only by affecting our course gained appraisals. That means *molecular appraisals may affect our emotions but*

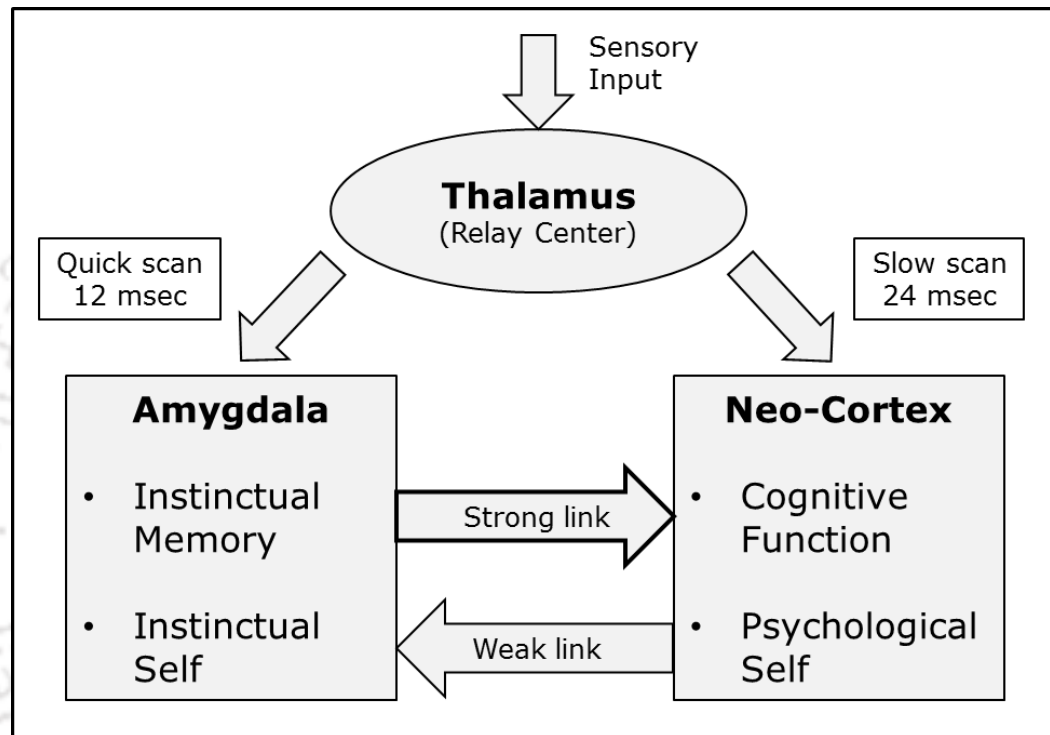
*not an essential aspect of emotion elicitation.* Some dimensional appraisal theorists may agree, treating the molecular appraisals as a part of semantic analysis of emotion terms rather than as components of an emotion process model (Ortony, Clore, & Collins, 1988).

Most of the cognitive theories regarding emotion and design explained about appraisal process. Details about these theories are discussed in the subsequent sections of this chapter.

### 3.2. *Non-cognitive causes*

Most of the non-cognitive elicitors of emotions are perceptual states. For example, a fuel smell can cause disgust, a sudden loss of support can cause fear and seeing someone cry can cause sadness. It can be assumed that perceptual states may evoke/induce emotions by affecting our appraisal process. Perception generally requires interpretation before emotion arises. Perceptual states may or may not require interpretation to elicit an emotion. For example, when there is a sudden sound, it rapidly generates an emotion. Such stimuli would seem gratuitous to postulate an intervening thought. More direct evidence for emotion induction without cognition comes from studies in the field of neuroscience. Amygdala is an almond-shaped structure of brain composed of collection of nuclei. This brain structure is closely related with emotional responses. Laberge et al. (2006) stated that amygdala is an ancient brain structure- a part of limbic system- with homologues in reptiles. This structure of brain is itself too primitive to harbor cognitive states. Cognitive states can cause emotions via amygdala, because it is connected with frontal cortex which is evolutionary advanced in human. It is evident that amygdala responses can be triggered by non-cognitive structures of brain, including both cortical and subcortical perception pathways (LeDoux, 1996). Subcortical pathways make emotional changes most dramatically. The thalamus is connected to the amygdala via superior colliculus and it receives sensory information from sensory transducers. For example, visual information that not yet reached to neocortex (where visual object recognition is taking place) via the optic nerves can be sent to amygdala. This may be what

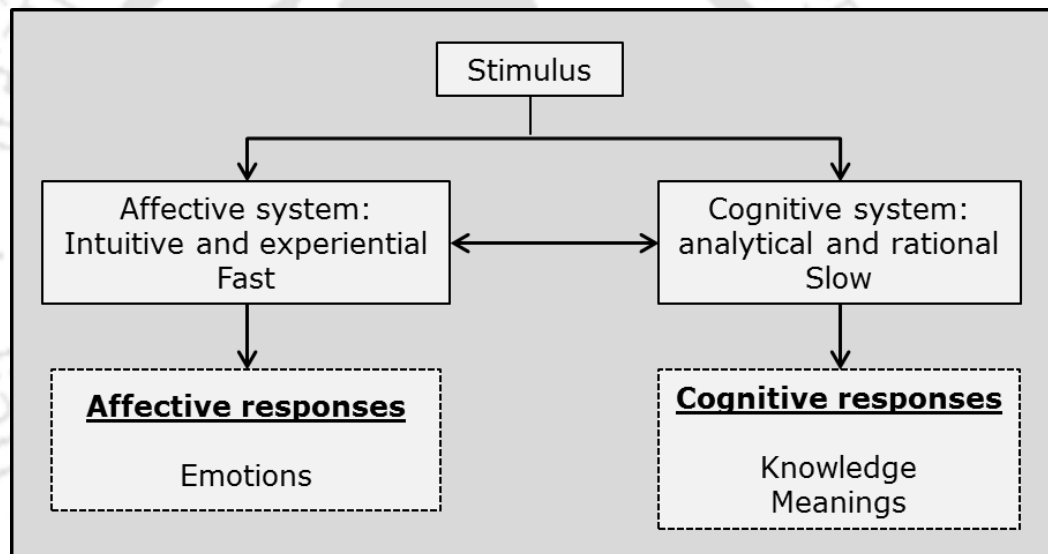
happens when we have sudden fear response to coiled rope, mistaking it as a snake. In such situations, fear may already be experienced before our realization that we are not in danger. Thus, there is a good reason to think that emotion can be generated by non-cognitive causes. Role of amygdala and other related brain structures in control of emotion/ affect is illustrated in **Figure 2.1**.



**Figure 2.1** Role of amygdala and other brain structure in emotion regulation (This figure is adapted from Helander & Khalid, 2012)

Even emotions can be generated from what we perceived, what we feel. Emotions can be affected by music (Blood et al., 1999), by weather (Palinkas & Houseal, 2000), and exercise (Roth, 1989). Emotions may be affected by changing chemistry of the brain. For example certain drug administration, alcohol uptake may alter human emotional states. Facial feedback may as a way of calibrating emotions in groups: If any one automatically mimics other's expressions and thereby feels the expressed emotion. *In this way, automatic, non-cognitive process can generate contextually appropriate emotions even when we lack of cognitive insights into the reasons for having those emotions.* Some cognitive theorists rejected this thought by highlighting the *unconscious* cognitive

appraisal rather than non-cognitive causes. According to them evolutionary pressure promotes the emergence of emotional responses that arises immediately upon perceiving stimuli that have great relevance for survival. Cognitive mediators may slowdown vital reactions such as freezing after sudden noise (Prinz, 2012). Cross-talk between cognitive and affective system is presented in **Figure 2.2**. It seems that the sensory information about the stimulus goes to both affective and cognitive systems. Human affective system is more intuitive and experiential in nature and it generates emotional responses very quickly. On the contrary, cognitive system is little slow; and, it is analytical and rational in nature. Human cognitive system generally helps to understand meanings and to gain knowledge.



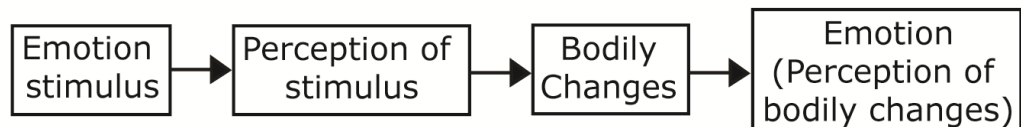
**Figure 2.2** Cross-talk between cognitive and affective system (Adapted from: Helander & Khalid, 2012).

#### 4. Theories of Emotion

Theories of emotion described here will help the reader to understand the development of knowledge about human emotion, ways of its measurement and the application of these theories in practical scenarios. Few of these theories relate the psychophysiological concern, few of these relate the psychosocial concerns and few of these relate the human cognition and communications. This section of the thesis covers a total of nine famous theories and or models which are related to human emotion.

#### 4.1. James-Lange Theory: Emotion as a perception of bodily changes

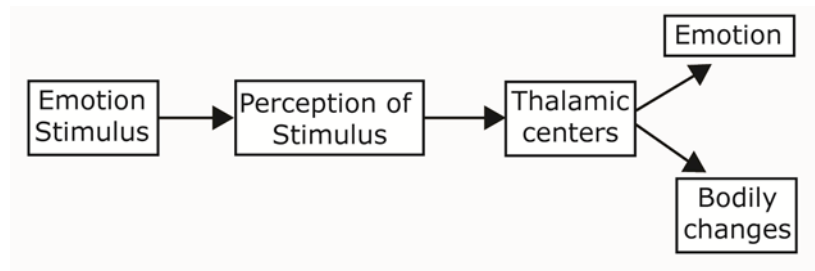
One of the earliest theories of emotion was James-Lange theory (**Figure 2.3**). This theory is based on the perception of bodily changes in respect to emotions. This theory proposes the following sequences of events in emotional events: 1) 'We perceive the situation that produces emotion', 2) 'We react to this particular situation' and 3) 'We notice our reactions' (Morgan et al., 2008). According to this theory human perception of the reaction is the basis of the emotion which is a human experience.



**Figure 2.3 James-Lange model of emotion.**

#### 4.2. Cannon-Bard Theory: Feelings of Emotion and Bodily Responses are Independent

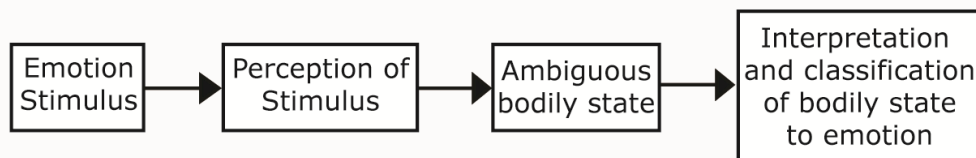
The Cannon-Bard theory says that bodily changes/reactions during emotion and felt emotion are independent of each other; but, both are triggered simultaneously (**Figure 2.4**). According to this theory, hypothalamus (a lower brain region) is activated first and sends signals to our internal organs and muscles to produce bodily expressions of emotion. Then, hypothalamus sends signal to cerebral cortex, where a pattern of discharge is perceived as the felt emotion. In contrast to James-Lange theory, this theory establishes the fact that bodily changes are not the basis of felt emotion (Morgan et al., 2008).



**Figure 2.4 Cannon-Bard model of emotion.**

#### 4.3. Schachter-Singer Theory: Interpreting Bodily Arousal

This theory was established by Schachter and Singer (1962). They argued that bodily states of emotional arousal are much the same for most of the emotions. Any number of emotions can be felt from stirred-up bodily condition as the bodily changes are ambiguous in nature. It is generally found that given a state of arousal, we experience the emotion that seems appropriate to the situation in which we find ourselves. According to this theory events of emotional feelings are as follows: 1) 'Perception of a potential emotion producing stimulus/situation'; 2) 'An aroused bodily state (ambiguous) results from perception'; and 3) 'Interpretation and classification of the bodily state so that it fits the perceived state' (**Figure 2.5**).



**Figure 2.5 Schachter-Singer model of emotion.**

#### 4.4. Cognitive-Appraisal Theory of Emotion

Though Schachter-Singer theory is sometimes known as cognitive theory as this theory involves thoughts about the cause of perceived state of arousal, Cognitive appraisal theory was better explained by Lazarus and his colleagues (1970, 1984). Lazarus emphasizes the appraisal of information from different sources. Cognitive appraisal theory states that felt emotions result from appraisal process (evaluation of stimulus, processing of information about stimulus and the state of body).

Since appraisal involves cognition, or the processing of information from the surrounding environment, the body and memory, this theory is totally a cognitive one. In an experiment by Spiesman et al. (1964) with an emotion producing movie clip it was clear that how emotional responses depends on the cognitive process and how emotions are associated with different bodily changes. Experimenters used a movie clip depicting the circumcision rites of Australian aborigines. This same clip was presented to different groups of participants with different sound tracks (trauma track, denial track and intellectualization track) and no sound track. Highest stress reactions (was measured by measuring heart rate and GSR) were found for silent condition and trauma track whereas lowest reactions were found in case of denial track and intellectualization track. Thus, sound tracks induced the subjects to make different appraisals for different situations for a same stimulus (the movie clip). Psycho-physiological basis of product related emotional changes (in terms of variations in facial muscle activities and galvanic skin resistance) can be studied in future (Like Laparra-Hernández et al., 2009).

#### *4.5. Action-readiness theory*

One of the largest standing cognitive theories of emotion is the Frijda's action readiness theory. In this theory Frijda postulates that appraisal yields pleasantness or unpleasantness, with its tendency to approach or to avoid (Frijda, 1986; Frijda & Parrot, 2011). This theory is quite similar to componential theory of Ortony, Clore, and Collins (Clore & Ortony, 2013; Ortony, 2009). According to action-readiness theory, different states of action readiness have different aims, generated by appraisal process which involves an event that elicits an emotion should be enhanced or diminish. For example, in case of joy, the aim is to enhance engagement in the current situation. On the contrary, in fear the aim is to diminish danger. In this theory, emotion is described as a process rather than a state and cognitions can regulate each of its phases (Frijda, 1986; Dan-Glauser & Gross, 2013). This theory may be applicable for explanation of user engagement with products. Products which are associated to positive emotions engage users in

their use, for instance, computer game engages users more if the game is associated with joy/ pleasure.

#### *4.6. Core-affect theory*

This theory was proposed by Russell (2003), says that underlying any emotion is a core-affect i.e. a state with two dimensions: level of arousal and pleasure vs. displeasure. This theory is closely associated with circumplex model of emotion and is augmented by some other researchers (Kuppens, et al., 2013; Yik, M. et al., 2011). The core-affect theory postulates two stages for generation of an emotion like Schachter and Singer's theory (Reisenzein, 1983). The first step is the arousal (with an added pleasure–displeasure dimension) and the second stage is the social construction. Like appraisal, social construction is also a long standing consideration in cognitive approaches to emotions. According to core-affect theory, core affect prompts experience of an emotional episode which is constructed from social customs and cultural ideas, acting as a prototype of anger, fear, or suchlike. An emotional prototype generally comprises of an event, the perception of core-affective quality and attribution of the emotion to an object, appraisal of the object, and an action directed toward the object. This theory may be helpful for the designer to understand how a product choice/ product purchase intention could be directed by a product with positive emotional attributes. In other words, this theory would be helpful to explain the underlying phenomena of emotional product acceptance in the market and prediction of product acceptance. Another important point to be highlighted regarding this theory is social construction which is an important aspect of selection of design element. For example, meaning of a particular colour may be different across culture/ geographic locations. Therefore, designers should think about emotional meaning of design elements (e.g. colour, shape etc.) to design a particular product for a particular socio-cultural target group to whom designed product will be delivered.

#### 4.7. *Communicative theory*

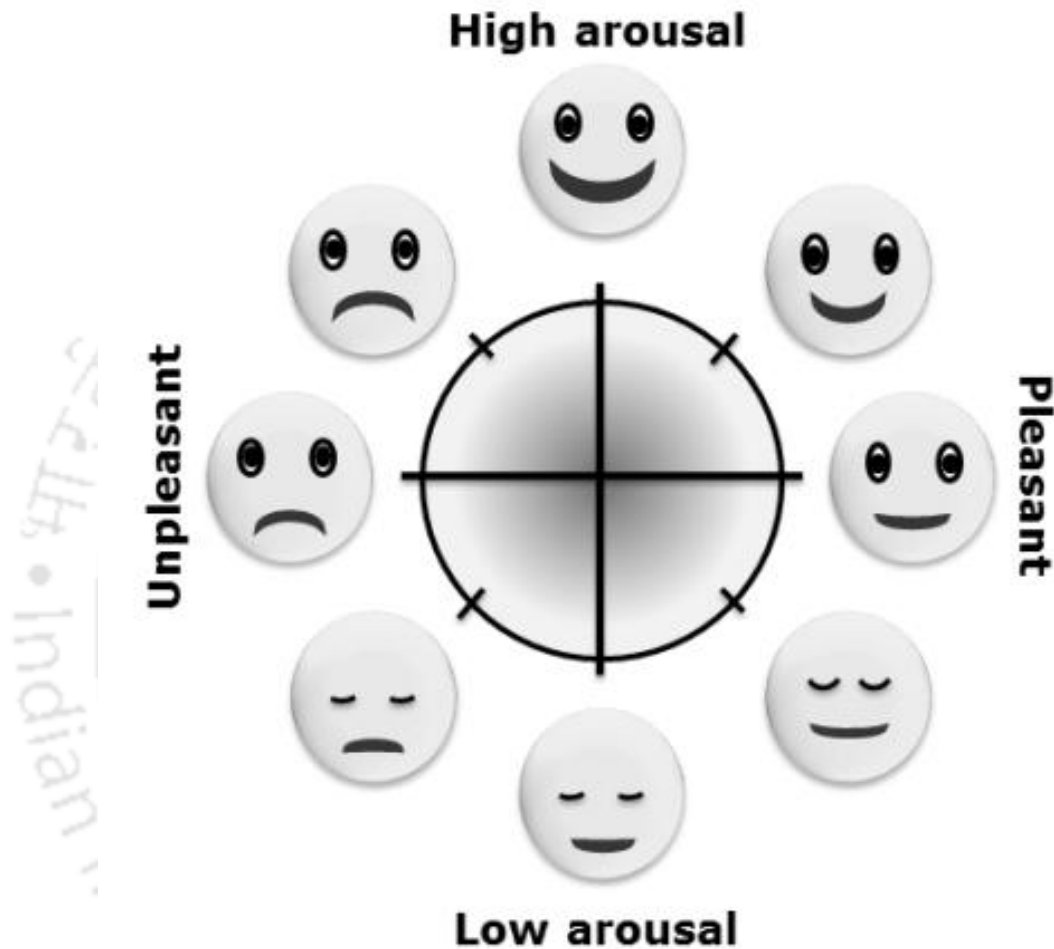
Communicative theory of emotions postulates that emotions are communications within brain and among individuals (Oatley & Johnson-Laird, 1987; Oatley & Johnson-Laird, 2011). Some basic emotions, such as happiness, sadness, anger, and fear- can occur without an object but other emotions like love, hatred and disgust necessarily have objects (Oatley & Johnson-Laird, 2014). Emotions sometimes act as communications to others, by gestures, postures, facial expressions, and verbalizations. For example emotions often produce empathy in others and they can help to maintain relationships such as happy cooperation or angry conflict. This theory also postulates that the distinct basic emotions evolved as adaptations in social mammals (Nesse & Ellsworth, 2009). According to this theory, appraisals are cognitive, although not necessarily conscious (Oatley & Johnson-Laird, 2014). The communicative theory has been applied to the semantics of emotion terms (Reisenzein, 1995), such as the effects of emotion on reasoning, the changes of emotions in relation to music or film (Oatley & Johnson-Laird, 2014) etc.

#### 4.8. *Circumplex Model of Emotion: A Dimensional Approach*

This model of was established based on the dimensional approach of emotion. Actually dimensional approaches have been taken to classify the range of emotional states on certain specific scale. It is necessary to know about two terms that are ‘Arousal’ and ‘Valance’ for better understanding of the circumplex model of emotion. Arousal is defined as the overall term for the bodily changes that occur in emotion, such as changes in heart rate, sweating, and release of stress hormone in response to a particular stimulus. On the other hand, ‘Valance, is the subjective quality (may be positive or negative), of the emotional response to the specific stimulus/object/event. The ‘Circumplex model’ puts ‘arousal’ on one axis and ‘valance’ on the other (Barrett & Russell, 1999; Russell, 1980).

Arousal actually refers to both the state of activation or deactivation of emotion and the strength of the responses to a stimulus; whereas, valance reflects

the degree upon which the experience is pleasant or unpleasant. With these two dimensions, circumplex model represents a graphic framework to present and explain different emotional states (See **Figure 2.6**).



**Figure 2.6** Circumplex model of emotion.

#### 4.9. Facial expression and emotion recognition

Charles Darwin was one of the first who proposed that there are a limited number of basic and universal emotions (1859, 1872). He also argued that human facial expressions are part of innate patterns of behavioral responses that we can see in other species. Ekman and Friesen (1971) have suggested that there are six basic

emotions viz. anger, disgust, fear, happiness, sadness, and surprise. These emotions can be perceived through facial expressions.

Neural process in the recognition of emotional expressions is less understood than those of their production. Adolphs et al. (2000) showed that judgment of emotions in facial expressions was most affected by lesions in the right somatosensory cortex but different emotions in different ways by overlapping regions of brain. Lesion studies have shown that the amygdala is involved in recognition of emotion, particularly fear, from visual stimuli (Adolphs & Tranel, 1999). Adolphs, Baron-Cohen, and Tranel (2002) have recently suggested that damage to amygdala produces deficits specifically in relation to social emotions (e.g. guilt) rather than basic emotions (e.g. happiness and anger).

In a recent study by Miesler, Leder, and Herrmann (2011), studied changes in facial expressions through electromyography (EMG) against different images of car faces and found that electrical activity of zygomatic major muscle was higher and corrugator supercilii muscle activity was lower in case of baby like car face rather than the original/existing non-baby faced car font. As higher activity of zygomatic major muscle and lower activity of corrugator supercilii muscle are associated with pleasure, baby faced car front was found more pleasurable than non-baby faced car font.

## **5. Theories related to pleasurable and emotional product design**

In this section, a total of six important theories and /models of emotional product design have been described with an intention to know about the current status and methods available for emotional product design. Following sub sections covers these theories or models related to product design.

### *5.1. Kansei Engineering*

The concept of Kansei Engineering (KE) was established by Mitsuo Nagamachi (1995). 'Kansei' is the Japanese word that covers several English meanings such as sensitivity, sense, sensibility, feeling, aesthetics, emotion, affection, and intuition. All these words are associated with mental responses to external stimuli,

often summarily referred to as feelings. The idea and goal of KE is similar to pleasurable product design. According to Jordan (2000), KE is roughly translated as 'Pleasure Engineering'. KE helps the investigator to understand the relationship between formal and experiential properties of a product. KE is also helpful for gaining insights about expectations of users and consequent product properties through these intended user benefits. According to Nagamachi (1995, 1996), KE follows four basic steps. First step starts with collecting appropriate Kansei words or adjectives related to product of interest from targeted user population. Second step involves establishment of correlation between product features/attributes and Kansei words. In third step, a data bank of these correlations is searched for Kansei words. These words in turn are represented with semantic differential scales, and, analyzed, typically using factor analysis to reduce often the large numbers to a manageable set of words. Approaches taken in this step is similar to the semantic product design. Fourth and last step follows the evaluation of new design with potential users in terms of Kansei words to establish how close the tested product is to the ideal product. Nagamachi (1995) described two different directional approaches/ flows of KE. These are 'from design to diagnoses' and 'from context to design'. The first approach involves manipulation of individual attributes of a product in order to test users' overall responses towards the product. In the second approach, qualitative data about the products are gathered via field observations and then establishment of the relationships between formal properties of design and the user benefits associated with the products. With the help of KE, products could be engineered by the designers based on semantic meanings of the products to improve sales, usability, and user's satisfaction. However, KE cannot predict feelings of consumers directly and is unable to explain underlying phenomena in the brain due to product emotion but it is still helpful to explain the socially constructed phenomena (for instance, various social factors related to product features and product emotion).

## 5.2. Theories of product personality

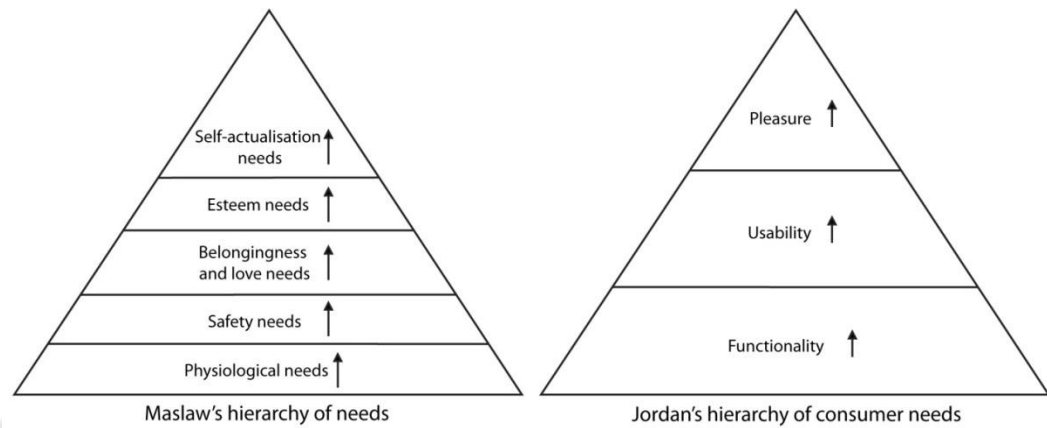
Product personality assignment is an approach which was developed by ‘Philip Design’ (Jordan, 1997). The concept of product personality comes from semantic meaning (s) of the product and it is closely associated with product semantics (the study of relationships between signs and the objects/products they refer to or signify). These symbolic meanings may refer to the physical product itself and the product can be described by human personality characteristics which are termed as ‘product personality’ (Jordan, 1997; 2000). Consumers not only consider product in terms of their functionality but also often think about product’s personality like human beings (Govers, Hekkert, & Schoormans, 2004). Product personality has prominent influence on product choice while functionality and usability across products are same. For example, a person can be happy, cute, and honest; similarly a product may appears like happy, cute, and honest. Although, personality of a product is reflected mainly through visual attributes of the product, it may also be perceived through physical interaction (Desmet, Nicolás, & Schoormans, 2008). There are some proposed models of product personality which conclude the role of product personality on product choice (Dumitrescu, A., 2010; Govers, Hekkert, & Schoormans, 2004; Govers, & Schoormans, 2005; McDonagh, Bruseberg, & Haslam, 2002). Personality congruence model well explains why people would like to select a product based on product personality (McDonagh, Bruseberg, & Haslam, 2002). This model states that product personality influences product choice due to personality congruence effect of consumers but not due to user congruence effect. According to this model, product personality depends on product attributes and if perceived personality of a product matches with the personality of the consumer then consumer would like to choose the product. It is necessary to state that product personality assignment is one of the important techniques for pleasurable product design (Jordan, 2000). Designers may manipulate characteristics of a product using personality assignment technique to make it pleasurable one in order to achieve better market acceptance than the other competitive products which have similar usability.

### 5.3. *Pleasure Model*

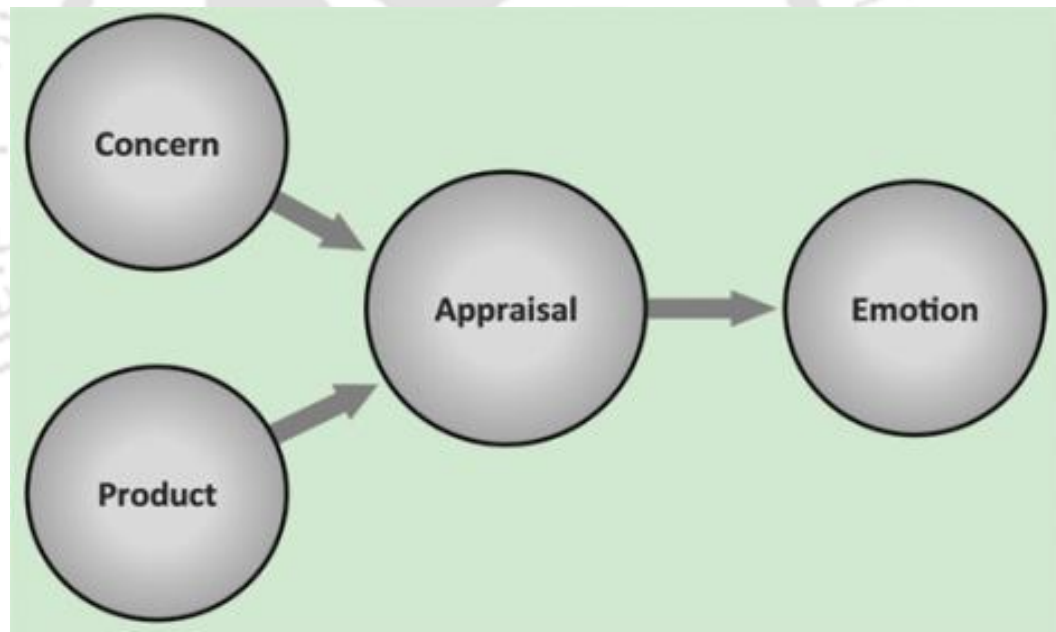
This model was proposed by Patrick Jordan (2000). This alternative affective model focuses more on pleasurable aspects of our interactions with products. This model considers all the potential benefits that a product can deliver. Similar to the framework of pleasure provided by Lionel Tiger (1992), pleasure model proposes four conceptually distinct types of pleasure (Jordan, 2000). These include a) Physio-pleasure; b) Socio-pleasure; c) Psycho-pleasure and d) Ideo-pleasure. Physio-pleasure is related with bodily aspects which are connected to sensory experiences about product, e.g. tactual pleasure of holding a mobile phone. Socio-pleasure refers to enjoyments derived from relationships with others. Products can facilitate social interactions in different ways. For example, a coffee maker provides a service which may act as a central focus of attraction of small social gathering 'Coffee evening'. Psycho-pleasure is associated with cognitive and emotional reactions. A product may need a particular level of cognitive ability to use it and the product attributes/ interaction style may elicit emotional response based on the experience about the product. Ideo-pleasure refers to people's understanding of their own values. For example, a product made up of biodegradable materials is associated with value of environmental responsibilities of user.

Similar to 'Maslow's hierarchy of needs', Jordan (2000) highlighted about a hierarchy of consumer needs (**Figure 2.7**). In this hierarchy Jordan placed pleasure in the third level after usability and functionality as per user's priority. According to Jordan, when consumers/ users take a purchase decision, they are initially concerned about functionality, then usability and lastly pleasure. While functionality and usability of many products are similar, pleasure plays important role in product selection. Though pleasure model does not able to explain how neurological basis of pleasure perception, but it helps designers to think about ways of expression of different kind of pleasure through product attributes/ interaction styles. Another drawback of this model is that it does not prescribe how to incorporate all types of pleasures into a single product. This model talks

much about product acceptance on the basis of pleasure; but role of other emotion (e.g. fear, anger, surprise etc.) in product choice is less clear.



**Figure 2.7 Hierarchy of needs.**



**Figure 2.8 Model of product appraisals. Source (This figure is adapted from Desmet, 2002).**

#### *5.4. Basic Model of Product Appraisal*

A model of product appraisal process was developed by Desmet and coworkers (Desmet, 2002; Desmet, & Hekkert, 2002). This model is similar to Frijda's 'action readiness account' (Frijda, 1986) and chiefly based on appraisal theory of Ortony et al. (1988). According to this model, product appraisal depends on

product attributes and the judgment of product design against a concern; and, the appraisal leads to emotion (**Figure 2.8**). For example, if attitude (concern) towards a product (stimulus) is positive, appeal of that product (appraisal) may lead to emotion (joy/pleasure/happiness).

In this model a holistic approach has been taken for explanation towards generation of emotions due to product through appraisal process. Therefore, this model will be beneficial for designers to explain how a product may elicit emotion among users.

### 5.5. Emotional Design Model

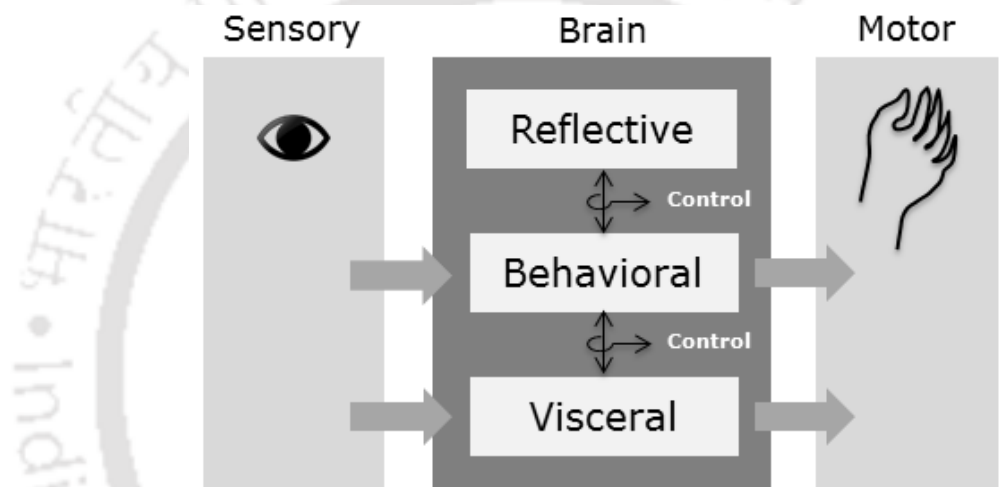
This model was established by Norman and his colleagues, Andrew Ortony and William Revelle (Norman, 2004). It explains how emotion and behavior are determined by different levels in the brain. According to this model, there are three levels of brain organizations which are related to emotion regulation (**Figure 2.9**). First level is known as visceral level which is associated with immediate communication in response to change in surrounding environment. The second level is behavioral level which is involved in regulation/control of our everyday behavior. At the highest level, brain further processes and anticipates the signals of behavioral level. This third level is called reflective level.

According to Norman's model (Boehner et al., 2007; Norman, 2004), visceral level responds rapidly, making judgments about what is good or bad, safe or dangerous, pleasurable or disgusting etc. It also triggers different emotional responses against stimuli, such as fear, joy, anger and sadness which are a combination of physiological and behavioral responses. For example if someone finds a large hairy spider in the bathroom, he/she experiences fear and screams. These screaming or running away are due to the response from the behavioral level wherefrom most human activities are controlled. In reflective level people decides how to control emotion and how to respond further towards the stimulus.

Several explanations have been made on the basis of this model e.g. how we respond to stressful or pleasurable situations. The central theme of this model is that our affective state (can be it positive or negative) depends on how we think

about the situation. For example, when we are tensed, the emotional response is to focus on the problem at hand and try to resolve it. In such situation, our bodies respond by enhancing our muscles tone and sweating. On contrary, when people are happy due to the victory of their favorite team in a cricket match, emotional responses are lough, cheer, and jump about. Human body relaxes in such moment.

Following above discussions, few questions arise in our mind regarding application of this theory in product design. (A) Should designers create products according to varying emotional states of the users/consumers? (B) Is it realistic to conceptualize this type of product?



**Figure 2.9 Model of emotional design. Source (This figure is adapted from Norman, 2004).**

Creating a product according to varying emotional states or conceptualization of such product is less practical but Norman's model is applicable in context specific design practice. Norman mentioned that a product which is intended to be used during leisure time or moment of fun, designers need not to worry about the amount and type of information coming from product interface but they should concentrate on how to make the product more enjoyable. On the contrary, he argued that for designing interface for serious task e.g. car driving, designers need to pay attention to all information required to perform that task and the interface should be clearly visible and unambiguous in feedback. Most acceptable application of his model is how to design products in relation to the three levels of information processing. Visceral design is widely applied for

providing product's look, feel and sound good. Designers can use aesthetic techniques to make a product emotional e.g. designers may use clean lines, balance, colour, shapes and texture for this purpose. According to this model, some affects related to our senses and their valences have been presented in **Table 2.1** which may be useful for product/interface design.

Norman's model also explains that people are readily choosing a same product to due to positive emotions associated with the product (behavioral level of processing). The reflective level of processing happens when consumers/ users are deciding to continue use a product or to switch from one product to another product. It can be argued that users will continue liking to use a product if it's design is good. In other words, a good design may involve all level of emotional processing (visceral, behavioral and reflective) through user-product experience over time.

**Table 2.1 Examples of affects in relation to different sensory modalities**

<i>Affect</i>	<i>Positive</i>	<i>Negative</i>
Visual	Smiling faces	Frowning disgusted faces
Touch	Rounded objects	Sharp objects
Hearing	Soothing/ harmonious sounds	Harsh/ discordant sound
Smell	Sweet smells	Smell of spoiled egg
Taste	Sweet taste	Bitter taste

Source: Information presented in this table is adapted from Norman, 2004.

### 5.6. Technology as Experience Framework

McCarthy and Wright (2004) proposed a framework regarding user experience to explain how the user feels about the product in different phases of product experience. They proposed that there are four core threads which are responsible for the user's holistic experiences. These are the 'sensual thread', 'emotional thread', 'compositional thread', and 'spatio-temporal thread'. The 'sensual thread' is concerned with our sensory engagement with situation and is similar to visceral level of Norman's model (Norman, 2004). For examples, sensory engagement during interactivity of users with cell phones, computer games, chat-room etc. The 'emotional threads' involve common human emotions, such as sorrow, anger,

happiness etc. which are influenced during product use. For example, a person may feel anger while facing problems in typing due to faulty key board. The ‘compositional thread’ refers to narrative part of product experience; as it unfolds the way a person make sense of them. For example, if consumers experience frustration during product purchase process due to e-retailer’s website design related problems, they may not purchase products from the same website though they like the products. The ‘spatio-temporal thread’ is concerned with space and time in which our experiences take place and the effect of various factors which influence space and time. For example, people avoid crowd and prefer quiet place/ambience for important discussion. Space designers may think about such situation for their design implementation.

## 6. Theoretical Framework for Designing Emotional Product

An integrated framework has been developed after identification of advantages and disadvantages about theories discussed in the above sections for designing of emotionally appealing product. Benefits and drawbacks of above described six theories are presented in **Table 2.2**. In the proposed framework different potential and useful components of emotional product design have been included from various cognitive theories of emotion. Designers may take following considerations while designing emotional products (see **Figure 2.10**). This framework highlights in details about both pre-design and methodological considerations to express emotion in product.

**Table 2.2 Examples of affects in relation to different sensory modalities**

<i>Theories</i>	<i>Advantages</i>	<i>Disadvantages</i>
Kansei Engineering	Relates product appearance with different emotional and semantic meanings of product.	Not able to explain how emotion is generated by product.
Product Personality Theory	Relates product appearance/usability with different emotional and human personality related semantic meanings.	Though it is able to explain consumer congruence effect but still unable to explain how emotion is generated.
Pleasure Model	Explains different sources of product pleasure e.g. physiological, psychological, ideological and sociological.	Not able to explain cognition and emotion related behavioral information processing.

Product Appraisal Model	Can explain how context and emotional product attributes generate emotion through appraisal.	Less empirical evidences are found on emotional product design which is validating this model.
Emotional Design Model	Can explain psycho-physiological basis of emotional information processing and product choice.	Less empirical evidences are found on emotional product design which is validating this model.
Technology as Experience Framework	Highlights the way to overcome different threats of user experiences in real time scenarios.	Not able to explain cognition and emotion related behavioral information processing.

Various pre-design concerns of the proposed framework would help designers to consider about different aspects for designing an emotional product. Prior to designing an emotional product, designers need to consider the context of design, feasibility of value addition through emotional attributes of the product, different sources of pleasant user experiences, suitable way of emotion expression through product characteristics involving one or more sensory modalities, and socio-economic feasibility for unambiguous emotional product purchase decision. When, designers are able to presume and conceptualize product/ service design features based on all these pre-design consideration, they may proceed to subsequent development of prototypes.

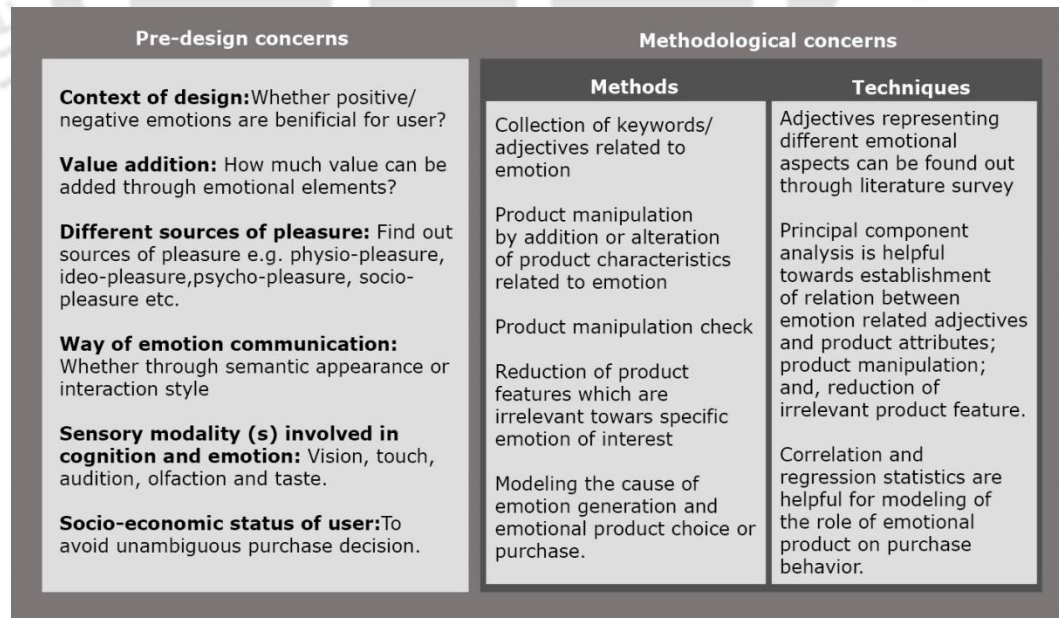


Figure 2.10 Framework to design emotional product.

After developing the probable prototypes, user evaluation can be performed using methodological concerns. Methods and techniques (as mentioned in **Figure 2.10**) can be followed for prototype evaluation. According to this framework, methodological concerns are important because it helps in emotional value addition to a particular product. Designer can add either positive or negative emotional value using this framework as per the need and context of the design. For instance, the impact of the human skull symbol as product attribute in car driving interface may sometime be beneficial to represent the meaning danger or warning; however, this symbol helps to generate fear, a negative emotion. The smiling face of an emoticon is representing happiness (a positive emotion). The proposed framework may also able to relate the usefulness of such attribute as design feature in an interface (e.g. social networking interface). In addition, evaluation of emotional product design may further be extended with some advanced neurophysiological techniques such as eye-tracking, facial EMG, GSR, and MRI as these techniques are sensitive enough to explain neuropsychophysiological basis of product choice decision (Balconi, Bortolotti, & Gonzaga, 2011; Mele, & Federici, 2012; Miesler, Leder, & Herrmann, 2011; Laparra-Hernández et al., 2009). In this context it is worthy to mention that ‘Somatic Marker Hypothesis’ (Damasio, 1996) is also very relevant for identification of neurophysiological basis of emotional product choice decision. Contemporary economic theory ignores the impact of emotions on decision-making but emerging neuroscience evidence suggests that sound and rational decision making depends on emotional processing. The somatic marker hypothesis actually provides a systems-level neuroanatomical and cognitive framework for decision-making and its impact by emotion. The key idea of this hypothesis is that decision-making is a process which is influenced by bodily marker signals; generally arise during bioregulatory processes, including those that express themselves in emotions and feelings. Therefore, neurophysiological markers are also important for product evaluation process. After whole evaluation of prototypes, designers can take decision for redesigning of product or they can proceed for manufacturing. Thus, the proposed framework would be beneficial for

the designer to get an overall idea about emotional product design and steps to be followed for the same.

### **7. Pleasure as a positive emotional construct for product design**

Beyond usability, pleasure is an influential factor for product quality evaluation. Pleasure is defined as the positive emotional state which can be best expressed in terms of pleasantness, happiness, joy and satisfaction (Desmet, 2002; Desmet, 2012; Demirbilek & Sener, 2003; Laparra-Hernández et al., 2009). However, some other pleasure related words such as cheerfulness, cuteness etc. are also reported in literature (Jiao, Zhang, & Helander, 2006; Luo, Fu, & Korvenmaa, 2012). Jordan (1997) stated about four different kinds of pleasures which are closely associated with product emotion. These four types include physio-pleasure (related to touching and holding a product); social-pleasure (related to social relationships and communication that a product enables); psycho-pleasure (gained when a product helps the user to accomplish a task); and, Ideo-pleasure (related to values that a product and its use represent or support). Therefore, the user perceives pleasure in product from four different aspects. All four pleasures may or may not come in to action together for all the contexts of product use.

Many emotion and pleasure related studies have been conducted under the discipline of 'Kansei Engineering' (Nagamachi 1995), also known as 'Pleasure Engineering' (Jordan 2000). 'Kansei Engineering (KE)' is "translating technology of a consumer's feeling and image for a product into design elements". Therefore, KE addresses the relationships between emotions and products. Petiot and Yannou (2004) described about product semantics, the "study of the symbolic qualities of man-made forms in the context of their use, and application of this knowledge to industrial design". For example, Karlsson, Aronsson, and Svensson (2003) evaluated the relationship between different forms of car interior and pleasantness. They explained semantic environment description (SMB) method which measures the impression with eight factors: pleasantness, complexity, unity, potency, social status, enclosedness, affection and originality. They found this method as useful and effective method for vehicle interior assessment.

Chuang, Chang, and Hsu (2001) demonstrated that users' preference is positively associated with the mobile phone form expressing positive emotional meanings. Hsiao and Chen (2006), studied emotional responses against product forms and described relevant emotion related affective adjectives for different product categories such as automobile, sofa, and kettle etc. Huang, Chen, and Khoo (2012) stated consumers' emotional requirements as a 'Kansei needs' and they highlighted about the semantic differential (SD) method which will be helpful in the emotional product design. They studied different forms of perfume bottles and they classified designs of perfume bottle into different emotional categories. Hsiao, Chiu, and Lu (2010) built a product-form model based on visual appearance of a coffee maker. Best combination of car body types and wheel hub forms, based on semantic expressions of product appearance was determined by Luo, Fu, and Zhou (2012) and emotional responses were collected from users/ consumers. Study of Demirbilek and Sener (2003) highlights the motto of 'Frog Design' (one of the world's famous design companies) i.e. 'Form Follows Emotion'. According to their philosophy, if a product form can generate emotional responses such as happiness and joy etc., users then find pleasure in it. In addition, according to model of product appraisal, appraisal of a product depends on emotional responses generated by the product (Desmet, 2002; Desmet & Hekkert, 2007). If form of a product is visually good, it may generate pleasure; and user may feel happy and joy in it. Thus, product form is very much associated with pleasure and positive emotional responses. Further, user satisfaction and pleasantness of the product is related with usability of the product (Nielsen 1993). Therefore, designers can satisfy consumer through incorporating the feelings of pleasure using different product forms. In a very recent study, it has been highlighted that anthropomorphic products has the potential to induce pleasure as they may reflect different personality (Chelho, Versos, & Silva, 2013). Therefore, anthropomorphic product form would be the possible way to express pleasure through product appearance.

There are few common techniques through which it is possible to evaluate pleasure contributed by product attributes such as product appearance. Few of

these effective techniques include semantic differential method (involving semantic differential scale), galvanic skin response (GSR) and facial electromyography (EMG). Among these techniques, GSR and facial EMG are psychophysiological techniques for measuring emotional states. Actually, GSR is a marker of sympathetic emotion. The GSR involves the sweat gland and an epidermal component each responding preferentially according to the demands of the behavioral situation. Similarly, specific facial muscles activities are associated with emotional changes and these muscles activities can be recorded through facial EMG. In recent years, GSR and facial EMG have been employed to evaluate the product and to determine product emotions. Van-den-Broek and Westerink (2009) highlighted about the feasibility of product evaluation using GSR and facial EMG. Laparra-Hernández et al. (2009) studied ceramic flooring designs using GSR and facial EMG techniques. Miesler, Leder, and Herrmann (2011) reported about the evaluation of car face design using facial EMG.

### **8. Importance of visual appeal and usability in product design**

Human perceptual process depends basically on five sensory modalities. It is possible to interact with a product by virtue of these five sensory modalities. Visual, auditory and kinesthetic channels are much busy sensory channels for perceiving and interacting with objects in daily life situations (Robinson-Riegler & Robinson-Riegler, 2008).

Designing and making product visually appealing is not new but there are some problems associated with visual attractiveness. For instance, consumer may select a product which is visually appealing and may purchase this product but visually good products may not always be usable. Usefulness of the product might be better understandable after buying and using the product. In such cases it disobeys “What is beautiful is good” principle (Dion et al., 1972). Hence, visually appealing or aesthetically good products are not always associated with good usability (Mugge & Schoormans, 2012), much safety and much comfort. Vergara et al. (2011) emphasized that product’s pleasant appearance must be associated with comfort and safety of use.

Usability, safety and comfort of a product is mainly reflected through product's appearance (visual) and interaction style and these three ergonomic factors play an important role in the perception and determination of product value, and product choice (Creusen & Schoormans, 2005). Product designer should consider these three factors when designing products but unfortunately it was found in history of marketing research that these factors are under less considered by designers in the context of anthropomorphic product design. As a consequence of this fact, designed products may not be sustained in the market for long time.

According to definition of "usability;" "*when a product or service is truly usable, the user can do what he or she wants to do the way he or she expects to be able to do it, without hindrance, hesitation, or questions*" (Rubin & Chisnell, 2008). The factors which need to be consider for making a product usable are usefulness, efficiency, effectiveness, learnability, satisfaction and accessibility. It was found that product functionality directly related with product usability. There are basically two ways to perceive the usability of a product: 1) through physical interaction with the product while using the product; and, 2) by only viewing the physical appearance of the product. After going beyond functionality of the product, in recent years, concept of apparent usability has came up with the concept of visual domain of the product design and it is very much associated with product's physical appearance. Apparent usability is the prior perception of consumers about the ease of use of products. Apparent usability is important because consumers are often not able to use and interact with products before purchase (Thompson, Hamilton, & Rust, 2005), which makes it essential for consumers to rely on their prior expectations of the product by evaluating the product's usability through evaluating the product's appearance. Pelzer, Jong, & Kanis (2007) also emphasized the importance of apparent usability and its significant influence on consumer preferences in comparison to inherent usability aspects. Though some separate reports are found on apparent usability and; visual perception of product safety and comfort, still cross talks between these three

factors are needed to be evaluated simultaneously in the context of anthropomorphic product design.

### ***8.1. Crosstalk between visual attractiveness and pleasure in the context of product design***

Yun et al. (2003) considered attractiveness as an important dimension to satisfy the users through looks of mobile phone design. Many other researchers mentioned visual attractiveness as an important criterion for enriching the market value through product's appearance (Bloch, 1995; Bloch, Brunel, & Arnold 2003; Creusen & Schoormans, 2005; Hassenzahl, 2004; Moshagen, Musch, & Göritz, 2009) which is capable of influencing the product purchase intention positively (Wells, Valacich, & Hess, 2011). Therefore, there is opportunity for designers to satisfy consumers' emotional needs through incorporation of attractiveness and feelings of pleasure using different product forms.

Visual attractiveness is an essential factor in product design because it is closely related with the product's appearance. It is well proved that visual appearance of products plays a significant role in determining consumers' product choice (Creusen & Schoormans, 2005), commercial success and consumers' life quality (Crilly et al., 2004). Recent reports suggested that products which are more visually attractive, grabbing more attention towards it when many products are placed simultaneously in shopping mall environment (Tonkin et al., 2011). Therefore, evaluation of visual attention analysis is necessary when aiming for visually attractive product design.

To handle or manage bulk amount of information coming from environment, human beings require a selective focus (attention) to certain amount of information as the short term memory (STM) store is limited for every human beings. Therefore, attention is important to choose information of interest and for managing huge amount of information. In general, attention is normally discussed in terms of visual and auditory senses. Wickens (1992) classified attention into three categories viz. selective attention, focused attention and divided attention. Definitions of these attention types are -

*Selective attention-* “Selection is the choice of what to pay attention to. An error in selective attention is the unwise deliberate choice to pay attention to an environment source of information that is less than optimal for the task at hand.” Selective attention may occur due to tunnel vision that makes us less open to alternative options.

*Focused attention-* “Focus in attention is the ability to withstand distractions. Failure to maintain focus results in the intrusion of external environmental information in spite of an individual’s efforts to shut it out.” In this context, it may be reasonable to state that focused attention can be diverted easily by emotionally charged stimulus and our focus may be directed to this emotional stimulus.

*Divided attention-* “Divided attention is an attention type which is required when human beings are doing more than one activity at the same time.” People often experience problems when attempting to divide their attention between two or more sources of information. In such situation, what we are doing is quickly shifting our attention between tasks rather than working on these tasks simultaneously.

There are different factors that are influencing visual attention such as colour, form, task demand etc. Colour display, color formation and alignment should be considered first when designing interfaces for selecting product colour combinations (Wu & Chen, 2009). On contrast, form of a product relates to the consumers’ psychological and behavioral responses (Bloch, 1995).

There are different tools available for understanding visual behavior and visual attention such as electrooculography (EOG), eye-tracking devices etc. Among these eye-tracking device is more effective in the context of visual behavior analysis (Duchowski, 2007). In addition, there are different eye-tracking variables which are related to visual attention e.g. pupil diameter size, blinking duration, number of blinks, number of fixations, fixation time/duration, number of saccades, visual scan path, heat map, focus map etc. Among these pupil diameter size, blink duration, blink count, fixation counts, first fixation duration and fixation time/duration are the quantitative measure of visual attention whereas, visual scan path, heat map and focus map are qualitative measures of visual attention (Ahlstroma & Friedman-Berg, 2006; Duchowski, 2007). **Table 2.3** represents eye-tracking measures and their definitions which are currently practiced in eye-movement researches.

**Table 2.3 Definitions of eye-tracking measures.**

<i>Measures</i>	<i>Definition</i>
<i>Temporal</i>	
Total fixation duration	Total time spent on fixations
Gaze duration	Total fixation duration within a word or an AOI
<b>Average fixation duration</b>	<b>Mean of fixation duration on each AOI. (i.e., Gaze duration mean)</b>
<b>First fixation duration</b>	<b>Time spent on the first fixation</b>
Time to first fixation	Time spent from stimuli onset to the first fixation arrival
Revisited fixation duration	Sum of revisited fixation durations within an AOI
Proportion of fixation duration	Proportion of time fixated on an AOI compared to the total fixation durations or total reading time of a whole task
Saccade duration	Sum of saccadic time spent within an AOI
Total reading time	Total time spent for a reading task or spent within an AOI
First pass time	Time spent for the first entering of an AOI until leaving
Re-reading time	Sum of revisited time spent within an AOI
<i>Spatial</i>	
Fixation position	Location of a fixation
Fixation sequence	Sequence of fixation allocations on AOIs
Saccade length	Distance between two consecutive fixations
Scanpath pattern	Pattern of fixation sequences
<i>Count</i>	
Total fixation count	Total number of fixations counted in an AOI or in a task
<b>Average fixation count</b>	<b>Average fixation count on each AOI</b>
Revisited fixation count	Sum of revisited fixations count within an AOI
Probability of fixation count	Probability of fixation count within an AOI compared to the number of fixations overall
Saccade count	Total number of saccades counted within an AOI
Inter-scanning count	Number of fixation transactions between AOIs

Source: This table is adapted from Lai et al. (2013).

In this thesis work many eye-movement related literature have been reviewed. It was observed from literate survey that there are three most frequently considered eye-movement measures used in eye-movement research. These are:

- 1) *First fixation duration*
- 2) *Average fixation duration*

### 3) Fixation Count

Articles which are reported about these three eye movement variables are presented in **Table 2.4**.

**Table 2.4 Literatures related to visual attention and eye-tracking.**

<i>Reference</i>	<i>Purpose(s)</i>	<i>Related learning topic</i>	<i>Eye-movement measure(s)</i>
van Asselen et al. (2011)	This study aimed to study how object information can facilitate a visual search during an object based contextual cueing task	Perception	<ul style="list-style-type: none"> <li>• Average number of fixations</li> <li>• Fixation duration</li> </ul>
Blair, Watson, Walshe, & Maj (2009)	This study investigated how skilled readers use contextual and morphemic information in the process of incidental vocabulary acquisition during reading	Language	<ul style="list-style-type: none"> <li>• Average fixation duration</li> <li>• First fixation duration</li> </ul>
Chowdhury et al. (2013)	Effectiveness of product personality rating style for tactile need satisfaction in case of online shopping	Perception and attention in the context of e-retailer's website selection and product choice	<ul style="list-style-type: none"> <li>• Number of fixation</li> </ul>
de Koning et al. (2010)	This study examined how visual attentional resources are allocated when learning from a complex animation	Conceptual development	<ul style="list-style-type: none"> <li>• Number of fixations</li> <li>• Average fixation duration</li> </ul>
Chowdhury et al. (2012)	Brand name recognition error in case of orthographically mutated brand name	Perception and cognition of brand name	<ul style="list-style-type: none"> <li>• Number of fixation</li> <li>• Fixation duration</li> </ul>
Goldinger et al. (2009)	The goal was to replicate the standard ORB, contrasting recognition memory to Asian and Caucasian faces, as a function of study time	Meaning-based representation	<ul style="list-style-type: none"> <li>• Total fixation duration</li> <li>• Average fixation duration</li> <li>• Number of fixations</li> </ul>
Chen & Pu (2014)	Effect of attention on product selection based on user interface evaluation	Usability of interface	<ul style="list-style-type: none"> <li>• Fixation frequency per AOI</li> <li>• Fixation duration per AOI</li> </ul>
Hout & Goldinger (2011)	This study investigated under what conditions during visual search does the incidental learning of BK occur? and what does viewing behavior reveal about the efficiency of attentional deployments over time?	Perception	<ul style="list-style-type: none"> <li>• Number of fixations</li> <li>• Average fixation durations</li> </ul>
Tinker (1963)	Effect of quality of the print and character size on character legibility	Typography	<ul style="list-style-type: none"> <li>• Fixation duration</li> </ul>
Ozcelik et al. (2009)	This study investigated the underlying cause of the color coding effect by utilizing eye movement data	Conceptual development	<ul style="list-style-type: none"> <li>• Average fixation duration</li> </ul>
Yen et al. (2011)	Effect of text size on typeface legibility and readability	Typeface evaluation	<ul style="list-style-type: none"> <li>• Fixation duration</li> </ul>
Rehder and Hoffman (2005)	This study tested D. L. Medin and M. M. Schaffer's (1978) 5-4 category structure (indicating the superiority of multiplicative prototype, MPM)	Meaning-based representations	<ul style="list-style-type: none"> <li>• Number of fixations</li> <li>• Average fixation duration</li> </ul>
Windhager et al. (2010)	Perception of car face like human face	Emotional Meaning-based representations	<ul style="list-style-type: none"> <li>• Number of fixation</li> <li>• Fixation duration</li> </ul>
Inhoff (1984)	Reading and relatively earlier stage of lexical access	Lexical processing	<ul style="list-style-type: none"> <li>• First fixation duration</li> </ul>
Robinson-Riegler, & Robinson-Riegler (2008)	Perception and cognition of text	Meaning-based representations	<ul style="list-style-type: none"> <li>• Number of fixation</li> <li>• Fixation duration</li> </ul>
Lee, Tang, & Tsai (2005)	Product colour preference evaluation	Perception of colour and attention	<ul style="list-style-type: none"> <li>• Number of fixation</li> <li>• Fixation duration</li> </ul>
Wills et al. (2007)	This study employed electrophysiological measures to reveal early attentional differentiation of events that differ in their previous involvement in errors of predictive judgment	Meaning-based representations	<ul style="list-style-type: none"> <li>• Average fixation duration</li> </ul>
Duchowski (2007)	Overview on eyetracking technology	Working principles and applications of eyetracking techniques	<ul style="list-style-type: none"> <li>• Number of fixation</li> <li>• Fixation duration</li> </ul>
Tonkin, Ouzts, & Duchowski (2011)	Packaging design workflow and it's interaction with physical and virtual shelves	Packaging design evaluation	<ul style="list-style-type: none"> <li>• Number of fixation</li> <li>• Fixation duration</li> </ul>
Maughan, Gutnikov, & Stevens (2007)	Attractiveness evaluation of advertisement	Advertisement design evaluation	<ul style="list-style-type: none"> <li>• Number of fixation</li> <li>• Fixation duration</li> </ul>
Singh & Das (2010)	Which is the Most Delicious Part of a Motorbike?	Automobile design evaluation	<ul style="list-style-type: none"> <li>• Fixation count</li> </ul>

It is now known that longer the participants' eyes fixated on a target, the more detailed information will be gathered. The fixation count was an index of knowing the number of the perceptual times for a specific type of stimulus (Tseng et al., 2013). Longer fixation durations correlate with more concentrated perceptions (Nuthmann et al., 2010). Fixation duration and fixation count are more relevant eye-tracking variables to analyse visual attention and attractiveness (Chowdhury et. al., 2012). More fixation counts per area of interests (AOI) on an object means more interest or attention towards this object (Chowdhury et. al., 2013). Fixation frequency and fixation duration per AOI was analysed to observe the effect of attention on product choice (Chen & Pu, 2014). The longer the participants' eyes fixated on a target, the more detailed information could be gathered. The fixation count is an index of knowing the number of the perceptual times for a specific type of stimulus (Tseng et al., 2013).

Since long time, many studies on eye-tracking have been conducted; and, several arguments have been made based on eye movement results. Even, eye-movement studies during reading experiments helps researchers a lot to understand cognitive and perceptual processes. Typographic variables such as quality of the print and character size may influence fixation duration because of character legibility (Tinker, 1963). In an eye-movement study it was established that the first fixation duration is a measure which reflects the relatively earlier stage of lexical access (Inhoff, 1984).

Eye-movement recordings can actually indicate the thought 'on top of the stack' of a person's cognitive processes and provide a dynamic trace of where her/his attention is being directed in relation to a visual display (Just & Carpenter, 1976). Cognitive scientists and eye movement researchers agree that the eye movement data reflect the participants' cognitive state (Sun et al., 2014). It was reported that the eye location and covert attention overlap (Rayner, 2009). Eye-movement analyses revealed that text in smaller-sized characters had longer fixation duration, fewer fixations and fewer regressions than the text in larger-sized characters (Yen et al., 2011). Eye fixation becomes a vital indicator for visual attention allocation and moment-to-moment cognitive processing during

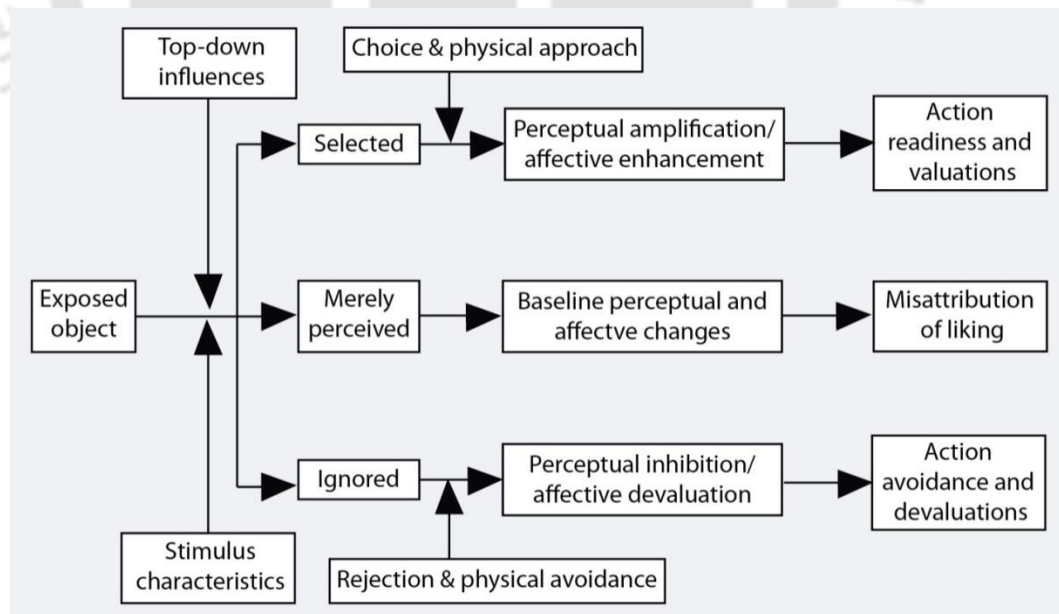
reading-and search-based activities (Kammerer & Gerjets, 2012; Rayner, 1998). There are very few eye-tracking studies related to cognitive ergonomics, branding and product choice. In a cognitive ergonomics related study it was reported that the visibility, meaningfulness and placement of specific interface elements can be evaluated using eye-tracking device, and the study findings can be used to improve the design of the interface (Goldberg & Kotval, 1999).

During practice, the process of inferring useful information from eye-movement recordings involves the human-computer interaction researcher defining 'AOI' over certain parts of a display or interface that is under evaluation, and analysing the eye movements which fall within such areas (Chen & Pu, 2014). In this context of usability evaluation it may be reasonable to highlight that fixation frequency and fixation duration per AOI was analysed to observe the effect of attention on product selection based on user interface evaluation (Chen & Pu, 2014). It has been observed that in comparison to a randomly organized set of component buttons in computer interface, well organized functional grouping resulted in shorter scanpaths, covering smaller areas. The poorer interface resulted in more fixations than the better interface, but there was no difference in fixation duration (Goldberg & Kotval, 1999). Alonso et al. (2013) investigated the possibility to integrate a free head motion eye-tracking system as input device in air traffic control (ATC). They found that the combined use of gaze dwell-time selection and continuous eye-gaze feedback allowed the best performance and that target size had a greater impact on performance than target distance. For instance, Maughan et al. (2007) established that increased number and duration of fixations on the attractive advertisement than the less attractive advertisements. In another example, it was proved that physical environment afforded significantly faster search performance than the virtually projected image during product selection in a supermarket (Tonkin et al. 2011). The correlation between eye-tracking gaze data and product attitude was established by Kukkonen (2005). In a e-retailer's website design study, it was established using eye-tracking study that product personality rating style effectively satisfied the tactile need of consumers

in case of online shopping (Chowdhury et al., 2013). This study also correlates fixation counts with product choice behaviour of online buyers.

### ***8.2. Visual attention and visual search behavior may be influenced by emotionally valanced stimulus***

From the available literatures it is evident that there are many consequences of attentional shifts due to emotionally valanced stimulus. Tavassoli (2008) made a theoretical framework on affective consequences of visual attention which emphasizes the role of pleasure on visual attention (**Figure 2.11**). According to this framework, sensory input of items that are selected for attention is amplified. This may further lead to affective enhancement. Moreover, objects selected for attention may be automatically emotionally enhanced in order to support future actions. On the contrary, negative (threatening) stimulus characteristics/information shifts the attention away from the primary task resulting in a behavior known as conscious inhibition. Another probable affective consequence may be the misattribution of liking a product/ an event/ a situation, as stimulus information was merely perceived earlier.



**Figure 2.11 Attention and its affective consequences.**

Very recent studies on product design it was observed that consumers perceived characteristics, emotions, personality traits, and attitudes of car fronts as they perceived all these factors through human facial attributes such as eyes, lips, nose etc. (Windhager et al., 2008). Windhager et al. (2010) reported that eye movement patterns indicated on which visual information participants relied to solve the task and clearly revealed the perception of facial features in cars, such as headlights as eyes or grille as nose. In another recent eye-tracking study it was established that the fuel tank is the most delicious part of a motorbike (Singh & Das, 2010). Their report also illustrates how motorbike designers vary the fuel tank forms, colours and graphics to differentiate motorbikes belonging to different biking segments. Stasi et al. (2011) concluded that eye-movement study for hypermedia interactions as a neuroergonomics approach. Their study results showed that the visual scanning behaviour coincided with subjective test scores and performance data in showing a higher information processing load in Goal oriented shopping. In this study, variations of pupil diameter were able to explain user activation during the interaction task and confirming the validity of pupil size as an index of arousal. Ho and Lu (2014) recently described that it is possible to evaluate emotionally valenced product appearance using eye-tracking technology. Their study also stated that negative emotional responses to products were characterised by lower pupil size than the other emotional responses. However, the measurement of pupil size cannot distinguish between positive and neutral emotional responses.

Therefore, for the present research work eye-tracking study may be conducted assuming that less visual effort given to search a product with more pleasant anthropomorphic appearance than the product having less pleasant anthropomorphic look.

### ***8.3. Crosstalk between pleasure and apparent usability in product design***

Previously, function and usability were rigorously studied as primary factors in user experience and user centred design research as usability influences product choice (Mack & Sharples, 2009). However, usability is still an important matter

of concern as highlighted in the context of nanoscalar product design (Chowdhury et al., 2012). Nielsen (1993) defines usability in terms of five product/ system attributes: learnability, efficiency, memorability, errors and satisfaction. Usability of a product or system will be high if users' learnability, memorability, efficiency and satisfaction towards a system or product are high; and, conversely, the error is less. Kurosu and Kashimura (1995) classified usability into two types: inherent usability and apparent usability. Inherent usability defined as actual usefulness of a product which may be perceived only after using the product. On the contrary, apparent usability may be perceived through visual appearance of the product. It has recently been established that vision is most important sensory modality at the time of product purchase (Fenko, Schifferstein, & Hekkert, 2010). Therefore, consideration of apparent usability is important as it may be perceived through product appearance. Further, apparent usability is important because in many purchase context consumers are not able to use products before purchase (e.g. online product purchase) (Thompson, Hamilton, & Rust, 2005). In such context, if consumers perceive inferior usability by seeing the product itself in pre-purchase stage, it might have a negative impact on post-purchase usability perception, though the inherent usability of the product is high (Seva et al. 2010). It is worthy to note about the belief of few researchers who mentioned in their studies that "What is beautiful is good" (Dion, Berschied, & Walster, 1972) and "What is beautiful usable" (Tractinsky, Katz, & Ikar, 2000). On the contrary, Hassenzahl (2004) challenged these previous findings for a product's usability and proposed that 'What is judged to be more beautiful is not necessarily perceived as more usable'. However, apparent usability of the product should match with inherent usability of the product; otherwise, it may contribute to user disappointment after product purchase.

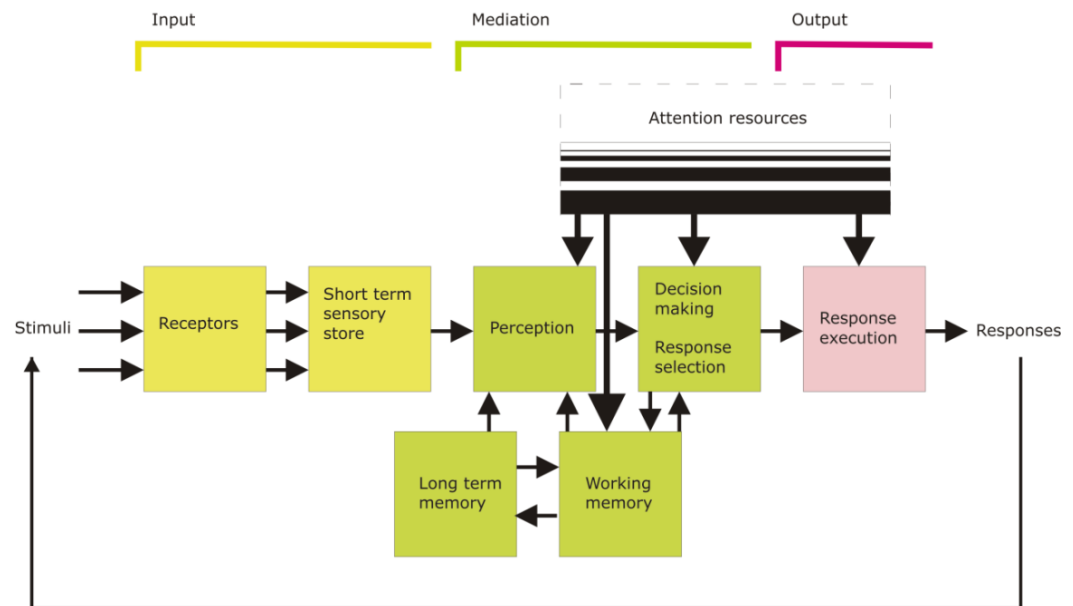
A study conducted by Kurosu and Kashimura (1995) suggested that apparent usability related to the interface component design, layout, and interactions on the interface. It was also found in this study that a positive relationship exists between aesthetics and apparent usability (Kurosu & Kashimura, 1995; Tractinsky, 1997). In a recent study, it was reported that high

level of novelty due to product colour causes perception of low apparent usability by users (Mugge & Schoormans, 2012). Authors used aesthetic technique to modify the level of novelty in product appearance through change in product colour. Thus, it is clear that product appearance may influence apparent usability. In addition, it was found that product form has linear relationship with usability of the product as “Product Form Follows Function” (Mack & Sharples, 2009; Schifferstein & Hekkert, 2009; Wake & Das, 2000). Therefore, apparent usability would be the important factor in the context of anthropomorphic product appearance design.

### **9. Information processing and decision making models considers cognition, attention and emotion**

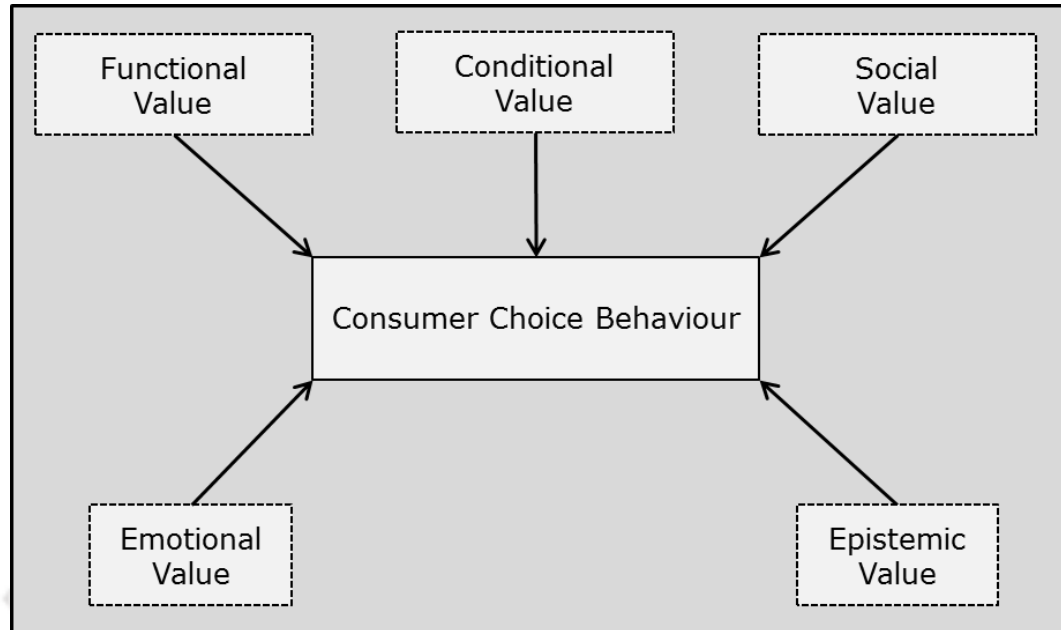
There are different decision making and information processing models available in literatures. Following paragraphs covers only few of these important models (related to attention, cognition, emotion and product choice decision) which are very relevant to the present thesis. In 1992, C. Wickens described a qualitative model of human information processing that incorporates various stages which are used to perceive sensations, transform data and choose action. Each stage takes certain time to perform. Time taken for each stage may be extended due to additional considerations (e.g. uncertainty). According to this model attentional resources are finite in nature. Choices on how to distribute or allocate attentional resources have significant implications for workload assessment and work design.

According to this model, receptors help to transduce stimuli into neural signals which are transferred to brain for further processing of information through perceptual and cognitive process. Details of perceptual and cognitive process; and, role of different memory have already been discussed in previous paragraphs. Schematic diagram of human information processing is presented in **Figure 2.12.**



**Figure 2.12 Information processing model. (Adapted from Wickens, 1992)**

Though there are many proposed theories and models of decision making such as Anderson model (1965), Nicosia model (1976), Howard-Sheth model (1969), Engel-Kollat-Blackwell (EKB) model (1972), Bettman's model (1979), and Sheth-Newman-Gross model (1991)], two decision making model are very relevant to emotional product purchase decision (Majumdar, 2011). These models are Sheth-Newman-Gross (SNG) Model and 'Engel-Kollat-Blackwell (EKB) Model'. Both of these two models talked about the influence of product related stimuli attention, consumer satisfaction and emotion. These models also elaborated the roles of attention, consumer satisfaction and emotion in consumers' decision making or product choice behaviour. EKB model and SNG models are briefly discussed below.



**Figure 2.13 The Sheth-Newman-Gross Model.**

The SNG model was proposed in the year 1991 to explain the process of consumers' choice behaviour (**Figure 2. 13**). This particular model has practical relevance for segmenting any market. The SNG model is constituted with the basic premise that "Consumer choice is a function of certain specific composition values". These values are:

1. *Functional value*
2. *Social value*
3. *Emotional value*
4. *Epistemic value*
5. *Conditional value*

Definitions of these five types of composition values are presented in **Table 2.5**. These five composition values have their self-proclaimed influence in specific choice context. Product choice is positively related with each of these compositional values, for instance, to a first time home buyer, the purchase of home might provide functional value (the home might contain more space than present apartment), social value (close friends/relatives are also buying homes), emotional values (the consumer feels more secure in owning a home than the

apartment), epistemic value (the novelty of purchasing a home is enjoyable), and conditional value (starting a family). Therefore, designers should think about all these compositional values and may add these values into product/ service.

**Table 2.5 Definitions of composition values.**

<i>Composition value</i>	<i>Definition</i>	<i>Reference</i>
Functional value	The perceived utility acquired from an alternative for functional, utilitarian, or physical performance. An alternative acquires functional value through the possession of salient functional, utilitarian, or physical attributes. Functional value is measured on a profile of choice attributes.	Sheth, Newman, & Gross (1991)
Social value	The perceived utility acquired from an alternative association with one or more specific social groups. An alternative acquires social value through association with positively or negatively stereotyped demographic, socioeconomic, and cultural-ethnic groups. Social value is measured on a profile choice imagery.	Sheth, Newman, & Gross (1991)
Emotional value	The perceived utility acquired from an alternative's capacity to arouse feelings or affective states. An alternative acquires emotional value when associated with specific feelings or when precipitating those feelings. Emotional values are measured on a profile of feelings associated with the alternative.	Sheth, Newman, & Gross (1991)
Epistemic value	The perceived utility acquired from an alternative's capacity to arouse curiosity, provide novelty, and/or satisfy desire for knowledge. An alternative acquires epistemic value by items referring to curiosity, novelty, and knowledge.	Sheth, Newman, & Gross (1991)
Conditional value	The perceived utility acquired by an alternative is the result of the specific situation or set of circumstances facing the choice maker. An alternative acquires conditional value in the presence of antecedent physical or social contingencies that enhance its functional or social value. Conditional value is measured on a profile of choice contingencies.	Sheth, Newman, & Gross (1991)

The EKB model proposes how a set of information is processed through a decision-making process, external influence on consumers to arrive at a decision to purchase (Engel, Blackwell, & Miniard, 1995). This model is able to explain both pre-purchase and post-purchase information processing and their relationships with product choice decisions (**Figure 2.14**).

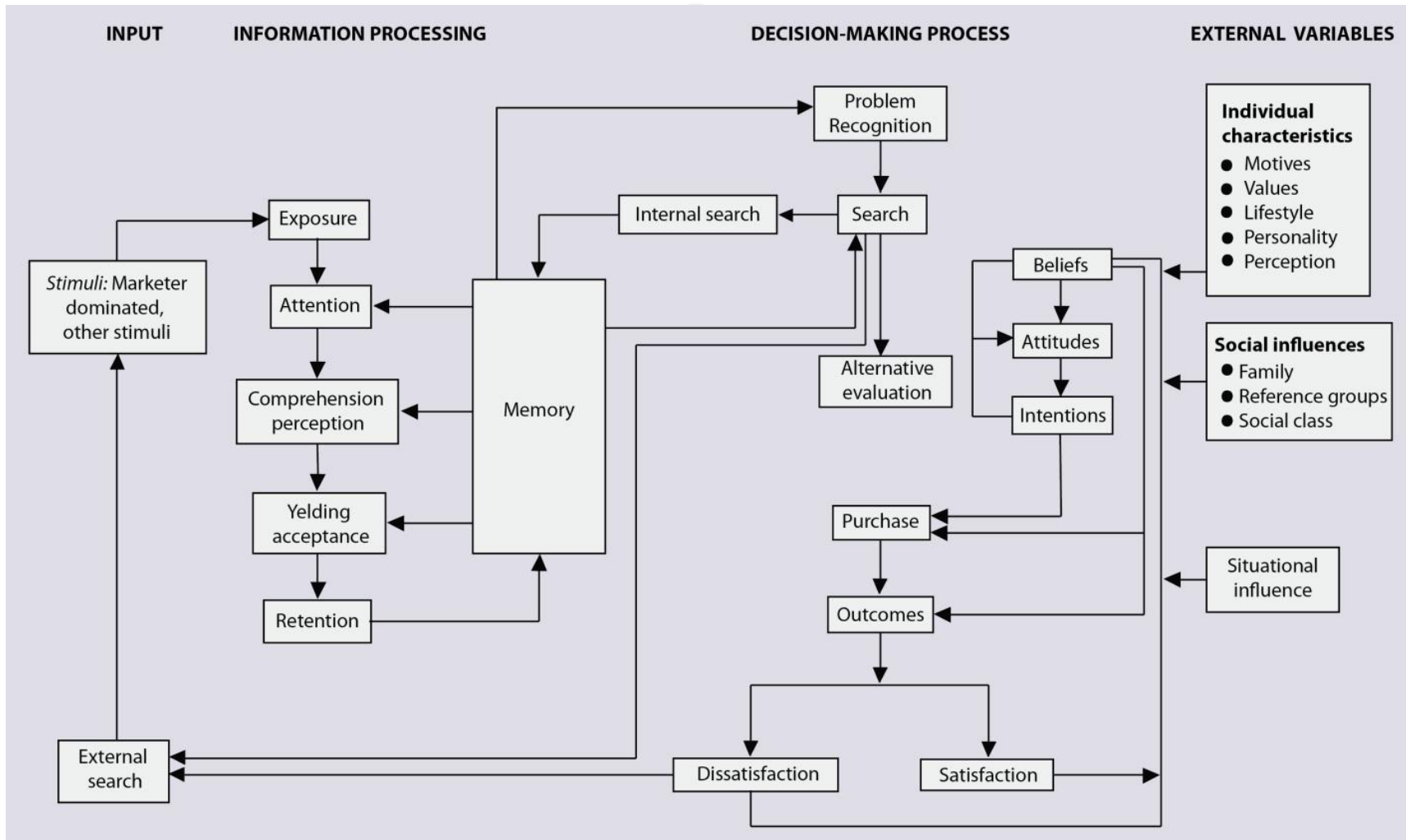


Figure 2.14 The Engel-Kollat-Blackwell Model.

The model has four discrete sections:

1. *Information input*
2. *Information processing*
3. *Decision-making process*
4. *External variables operating in the background of the consumer*

According to this model, consumers/users may be exposed to a large amount of information from different sources. They may get information input at the initial stage of information exposure or external search when a purchase outcome doesn't satisfy consumer's expected outcome at the latter stages of the decision making process. In EKB model, information processing stage consists of consumer's exposure, attention, comprehension/ perception and retention of incoming information in memory. The EKB model also talks about five basic stages in consumers' decision-making process. These stages are:

- (i) *Problem recognition*
- (ii) *Search*
- (iii) *Alternative evaluation (all of which lead to the formation of attitudes)*
- (iv) *Purchase intention*
- (v) *The final act of buying*

According to EKB model, the consumer's individual characteristics (e.g. motivation, personality, perception etc.) may influence the decision making. Other factors affecting decision making includes social and situational factors. Social influences may be family, social class, reference group etc.

## **10. Areas Unexplored**

There is no doubt, anthropomorphism is reflected in many available house hold products such as chairs, spoons, pillow etc. through visual appearance, but, it is also observed that many anthropomorphic products are not conveying the visual message for apparent usability and pleasantness. Consequences of lack of apparent usability due to anthropomorphic appearance are not well understood. In

some other cases it is also identified that complexity of design increased due to anthropomorphism. Thus, the potential of anthropomorphism to increase purchase intention will be lost dramatically. Due to these facts, there is a need to consider apparent usability (a factor related to cognitive ergonomics) in the context of anthropomorphic product design as there is potential role of apparent usability in product choice which has been evident from literature. Literature suggested that the role of pleasure due to anthropomorphic appearance is less explored though pleasure is an important factor in the context of consumers' product choice. Furthermore, visual attractiveness is an important variable which has relationships with apparent usability and pleasure. Consumer may like anthropomorphic products but it is less clear that this liking is due to visual attractiveness or apparent usability or pleasure perceived in the product. Even, which factor is more important for anthropomorphic product purchase intention is not clear. It is assumed that if anthropomorphic product is able to express apparent usability, pleasure and visual attractiveness through its appearance then it will ultimately lead to a positive effect on consumers' product purchase intention.

The study of visual attention, especially the visual search behavior when selecting an anthropomorphic product is not evident in literature. It is possible to evaluate such visual behavior with the help of eye-tracking device.

All these issues are important for understanding consumers' cognitive and affective behavior in the context of product purchase. Still there are no such empirical evidences available for understanding the complex relationships between these above mentioned variables in the context of anthropomorphic design, so, there is a high scope for assessment of all these matters in the present research work. Moreover, one preliminary study was conducted to understand the relationships among product personality (human like personality of product, signifying anthropomorphism), usability and product choice. Results of this preliminary study showed that the product which has higher level of positive personality also had a higher level of usability in human product physical interaction. Furthermore, product personality (positive vs. negative), usability (low vs. high) and product choice (no vs. yes) were positively related with each

other. Based on the preliminary study results it can be concluded that the designer either need to concentrate on addition of positive personality to the product or to improve usability of the product, (through manipulation of product features) when consumers/ users are able to experience the product physically, before purchase. Details about preliminary study are presented below in the text box. It is reasonable to mention that consumers/ users do not always get chance to use a product before purchase e.g. in case of online product purchase. Therefore, in such situations, consumers need to predict about the actual usability of the product based on the perception of product appearance. In such a scenario if anthropomorphic products are not able to convey more usability through its appearance then there is a chance of rejection of this product though it has anthropomorphic appearance. Further, as product may express human like personality, hence, product personality is related with anthropomorphism. In the preliminary study, it was found that positive personality in product causes high usability in case of human-product-physical interaction. Further, product personality assignment is a technique of pleasurable product design. Therefore, there is a chance to have relationships between apparent usability and anthropomorphism when both of these factors are perceived through anthropomorphic visual appearance of the product.

### **Preliminary study**

#### ***Role of usability and product personality on product choice in human-product physical interaction***

#### **Objectives**

- To understand variations of product usability (high vs. low) with product personality (Negative vs. Positive) or strength of overall product personality (High vs. Low).
- To observe influences of product personality and product usability on product choice.

#### **Hypothesis**

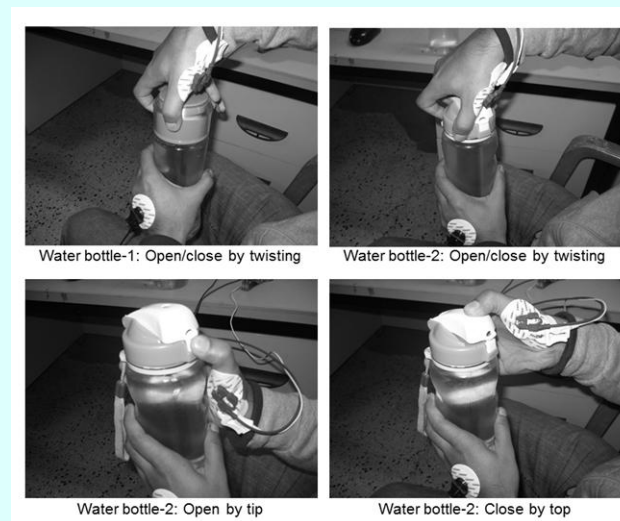
“There are significant differences in product personality due to differences in product usability”.

## Method

Two water bottles were selected for this study (**Figure 2.15**). One bottle had twisting type bottle mouth (bottle-1) and another bottle had tip-top type bottle mouth (bottle-2). Usability of these two water bottles (having different functions) was measured using standardized questionnaire and electromyography (EMG). The EMG study was conducted on thumb finger muscle (flexor pollicis brevis) as this muscle has maximum involvement in bottle mouth opening activity (both in twisting type bottle mouth and tip-top type bottle mouth) (**Figure 2.16**). Product personality was measured using five point scale with 20 items adopted from Mugge et al. (2009).



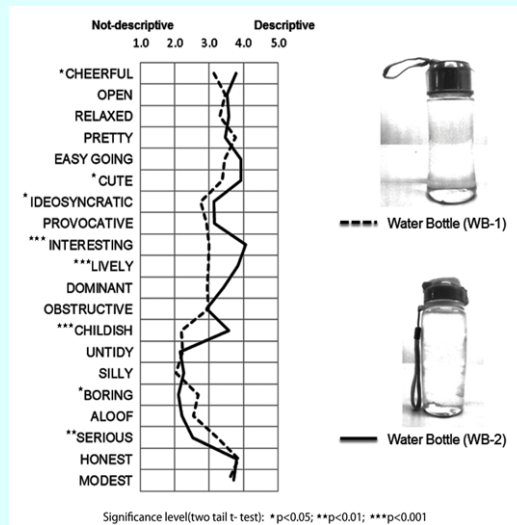
**Figure 2.15** Images of water bottles selected for the study (Water bottle-1 in left and water bottle-2 in right).



**Figure 2.16** Images of electromyographic recording during opening and closing of water bottles.

Water bottle-2 had more positive personality characteristics than water bottle-1 (**Figure 2.17**). Similarly, water bottle-2 is more usable than water bottle-1 (see **Table 2.6**).

**Results**



**Figure 2.17 Differences in product personality characteristics between water bottles.**

**Table 2.6 Results of usability and product personality variation study.**

Parameters	Water Bottle-1			Water Bottle-2		
	Mean	SD	Inference	Mean	SD	Inference
Product Personality: (n=42)						
Total score	3.02	0.52	Weak	3.26*	0.42	Strong
Usability: (n=42)						
Perceived Usability	2.30	1.19	Low	3.30***	0.96	High
Drinking Ease	2.31	1.12	Low	2.81*	1.04	High
Total Usability Score	4.60	2.20	Low	6.11**	1.89	High
%MVC <sub>RMS</sub> : (n=42)						
Open by twisting	60.12	12.75	NSD	59.25	13.80	NSD
Close by twisting	58.58	14.78	NSD	58.14	16.39	NSD
Open by tip	-	-	-	22.10***	9.47	Low
Close by top	-	-	-	26.81***	13.59	Low

Level of Significance (Two tail t-test): \*p<0.05, \*\*p<0.01 and \*\*\*p<0.001. NSD: No significant differences observed

**Key Findings**

Product personality assignment could be achieved through manipulation of product attributes related to product usability. As less muscular effort in product use is associated with higher level of product personality/usability, EMG might be used as a useful technique for product personality/usability evaluation during physical interaction with product. Product usability is more valuable predictor than product personality for product choice. Ergonomists and designers may directly concentrate on improvement of product usability when product usability and product personality are co-varying simultaneously in physical mode of product experience.

Theories of human emotions and emotional product design say that users/ consumers can feel different emotions by experiencing the product attributes to a particular context of the product use. Moreover, cognitive process may evoke positive emotion (e.g. pleasure). For example, users/ consumers may feel different emotions through perception of certain attributes related to product appearance. Sometimes, human beings may perceive bodily changes to specific feelings during certain emotions. Hence, there are possibilities to measure emotion in terms of bodily changes which could be identified through neuropsychophysiological markers (e.g. eye movements, facial activities etc.).

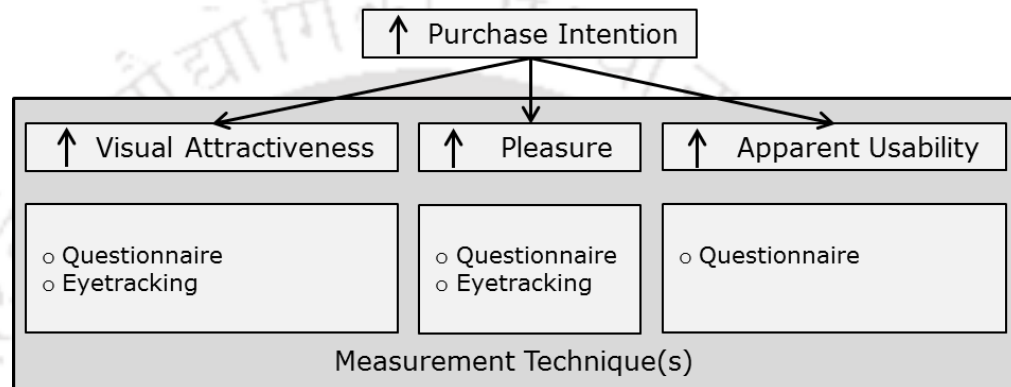
### ***10.1. Research questions***

Based on the literature survey, unexplored areas and results of the preliminary study following broad research questions were raised:

- Q1. How product purchase intention or product acceptance can be increased through anthropomorphic appearance?
- Q2. What are the consequences if apparent usability, visual attractiveness and pleasure are affected by anthropomorphic attributes?
- Q3. Which is more important cognitive ergonomics related factor among visual attractiveness and pleasure for anthropomorphic product purchase intention?
- Q4. Which is more important cognitive ergonomics related factor among apparent usability and pleasure for anthropomorphic product purchase intention?
- Q5. What is similarity in results if effects of anthropomorphic product appearance on purchase intention were measured through questionnaire based study and if measured through advance neurocognitive techniques (facial EMG and eye-tracking)?

From the literature review it was revealed that there are three probable ways to increase product purchase intention. These ways were presented in the

**Figure 2.18.** According to this figure, purchase intention of anthropomorphic product will be increased if levels of visual attractiveness, apparent usability and pleasure can be improved using the anthropomorphic attribute(s) in product appearance. Therefore, total five variables were identified for this thesis work to answer the above mentioned questions. These, were anthropomorphism, visual attractiveness, pleasure, apparent usability and purchase intention. Definitions of these variables for the present research are presented in the **Table 2.7**.



**Figure 2.18** Probable ways to increase purchase intention.

**Table 2.7** Working definitions of variables studied under this thesis work.

<i>Variable Name</i>	<i>Definition</i>
<b>Anthropomorphism</b>	Anthropomorphism is attribution(s) of humanlike appearance in non-human objects/ products.
<b>Visual Attractiveness</b>	Visual attractiveness (VA) is a complementary parameter for visual aesthetics. It can be defined as perceived beauty and attractiveness of the product when a product is visually presented to users/ consumers.
<b>Pleasure</b>	Pleasure can be defined as positive emotions such as happiness, joy, cheerfulness etc. perceived by users/ consumers while experiencing the product. However, sometimes pleasure is considered as equivalent to positive affect.  As the present thesis deals with visual appearance (i.e. anthropomorphic appearance) design of the product, therefore, the pleasure stated here actually means visually perceived pleasure.
<b>Apparent usability</b>	Apparent usability (AU) is defined as perceived usability of the product before use. The AU can be perceived through the product's appearance or sometimes through the product's sound.
<b>Purchase intention</b>	Intent to purchase a product is known as purchase intention. Purchase intention is an attitude and belief derived process.

## 10.2. Hypotheses

Based on the research questions and literature survey total 4 hypotheses were constructed. These were:

**H<sub>a1</sub>: Visual attractiveness and perceived pleasure (due to anthropomorphic product appearance) significantly affects the anthropomorphic product purchase intention.**

**H<sub>a2</sub>: Apparent usability and visually perceived pleasure (due to anthropomorphic product appearance) significantly affects the anthropomorphic purchase intention.**

**H<sub>a3</sub>: Facial muscles (viz. corrugator supercillii and zygomaticus major) activity significantly varies with levels of pleasant look in the anthropomorphic products.**

**H<sub>a4</sub>: Anthropomorphic appearance of the product significantly influences the visual attention of users; and, thus, visual attention in turn affects the anthropomorphic product purchase intention during in shop/ on shelf visual search behavior.**

### *Key points*

- ☞ Cognitive and affective theories indicate that attractiveness, apparent usability and pleasure may be the basis of anthropomorphic product choice.
- ☞ Evaluation of anthropomorphic appearance design may be possible through questionnaire, eye-movement study and facial EMG study.
- ☞ Eye-movement study and facial EMG study may be useful for validation of product evaluation results obtained from questionnaire based study.

## **Chapter-3: Anthropomorphic product appearance enhances product acceptance in the market: Influence of visual attractiveness and pleasure**

### **Abstract**

In present chapter, effect of anthropomorphic attributes (in product appearance) on visual attractiveness and visually perceived pleasure has been investigated along with unfolding of their influence on purchase intention. It is well established that visual appearance of product is a strong determinant in product choice and acceptance of product in market. Product choice is influenced by its visual attractiveness and also by visually perceived pleasure. There is no reported study on combined influence of visual attractiveness and perceived pleasure on anthropomorphic product purchase. Level of anthropomorphism, visual attractiveness, perceived pleasure and purchase intention were measured using different scales (seven point Likert scale and visual semantic scale) after showing images of two different products ('Tiffin Box' and 'Chair') to product buyers and users. Statistical analyses were carried out using SPSS 20.0 for interpretation of collected data. Present chapter summarizes the following key findings which are very important for product design strategy, more specifically in anthropomorphic product design: (a) 'Level of anthropomorphism is depending on number/ type of anthropomorphic attributes used in product form'; (b) 'Incorporation of anthropomorphism in product appearance is very useful to enhance visual attractiveness of the product'; (c) 'Anthropomorphic attributes which are associated with positive emotions (e.g. smile like facial expressions) not only helps to increase visually perceived pleasure but also visual attractiveness and these two factors in turn influence purchase intention' and (d) 'Influence of visual attractiveness on anthropomorphic product purchase intention is mediated via visually perceived pleasure'. Design strategy demonstrated in present research for visually attractive product design would surely augment consumers' product purchase intention. . Elaborated strategy of incorporation of anthropomorphic attributes in product form, to enhance consumers' visual attention and pleasure (positive emotion) towards products, would help industrial designers, ergonomists, and cognitive scientists to incorporate anthropomorphic features successfully in form design to ensure mass acceptance of products.

**Keywords:** *affective factors, cognition, decision making, industrial design, product design*

### **1. Introduction**

Product design is a very challenging job for designers in today's highly competitive commercial environment. In addition, consumers' behavior is changing day by day with their requirements and adaptation of new trends. In such scenario, designers and design researchers should rethink about the creation of newness in product design (Mugge & Schoormans, 2012a; Mugge & Schoormans, 2012b). At the conceptual design stage, an enterprise generally concentrate on creation of a certain product form which meets consumers' psychological preferences for making the product to be successful in the marketplace (Chang, Lai, & Chang, 2007; Hartono & Chuan, 2011; Hsiao & Tsai,

2005; Kuru & Erbu, 2013). Another strategy for marketing is to consider multiple combinations of product forms and designs to satisfy varied tastes of consumers to minimize the risk of their products being rejected by market. It is a well-established fact that user's experience about product form is important as 'product form follows function' and form plays an important role in product choice (Mack & Sharples, 2009; Schifferstein & Hekkert, 2009; Wake & Das, 2000). However, usability is still an important matter of concern as highlighted by Chowdhury et al. (2012). Since last three decades researchers have been interested to think beyond usability as in many instances consumers are unable to perceive actual usability of product due to constraint of physical interaction with products as in case of online purchase, well packaged products etc. In such situations, visually perceived pleasure is an important human factor consideration for predicting better product acceptance in market. Pleasure can be defined as positive emotional responses or feelings towards surrounding objects/environment of living or non-living world. Pleasure can be perceived through different sensory modalities such as vision, audition, olfaction, touch and taste sensation etc.

Visual appearance of a product should be designed in such a way that it would positively influence the consumers' product purchase intention (Wells et al., 2011). According to the concepts of three related fields of design research viz. hedonomics, design semantics and pleasure engineering, it is possible to convey emotional meanings through product form (Aronsson & Svensson, 2003; Artacho-Ramírez, Diego-Mas, & Alcaide-Marzal, 2008; Helander & Tham, 2003; Karlsson, Aronsson, & Svensson, 2003; Nagamachi, 1995; Petiot & Yannou, 2004). Nielsen (1993) stated that user satisfaction is related to how pleasant a product is to use. Demirbilek and Sener (2003) discussed about pleasure, happiness and joy as three significant emotional dimensions. They also highlighted 'Form Follows Emotion' as the motto of 'Frog Design' (one of the world's famous design companies). According to their philosophy, if a product form can generate emotional responses such as happiness and joy etc., users then find pleasure in it. In other words, if a product by its appearance can evoke positive emotions (e.g. joy/happiness/ good feelings) then that product would be

pleasurable for consumers and may get a better chance for market acceptance.

Yun et al. (2003) considered attractiveness as an important dimension to satisfy users through looks of mobile phone design. However, other researchers mentioned visual attractiveness as an important criteria for enriching the product value in the market through the product appearance (Bloch, 1995; Bloch, Brunel, & Arnold, 2003; Creusen & Schoormans, 2005; Hassenzahl, 2004; Moshagen, Musch, & Göritz, 2009) and it is capable of influencing product purchase intention positively (Wells, Valacich, & Hess, 2011). Therefore, there is an opportunity for designers to satisfy consumers' emotional needs through incorporating the attractiveness and feelings of pleasure using different product forms.

Many attempts have been taken by researchers and scholars to increase pleasure of users/consumers using different product forms. Chuang, Chang, and Hsu (2001) reported that users' preference was positively associated with mobile phone form expressing positive emotional meanings. Hsiao and Chen (2006) studied emotional responses against different categories of products such as automobile, sofa and kettle. Huang, Chen, and Khoo (2012) stated consumers' emotional requirements as 'Kansei needs'. Following evaluation of different forms of perfume bottles, they were able to classify designs of perfume bottle into different emotional categories. Appearance of a car interior was investigated with emotional design approach formulated by Luo, Fu, and Zhou (2012). From literature survey it is noticeably evident that less empirical evidences are available on emotional responses against specialized product form such as anthropomorphic form, though researchers studied different product form in different contexts. Few applications of anthropomorphism in the field of design have been found from available literatures and the same have been presented in next section.

Anthropomorphism is attribution of humanlike form(s) or interaction(s) into non-human objects (Soanes & Stevenson, 2005). Anthropomorphic products are generally reflecting different degrees of humanness either through their appearance or through different modes of interaction (Sharp, Rogers, & Preece,

2012). Various industrial designers have considered anthropomorphic forms for designing many modern products. DiSalvo and Gemperle (2003) highlighted some state of the art design examples which used anthropomorphic form in the products. Examples include design of perfume/soap bottles, pot scrubbers, car face design etc. In a study by Luczak, Roetting, and Schmidt (2003), an anthropomorphic interactive device was given to participants for experiencing and it was found to be helpful in their stress relief. According to their findings, the technical devices that were seen as helpers or friends were generally treated as less unfriendly than devices perceived as merely tools. People are generally found to talk to and interact in other humanlike ways with technical devices when they do not function as expected. This might be due to a malfunction or a time delay. Hence, this specific type of interaction determines the design weaknesses of the technical device which make users in stressful situation. So, these areas should be improved from design point of view. Initially, it might be helpful to make the kind of and reason for malfunction transparent to the user, since almost 73% of the respondents would like an informative response from the technical device when they are talking to it.

Anthropomorphism is also known as a means of culturally and biologically inspired product design. Demirbilek and Sener (2003) elaborated changes of semantic meanings with product forms. They illustrated how baby features and ‘cuteness’ can be expressed in biological form inspired car design. In another example, they showed how size of car head became more compacted over time like human skull. Besides, in many countries, anthropomorphism is also found in designs of many culturally inspired handicraft products such as sculptures, pots, fancy clay models for interior decorations etc. Chelho, Versos, and Silva (2013) stated that products could be anthropomorphized in such a way that it might reflect personality.

Following literature survey on potentials of anthropomorphism in product design, it is found that there are rarely any previous studies which are elaborating ‘how anthropomorphic elements/ attributes in product form influence product purchase intention of consumers through visual attractiveness and perceived

pleasure. Therefore, in present research, an attempt has been made to evaluate the role of anthropomorphic elements/ attributes on product purchase intention considering visual attractiveness, perceived pleasure as related underlying factors. The main hypothesis for the study of present chapter was –

**H<sub>a1</sub>: Visual attractiveness and perceived pleasure (due to anthropomorphic product appearance) significantly affects the anthropomorphic product purchase intention.**

This hypothesis was proved by two subsequent studies by coining few working hypotheses.

## **2. Study-1: Anthropomorphism and visual attractiveness**

Designers usually try to draw consumers' attention towards their designed product through its appearance which ultimately evokes product choice. It is already supported that consumers generally perceive product as good while the product is more beautiful and attractive and this follows 'What is beautiful is good' principle (Dion, Berscheid, and Walster, 1972; Moshagen, Musch, and Göritz, 2009; Mugge and Schoormans, 2012). Here, goodness means worthiness or satisfactory performance of the product to particular context. However, perceived usability became a strong determinant for goodness of a product after use of it. Buurman (1997) and Liu (2003a, 2003b) noted that visual aesthetics/beauty as an important aspect in human factors research and smart product design. Contextually, it is worthy to mention that centrality of visual product aesthetics (CVPA) has significant effect on the cognition of product aesthetic experiences (Bloch, Brunel, & Arnold, 2003; Kim, 2010). The CVPA is an important consideration for visual product evaluation because a rating for visual attractiveness of the product appearance is varying with CVPA (Bloch et al., 2003). The CVPA is actually representing sensitivity of individual towards aesthetics. Further, CVPA can be measured by using three related dimensions viz. aesthetic value, acumen, and response intensity (Bloch, Brunel, and Arnold 2003). Among these dimensions, sensitivity towards aesthetic value is more important as many authors has (Creusen & Schoormans, 2005; Hekkert, 2006; Hekkert, Snelders, and VanWieringen, 2003) has highlighted that aesthetic value

has a definite role in product choice. Therefore, sensitivity towards aesthetic value is specifically more important. Due to this fact, it was felt that there might be a role of 'consciousness towards aesthetic value' in anthropomorphic product selection process as this factor is complementary enough to CVPA. This newly coined term 'consciousness towards aesthetic value' can be defined as how much a consumer is conscious (high/low) about visual attractiveness/beauty of products when he/she is buying products from market. So, it is necessary to control effect of consciousness towards aesthetic value to get a better effect of anthropomorphism on the visual attractiveness. In fact, age group and gender of the product user are common and important demographic factors for product choice (Malhotra and Dash, 2010). Hence, these may also have influence on visual attractiveness perception of anthropomorphic products. Therefore, it was hypothesized in 'Study-1' that "degree of visual attractiveness significantly depends on different levels of anthropomorphism (due to the incorporation of varying number of anthropomorphic attributes) in product form; when age, gender and consciousness towards aesthetic value are co-varying simultaneously"(working hypothesis H<sub>a1.1</sub>).

## **2.1. Method**

### *2.1.1. Stimuli preparation*

Main intention of this study was to observe the variations of visual attractiveness with different levels of anthropomorphism due to incorporation of different anthropomorphic attributes in product form. It was reported that anthropomorphic forms were used in toys which were liked by many children (Choi & Kim, 2009). Miesler, Leder, and Herrmann (2011) used anthropomorphic form in the context of baby like car face design and showed baby schema effect which could be estimated by 'cuteness' ratings by users after presenting images of anthropomorphic car faces as stimuli. Based on these facts, it was decided to design tiffin boxes (for children) as products with varying levels of anthropomorphism to prove the hypothesis stated earlier. Design ideation considered that the design of tiffin box would be such that children can carry

foods/snacks in it as well as they can play with it. Moreover, consumers (not only children but also their parents/guardians) may feel beauty and happiness to see the tiffin box.

Images of three tiffin boxes were designed through incorporation of varying number of anthropomorphic attributes in such a way that they may lead to perception of three different levels of anthropomorphism. Hellén and Sääksjärvi (2013) reported that round/curvy shape is associated with childlike anthropomorphism. Keeping this in mind, basic shapes given in design of tiffin boxes for present were round and cylindrical to give childish look. It has been reported that red colour is representative of different semantic meanings such as human, exciting, hot, passionate and strong; similarly, yellow colour represents novelty, warmth etc. and blue colour represents coolness, femaleness etc. (Schiffman et al., 2013). So, these three colours were used for all the three tiffin boxes to express proper humanness in design. These three colours were kept constant across tiffin boxes to control the effect of colour on anthropomorphism and to get proper effect of anthropomorphic attributes in product form on degree/level of anthropomorphism. Adobe Illustrator CS-4 was used to design these tiffin boxes separately (image size: 841.89 pt × 595.89 pt; A4 and resolution: 300 pixels/inches for each). Images of these three tiffin boxes are shown in **Figure 3.1**. Tiffin box-1(TB-1) had relatively less anthropomorphic attributes in its form (only roundness/curviness) but tiffin box-2 (TB-2) and tiffin box-3 (TB-3) had relatively more humanlike attributes in their forms in addition to roundness. Design of tiffin box-2 included one additional anthropomorphic attribute (i.e. form of clamp of this tiffin box was human hand like) whereas tiffin box-3 included two additional anthropomorphic attributes (i.e. form of clamp of this tiffin box was human hand like and upper body of this tiffin box was with facial expressions) in its form. So, it was expected that tiffin box-1, tiffin box-2 and tiffin box-3 would consequently express relatively low, medium and high level of anthropomorphisms.



**Figure 3.1** Images of tiffin boxes used as stimuli.

### 2.1.2. Participant, measures and procedure

In this study, a total of 118 Indian adult buyers were assigned based on simple random sampling technique (Howell, 2012). Age and gender of all participants were noted. Among participants 55.7% male and 44.3% were female and their age ranged from 21-35 years ( $M_{Age} = 28.08$  years;  $SD_{Age} = 3.92$  years). All respondents participated in this study had either normal or corrected visual acuity and without any degree of colour blindness. Visual acuity was tested with Snellen's chart (Gofin & Falk, 1991; Graham, 2011) and colour blindness was checked with Ishihara test (Cosstick et al., 2005), respectively (Please see **Appendix 1** for details of these tests). The participants were asked to maintain an upright seated posture at a comfortable viewing distance of 67.0 cm from a LCD computer monitor (Marmaras, Nathanael, & Zarboutis, 2008; Sommerich, 2005) placed with in a comfortable gaze angle of 10 to 17.5 degrees to the center of the monitor, relative to horizontal (Psihogios et al., 2001; Sommerich, 2005). Static images of three tiffin boxes (stimuli) were presented on computer screen (size: 17 inches diagonally, resolution: 1280×1024 px) independently to all participants in controlled laboratory condition and three variables were measured viz. anthropomorphism, visual attractiveness and consciousness towards aesthetic value.

Levels of anthropomorphism were evaluated for all the three tiffin boxes using a self-designed scale which included six bipolar items such as fake/natural, machinelike/humanlike, artificial/realistic, lifeless/organic, dead/ lively and non-human animal like /humanlike. Seven-point semantic differential scales were used

for rating these six bipolar items. Contextually, it is worthy to highlight that existing anthropomorphism measurement scale (Bartneck et al., 2009) missed an important dimension (nonhuman animal like /humanlike) which actually differentiate between animacy (animalness) and anthropomorphism (humanness). However, other items considered here in this anthropomorphism scale were pretty similar to Bartneck et al. (2009). Consciousness towards aesthetic value was measured and controlled to get better effect of anthropomorphism on visual attractiveness. Consciousness towards aesthetic value was measured using three items (item-1: Owning products that have superior designs makes me feel good about myself; item-2: I enjoy seeing displays of products that have superior designs; and item-3: A product's design is a source of pleasure for me); taken from Bloch, Brunel, and Arnold (2003). Seven-point 'Likert scale' was used for rating of each items in which value '1' represents 'strongly disagreed' and '7' represents 'strongly agreed'. In current study, visual attractiveness (as a measure of visual aesthetics) of all three products was measured to understand how anthropomorphic attributes in product form helped to gain visual attention. To know the level of visual attractiveness for anthropomorphic product appearance, participants were asked to rate the visual attractiveness of products using three bipolar items (visually good/visually bad; ugly/beautiful; unattractive/attractive) on seven-point scale. Among these 3 items, first item was newly introduced and last two items were taken from Hekkert et al. (2003) and Page and Herr (2002), respectively.

Reliability of all the above mentioned scales used for different variables viz. anthropomorphism, consciousness towards aesthetic value and visual attractiveness were statistically checked by calculating Cronbach's alpha. Chronbach's alpha values of scales for anthropomorphism, consciousness towards aesthetic value and visual attractiveness were 0.96, 0.70 and 0.84 respectively and all these values satisfied the minimum reliability requirement ( $\alpha = 0.70$ ) (Field, 2009). Following acquisition of responses from the participants, data were further statistically analysed (using SPSS statistics 20.0) to prove the hypothesis of present.

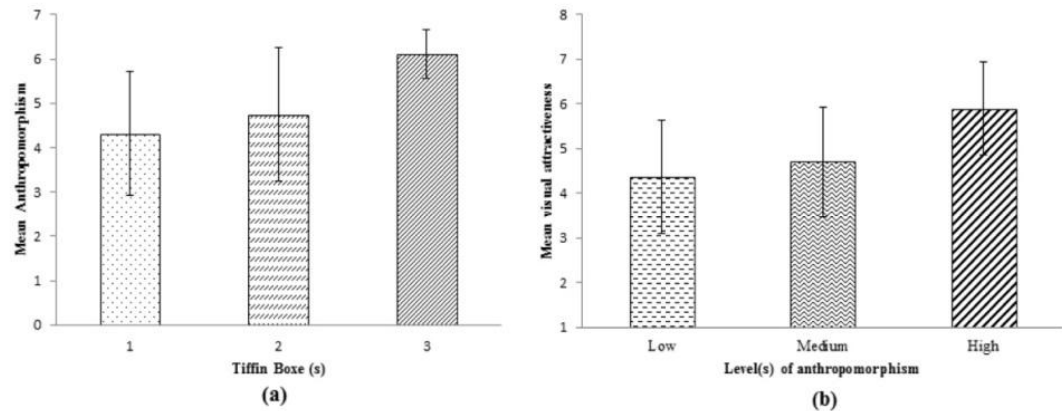
## 2.2. Results

### 2.2.1. Stimuli manipulation check

Variations in level/degree of anthropomorphism were tested with number (s) of anthropomorphic attributes incorporated in product form. These variations were calculated using one way ANOVA test, in which number of anthropomorphic attributes in the form of tiffin box was considered as independent variable and score for anthropomorphism was treated as dependent variable. Dummy 1, 2 and 3 were used for number(s) of anthropomorphic attributes in three successive product forms. From ANOVA it was found that level of anthropomorphism varied with different tiffin box (TB) forms [ $F(2, 36) = 7.251; p < 0.05$ ] Detail results of ANOVA were tabulated in ‘**Appendix-2**’. Expression of anthropomorphism was higher in case of TB-3 ( $M_{TB-3} \pm SD = 6.11 \pm 0.54$ ) than TB-1 ( $M_{TB-1} \pm SD = 4.32 \pm 1.41$ ) and TB-2 ( $M_{TB-2} \pm SD = 4.75 \pm 1.50$ ) (**Figure 3.2a**).

### 2.2.2. Testing of hypothesis

Analysis of covariance (ANCOVA) was performed using visual attractiveness as dependent variables and level of anthropomorphism as independent variable (dummy 1, 2 and 3 were used for successive levels); while age (in years), gender (dummy, ‘0’ for female and ‘1’ for male) and consciousness towards aesthetic value (interval scale) were considered as covariates. It was observed that tiffin box with comparatively higher level of anthropomorphism in their form also had higher level of visual attractiveness [ $F(2, 79) = 11.95; p < 0.001; M_{VA-1} \pm SD = 4.37 \pm 1.27; M_{VA-2} \pm SD = 4.71 \pm 1.23; M_{VA-3} \pm SD = 5.90 \pm 1.04$ ] while effect of age, gender and consciousness towards aesthetic value were co-varying (see **Figure 3.2b**). Detail results of ANCOVA were tabulated in ‘**Appendix-2**’.



**Figure 3.2 Variation of anthropomorphism among tiffin boxes with varying number of anthropomorphic attributes (a); and, visual attractiveness of tiffin boxes varies with level(s) of anthropomorphism (b).**

### 2.3. Discussion

Results of Study-1, established the earlier stated hypothesis that “Degree of visual attractiveness depends on different levels of anthropomorphism (due to incorporation of varying numbers of anthropomorphic attributes) in product form; when, age, gender and consciousness towards aesthetic value are co-varying simultaneously”. Findings of the Study-1 indicated that incorporation of anthropomorphism was very useful in enhancing visual attractiveness of the product. It was also proved that level of anthropomorphism varied among products (tiffin boxes) based on number of anthropomorphic attributes used in their forms but not necessarily due to the variations in age, gender and CTAV. However, the effect of age, gender and CTAV was not significant in ANCOVA (please see ANCOVA table in **Appendix-2**). In particular, participants perceived a product more visually attractive while there was higher level of anthropomorphic attributes (in product form) than the products with less anthropomorphic attributes. This observation is in corroboration with the findings of Miesler, Leder, and Herrmann (2011) who studied baby schema effect on anthropomorphized car fronts by modifying size of headlights. They explained similar variations of visual attractiveness due to incorporation of anthropomorphic attributes (baby like bigger eye size in car face) in product form. Blijlevens et al. (2013) and Hellén and Sääksjärvi (2013) reported that

round/curvy shape was associated with visual appeal of products which could be designed by manipulation of product forms. Similarly, anthropomorphic attributes used in present study were also curvy in nature e.g. human like hand and basic shapes were curvy in tiffin boxes which may be the reason of visual attractiveness. Dion, Berscheid, and Walster (1972) reported that people perceived a product good when it was beautiful. In addition, an object grabs more attention which is more visually attractive (Maughan, Gutnikov, & Stevens, 2007). Therefore, the product with relatively more anthropomorphic attributes will have greater chance to grab attention of consumer in market as anthropomorphic appearance leads to beauty and attractiveness. Although, in 'Study-1' the anthropomorphic product appearance is established as a significant cue to make a product more visually attractive, this finding can be further extended in another way. Hence, in 'Study-2', purchase intention and visually perceived pleasure were measured along with anthropomorphism to draw the definite role of anthropomorphic attributes on product purchase intention.

### **3. Study-2: Role of visual attractiveness and visually perceived pleasure in product purchase intention**

It was evident that attractiveness is an important factor associated with anthropomorphic product form (observation of 'Study-1'). On the other side, product form is associated with symbolic value of the product and may play an important role in product choice (Creusen & Schoormans, 2005). Reported literature suggests that pleasure is a positive emotional factor which can be perceived through product appearance and it is related to product acceptance in the market (Demirbilek & Sener, 2003; Hartono & Chuan, 2011; Jordan, 1998). Therefore, in present research, 'Study- 2' was planned to investigate whether perceived pleasure is related to visual attractiveness (contributed by anthropomorphic product form) and how these two factors are influencing the purchase intention of the anthropomorphic product. To establish this fact, 'Study-2' stated two working hypotheses. These are as follows-

- 1) *There are significant relationships among visual attractiveness, perceived pleasure and purchase intention of an anthropomorphic product ( $H_{a1.2}$ ).*
- 2) *Visual attractiveness and perceived pleasure have significant influence on purchase intention of an anthropomorphic product ( $H_{a1.3}$ ).*

### 3.1. Method

#### 3.1.1. Stimuli

To examine the relationships among visual attractiveness, perceived pleasure and purchase intention of an anthropomorphic product, images of two different products (Tiffin box and chair) were used in ‘Study-2’. In the present study, two images of tiffin boxes (‘Tiffin Box-1’ and ‘Tiffin Box-3’) were selected from ‘Study-1’ due to much mean difference in perceived anthropomorphism was found between these two tiffin boxes.



Figure 3.3 Product images which were selected as stimuli for ‘Study-2’.

Two new images of chairs were chosen in ‘Study-2’ to find out the effect of product category on similarities and dissimilarity in relationships among the afore said variables (visual attractiveness, perceived pleasure and purchase intention). These two chairs were anthropomorphised in different ways to manipulate the levels of anthropomorphism in their appearance. ‘Chair-1’ was anthropomorphised following the human leg postures while seating on a chair (‘V’ cut between two legs on seat pan). On the other side, ‘Chair-2’ was anthropomorphised such a way that somebody will lap behind the seated person. In addition, curviness of chairs was kept different as it was found in literature that curviness/ roundness is associated with anthropomorphism (Hellén & Sääksjärvi, 2013). The ‘Chair-2’ was curvier than ‘Chair-1’ (Please see **Figure 3.3**). Colour of these two chairs (Red) was kept constant to avoid the effect of colour on perception of anthropomorphism. Chair design manipulation was checked using anthropomorphism scale as used in ‘Study-1’. In this study, anthropomorphism scale was reliable as calculated Cronbach’s alpha ( $\alpha = 0.94$ ) is greater than 0.70 (Field, 2009). Manipulation check was confirmed through one way ANOVA by taking the type of anthropomorphic form as independent variable [Dummy numerical ‘1’ and numerical ‘2’ were used for ‘Chair-1’ and ‘Chair-2’ respectively) and anthropomorphism as the dependent variable. It was found that the mean value of anthropomorphism was significantly higher in case of ‘Chair-2’ than the ‘Chair-1’ [ $M_{\text{Chair-1}} = 4.50$ ;  $SD_{\text{Chair-1}} = 1.69$ ;  $M_{\text{Chair-2}} = 5.86$ ;  $SD_{\text{Chair-2}} = 0.87$ ;  $F(1, 55) = 14.333$ ;  $p < 0.001$ ].

### 3.1.2. Participant, procedure and measures

Total 206 participants (54.37 % male and 45.63 % female; Age range = 18 - 35 years;  $M_{\text{Age}} = 26.81$  years;  $SD = 3.67$  years) volunteered for tiffin box evaluations whereas total 190 participants (52.12 % male and 47.88 % female; Age range = 19-35 years;  $M_{\text{Age}} = 24.47$  years;  $SD = 4.65$  years) participated for chair evaluations in ‘Study-2’. All participants were assigned following simple random sampling technique(Howell, 2012).

In this study, perceived pleasure and purchase intention were measured after presenting images of three different tiffin boxes independently on computer screen (size: 17 inches; resolution: 1280 × 1024 px) in laboratory. Image size and resolution were 841.89 pt × 595.89 pt and 300 pixels/inches respectively. All respondents participated in this study were of either normal or corrected visual acuity and without any degree of colour blindness. Visual acuity was tested with Snellen's chart (Gofin & Falk, 1991; Graham, 2011) and colour blindness was checked by Ishihara test (Cosstick et al., 2005) (Please see **Appendix 1** for details of these tests). The participants were asked to maintain an upright seated posture at a comfortable viewing distance of 67.0 cm from a LCD computer monitor (Marmaras, Nathanael, & Zarboutis, 2008; Sommerich, 2005) placed with in a comfortable gaze angle of 10 to 17.5 degrees to the center of the monitor, relative to horizontal (Psihogios et al., 2001; Sommerich, 2005).

In 'Study-2', visual attractiveness of tiffin boxes and chairs were measured using the same scale as used in 'Study-1'. Reliability of visual attractiveness scale was tested for both products by calculating Cronbach's alpha ( $\alpha_{\text{Tiffin Box}} = 0.88$ ;  $\alpha_{\text{Chair}} = 0.91$ ) and it was found that alpha values were reliable as  $\alpha$  values were greater than 0.70 (Field, 2009). Visually perceived pleasure for images of tiffin boxes and chairs were measured using a scale containing total five bipolar items related to pleasure and were rated on seven-point semantic differential scale. Adjectives used for this purpose included not cute/ cute; displeased/ pleased; dissatisfied/ satisfied; unhappy/ happy; and, monotonous/ cheerful. Among these, adjectives of first item were adopted from Luo, Fu and Korvenmaa (2012) and adjectives of last four items were taken from Desmet (2012). Reliability of this perceived pleasure scale was checked for both tiffin boxes and chairs. Cronbach's alpha value for tiffin box was found as 0.92 and for chair it was 0.82. These alpha values satisfied the minimum requirement of alpha 0.70 (Field, 2009). Purchase intention was measured by asking two questions which are as follows:

Q1. Suppose, you wanted to buy a 'Tiffin Box / Chair' from market - How likely would you be to purchase this 'Tiffin Box/ Chair'?

Q2. Suppose, you wanted to buy a 'Tiffin Box/ Chair' from market - What is the likelihood that you would be selecting this 'Tiffin box/ Chair'?

Answers of these two questions were taken on seven-point scale in which '1' represents 'least likely' and '7' represents 'most likely'. Reliability of these two items was tested by calculating Pearson's correlation coefficient between items. Pearson's correlation coefficient between these two mentioned items of purchase intention scale was 0.84 for tiffin box study and 0.94 for chair study ( $p < 0.01$ ) which satisfied the minimum requirement of coefficient value ( $r = 0.50$ ) for reliability (Field, 2009). Further statistical analysis of all variables related to this was done using SPSS statistics 20.0.

**Table 3.1 Correlations between pleasure, visual attractiveness and purchase intention.**

<i>Product</i>		<i>Visual attractiveness</i>	<i>Perceived pleasure</i>	<i>Purchase intention</i>
<b>Tiffin Box</b>	<b>Visual attractiveness</b>	1.000	-	-
	<b>Perceived pleasure</b>	0.276*	1.000	-
	<b>Purchase intention</b>	0.221*	0.788*	1.000
<b>Chair</b>	<b>Visual attractiveness</b>	1.00	-	-
	<b>Perceived pleasure</b>	0.313*	1.00*	-
	<b>Purchase intention</b>	0.219*	0.494*	1.00

\* Significance level (two tail t-test) is equal to 0.01.

### **3.2. Results**

#### *3.2.1. Testing of hypothesis*

##### *3.2.1.1. Relationships among visual attractiveness, visually perceived pleasure and anthropomorphic product purchase intention*

Pearson's correlation coefficient ( $r$ ) was calculated among visual attractiveness, perceived pleasure and purchase intention. As expected, significant relationships were observed among these three variables. Details about correlation coefficients are presented in **Table 3.1**. For tiffin box study, value of correlation coefficient was found higher between perceived pleasure and purchase intention ( $r = 0.788$ ;  $p < 0.01$ ) than the relationship between visual attractiveness and purchase intention

( $r = 0.221$ ;  $p < 0.01$ ). Strength of relationship between visually perceived pleasure and visual attractiveness ( $r = 0.276$ ,  $p < 0.01$ ) was also higher than the relationship between visual attractiveness and purchase intention. Similar results were also found in the case of ‘Chair’ study. In the case of ‘Chair’, correlation coefficient between perceived pleasure and purchase intention was 0.494 ( $p < 0.01$ ) and the coefficient between visually perceived pleasure and visual attractiveness was 0.313 ( $p < 0.01$ ); which were higher than the coefficient between visual attractiveness and purchase intention ( $r = 0.219$ ;  $p < 0.01$ ). This kind of relationships among variables fulfilled the criteria of mediation statistics (Blijlevens et al., 2013). Following this observations, it was assumed that perceived pleasure might have a mediation effect on influence of visual attractiveness upon purchase intention. To check the mediating role of perceived pleasure on influence of visual attractiveness upon purchase intention, regression statistics was carried out in the next step.

### *3.2.1.2. Influence of visual attractiveness on anthropomorphic product purchase intention is mediated by visually perceived pleasure*

Regression analysis was carried out to predict anthropomorphic product purchase intention on the basis of visual attractiveness and perceived pleasure as well as to see the mediation effect of visually perceived pleasure. Simple regression analysis was done by taking visual attractiveness as predictor and ‘Tiffin Box’ / ‘Chair’ purchase intention as criterion.

It was revealed that visual attractiveness could significantly predict only 4.9% changes of anthropomorphic ‘Tiffin Box’ purchase intention [ $R^2 = 0.049$ ;  $F(1, 204) = 10.455$ ;  $p < 0.001$ ]; whereas, multiple regression analysis showed that visual attractiveness and perceived pleasure together could significantly predict 62.1% variations of ‘Tiffin Box’ purchase intention [ $R^2 = 0.621$ ;  $F(2, 203) = 166.202$ ;  $p < 0.001$ ]. Therefore, it can be stated that effect of visual attractiveness on anthropomorphic ‘Tiffin Box’ purchase intention; was higher in presence of the variable ‘perceive pleasure’. Remarkably, it was observed that while perceived pleasure was added in the predictor list along with visual attractiveness, the effect of visual attractiveness on ‘Tiffin Box’ purchase intention was found no

longer significant ( $t = 0.086$ ;  $p = 0.932$ ). Moreover, from **Table 3.2**, it is understood that value of calculated regression coefficient for visual attractiveness for model-2 ( $B = 0.008$ ) is lower than in model-1 ( $B = 0.484$ ). These observations indicate the strong mediation effect of perceived pleasure on influence of visual attractiveness upon ‘Tiffin Box’ purchase intention. Similar phenomenon was also observed in case of ‘Chair’. In case of ‘Chair’, visual attractiveness and perceived pleasure could significantly predict 24.9% variations of anthropomorphic ‘Chair’ purchase intention [ $R^2 = 0.249$ ;  $F(2, 187) = 30.967$ ;  $p < 0.001$ ] whereas visual attractiveness alone could significantly predict 4.8% variations of anthropomorphic ‘Chair’ purchase intention [ $R^2 = 0.048$ ;  $F(1, 188) = 30.967$ ;  $p < 0.002$ ]. Similar to ‘Tiffin Box’ purchase intention study, the influence of visual attractiveness on anthropomorphic ‘Chair’ purchase intention was no longer significant (Model-2:  $B = 0.098$ ;  $t = 1.067$ ;  $p > 0.287$ ) in presence of influence of perceived pleasure; though, the standalone influence of visual attractiveness on anthropomorphic ‘Chair’ purchase intention was significant (Model-1:  $B = 0.300$ ;  $t = 3.076$ ;  $p < 0.002$ ). All regression coefficients for ‘Tiffin Box’ and ‘Chair’ study were presented in **Table 3.2**.

**Table 3.2 Mediation model of perceived pleasure and regression coefficients.**

<i>Product</i>	<i>Model</i>	<i>Regression Coefficient</i>		<i>Standardized Coefficient</i>	<i>t-value</i>	<i>Sig. Level</i>
		<i>B</i>	<i>SE</i>	$\beta$		
Tiffin Box	1					
	Intercept	2.145	0.820	-	2.615	0.010
	Visual attractiveness	0.484	0.150	0.221	3.233	0.001
	2					
	Intercept	-0.163	0.536	-	-0.304	0.761
	Visual attractiveness	0.008	0.099	0.004	0.086	0.932
	Perceived pleasure	0.961	0.055	0.787	17.501	0.001
Chair	1					
	Intercept	3.670	0.527	-	6.962	0.001
	Visual attractiveness	0.300	0.097	0.219	3.076	0.002
	2					
	Intercept	1.102	0.594	-	1.857	0.065
	Visual attractiveness	0.098	0.091	0.071	1.067	0.287
	Perceived pleasure	0.681	0.096	0.472	7.071	0.001

Dependent variable: purchase intention

In this study, significance of mediation path i.e. ‘visual attractiveness to perceived pleasure to purchase intention’ was also calculated (**Table 5.3**). For calculation of significance of mediation pathway; first, influence of visual attractiveness on perceived pleasure (**Path-a**) was predicted through simple linear regression in which visual attractiveness and perceived pleasure were considered as predictor and criterion respectively. In the second step, influence of perceived pleasure on purchase intention (**Path-b**) was predicted using simple linear regression in which perceived pleasure and purchase intention were considered as predictor and criterion respectively. Then, in third step, coefficient of mediation path ( $\beta_a \beta_b$ ) and the standard error for this path ( $S_{\beta_a \beta_b}$ ) were computed to predict significance of mediation pathway of perceived pleasure. Regression coefficients of all paths and their significance levels were presented in **Table 5.3**. It was found that perceived pleasure significantly mediated the influence of visual attractiveness on both anthropomorphic ‘Tiffin Box’ ( $p < 0.001$ ) and anthropomorphic ‘Chair’ purchase intention ( $p < 0.01$ ).

**Table 3.3 Regression coefficients of path-a, path-b and mediation pathway (Path-VA to PP to PI).**

<i>Product</i>	<i>Path-a</i> (VA to PP)		<i>Sig.</i> <i>Level</i>	<i>Path-b</i> (PP to PI)		<i>Sig.</i> <i>Level</i>	<i>Mediation path</i> (VA to PP to PI)		<i>Sig.</i> <i>Level</i>
<b>Tiffin Box</b>	$\beta_a$	0.276		$\beta_b$	0.788		$\beta_a \beta_b$	0.217	
	$S_{\beta_a}$	0.067	0.001	$S_{\beta_b}$	0.043	0.001	$S_{\beta_a \beta_b}$	0.054	0.001
	<b>t value</b>	4.096		<b>t value</b>	18.276		<b>t value</b>	4.019	
<b>Chair</b>	$\beta_a$	0.313		$\beta_b$	0.494		$\beta_a \beta_b$	0.155	
	$S_{\beta_a}$	0.069	0.001	$S_{\beta_b}$	0.063	0.001	$S_{\beta_a \beta_b}$	0.039	0.01
	<b>t value</b>	4.518		<b>t value</b>	7.794		<b>t value</b>	2.948	

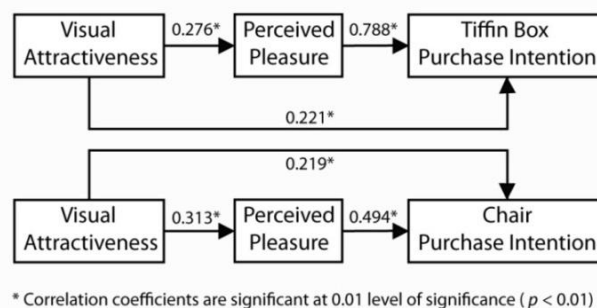
Note: VA, PP and PI represents ‘Visual Attractiveness’, ‘Perceived Pleasure’ and ‘Purchase Intention’ respectively.

### 3.3. Discussion

It is reported that product forms associated with positive emotional meanings may have a chance of better acceptance in market (Karlsson, Aronsson, & Svensson, 2003). Wells, Valacich, and Hess (2011) mentioned that visual attractiveness of websites contributed visual appeal towards website and the product purchase

intention from e-retailer's website is positively influenced by visual attractiveness. Therefore, visual attractiveness of a product may increase the chance of product acceptance. Similar observations were found in case of anthropomorphic products (in both the cases of 'Tiffin Box' and 'Chair') as represented in regression 'Model-1' in **Table 3.2**. Thus, it is verified that purchase intention of anthropomorphic product increased with higher level of anthropomorphism expressed through product appearance.

In present study, it was found that the anthropomorphic attributes in the product form were able to increase both visual attractiveness and perceived pleasure. Therefore, higher level of anthropomorphism attributed by curvier shapes in 'Tiffin Box' and 'Chair' not only helps to increase visual attractiveness but also visually perceived pleasure and these two factors in turn influences purchase intention. This observation is supported with the statement of Sonderegger (2012) who observed that the aesthetically appealing product had positive effect on perceived emotion. In addition, Chang (2008) reported that product form was associated with visual comfort in the context of digital camera design. The visual comfort may be caused by beauty and attractiveness of the product. Furthermore, product appearances are related to aesthetics and attractiveness. Therefore, visual comfort due to the anthropomorphic appearance may lead to visually perceived pleasure. Dion, Berscheid, and Walster (1972) reported that consumers felt good about the product which was aesthetically more beautiful. Hence, there is a chance of product acceptance if consumers/ users feel good to see a product.



**Figure 3.4 Influence of visual attractiveness on anthropomorphic product purchase intention is mediated via visually perceived pleasure.**

Results of the current research also indicates direct influence of visual attractiveness on anthropomorphic product purchase (path visual attractiveness to purchase intention in **Figure 3.4**) but this standalone influence of visual attractiveness is less than the combined influence of visual attractiveness and perceived pleasure (path visual attractiveness to perceived pleasure to purchase intention in **Figure 3.4**). Similar results were found in both the product cases ('Tiffin Box' and 'Chair'). Regression coefficient value for visual attractiveness is found no longer significant in presence of perceived pleasure as another determinant of purchase intention (shown in regression 'Model-2') though it is significant in regression 'Model-1' (**Table 3.2**). The pattern of the study results was same for both the products. These kinds of observations were also noticed by Blijlevens et al. (2013) while they were predicting the mediation effect of trendiness on the influence of curvature upon aesthetic appraisal. In addition, it was observed in preliminary study that mediation influence of product personality on product choice is mediated via product usability, with similar regression analysis. Therefore, it is clear that the influence of visual attractiveness on purchase intention of an anthropomorphic product is mediated through perceived pleasure (**Figure 3.4**). Hence, alternative hypothesis-1 ( $H_{a1}$ ) is proved in this chapter.

#### **Key points**

- ☞ Level of anthropomorphism significantly varies with number or type of anthropomorphic attributes incorporated in product appearance.
- ☞ Anthropomorphic appearance has significant influence on both visual attractiveness and visually perceived pleasure.
- ☞ Level of anthropomorphism, visual attractiveness and visually perceived pleasure are significantly correlated among each other.
- ☞ Visual attractiveness, apparent usability and pleasure perception may be affected by anthropomorphic product appearance.
- ☞ Though visual attractiveness and visually perceived pleasure have significant solitary influence on anthropomorphic product purchase intention; the influence of visual attractiveness on anthropomorphic product purchase intention is mediated through visually perceived pleasure.

## Chapter-4: Anthropomorphic appearance to enhance product purchase intention: Role of apparent usability and pleasure

### Abstract

It is a very potential field of research to find out the role of anthropomorphic product appearance in its market acceptance. Besides, anthropomorphism, perceived pleasure and apparent usability are important regulatory factors in product choice. Empirical evidences are lacking regarding impact of anthropomorphic appearance of product on its apparent usability and perceived pleasure. Present study aimed to observe the influence of anthropomorphic appearance in product purchase intention considering two underlying important factors viz. perceived pleasure and apparent usability. The whole research was subdivided into two separate studies with two different objectives. First study was conducted to observe variations of pleasure and apparent usability corresponding to levels of anthropomorphism and strategies of incorporation of anthropomorphic attributes. Second study was designed to understand the effect of anthropomorphic appearance on product's apparent usability and consequent impact on product purchase intention. First study revealed that pleasure and apparent usability was high in case of product in which high level of anthropomorphism was attributed without interference of pleasure and apparent usability. It was clear from the second study that purchase intention of anthropomorphic product was influenced by pleasure and apparent usability. Therefore, the present chapter summarizes with the following findings: (a) 'Strategy of incorporation of anthropomorphic attributes in product appearance significantly affected perception of apparent usability and pleasure'; (b) 'Users found a product more pleasurable in which apparent usability did not affect by anthropomorphic attributes'; (c) 'Anthropomorphic attribute (e.g. smiling lip) which were associated with positive emotions not only helped to increase visually perceived pleasure but also apparent usability and these two factors in turn influenced purchase intention' and (d) 'Influence of pleasure on anthropomorphic product purchase intention was found to be mediated via apparent usability'.

**Keywords:** *anthropomorphism; design strategy; emotional design; product innovation; user evaluation*

### 1. Introduction

Product design is very challenging job for designers in the present highly competitive commercial environment. In addition, consumers' behaviour is also changing day by day with their requirements and adaptation to new trends. In such a scenario, designers and design researchers should think about the creation of newness in the product design (Mugge & Schoormans, 2012). From the cognitive ergonomics point of view, aesthetic value (attractiveness), ergonomics value (usefulness/ usability, comfort and safety) and emotional value (pleasure) are important criteria for enriching product value in the market through product's

appearance (Creusen & Schoormans, 2005). These possibilities are enhancement of aesthetic value, emotional value, and ergonomics value in product appearance. Researchers argued that visual appearance of the product should be designed in such a way that it would positively influence the consumers' product purchase intention (Wells, Valacich, & Hess, 2011). Now, the question is there any possibility to enhance product purchase intention through anthropomorphic product appearance as anthropomorphic appearance may also convey different symbolic meanings. Therefore, it was supposed that use of anthropomorphic form in product design may be a new and fruitful way to enhance the market acceptance of the product.

## **2. Anthropomorphism and anthropomorphic products**

As it is already known that anthropomorphic products generally reflect the different degrees of humanness which may be through their humanlike appearance or through human like interaction style (Sharp, Rogers, & Preece, 2012). Though anthropomorphic appearances have been applied to many products still there are some difficulties in incorporation of anthropomorphic form to products. Kiesler (2006) first addressed about antecedents and consequences of anthropomorphism in consumer behaviour context. It is expected that if anthropomorphic form is wrongly used in a product, it may contribute to user disappointment. Therefore, it is expected that anthropomorphic forms should not negatively interfere with user experience aspects of a product appearance such as apparent usability and pleasure. Furthermore, there is no empirical evidence which expresses the strategy to incorporate anthropomorphic appearance into the product considering the above mentioned factors. Let us go through the literature about apparent usability and pleasure before considering these two factors in anthropomorphic product appearance design.

### 3. Apparent usability in product design

Previously, function and usability were rigorously studied as primary factors in user experience and user centred design research as usability influences the product choice (Mack & Sharples, 2009). However, usability is still an important matter of concern as highlighted in the context of nanoscalar product design (Chowdhury et al., 2012). Nielsen (1993) defines the usability in terms of five product/ system attributes: learnability, efficiency, memorability, errors and satisfaction. Usability of a product or system will be high if users' learnability, memorability, efficiency and satisfaction towards a system or product are high; and, conversely, error is less. Kurosu and Kashimura (1995) classified usability into two types: inherent usability and apparent usability. Inherent usability is defined as actual usefulness of a product which may be perceived only after use of the product. On contrary, apparent usability is the perceived usability before use of the product. It is noteworthy that apparent usability may be perceived through visual appearance of the product. Consumers are usually trying to predict many product features such as apparent size, weights, complexity etc. through visual appearance of the product. It has been established that vision is most important sensory modality at the time of product purchase (Fenko, Schifferstein, & Hekkert, 2010). Therefore, consideration of apparent usability is important as it may be perceived through product appearance. Further, the apparent usability is important because in many contexts of product purchase consumers are not able to use the products before purchase (e.g. online product purchase) (Thompson, Hamilton, & Rust, 2005). In such a context, if consumers perceive inferior usability by seeing the product in pre-purchase stage it might negatively impact the post-purchase usability perception though inherent usability of the product is high (Seva et al., 2010). It is worthy to note the suggestions of few authors that "What is beautiful is good" (Dion, Berschied, & Walster, 1972) and "What is beautiful usable" (Tractinsky, Katz, & Ikar, 2000). Hence, there is a chance to improve the apparent usability through beautiful and pleasurable product appearance. On the contrary, Hassenzahl (2004) challenged these previous findings for a product's usability and proposed that 'What is judged to be more

beautiful is not necessarily perceived as more usable'. However, apparent usability of the product should match with the inherent usability of the product; otherwise, it may contribute to user disappointment after product purchase.

Following their study, Kurosu and Kashimura (1995) suggest that apparent usability is related to the interface component design, layout, and interactions on the interface. It was also found in their research that a positive relationship exists between aesthetics and apparent usability (Kurosu & Kashimura, 1995; Tractinsky, 1997). In a recent study, it was reported that high level of novelty due to product colour, contributed to lower level of apparent usability (Mugge & Schoormans, 2012). Authors used aesthetic technique to modify the level of novelty in product appearance through change in product colour. Thus, it is clear that product appearance may influence apparent usability. In addition, it was found that product form has linear relationship with usability of the product as "Product Form Follows Function" (Mack & Sharples, 2009; Schifferstein & Hekkert 2009; Wake & Das 2000). Therefore, apparent usability would be the important factor in the context of anthropomorphic product appearance design.

#### **4. Role of pleasure in product design**

Beyond usability, pleasure is an influential factor for product quality evaluation. Pleasure is defined as the positive emotional state which can be best expressed in terms of pleasantness, happiness, joy and satisfaction (Desmet, 2002; Desmet, 2012; Demirbilek & Sener, 2003; Laparra-Hernández et al., 2009). However, some other pleasure related words such as cheerfulness, cuteness etc. are also reported in literature (Jiao, Zhang, & Helander, 2006; Luo, Fu, & Korvenma, 2012). Jordan (2000) stated about four different kinds of pleasures which are closely associated with product emotion. These four types include physio-pleasure (related to touching and holding a product); social-pleasure (related to social relationships and communication that a product enables); psycho-pleasure (gained when a product helps the user to accomplish a task); and, Ideo-pleasure (related to values that a product and its use represent or support). Therefore, the user perceives pleasure in a product from through four different ways; but, all of the

four pleasures may or may not come in action together for all contexts of product use.

Many emotion and pleasure related studies have been conducted under the discipline of 'Kansei Engineering' (Nagamachi, 1995), also known as 'Pleasure Engineering' (Jordan 2000). 'Kansei Engineering (KE)' is "translating technology of a consumer's feeling and image for a product into design elements". Therefore, KE addresses the relationships between emotions and products. Petiot and Yannou (2004) described about product semantics, the "study of the symbolic qualities of man-made forms in the context of their use, and application of this knowledge to industrial design". For example, Karlsson, Aronsson, and Svensson (2003) evaluated the relationship between different forms of car interior and pleasantness.

Chuang, Chang, and Hsu (2001) demonstrated that users' preference is positively associated with mobile phone form expressing positive emotional meanings. Hsiao and Chen (2006), studied emotional responses against product forms and described relevant emotion related affective adjectives for different product categories such as automobile, sofa, and kettle etc. Huang, Chen, and Khoo (2012) stated consumers' emotional requirements as 'Kansei needs' and they highlighted about the semantic differential (SD) method which will be helpful in emotional product design. They studied different forms of perfume bottles and they classified designs of perfume bottle into different emotional categories. Hsiao, Chiu, and Lu (2010) built a product-form model based on visual appearance of coffee maker. Best combination of car body types and wheel hub forms, based on semantic expressions of product appearance was determined by Luo, Fu, and Zhou (2012) and emotional responses were collected from users/consumers. Study of Demirbilek and Sener (2003) highlights the motto of 'Frog Design' (one of the world's famous design companies) i.e. 'Form Follows Emotion'. According to their philosophy, if a product form can generate emotional responses such as happiness and joy etc., users then find pleasure in it. In addition, according to basic framework of 'product appraisal', appraisal of a product depends on emotional responses generated by the product (Desmet, 2002;

Desmet & Hekkert, 2007). If form of a product is visually good, it may generate pleasure; and user may feel happy and joy in it. Thus, product form is very much associated with pleasure and positive emotional responses. Further, user satisfaction and pleasantness of the product are related with the usability of the product (Nielsen, 1993). Therefore, designers can satisfy consumer through incorporating the feelings of pleasure using different product forms. In a very recent study, it has been highlighted that anthropomorphic products has potential to induce pleasure as they may reflect different personalities (Chelho, Versos, & Silva, 2013). Therefore, anthropomorphic product form might be the possible way to express pleasure through product appearance.

Based on the literature review the second hypothesis of the present thesis was stated to understand the roles of pleasure and apparent usability in anthropomorphic product purchase intention. The hypothesis was-

*“Apparent usability and visually perceived pleasantness (due to anthropomorphic product appearance) significantly affects the anthropomorphic purchase intention ( $H_{a2}$ ).”*

This main hypothesis was proved through two different studies by stating few working hypotheses. These working hypotheses were mentioned under ‘Study-1’ and ‘Study-2’ of present chapter.

### **5. Study 1: Effect of anthropomorphism on the perception of apparent usability and pleasure**

Based on literature survey, it is now clear that there is a need for consideration of apparent usability and pleasure as underlying factors for understanding the influence of anthropomorphic appearance on product purchase intention. In addition, some questions have been raised after literature survey in order to clear the study goals: What are the consequences if anthropomorphic attributes are used in an inappropriate manner in product appearance? How does anthropomorphic attributes in product form contribute pleasure? Does any type of anthropomorphic attribute in product appearance contribute pleasure? Is there any contribution of

apparent usability in pleasure? To answer these research questions, a hypothesis has been formulated in ‘Study-1’: “*Apparent usability and pleasure varies with strategy/way of incorporation of anthropomorphic attribute(s) and level of anthropomorphism in product appearance (H<sub>a2.1</sub>).*”



**Figure 4.1** Watch images which were selected for the study.

## **5.1. Method**

### **5.1.1. Stimulus preparation**

Images of ‘Wrist Watch’ were chosen as stimuli of interest because of two reasons: 1. Present study deals with anthropomorphic appearance; and, 2. ‘Wrist Watch’ use and purchase depends on visual aspects of product design. To prepare stimuli, more than two concepts of unisex watch design were developed for giving humanlike (anthropomorphic) look into watch dial. Between these design concepts, only one basic watch design concept was taken forward for experimental purpose, as 71.43% users supported this concept as a better one over other developed concepts (N = 21). The accepted concept deals with the watch dials which were anthropomorphized such a way that it looks like face of human being, listening music with headphones (See **Figure 4.1**).

Based on the selected concept, total three images of watch were prepared according to objective of the study. The objective was to find out the variations in perceptions of apparent usability and pleasure due to variations in ways/strategies of incorporation of humanlike attribute in product appearance. Adobe Illustrator

CS-5 was used to design these images and prepared in separate pages, keeping the size (841.89 pt × 595.89 pt; A4) and the resolution (300 pixels/inches) of these images same. To manipulate levels of anthropomorphism in watch appearance, additional anthropomorphic attributes were incorporated in the watch appearance.

As it can be seen from '**Figure 4.1**' that dial of 'watch-1' had humanlike face with headphone only and it was reflecting comparatively low level of anthropomorphism; whereas, 'watch-2' and 'watch-3' includes curvier dial shapes and humanlike smiling lips on these watch dial in addition to humanlike face with headphone. Appearance of 'watch-2' and 'watch-3' were made curvier than 'watch-1' as it was reported that roundness/ curviness has positive relationship with childlike anthropomorphism (Hellén & Sääksjärvi, 2013) and childlike attribute results in cuteness and pleasure in product appearance (Miesler, Leder, & Herrmann, 2011). Humanlike smiling lips were added to the dial face as smiling face is positively associated with happiness and pleasure (Deschamps et al., 2012; Fujimura, Sato, & Suzuki, 2010; Sato, Fujimura, & Suzuki, 2008). Therefore, it was expected that 'watch-2' and 'watch-3' would provide more anthropomorphic and pleasant look than watch-1.

Two different design strategies were adopted to increase anthropomorphism into watches using same anthropomorphic attribute (humanlike smiling lip) but in different ways to manipulate the levels of apparent usability and pleasure. Though number and type of anthropomorphic attributes in 'watch-2' and 'watch-3' are same but humanlike smiling lips were added to these two watch models using two different strategies. In 'watch-2', humanlike smiling lip was placed behind the digits (5, 6 and 7) of this analogue watch (design strategy-1). It is expected that it would be troublesome to read time in between 5 o'clock to 7 o'clock. On contrary, humanlike smiling lip was placed little above the digits 5, 6 and 7 in case of watch-3 (design strategy-2); thus, the smiling lip may not interfere with reading of time in between 5 o'clock to 7 o'clock. Thus, it is expected that perception of apparent usability and pleasure would vary with levels of anthropomorphism as well as with ways or strategies of incorporation of anthropomorphic attributes in watch appearance.

**Table 4.1 Items used in the questionnaire.**

<i>Name of scale</i>	<i>Items</i>	<i>Adopted from</i>
<b>Anthropomorphism (AM)</b>		
AM1	Fake/ Natural	Self-constructed
AM2	Machinelike/ Humanlike	Self-constructed
AM3	Artificial/ Realistic	Self-constructed
AM4	Lifeless/ Organic	Self-constructed
AM5	Dead/ Lively	Self-constructed
AM6	Non-human animal like/Humanlike	Self-constructed
<b>Perceived Pleasure (PP)</b>		
PP1	Not cute/ Cute	Chang & Wu, 2009; Hsiao & Chen, 2006; Jiao, Zhang, & Helander, 2006; Luo, Fu, & Korvenmaa, 2012
PP2	Displeased/ Pleased	Demirbilek & Sener, 2003; Desmet, 2012; Jordan, 1998
PP3	Dissatisfied/ Satisfied	Demir, Desmet, & Hekkert, 2009; Desmet, 2012; Jordan, 1998
PP4	Unhappy/ Happy	Demir, Desmet, & Hekkert, 2009; Desmet, 2012
PP5	Monotonous/ Cheerful	Desmet, 2012; Jiao, Zhang & Helander, 2006; Luo, Fu, & Korvenmaa, 2012
<b>Apparent Usability (AU)</b>		
AU1	This product has superior utilitarian function (s).	Self-constructed
AU2	This product has superior usefulness.	Self-constructed
AU3	This product is easy to use.	Self-constructed
AU4	This product is user friendly.	Self-constructed
AU5	This product is comfortable to use.	Self-constructed
AU6	This product is relaxed to use.	Self-constructed
<b>Purchase Intention (PI)</b>		
PI1	Suppose you wanted to buy this 'Product' from market. How likely would you be to purchase this product among following products?	Wells, Valacich, & Hess, 2011
PI2	Suppose you wanted to buy this 'Product' from market. What is the likelihood that you would be selecting this product among following products?	Wells, Valacich, & Hess, 2011

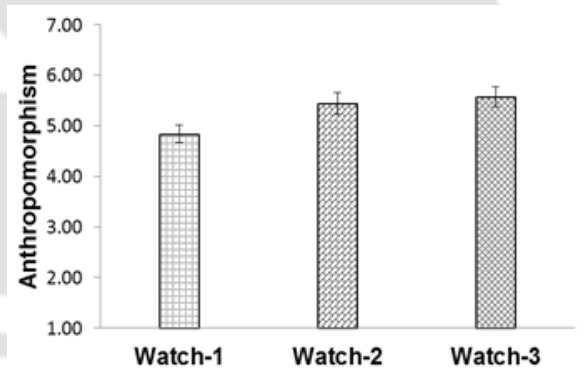
### 5.1.2. Participants, measures and procedure

All participants ( $M_{\text{age}}$ : 23.39 years,  $SD = 4.58$  years; Female: 41.94% and Male: 58.06%) volunteered for present study, were watch users and watch buyers. These facts were confirmed through asking two questions: Q1. Are you using wrist watch? and Q2. Did you purchase any wrist watch? Options of the two questions were Yes/No. Participants were assigned randomly for the present study (Howell, 2012). All participants have either normal or corrected visual acuity and without any degree of colour blindness. Visual acuity was tested with Snellen's chart for visual acuity (Gofin & Falk, 1991; Graham, 2011) and colour blindness has been checked with Ishihara test (Cosstick et al., 2005), respectively. Stimuli (static images of three watches) were presented on computer screen (size: 17 inches, resolution: 1280×1024 px) independently to all participants and three variables viz. anthropomorphism (AM), perceived pleasure and apparent usability were measured using questionnaire. Level of anthropomorphism and perceived pleasure of each watch were evaluated by taking responses on seven point semantic differential scale, whereas apparent usability of watches has been evaluated using seven points Likert scale. All the items for each scale were tabulated in 'Table 4.1'. Cronbach's alpha values of scales for anthropomorphism, apparent usability and perceived pleasure were 0.96, 0.76 and 0.84 respectively and all these values satisfied the minimum reliability criteria ( $\alpha = 0.70$ ) (Field, 2009). Following acquisition of responses from the participants, data were further statistically analysed (using SPSS statistics 20.0) to prove the hypothesis of present study. Two different experiments were conducted under study-1 involving same participants (within-subjects study) to understand the effect of strategic application (in two different ways) of same anthropomorphic attribute (Humanlike smiling lip) in watch appearance on the variation of perception of apparent usability and perceived pleasure among watches. In 'Experiment-1', mean values of perceived apparent usability and perceived pleasure were compared between 'watch-1' and 'watch-2'; whereas, mean values of apparent usability and perceived pleasure have been compared between 'watch-1' and 'watch-3' in 'Experiment-2'.

## 5.2. Results

### 5.2.1. Stimulus manipulation check

One way ANOVA was conducted to check variations in levels of anthropomorphism following incorporation of anthropomorphic attributes in watches. It was found that mean values of anthropomorphism significantly varied with number of anthropomorphic attributes in watch appearance [ $M_{\text{watch-1}} = 4.74$ ,  $SD = 0.78$ ;  $M_{\text{watch-2}} = 5.43$ ,  $SD = 1.04$ ;  $M_{\text{watch-3}} = 5.58$ ,  $SD = 0.98$ ;  $F(2, 69) = 5.393$ ,  $p < 0.01$ ] (Please see ‘**Appendix-3**’ for detailed results). Post-hoc test (Bonferroni test) revealed that level of anthropomorphism was significantly higher in case of both ‘watch-2’ ( $p < 0.05$ ) and ‘watch-3’ ( $p < 0.01$ ) in comparison to ‘watch-1’ but no significant difference was noticed when mean values of anthropomorphism were compared between ‘watch-2’ and ‘watch-3’ ( $p > 0.05$ ) (see **Figure 4.2**).



**Figure 4.2** Differences in anthropomorphism among watches.

### 5.2.2. Variations of apparent usability and pleasure

Repeated measure ANOVA was carried out to observe the impact of design strategy and anthropomorphism during comparison of mean values of apparent usability and pleasure (Please see ‘**Appendix-3**’ for detailed results). In this study, design strategies were considered as within subjects factor/variable and levels of anthropomorphism were considered as between-subjects factor. Following ANOVA, it was found that mean values of apparent usability

significantly varied within subjects with strategies of incorporation of anthropomorphic attribute ('strategy-1' vs. 'strategy-2') [ $F(1, 60) = 7.414, p < 0.01, \eta_p^2 = 0.110$ , observed power = 0.764]. In addition, there was a significant, interactive, within-subjects effect of design strategy and anthropomorphism observed on perception of apparent usability [ $F(1, 60) = 81.541, p < 0.001, \eta_p^2 = 0.576$ , observed power = 1.000]. However, no between-subjects effect of levels of anthropomorphism was found on perception of apparent usability [ $F(1, 60) = 2.993, p > 0.05, \eta_p^2 = 0.047$ , observed power = 0.329]. Follow up 'Paired t-test' was conducted to understand the mean differences of apparent usability between 'watch-1' vs. 'watch 2' and 'watch-1' vs. 'watch 3'. It was observed that mean apparent usability value was significantly higher in case of 'watch-1' when compared to 'watch 2' [ $t(30) = 10.073; p < 0.001$ ]; whereas, mean apparent usability value was significantly lower in 'watch-1' when compared to 'watch 3' [ $t(30) = -6.075; p < 0.001$ ].

Similar to apparent usability, it has been observed that mean values of perceived pleasure significantly varied within subjects with strategies of incorporation of anthropomorphic attribute (strategy-1 vs. strategy-2) [ $F(1, 60) = 17.448, p < 0.001, \eta_p^2 = 0.225$ , observed power = 0.984]. Furthermore, there was a significant, interactive, within-subjects effect of design strategy and anthropomorphism on perceived pleasure [ $F(1, 60) = 32.928, p < 0.001, \eta_p^2 = 0.354$ , observed power = 1.000]. However, between-subjects effect of levels of anthropomorphism was not observed on perceived pleasure [ $F(1, 60) = 2.080, p > 0.05, \eta_p^2 = 0.034$ , observed power = 0.295]. Thus, hypothesis of the present study was accepted and it could be inferred that strategy of incorporation of anthropomorphic attribute matters in perception of pleasure and apparent usability in product appearance. It was observed following 'Paired t-test' that mean value of perceived pleasure was significantly higher in case of 'watch-1' than the mean value of perceived pleasure in case of 'watch 2' [ $t(30) = 2.682; p < 0.012$ ]; whereas, mean perceive pleasure value was significantly lower in 'watch-1' when compared to 'watch 3' [ $t(30) = -5.680; p < 0.001$ ].

According to design ‘strategy-1’ (experiment-1), pair wise means of apparent usability and perceived pleasure were compared between ‘watch-1’ with ‘watch-2’. It was found that mean values of apparent usability and perceived pleasure were significantly lower in case of ‘watch-2’ though it had comparatively higher level of anthropomorphism in comparison to watch-1 (see **Table 4.2**). Like strategy-1, in case of ‘strategy-2’ (experiment-2), mean values of apparent usability and perceived pleasure were compared between ‘watch-1’ and ‘watch-3’. It was observed that users perceived significantly higher apparent usability and pleasure in ‘watch-3’ in which high level of anthropomorphism was perceived by users than the ‘watch-1’ which had lower level of anthropomorphism (see **Table 4.2**).

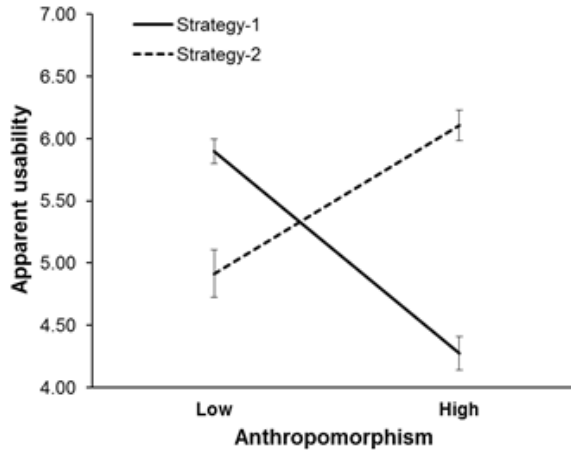
**Table 4.2 Comparison of mean(s) according to two different design strategies.**

<i>Design Strategy</i>	<i>Dependent Variable</i>	<i>Watch</i>	<i>Mean</i>	<i>SE</i>
<b>1</b>	<b>Apparent Usability</b>	<b>1</b>	5.90	0.10
		<b>2</b>	4.27	0.14
	<b>Perceived Pleasure</b>	<b>1</b>	5.28	0.19
		<b>2</b>	4.72	0.20
<b>2</b>	<b>Apparent Usability</b>	<b>1</b>	4.91	0.19
		<b>3</b>	6.11	0.12
	<b>Perceived Pleasure</b>	<b>1</b>	5.06	0.23
		<b>3</b>	5.24	0.09

### **5.3. Discussion**

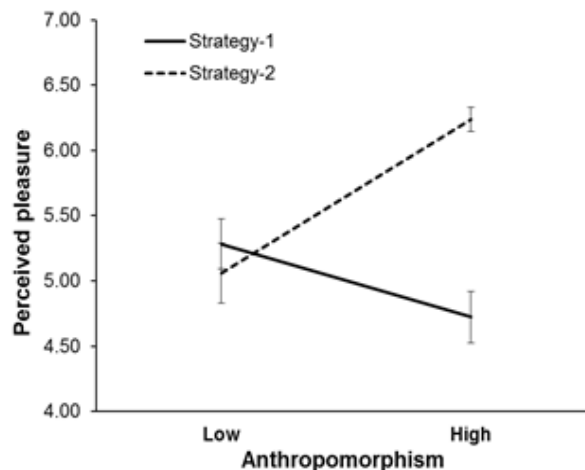
As expected, level of anthropomorphism was significantly higher in case of ‘watch-2’ than the ‘watch-1’. Participants probably felt that there might be a visibility problem in the time segment 5 to 7 o’clock due to presence of anthropomorphic attribute (humanlike smiling lip) in ‘watch-2’. This led to perception of lower apparent usability in ‘watch-2’ than ‘watch-1’ (See **Figure 4.3**). On the contrary, when ‘watch-1’ was compared with ‘watch-3’, users perceived high apparent usability in ‘watch-3’, as anthropomorphic attribute (humanlike smiling lip) was placed in such a way that it did not interrupt the

visibility of time in the time segment 5 to 7 o'clock. Therefore, it could be stated that the way which has been undertaken in 'strategy-2' to increase anthropomorphism in watch appearance is better than 'strategy-1'.



**Figure 4.3** Differences in mean values of apparent usability according to design strategies.

Users perceived pleasure similarly in a way as they perceived apparent usability. Users perceived low pleasure in 'watch-2' than 'watch-1' (See **Figure 4.4**), whereas, users perceived high pleasure in 'watch-3' than 'watch-1' as anthropomorphic attribute (humanlike smiling lip) was placed in a right way (the attribute was not interrupting the visibility of time in the time segment 5 to 7 o'clock). As it was observed that changes in perceived pleasure are similar to apparent usability, they might have positive relationships to each other.



**Figure 4.4** Differences in mean values of perceived pleasure according to design strategies.

It is now clear that strategy/ way of incorporation of anthropomorphic attributes in product has a significant role in the perception of apparent usability and pleasure of the product. Apparent usability and pleasure can be increased using anthropomorphic attributes in product appearance by incorporating them in an appropriate manner. So, it should not negatively interfere with the apparent usability and pleasure. Miesler, Leder, and Herrmann (2011) studied baby schema effect of anthropomorphized car fronts by modifying the size of headlights. Their study explained variations of visual attractiveness and cuteness due to incorporation of anthropomorphic attributes (baby like bigger eye size in car face) in product form. Visual attractiveness in turn positively related with apparent usability (Kurosu & Kashimura, 1995; Tractinsky, 1997). Visual attractiveness is also positively related with pleasure (Jordan, 2000). Therefore, variations of anthropomorphism affect the apparent usability and pleasure in a similar fashion. In addition, it can also be argued that apparent usability depends on how pleasant the product (watch) is to use. Similar, statements were also given by Nielsen (1993) in the context of inherent usability of the system; and Jordan (2000) in the context of product design.

#### **6. Study 2: Role of Apparent usability and perceived pleasure in product purchase**

Result of ‘Study-1’ reveals that higher level of anthropomorphism causes perception of higher levels of apparent usability and pleasure in product if anthropomorphic attributes were incorporated in the product in a proper way. In a study, Mack and Sharples (2009) stated that usability influences product choice. Similarly, Jordan (2000) argued that if the product is pleasurable there is more chance of acceptance of this product in market. Therefore, ‘study-2’ aims to find out the combined influence of apparent usability and perceived pleasure on anthropomorphic product purchase. According to the aim of this study, two working hypotheses were proposed:

**H<sub>a2,2</sub>**: There are significant relationships among apparent usability, perceived pleasure and anthropomorphic product purchase intention.

**H<sub>a2,3</sub>**: Apparent usability and perceived pleasure can significantly predict anthropomorphic product purchase intention.



**Figure 4.5** Images of products selected for ‘Study-2’.

## **6.1. Method**

### **6.1.1. Stimuli**

Images of two different products (watch and chair) were used as stimuli in ‘study-2’. Images of ‘watch-1’ and ‘watch-3’ were considered as stimuli in this study. In addition, two new images of chair were adopted as stimuli (see **Figure 4.5**). Level of anthropomorphism was manipulated with different types of anthropomorphic attributes in both products considering the role of interference of anthropomorphic attributes with apparent usability and pleasure. Details about watch images manipulation was mentioned in ‘study-1’ of present chapter. Levels of anthropomorphism were significantly higher in case of ‘watch-3’ than ‘watch-1’.

Similarly, 'chair-2' had higher level of anthropomorphism than 'chair-1'. Both 'chair-1' and 'chair-2' was anthropomorphized such a way that these chair shows significantly different levels of anthropomorphism. Curviness between the chairs was kept different as roundness/ curviness has positive association with anthropomorphism (Hellén & Sääksjärvi, 2013). 'chair-2' was curvier than 'chair-1'. In addition, 'chair-2' was anthropomorphized such a way that it will lap the seated person with arms of the chair whereas seat pan of the 'chair-1' was anthropomorphized in like our common seating style for men ('V' cut between the legs, horizontal to the seat pan).

#### *6.1.2. Participants, measures and procedure*

All participants were watch/ chair users and buyers. These facts were confirmed by asking two questions: Q1. Are you using wrist watch/ chair? and Q2. Did you purchase any wrist watch/ chair? Options of the two questions were Yes/No. Detailed demographic characteristics of participants are presented in 'Table 4.3'. All respondents participated in this study were assigned randomly (Howell, 2012) and they had either normal or corrected visual acuity and without any degree of colour blindness. Visual acuity was tested with Snellen's chart was used for visual acuity test (Gofin & Falk, 1991; Graham 2011); and, the colour blindness was checked using 'Ishihara test' (Cosstick et al., 2005). Stimuli were presented on computer screen (size: 17 inches, resolution: 1280×1024 px) independently to all participants and they were asked to rate the apparent usability, perceived pleasure and product purchase intention independently for each product image of each product category (watch/ chair). Items used in apparent usability, perceived pleasure and product purchase intention were presented in 'Table 4.1'. Cronbach's alpha values of scales for apparent usability and perceived pleasure scale were 0.76 and 0.84 respectively and all these values satisfied the minimum reliability criteria (alpha= 0.70) (Field, 2009). Reliability of purchase intention scale was tested by calculating Pearson's correlation coefficient between items. Pearson's correlation coefficient for this scale was 0.50 ( $p < 0.01$ ) which satisfied the minimum requirement of product moment ' $r$ ' value for reliability (Field, 2009).

Following acquisition of responses from the participants, the data was further statistically analysed (using SPSS statistics 20.0) to prove the hypotheses of present study.

**Table 4.3 Demographic characteristics of the participants of ‘Study-2’.**

<i>Product</i>	<i>Age in years</i>		<i>Gender</i>	
	<i>(Mean ± SD)</i>	<i>Age range in years</i>	<i>Male (%)</i>	<i>Female (%)</i>
<b>Watch</b>	23.65 ± 4.52	19-38	54.84	45.16
<b>Chair</b>	24.39 ± 4.57	19-35	55.38	44.17

## 6.2. Results

### 6.2.2. Relationships among apparent usability, pleasure and anthropomorphic product purchase

Pearson’s correlation coefficient ( $r$ )s were computed to find out the relationships among apparent usability, pleasure and anthropomorphic product purchase intention. There were significant positive relationships found among apparent usability, perceived pleasure and anthropomorphic product purchase intention ( $p < 0.01$ ) for both the products (See **Table 4.4**). It is observed that the value of correlation coefficient ( $r$ ) between apparent usability and purchase intention was higher than the ‘ $r$ -value’ between perceived pleasure and purchase intention. Further, the ‘ $r$ -value’ between perceived pleasure and apparent usability was found higher than the ‘ $r$ -value’ between perceived pleasure and purchase intention. Similar findings were observed for both the products (watch and chair). This kind of observations fulfilled the pre-requisites of mediation effect of apparent usability on influence of perceived pleasure on anthropomorphic product purchase intention. In this context, it is worthy to mention that similar prerequisites were taken by Blijlevens et al. (2013) while stating mediation effect of trendiness on the influence of curvature upon aesthetic appraisal.

**Table 4.4 Correlation coefficients among apparent usability, perceived pleasure and purchase intention of two selected products.**

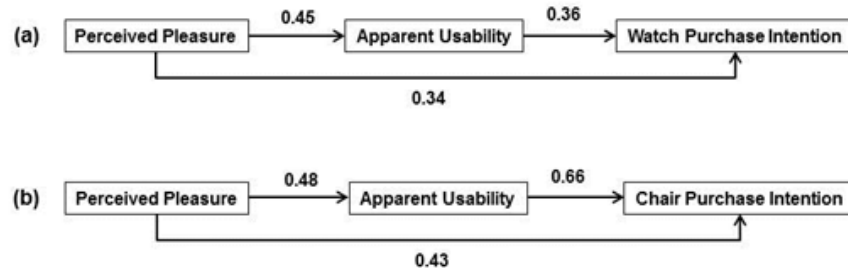
<i>Product</i>		<i>Apparent Usability</i>	<i>Perceived Pleasure</i>	<i>Purchase Intention</i>
Watch	Apparent Usability	1	-	-
	Perceived Pleasure	0.452 **	1	-
	Purchase Intention	0.363 **	0.342 **	1
Chair	Apparent usability	1	-	-
	Perceived Pleasure	0.483**	1	-
	Purchase Intention	0.658**	0.432**	1

\*\* Correlation is significant at the 0.01 level (2-tailed)

### 6.2.3. Influence of apparent usability and pleasure on anthropomorphic product purchase intention

In case of watch, it was observed from the result of simple regression analysis that perceived pleasure could significantly predict the variations of anthropomorphic product purchase intention around 10.2% [ $R_a^2 = 0.102$ ,  $F(1, 60) = 7.960$ ,  $p < 0.01$ ] (see model-1 of watch in **Table 4.5**). Similarly, the solitary influence of apparent usability was also significant and it could significantly predict more variations [ $R_a^2 = 0.117$ ,  $F(1, 60) = 9.081$ ,  $p < 0.01$ ] of anthropomorphic product purchase intention (about 11.7 %) than pleasure. However, there was no significant effect of perceived pleasure observed ( $p > 0.05$ ) when both perceived pleasure and apparent usability were considered together as predictors in multiple regression analysis to predict anthropomorphic product purchase intention (criterion) (See model-2 of watch in **Table 4.5**). Thus, it was proved that apparent usability is mediating the influence of perceived pleasure on anthropomorphic watch purchase intention. It was also observed that perceived pleasure and apparent usability together could significantly predict more variations of anthropomorphic product purchase intention (14.3%) [ $R_a^2 = 0.143$ ,  $F(2, 59) = 6.105$ ,  $p < 0.01$ ] than independent prediction power of each of these predictors. It was also found that perceived pleasure can significantly predict the variations of apparent usability by around 19.1 % [ $R_a^2 = 0.191$ ,  $F(1, 60) = 15.389$ ,  $p < 0.001$ ], in case of watch.

Similar to watch, in the case of chair, perceived pleasure could significantly predict the variations of anthropomorphic product purchase intention by around 18.0 % [ $R_a^2 = 0.180$ ,  $F(1, 118) = 27.044$ ,  $p < 0.001$ ]. Perceived pleasure and apparent usability together could significantly predict the variations of anthropomorphic product purchase intention by around 44.1% [ $R_a^2 = 0.441$ ,  $F(2, 117) = 47.910$ ,  $p < 0.001$ ]. Moreover, perceived pleasure could significantly predict the variations of apparent usability by around 22.6 % [ $R_a^2 = 0.226$ ,  $F(1, 118) = 35.839$ ,  $p < 0.001$ ]; and, apparent usability intern can significantly predict the variations of anthropomorphic product purchase intention by around 43.3 % [ $R_a^2 = 0.443$ ,  $F(1, 118) = 90.211$ ,  $p < 0.001$ ]. It is noteworthy that no significant influence of perceived pleasure on purchase intention was found ( $p > 0.05$ ) when perceived pleasure and apparent usability have been considered together as predictors for anthropomorphic product purchase intention (See model-2 of chair in **Table 4.5**). Therefore, it can be argued that apparent usability is mediating the influence of perceived pleasure on anthropomorphic chair purchase intention.



**Figure 4.6 Mediation models of apparent usability.**

All these results suggest that apparent usability is mediating the influence of perceived pleasure on anthropomorphic product purchase intention in both the cases of watch (**Figure 4.6a**) and chair (**Figure 4.6b**). Regression coefficients (or slope) of the mediation pathways were computed (as presented in **Table 4.6**). For ‘watch’, regression coefficient of the mediation path was 0.164; whereas, for ‘chair’ it was 0.318. Both the mediation pathways were significant (Watch:  $p < 0.01$  and Chair:  $p < 0.001$ ). In addition, it was also observed that mediation effect of apparent usability is stronger in case of ‘chair’ than ‘watch’. However, the mediation phenomena of apparent usability were the same.

**Table 4.5 Mediation models of apparent usability for the two selected products.**

Product	Model	Regression Coefficient		Standardized Coefficient	t-value	Sig. Level
		B	SE	$\beta$		
Watch	<b>1</b>					
	Intercept	4.176	0.536	-	7.790	0.001
	Perceived pleasure	0.264	0.094	0.342	2.821	0.01
	<b>2</b>					
	Intercept	3.610	0.597	-	6.045	0.001
	Apparent usability	0.210	0.107	0.261	1.967	0.054
Perceived pleasure	0.173	0.103	0.224	1.688	0.097	
Chair	<b>1</b>					
	Intercept	1.799	0.633	-	2.840	0.01
	Perceived pleasure	0.613	0.118	0.432	5.200	0.001
	<b>2</b>					
	Intercept	0.880	0.537	-	1.639	0.104
	Apparent usability	0.211	0.111	0.149	1.901	0.060
Perceived pleasure	0.577	0.077	0.586	7.493	0.001	

Dependent variable: anthropomorphic product purchase intention.

**Table 4.6 Regression coefficients of path-a, path-b and mediation pathway (Path-PP to AU to PI).**

Product	Path-a (PP to AU)		Sig. Level	Path-b (AU to PI)		Sig. Level	Mediation path (PP to AU to PI)		Sig. Level
	$\beta_a$	$S_{\beta_a}$		$\beta_b$	$S_{\beta_b}$		$\beta_a \beta_b$	$S_{\beta_a \beta_b}$	
Watch	$\beta_a$	0.452	0.001	$\beta_b$	0.363	0.01	$\beta_a \beta_b$	0.164	0.01
	$S_{\beta_a}$	0.115		$S_{\beta_b}$	0.120		$S_{\beta_a \beta_b}$	0.066	
	t value	3.923		t value	3.013		t value	2.485	
Chair	$\beta_a$	0.483	0.001	$\beta_b$	0.658	0.001	$\beta_a \beta_b$	0.318	0.001
	$S_{\beta_a}$	0.081		$S_{\beta_b}$	0.069		$S_{\beta_a \beta_b}$	0.063	
	t value	5.987		t value	9.498		t value	5.048	

**6.3. Discussion**

Results of this study indicate the significant positive relationships among apparent usability, perceived pleasure and anthropomorphic product purchase intention ( $p < 0.01$ ) in both products (watch and chair) (See **Table 4.4**). Thus, it supports the working hypothesis-1(**H<sub>a2.2</sub>**) of study-2. Therefore, it can be said that product purchase intention will be higher in case of a product that has high level of

anthropomorphism, as there is significant and positive relationships was observed among apparent usability, pleasure perceived and anthropomorphic product purchase intention. Miesler, Leder, and Herrmann (2011) studied about baby schema effect on anthropomorphized car fronts by modifying the size of headlights. Their study explained that pleasure was contributed by anthropomorphic attributes (baby like bigger eye size in car face) in the product form. Therefore, findings of the present study are supported by this report. An alternative explanation of the present results could be the aesthetics as it might be affected by product design manipulation using anthropomorphic attributes. Mugge and Schroomans (2012) also reported that apparent usability is related to attractiveness of the product.

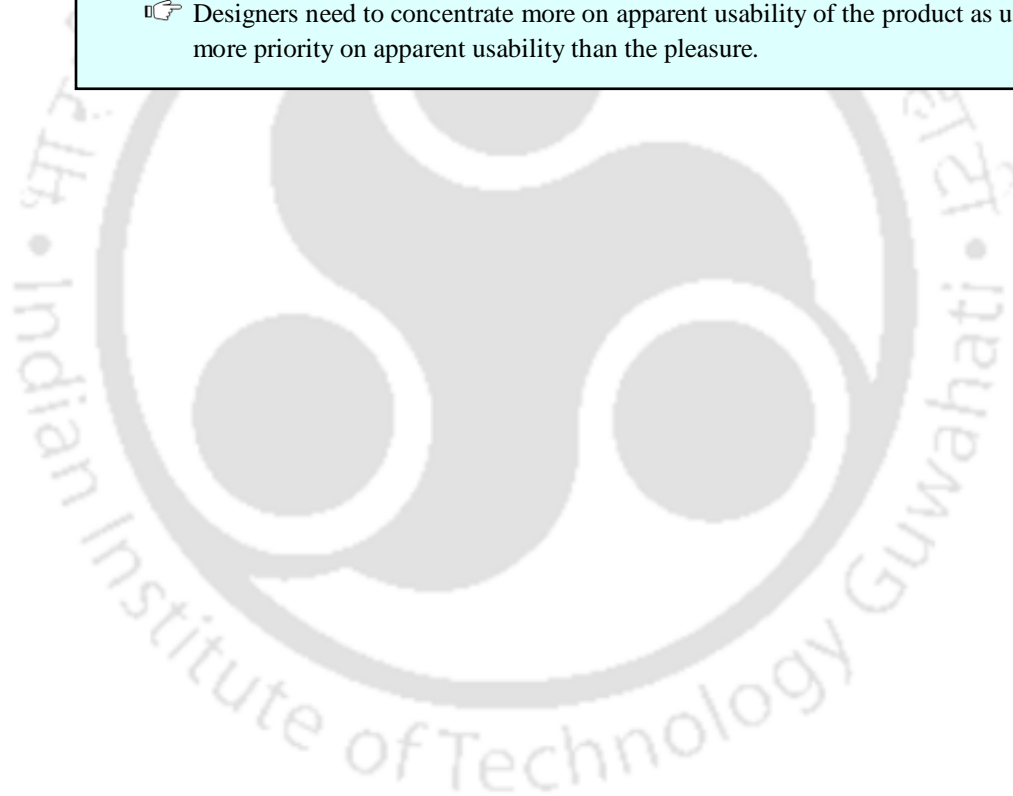
Working hypothesis-2 ( $H_{a2.3}$ ) was also proved as apparent usability and pleasure could significantly and independently predict anthropomorphic product purchase intention. In addition to the above findings, it was also revealed that apparent usability is mediating the influence of perceived pleasure on anthropomorphic product purchase intention. This means apparent usability of the product is most important factor for anthropomorphic product appearance design. According to Jordan's framework of hierarchy of users need, need of pleasure is coming after fulfilment of usability requirement of the product (Jordan 2000). This might be the reason for the mediation effect of apparent usability on the influence of pleasure upon purchase intention. Nielsen (1993) stated that acceptance of product depends on how easy a product is to use. Jordan (2000) stated that consumer will accept the product if the pleasant in look or pleasant in use. Mugge and Schoormans (2012) proved that apparent usability depends on the product appearance and it might play a role in product acceptance. Similarly, in present study it has been found that apparent usability is playing a crucial role in anthropomorphic product acceptance as it mediates the influence of perceived pleasure on product purchase intention.

Therefore, it can be argued that the use of anthropomorphic appearance could be the modern approach to increase product purchase intention in many product categories. However, designers should careful about the way of

incorporation of the anthropomorphic attributes in a product. Anthropomorphic attributes should not negatively interfere with the perception of apparent usability and pleasure.

**Key points**

- ☞ Anthropomorphic attributes have significant effect on both apparent usability and visually perceived pleasure.
- ☞ Strategy of incorporation of anthropomorphic attributes in product appearance is important.
- ☞ There is chance of low market acceptance of anthropomorphic product if humanlike attributes used in the product affect apparent usability and visually perceived pleasure.
- ☞ Designers should think about apparent usability and visually perceived pleasure while designing anthropomorphic product appearance.
- ☞ Designers need to concentrate more on apparent usability of the product as users gave more priority on apparent usability than the pleasure.



## Chapter-5: Neurocognitive approach to anthropomorphic product appearance evaluation

### Abstract

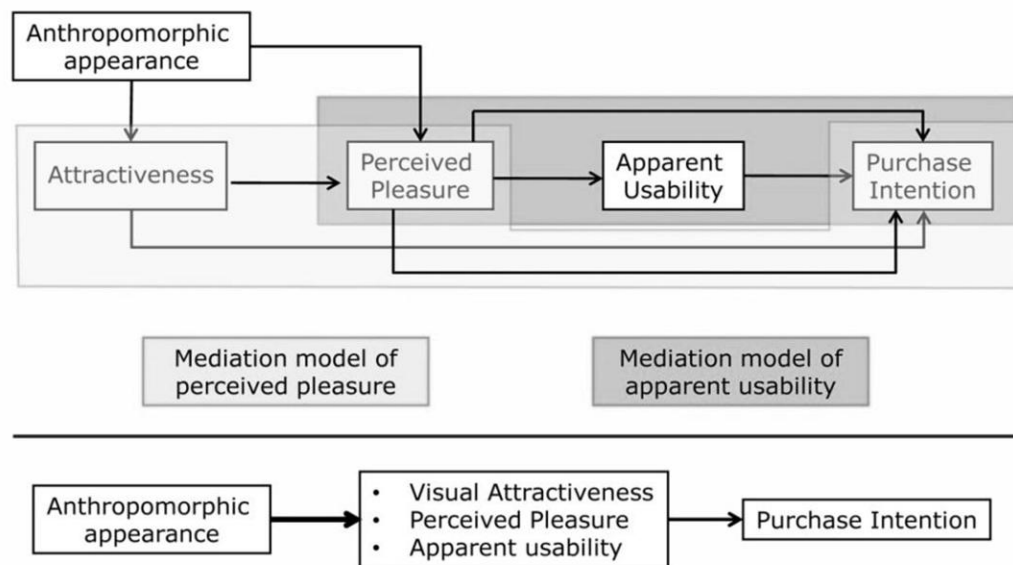
Neurocognitive techniques are used to understand the neuropsychophysiological basis of brand and product choice decisions. Most of the studies applied f-MRI for the same but facility to avail this technique is too costly to evaluate a product. In addition, facial EMG and eyetracking techniques are relatively cheaper than the f-MRI but sensitive enough to get evidences for the emotional basis of brand and product choice decisions. However, facial EMG and eyetracking techniques were comparatively less applied for product evaluation and to understand the neuropsychophysiological basis of product choice. Questionnaire study results of previous chapters of this thesis support that it is possible to make product attractive, pleasurable and apparently usable through anthropomorphic product appearance. Further, attractiveness, pleasure and apparent usability are related to each other. Now, in the present chapter, the previous results were further validated using subjective pleasure measurement technique facial EMG and the visual attractiveness measurement technique eyetracking. Facial EMG and eyetracking studies revealed that there are similarities between results of questionnaire based study with results of facial EMG study and eye-tracking study.

**Keywords:** *Anthropomorphic product; cognitive ergonomics; eye-tracking; facial EMG;*

### 1. Introduction

Role of anthropomorphic appearance in visual attractiveness and pleasure perception was established in the ‘**Chapter-3**’ of this thesis. It was established in this chapter that attractiveness of a product can be increased through addition of anthropomorphic attributes in product shape. In addition, the influence of attractiveness (due to anthropomorphic appearance) on product purchase intention is mediated via perceived pleasure (mediation model of perceived pleasure). In ‘**Chapter-4**’, it was shown that the strategy of incorporation of anthropomorphic attributes may moderate the perception of apparent usability of anthropomorphic product. Furthermore, effect of perceived pleasure (due to anthropomorphic appearance) on product purchase intention is mediated through apparent usability (mediation model of apparent usability). If mediation model of perceived pleasure is integrated with mediation model of apparent usability, it is possible to derive the conclusion that the anthropomorphic product purchase intention chiefly depends on three major factors viz. visual attractiveness, perceived pleasure and apparent usability (**Figure 5.1**). According to the integrated model, pleasure is the common key factor which shared the effects on purchase intention in the both

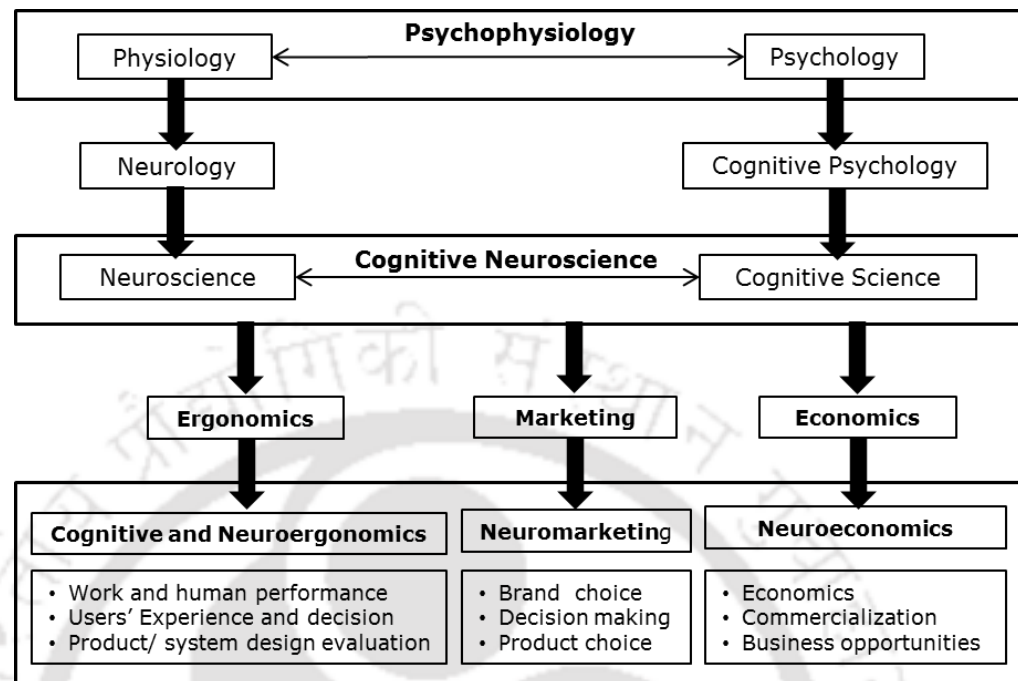
mediation models. Therefore, it was decided to validate the effect of pleasure on the anthropomorphic product purchase intention employing neurocognitive techniques, as most of these techniques are more sensitive than the questionnaire based evaluation.



**Figure 5.1 Visual attractiveness, perceived pleasure and apparent usability are basis of anthropomorphic product purchase intention.**

## 2. Cognitive ergonomics in product design

As discussed in the 'Chapter-1', it is clear that under the discipline of 'Cognitive Ergonomics' researcher investigates the human cognitive processes, such as sensation, perception, attention, cognition, emotion etc. The discipline of cognitive ergonomics is evolved from routes of natural and social sciences as represented in **Figure 5.2**. Furthermore, 'neuroergonomics' was evolved from cognitive neuroscience and cognitive ergonomics. It has been found from the literature that other cognitive neuroscience related disciplines such as neuromarketing and neuroeconomics also coevolved simultaneously. Even there are relationships in study goals among cognitive and neuroergonomics, neuromarketing and neuroeconomics (see **Figure 5.2**).



**Figure 5.2** Cognitive and neuroergonomics related fields are evolved from natural science (physiology) and social science (psychology).

### 3. Neurocognitive techniques and its application in product design related disciplines

As cognitive/ neuroergonomics, neuromarketing and neuroeconomics are related disciplines, many techniques applied for the product or the brand evaluation are common. These are electroencephalography (EEG), magnetoencephalography (MEG), positron emission tomography (PET), functional magnetic resonance imaging (f-MRI), facial electromyography (Facial EMG), Eye-tracking, transcranial magnetic stimulation (TMS) technique, and galvanic skin response (GSR). Commonly used neurocognitive techniques for product or brand evaluation are electroencephalography (EEG), magnetoencephalography (MEG), functional magnetic resonance imaging (f-MRI), Eye-tracking and galvanic skin response (GSR). Applications of different neurocognitive techniques in the fields of product and/ brand evaluation are presented in **Table 5.1**. Although these studies identified neuropsychophysiological basis of either product decision or brand value using different techniques, there are hardly few studies which applied

facial EMG and Eye-tracking together for the same purpose. In addition, facial EMG and Eye-tracking techniques were less explored in the determination of product choice.

**Table 5.1 Applications of neurocognitive techniques in different fields related to design and social sciences.**

Author (s)	Purpose	Neurocognitive techniques							
		EEG	MEG	PET	f-MRI	Facial EMG	Eye-tracking	TMS	GSR
Kenning, & Linzmajer (2011)	<ul style="list-style-type: none"> <li>• Price policy</li> <li>• Product policy</li> <li>• Communication policy</li> <li>• Distribution policy</li> <li>• Brand research</li> </ul>	✓	✓	✓	✓	✓	✗	✓	✗
Kenning, Plassman, & Stanford (2007)	<ul style="list-style-type: none"> <li>• Brand choice</li> <li>• Product choice</li> <li>• Advertisement</li> </ul>	✗	✗	✗	✓	✗	✗	✗	✗
Garcia, & Saad (2008)	<ul style="list-style-type: none"> <li>• Brand choice</li> <li>• Product choice</li> <li>• Price distinctions</li> </ul>	✗	✗	✗	✓	✗	✗	✗	✗
Dapkevicius, & Melnikas (2009)	<ul style="list-style-type: none"> <li>• Brand building</li> <li>• Product quality</li> <li>• Product choice</li> <li>• price distinctions</li> </ul>	✓	✓	✗	✓	✗	✗	✗	✗
Fugate (2008)	<ul style="list-style-type: none"> <li>• Brand personality</li> <li>• Service products</li> <li>• Emotional satisfaction</li> <li>• Product decision</li> </ul>	✓	✓	✗	✓	✗	✗	✗	✗
Wilson, Gaines, & Hill (2008)	<ul style="list-style-type: none"> <li>• Decision making</li> <li>• Persuasion</li> </ul>	✓	✗	✗	✓	✗	✗	✗	✗
Javor et al. (2013)	<ul style="list-style-type: none"> <li>• Trustworthiness evaluation</li> <li>• Prediction of the other person's future action</li> <li>• Calculation of future reward</li> <li>• Processing of cognitive conflict</li> </ul>	✓	✗	✗	✓	✗	✗	✗	✓
Neto, Filipe, & Ramalheiro (2011)	<ul style="list-style-type: none"> <li>• Product colour</li> <li>• Product price</li> <li>• Product choice</li> <li>• Branding</li> </ul>	✓	✗	✗	✓	✗	✓	✗	✓
Butler (2008)	<ul style="list-style-type: none"> <li>• Brand positioning</li> <li>• Advertising</li> <li>• Pricing</li> </ul>	✗	✗	✗	✓	✗	✗	✗	✗
Madan (2010)	<ul style="list-style-type: none"> <li>• Brand familiarity</li> <li>• Product preference</li> <li>• Advertisement</li> </ul>	✓	✗	✗	✓	✗	✗	✗	✗

Morin (2011)	<ul style="list-style-type: none"> <li>• Advertisement</li> <li>• Brand choice</li> <li>• Product choice</li> </ul>	✓	✓	✗	✓	✗	✓	✗	✗
Eser , Isin & Tolon (2011)	<ul style="list-style-type: none"> <li>• Advertisement</li> <li>• Brand choice</li> <li>• Product choice</li> </ul>	✓	✓	✗	✓	✗	✗	✗	✗
Lee, Butler & Senior (2010)	<ul style="list-style-type: none"> <li>• Advertisement</li> <li>• Brand choice</li> <li>• Product choice</li> </ul>	✗	✗	✗	✓	✗	✗	✗	✗
Vecchiato et al. (2010)	<ul style="list-style-type: none"> <li>• Advertisement</li> </ul>	✓	✓	✗	✓	✗	✗	✗	✗
Murphy, Illes, & Reiner (2008)	<ul style="list-style-type: none"> <li>• Brand preference</li> <li>• Product effectiveness</li> <li>• Product validity</li> </ul>	✓	✗	✓	✓	✗	✗	✓	✗
Lee, Broderick, & Chamberlain (2007)	<ul style="list-style-type: none"> <li>• Smell of product</li> <li>• Colour of product</li> <li>• Brand trust</li> <li>• Advertisement</li> </ul>	✓	✓	✓	✓	✗	✗	✗	✓
Farah (2005)	<ul style="list-style-type: none"> <li>• Consumers' desire for product</li> <li>• Brand preference</li> </ul>	✓	✓	✓	✓	✗	✗	✓	✗
Hubert (2010)	<ul style="list-style-type: none"> <li>• Advertisement</li> <li>• Product policy</li> <li>• Brand impact</li> </ul>	✓	✗	✗	✓	✗	✗	✓	✗
Maa et al. (2008)	<ul style="list-style-type: none"> <li>• Brand/ product extension</li> </ul>	✓	✗	✗	✓	✗	✗	✗	✗
Laparra-Hernandez et al. (2009)	<ul style="list-style-type: none"> <li>• Emotion</li> <li>• Product experience</li> <li>• Product perception</li> <li>• Product evaluation</li> </ul>	✗	✗	✗	✗	✓	✗	✗	✓
Miesler, Leder, & Herrmann (2011)	<ul style="list-style-type: none"> <li>• Affect/ Emotion</li> <li>• Automobile design</li> <li>• Product perception</li> <li>• Product evaluation</li> </ul>	✗	✗	✗	✗	✓	✗	✗	✗
van der Zwaag et al. (2013)	<ul style="list-style-type: none"> <li>• Emotion</li> <li>• Mood</li> <li>• Driving experience</li> </ul>	✗	✗	✗	✗	✓	✗	✗	✗
Windhager et al. (2008)	<ul style="list-style-type: none"> <li>• Emotion</li> <li>• Automobile design</li> <li>• Product perception</li> <li>• Product evaluation</li> </ul>	✗	✗	✗	✗	✗	✓	✗	✗
Windhager et al. (2010)	<ul style="list-style-type: none"> <li>• Emotion</li> <li>• Product perception</li> <li>• Product evaluation</li> </ul>	✗	✗	✗	✗	✗	✓	✗	✗
van den Broek & Westerink (2009)	<ul style="list-style-type: none"> <li>• Emotion</li> <li>• Product experience</li> <li>• Product perception</li> <li>• Product evaluation</li> </ul>	✗	✗	✗	✗	✓	✗	✗	✓
Clement (2007)	<ul style="list-style-type: none"> <li>• Brand Choice</li> <li>• Packaging design</li> <li>• Buying decision</li> </ul>	✗	✗	✗	✗	✗	✓	✗	✗

Pieters, & Warlop (1999)	<ul style="list-style-type: none"> <li>• Brand choice</li> <li>• Decision making</li> </ul>	×	×	×	×	×	✓	×	×
Chowdhury et al. (2012)	<ul style="list-style-type: none"> <li>• Brand recognition</li> <li>• Orthography</li> </ul>	×	×	×	×	×	✓	×	×
Singh, & Das (2010)	<ul style="list-style-type: none"> <li>• Automobile design</li> <li>• Visual attention</li> </ul>	×	×	×	×	×	✓	×	×
Chowdhury et al. (2013)	<ul style="list-style-type: none"> <li>• Website design</li> <li>• Product choice</li> <li>• Product personality</li> </ul>	×	×	×	×	×	✓	×	×

: In this table, 'Cross' mark designates the technique which is not mentioned in the study; whereas, the 'Tick' mark in the table means the opposite fact.

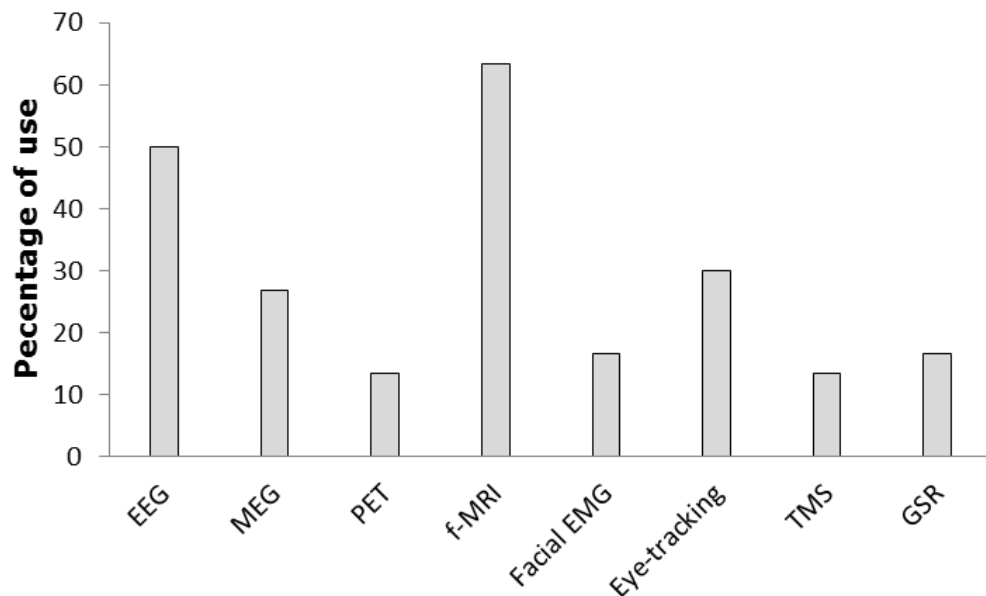
**Table 5.2 Summary of the main brain areas of interest to consumer neuroscience.**

<i>Brain area</i>	<i>Key functions of interest</i>
<i>Amygdala</i>	<ul style="list-style-type: none"> <li>• Processing of emotions, particularly negative emotions; aversive responses to inequity</li> <li>• Modulator of the memory system</li> </ul>
<i>Anterior cingulate</i>	<ul style="list-style-type: none"> <li>• Integration of emotional and motivational information in the decision-making process</li> </ul>
<i>Dorsolateral prefrontal cortex (DLPFC)</i>	<ul style="list-style-type: none"> <li>• Internal conflict between alternative options</li> <li>• Cognitive control, including over impulses towards social norm compliance</li> </ul>
<i>Hippocampus</i>	<ul style="list-style-type: none"> <li>• Formation and consolidation of memory (long-term memory)</li> <li>• Acquisition and recall of declarative memory</li> </ul>
<i>Insula</i>	<ul style="list-style-type: none"> <li>• Perception and expectation of risks (e.g. financial and social risks)</li> <li>• Anger and disgust against unfair economic situations</li> </ul>
<i>Occipital lobe</i>	<ul style="list-style-type: none"> <li>• Processing of visual stimuli</li> </ul>
<i>Orbitofrontal cortex (OFC)</i>	<ul style="list-style-type: none"> <li>• Evaluation of the capacity of outcomes to satisfy one's needs</li> <li>• Experience and anticipation of the emotion of regret when outcomes differ from expectations</li> </ul>
<i>Striatum</i>	<ul style="list-style-type: none"> <li>• Evaluation of actual rewards with respect to expectations</li> </ul>
<i>Ventrolateral prefrontal cortex (VLPFC)</i>	<ul style="list-style-type: none"> <li>• Representation of the threat of punishment for non-compliance with social norms</li> </ul>
<i>Ventromedial prefrontal cortex (VMPFC)</i>	<ul style="list-style-type: none"> <li>• Processing of different alternatives and their perceived value</li> </ul>

Source: This figure is adapted from: Solnais et al. (2013)

These neurocognitive techniques are so sensitive that if we are able to use these techniques (one or more than one) for product evaluation it gives us insights about neuropsychophysiological basis of buying behaviour and product choice (Butler, 2008; Damasio, 1996; Dapkevicius and Melnikas, 2009). Please see various purposes of studies which employed these neurocognitive techniques in

**Table 5.1.** After many studies which employed these techniques, now, researchers have identified the brain areas responsible for different buying behaviours. Identified functions of different brain areas were presented in **Table 5.2.**



**Figure 5.3** Percentage of neurocognitive technique usage.

In present thesis, total 30 articles related to the application of neurocognitive techniques in brand/product design evaluation were reviewed. Among these studied literature, around 50.0% of the studies mentioned about EEG, 26.7% mentioned about MEG, 13.3% mentioned about PET, 63.3% mentioned about f-MRI, 30.0% mentioned about eye-tracking, 13.3% mentioned about TMS and 16.7% studies mentioned about GSR. Therefore, it was profound that maximum studies applied f-MRI for product/brand evaluation whereas, comparatively very few studies were reported about eye-tracking and facial EMG based product evaluation (**Figure 5.3**). Moreover, f-MRI is a much costlier technique than the eye-tracking and facial EMG. Literature review from journals related to cognitive and neuroergonomics, neuromarketing and design, it become clear that few neurocognitive techniques are common across these three disciplines. These techniques are eye-tracking, facial EMG and GSR (**Figure 5.4**). Therefore, these techniques may be more fruitful for the present thesis work. As

the ergonomics laboratory of the Department of Design, IIT- Guwahati has BIOPAC MP-100 EMG system and SMI-HED-Eye-tracking system; hence, it was feasible to evaluate anthropomorphic product appearances only through two techniques facial EMG and eye-tracking, for the present thesis work.

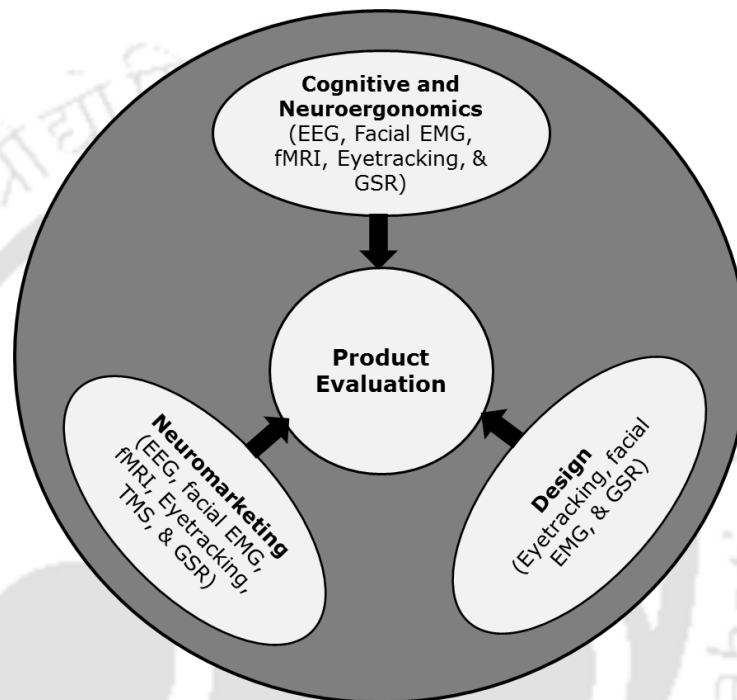


Figure 5.4 Similar psychophysiological techniques have been used in different related field for product evaluation.

#### 4. Study 1: Facial EMG based evaluation of product appearance

##### 4.1. Background

It is well established that levels of pleasure can be detected through somatic (bodily) markers as it was established that bodily emotions are associated with bodily changes (as stated in ‘James-Lange Theory’, ‘Cannon-Bard Theory’ and ‘Somatic Marker Hypothesis’). According to the ‘*Circumplex Model of Emotion*’ every emotion are composed of two dimensions which are arousal and valance (Barrett and Russell, 1999; Russell, 1980). Arousal actually refers to the state of activation/deactivation of emotion as well as the strength of the responses to a

stimulus; whereas, valance represents the extent to which the experience is pleasant or unpleasant. Valance and arousal are generally changing with different situations or events.

It is important to note that pleasant state is a positive valance of emotion and the unpleasant state is a negative valance of emotion. In an electromyographic (EMG) study with different human facial expressions, it was established that zygomatic major muscle activity was stronger in case of high-arousal pleasant expressions when compared to low-arousal pleasant expressions (Fujimura, Sato, & Suzuki, 2010). Similar activity was induced in the corrugator supercilii muscle in response to both high and low arousal unpleasant facial expressions, and this was true for both dynamic and static stimuli presentations. Rymarczyk et al. (2011) reported that subjects reacted spontaneously and rapidly to happy faces with increased zygomaticus major EMG activity and decrease corrugator supercilii EMG activity. Sato, Fujimura and Suzuki (2008) established that dynamic presentations of angry expressions induced stronger EMG activity from the corrugator supercilii than static presentations, while dynamic presentations of happy expressions induced stronger EMG activity from the zygomatic major compared to static presentations. However, dynamic image presentation technique is less realistic for tangible product image evaluation. Philipp, Storrs, and Vanman (2012) highlighted that facial electromyography as a marker for assessment of affect in immersive virtual environments. Their study also reported that the mere presence of virtual humans is enough to elicit sociality effects on facial expressiveness. These results support that it is possible to measure different emotional states (e.g. pleasant or unpleasant) through EMG study. Therefore, designers are able to evaluate the product having different emotional valances. In addition, it is also clear that zygomatic major and corrugator supercilii muscles are marker for both positive and negative valances. Sometimes happiness is considered as positive affect and unpleasantness state as negative affect (Miesler, Leder, & Herrmann, 2011).

Though maximum facial EMG studies have been conducted on human facial expression recognition and emotion generation evaluation; now-a-days,

researchers are using facial EMG for product design evaluation. In a feasibility study it was illustrated that electromyographic (EMG) signals of three muscles viz. frontalis, corrugator supercilii, and zygomaticus major, can be recorded to evaluate emotion awake consumer products (van den Broek, & Westerink, 2009). It was revealed in this study that it is possible to get EMG signals of these three muscles for abstract product figures up to 20 seconds after the onset of stimulus (better signal up to 10 seconds). In a very recent study of baby-schema effect on car faces revealed that the overall zygomaticus major activity was larger for babyfaced car fronts than for the original BMW cars during the five seconds of first stimulus exposure (Miesler, Leder, & Herrmann, 2011). In addition, separate analyses for each of the five time intervals revealed that babyfaced car fronts elicited a significantly larger zygomaticus major activation than the original cars in the first second after stimulus onset. Literature review suggests that very few studies have been conducted on facial EMG based product appearance evaluation, though it is feasible. Therefore, in the present thesis, an attempt has been made to evaluate the anthropomorphic products using facial EMG as a neurocognitive technique to confirm the results got through questionnaire study. Questionnaire based studies in ‘**Chapter-3**’ and ‘**Chapter-4**’ revealed that anthropomorphic appearance in product has relationships with the pleasure which is perceived by the users/consumers. In addition, it was also revealed that the perceive pleasure is positively related with apparent usability (see results of ‘**Chapter-4**’). Based on the literature and results of previous studies, it is hypothesized that “*Facial muscle (viz. corrugator supercilii and zygomaticus major) activities significantly varies with levels of pleasant look in the anthropomorphic products ( $H_{a3}$ )*”. This hypothesis was subdivided into the following working hypotheses for the ease of this study:

*Working hypotheses:*

- H<sub>a3.1</sub>**: Corrugator supercilii muscle activity significantly and inversely varies with levels of pleasant anthropomorphic product appearance.
- H<sub>a3.2</sub>**: Zygomaticus major muscle activity significantly and directly varies with levels of pleasant anthropomorphic product appearance.

The EMG study was carried on three different categories of products viz. tiffin box (adapted from study reported in '**Chapter-3**'), watch (adapted from study reported in '**Chapter-4**') and bike (new one).

## **4.2. Method**

### **4.2.1. Stimuli preparation**

In this study, eight images of human faces (four male and four female) were captured from two different facial actors (one male and one female) and four images of two different products (two tiffin boxes and two wrist watches) were adapted from previous chapters for facial mimicry task. In addition, two images of bikes were newly prepared for this study.

Anthropomorphic appearance in tiffin box was designed by manipulating a number of anthropomorphic attributes. As shown in '**Figure 5.6**', one tiffin box was with two rounded food container with simple clamps; whereas; in another tiffin box, upper food container was anthropomorphized as humanlike smiling face and the clamps of this tiffin box were human hands like. Smiling face of upper food container helps to bring pleasantness as well as the anthropomorphic look; whereas, other tiffin box appeared like neutral in valance (as reported in '**Chapter-3**'). On the other side, watch dial was anthropomorphized in such a way that it would express like a human face listening music with headphones. One watch dial appeared like neutral in valance as no pleasure related anthropomorphic attributes was used in it; whereas, in another watch dial, smiling lip like anthropomorphic attribute was used to express pleasure (see '**Figure 5.6**'). In case of bikes, valance was manipulated by changing the anthropomorphic attributes of bike headlights in a similar way to tiffin box/ watch. For bikes, head light arrangement and number of lights were altered to make headlights similar to human faces. In one bike, tow lights were placed in headlight in such a way that it appears like human eyes; while, in another bike, three lights were arranged in headlight in a way that headlight appears like a human smiling face (see '**Figure 5.6**').

People can perceive different valence of emotion (such as neutral, pleasant etc.) through facial expressions (Barrett & Russell, 1999; Russell, 1980). From the facial mimicry experiments it was observed that participants mimic different facial expression sometimes consciously and sometimes unconsciously. This is a natural human behaviour as reported by many researchers (Ekman & Friesen, 1971; Fujimura, Sato, & Suzuki, 2010; Miesler, Leder, & Herrmann, 2011; Sato, Fujimura, & Suzuki, 2008). In addition, it was reported in a recent feasibility study on 6–7 year old children that an increase in zygomaticus activity and a decrease in corrugator activity in case of happy human face (Deschamps et al., 2012). In a product ergonomics study it was established that the activity of zygomaticus major was significantly higher in smiling face than neutral and frowning face (Laparra-Hernández et al., 2009). Therefore, it is expected that consumers or users will be able to mimic differently when exposed to different anthropomorphic product faces as these were with different valences (neutral vs. pleasant).

In this study both male and female human faces were used as positive control for facial mimicry task. This study involves two different sets of human faces. One set of human face images were used as positive control for tiffin box/bike study and another set of human face images were used for watch study (see **Figure 5.7**). It is expected that participants of facial mimicry task were able to mimic facial expressions (neutral vs. pleasant) according to the human face images presented to them. It was also assumed that facial expressions of participants to neutral and pleasant product faces might be similar to neutral and pleasant human faces respectively.

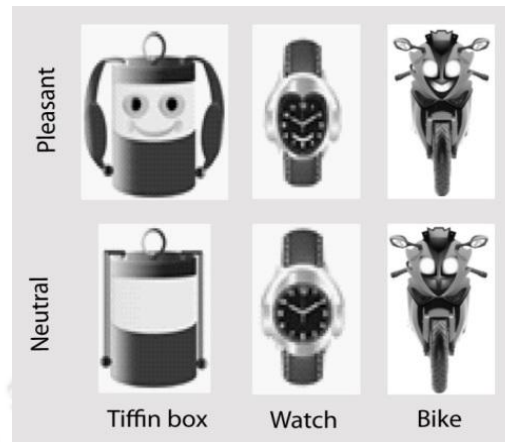


Figure 5.6 Product images with different valences.

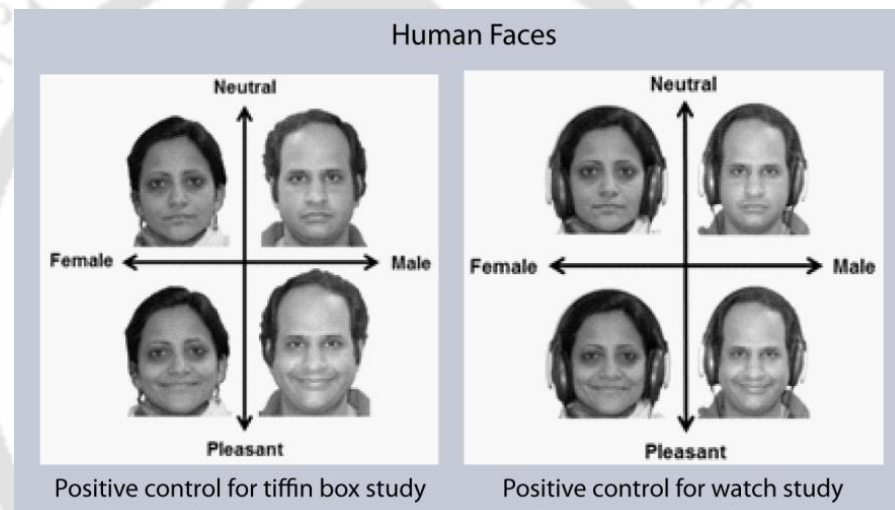


Figure 5.7 Images of human faces with different valences.

#### 4.2.2. Participants

A total of 30 participants participated in both tiffin box and watch studies (Male: 80.00 %, Female: 20.00 %;  $M_{\text{age}} = 22.77$ ,  $SD = 3.63$ ). On the other side, a total of 38 participants (Male: 71.05 %, Female: 28.95 %;  $M_{\text{age}} = 23.21$ ,  $SD = 3.60$ ) participated in bike appearance evaluation study. All participants were assigned through simple random sampling (Howell, 2012) for this study.

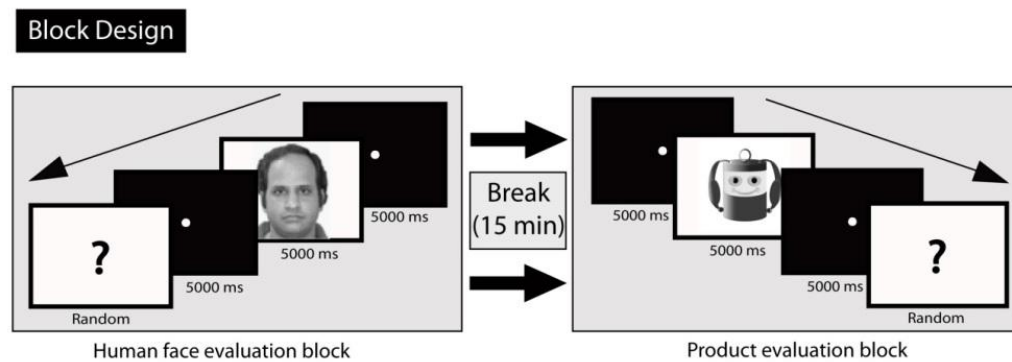
#### 4.2.3. Measures

Anthropomorphism was checked using a seven point visual semantic scale composed of six bipolar items. These items were fake/ natural, machinelike/ humanlike, artificial/ realistic, lifeless/ organic, dead/ lively and non-human animal like/ humanlike. Emotional valance for all images (product images and human faces) were measured by asking a question to participants i.e. “Is this image expressing neutral (or pleasant) human (or product) face?” Participants supposed to be given their answer either through selection of ‘Yes’ or ‘No’. Activity of two facial muscles viz. zygomaticus major and corrugator supercili were measured using facial electromyography as electrical activities of these two muscles vary with different facial expressions due to different emotion (here effect of neutral vs. pleasant was studied).

#### 4.2.4 Procedure

Facial mimicry task was designed to get facial electromyographic responses from a group of participants. To execute facial mimicry task, a stimulus block design was employed as described by Miesler, Leder, and Herrmann (2011). Two stimuli blocks were designed for each product type in facial mimicry task. These two blocks were ‘Human Face Evaluation Block (HFEB)’ and ‘Product Evaluation Block (PEB)’. The HFEB was composed of images of facial actors of two different gender (male/ female) with two different valances (neutral vs. pleasant) for three times ( $2 \times 2 \times 3$  within subject repeated measure design). On the other side, PEB was composed of two different valance (neutral vs. pleasant) and three trials ( $2 \times 3$  design). For tiffin box, watch and bike studies, different sets of HFEBs and PEBs were designed. Therefore, total six blocks of stimuli were used in this study. Stimuli blocks were designed using static images of product for PEB (**Figure 5.6**) and images of human faces (**Figure 5.7**) for HFEB. Stimuli presentation style in each block for facial EMG was presented in **Figure 5.8**. Total stimuli presentation time for each block was two minutes five seconds (for 12 trials). To avoid tediousness among participants and its effect on facial EMG,

fifteen minutes break was taken in between the HFEB and the PEB.



**Figure 5.8 Stimuli presentation style for facial EMG study.**

Each stimulus block was presented on computer screen and EMG recordings were taken for each participant by placing positive and negative electrodes (silver chloride button electrodes having diameter of 0.4 mm) on corrugator supercillii and zygomaticus major muscles. Electrodes were placed on the left side of the face to obtain maximum reactions (Dimberg & Patterson, 2000). Electrodes were placed as per the instructions given by Fridlund and Cacioppo (1986). A ground electrode was placed on the forehead of the participant. Impedances of electrodes were balanced and maintained below 15 k $\Omega$  during recording.

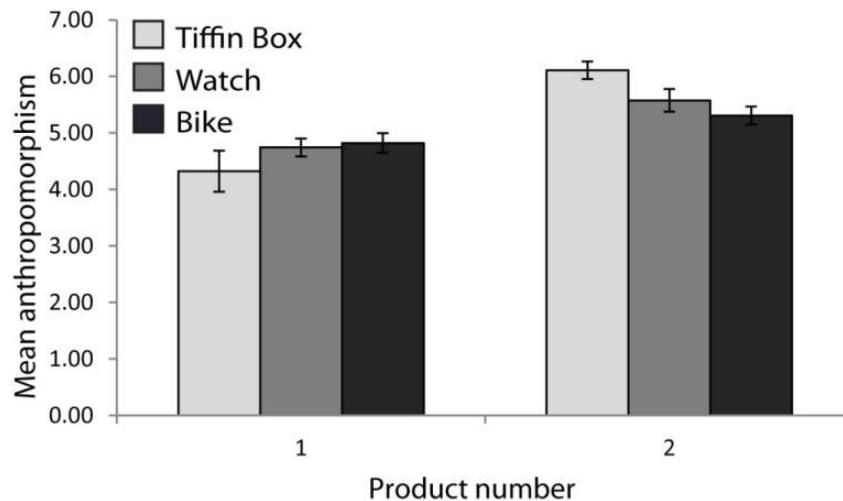
#### 4.2.5 Apparatus

A computer system (Monitor: LG-FLATRON-L1752S, Size: 17 inches diagonally, Resolution: 1280 $\times$ 1024 px, Microsoft<sup>TM</sup> Windows 7, 32 bit Operating System) was used for the presentation of stimuli blocks. EMG data was collected by MP100, BIOPAC Systems at 2000 Hz sampling rate. For the purpose of artifact rejection, a video recording was unobtrusively conducted using a digital video camera (Nikon Coolpix, L300).

#### 4.2.6 EMG signal processing

Collected EMG data was further processed offline using Acq-Knowledge software

(Version 3.7.2). Data was filtered using different IIR filters (viz. band pass: 5–1000 Hz; notch: 60 Hz) in Acq- Knowledge software platform. Filters were used as per the procedure used by Sato, Fujimura, and Suzuki (2008) for facial EMG data. The data were sampled for 5000 ms in each trial and a pre-stimulus baseline data for 1000 ms (while fixation point was presented).



**Figure 5.9 Perception of anthropomorphism varies with number of humanlike attributes added in the product.**

### 4.3. Results

#### 4.3.1. Stimulus manipulation check

First, level of anthropomorphism for all products were checked and it was observed that mean values for each product image were more than four in seven point scale (in which 4 is neutral point) (see **Figure 5.9**). Therefore, most of the participants rated anthropomorphism towards point seven on the anthropomorphism scale which was consisted with seven points. This result meant that participants perceived all products as anthropomorphic. Therefore, all the products are anthropomorphic in nature. Interestingly it was also observed from the results reported in ‘**Chapter-3**’ that tiffin box-2 was perceived as significantly more anthropomorphic than tiffin box-1 [ $F(1, 26) = 17.180, p < 0.001$ ]. Similarly, watch-2 was comparatively more anthropomorphic than watch-

1 [ $F(1, 47) = 10.551, p < 0.002$ ] (result adapted from ‘**Chapter-4**’). In this chapter, levels of anthropomorphism in bikes were measured and it was observed that bike-2 is significantly more anthropomorphic in nature than the bike-1 [ $F(1, 63) = 4.206; p < 0.05$ ].

As it was expected, most of the participants perceived images of tiffin box-1, watch-1 and bike-1 as neutral in valance; whereas, tiffin box-2, watch-2 and bike-2 as pleasant. Similarly, images of human faces selected for the present study were also appropriate as these images reflected different valances (neutral and pleasant). Significantly most of the participant perceived neutral face of facial actor as neutral ( $p < 0.05$ ) and pleasant face of the facial actor as pleasant ( $p < 0.05$ ). Detail results about the valance perception by participants were presented in **Table 5.3**.

**Table 5.3 Total number of participants (with percentage of agreed) for proposed valance of each images.**

<i>Image</i>	<i>Valance</i>	<i>N (%)</i>	<i><math>\chi^2</math> value</i>	<i>Sig. level</i>
Tiffin box	Neutral	16 (81.3)	6.250	$p < 0.012$
	Pleasant	16 (87.5)	9.000	$p < 0.003$
Watch	Neutral	16 (75.0)	4.000	$p < 0.046$
	Pleasant	16 (81.3)	6.250	$p < 0.012$
Bike	Neutral	16 (81.3)	6.250	$p < 0.012$
	Pleasant	16 (75.0)	4.000	$p < 0.046$
Human face (Tiffin box/ Bike)	Neutral	20 (85.0)	9.800	$p < 0.002$
	Pleasant	20 (85.0)	9.800	$p < 0.002$
Human face (Watch study)	Neutral	20 (80.0)	7.200	$p < 0.007$
	Pleasant	20 (95.0)	16.200	$p < 0.001$

### 4.3.2. Changes in corrugator activity

#### 4.3.2.1 Human face

Repeated measure ANOVA was conducted to observe the effect of gender (male vs. female)  $\times$  valance (neutral vs. pleasant)  $\times$  trials (first vs. second vs. third) ( $2 \times 2 \times 3$ ) of different human faces on corrugator supercilii activity. In case of human faces selected for control against tiffin box/ watch, no significant within subject

effect of trials [ $F(1, 57) = 0.023, p > 0.05, \eta_p^2 = 0.000$ , observed power = 0.053] and gender  $\times$  trials [ $F(1, 57) = 0.046, p > 0.05, \eta_p^2 = 0.001$ , observed power = 0.055] were found on corrugator muscle activity; whereas, within subject interactive effect of valance  $\times$  trials [ $F(1, 57) = 11.567, p < 0.001, \eta_p^2 = 0.169$ , observed power = 0.917] was found significant on corrugator muscle activity. Corrugator muscle activity was also significantly different due to valance of human faces (neutral vs. pleasant) selected for control against tiffin box images [ $F(1, 57) = 3.978, p < 0.05, \eta_p^2 = 0.065$ , observed power = 0.500]. It was observed that corrugator muscle activity always less in case of pleasant human face than neutral human face. Corrugator activity in case of pleasant human face was comparatively lesser in first trial and it was comparatively higher in third trial. On the contrary, corrugator activity was not significantly affected by gender of facial actors [ $F(1, 57) = 0.022, p > 0.05, \eta_p^2 = 0.000$ , observed power = 0.052].

In case of human faces selected for control against watch, there was no significant within subject effect of trials [ $F(1, 56) = 0.000, p > 0.05, \eta_p^2 = 0.000$ , observed power = 0.050], interactive effect of valance  $\times$  trials [ $F(1, 56) = 12.339, p < 0.001, \eta_p^2 = 0.181$ , observed power = 0.932] and interactive effect of gender of human actors  $\times$  trials [ $F(1, 56) = 0.049, p > 0.05, \eta_p^2 = 0.001$ , observed power = 0.055] found on corrugator muscle activity. Corrugator muscle activity was also significantly different due to valance of human faces (neutral vs. pleasant) selected as positive control for watch study [ $F(1, 56) = 3.927, p = 0.05, \eta_p^2 = 0.066$ , observed power = 0.495]. It was observed that corrugator muscle activity was always less in case of pleasant human face than neutral human face. Corrugator activity in case of pleasant human face was comparatively lesser in first trial whereas it was comparatively higher during second and third trial. No significant between-subjects effect of gender of human faces was observed on variations of corrugator activity [ $F(1, 56) = 0.021, p < 0.05, \eta_p^2 = 0.000$ , observed power = 0.052].

There were no significant within subject variations in corrugator muscle activity were found due to trials [ $F(1, 73) = 1.435, p > 0.05, \eta_p^2 = 0.019$ , observed power = 0.219] interactive effect of valance  $\times$  trials [ $F(1, 73) = 0.165, p$

$> 0.05$ ,  $\eta_p^2 = 0.002$ , observed power = 0.069] and interactive effect of trials and gender of facial actors [ $F(1, 73) = 2.870$ ,  $p > 0.05$ ,  $\eta_p^2 = 0.038$ , observed power = 0.387]. Average corrugator muscle activity of participants was significantly lower in case bike-2 (pleasant appearance) than the bike-1 (neutral appearance) [ $F(1, 73) = 6.211$ ,  $p < 0.01$ ,  $\eta_p^2 = 0.078$ , observed power = 0.691]. It was also noticed that mean value of corrugator activity in case of pleasant human face was comparatively greater during first and second trials than third trial. On the contrary, the between-subjects effect of gender of facial actors on corrugator activity was not significant [ $F(1, 73) = 0.116$ ,  $p > 0.05$ ,  $\eta_p^2 = 0.002$ , observed power = 0.063].

#### 4.3.2.2 Product face

To observe the effect of valance  $\times$  trial ( $2 \times 3$ ) of different product faces on corrugator supercillii muscle activity, repeated measure ANOVA was conducted. In case of product face (tiffin box), no significant within subject effect of trials [ $F(1, 58) = 0.000$ ,  $p > 0.05$ ,  $\eta_p^2 = 0.000$ , observed power = 0.050] and interactive effect of valance  $\times$  trials [ $F(1, 58) = 2.451$ ,  $p > 0.05$ ,  $\eta_p^2 = 0.041$ , observed power = 0.337] were found on corrugator supercillii muscle activity. Corrugator muscle activity was significantly different due to valance of tiffin box faces (neutral vs. pleasant) [ $F(1, 58) = 8.909$ ,  $p < 0.004$ ,  $\eta_p^2 = 0.133$ , observed power = 0.050]. It was observed that corrugator activity was always lesser in case of pleasant tiffin box than neutral tiffin box. Corrugator activity in case of pleasant tiffin box was comparatively lesser during first and second trials, whereas, it was comparatively higher in third trial.

In case of product face (watch), no significant within subject effect of trials [ $F(1, 58) = 0.000$ ,  $p > 0.05$ ,  $\eta_p^2 = 0.000$ , observed power = 0.050] and interactive effect of valance  $\times$  trials [ $F(1, 58) = 0.016$ ,  $p > 0.05$ ,  $\eta_p^2 = 0.009$ , observed power = 0.052] were found on corrugator supercillii muscle activity. Corrugator muscle activity was significantly different due to valance of watch faces (neutral vs. pleasant) [ $F(1, 58) = 4.194$ ,  $p < 0.045$ ,  $\eta_p^2 = 0.067$ , observed power = 0.522]. It was observed that corrugator activity was always lesser in case

of pleasant watch than neutral watch. Corrugator activity in case of pleasant watch was comparatively lesser in third trial, whereas, it was comparatively higher during first and second trials.

In case of the bike headlight study, no significant within subject effect of trials [ $F(1, 74) = 0.000, p > 0.05, \eta_p^2 = 0.000$ , observed power = 0.050] and interactive effect of valance  $\times$  trials [ $F(1, 74) = 3.272, p > 0.05, \eta_p^2 = 0.042$ , observed power = 0.431] were found on corrugator supercillii muscle activity. Though, corrugator muscle activity was significantly different due to different valance in bike faces (neutral vs. pleasant) [ $F(1, 74) = 4.687, p < 0.05, \eta_p^2 = 0.060$ , observed power = 0.570]. It was observed that mean values of corrugator activity were always lesser in case of pleasant bike headlight than neutral bike headlight among trials. Corrugator activity in case of pleasant bike was comparatively lesser in third trial, whereas, it was comparatively higher during first and second trials.

### 4.3.3. Changes in zygomaticus activity

#### 4.3.3.1 Human face

Repeated measure ANOVA ( $2 \times 2 \times 3$ ) was conducted to observe the effect of gender of facial actors (male vs. female)  $\times$  valance (neutral vs. pleasant)  $\times$  trial (first vs. second vs. third) of different human faces on zygomaticus major muscle activity. In case of human faces selected for control against tiffin box, no significant within subject effect of trials [ $F(1, 57) = 0.219, p > 0.05, \eta_p^2 = 0.004$ , observed power = 0.075] and interactive effect of valance  $\times$  trials [ $F(1, 57) = 0.655, p > 0.05, \eta_p^2 = 0.001$ , observed power = 0.125] were found on zygomaticus major muscle activity. Zygomaticus major muscle activity was significantly different due to valance of human faces (neutral vs. pleasant) selected for control against tiffin boxes / watches [ $F(1, 57) = 4.594, p < 0.036, \eta_p^2 = 0.075$ , observed power = 0.559]. Even, the zygomaticus activity was not significantly varied due to gender difference in human faces [ $F(1, 57) = 0.575, p > 0.05, \eta_p^2 = 0.010$ , observed power = 0.575]. It was observed that zygomaticus activity was always greater in case of pleasant human face than neutral human face. Zygomaticus

activity in case of pleasant human face was comparatively lesser during first and second trials and it was comparatively higher in third trial. Zygomaticus activity was not significantly varied due to between-subjects effect of gender of human actors [ $F(1, 57) = 0.212, p > 0.05, \eta_p^2 = 0.004$ , observed power = 0.074].

In case of human faces selected for control against watch, no significant within subject interactive effect of trials [ $F(1, 56) = 0.000, p > 0.05, \eta_p^2 = 0.000$ , observed power = 0.050], valance  $\times$  trials [ $F(1, 56) = 0.655, p > 0.05, \eta_p^2 = 0.012$ , observed power = 0.125], and gender  $\times$  trials [ $F(1, 56) = 0.438, p > 0.05, \eta_p^2 = 0.008$ , observed power = 0.100] were found on zygomaticus major muscle activity. Zygomaticus major muscle activity was significantly different due to valance of human faces (neutral vs. pleasant) selected for control against tiffin box images [ $F(1, 56) = 4.517, p < 0.05, \eta_p^2 = 0.075$ , observed power = 0.551]. It was observed that zygomaticus activity was greater in case of pleasant human face than neutral human face (See **Figure 5.10**). Zygomaticus activity in case of pleasant human face was comparatively lesser during first and second trials whereas activity was comparatively higher in third trial. Between-subjects effect of gender difference in human face stimuli on zygomaticus major was not significant [ $F(1, 56) = 0.208, p > 0.05, \eta_p^2 = 0.004$ , observed power = 0.073].

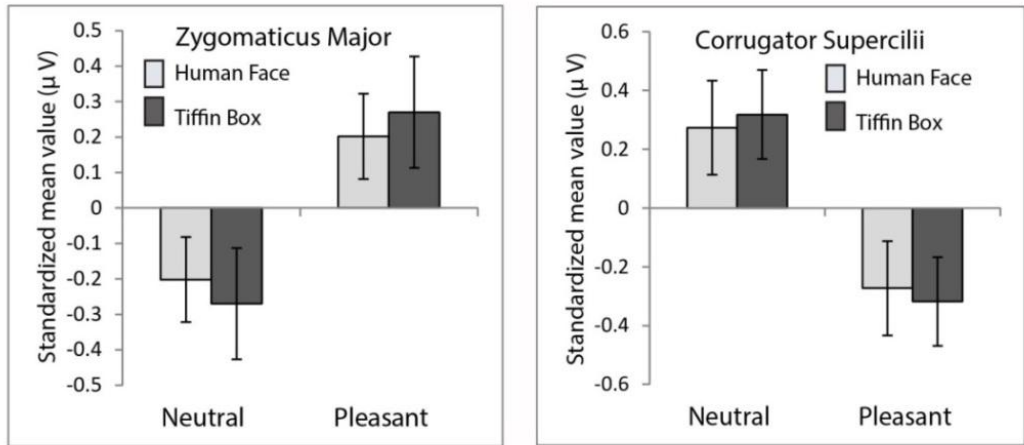
There were no significant within subject variations in zygomaticus major activity found due to trials [ $F(1, 73) = 0.201, p > 0.05, \eta_p^2 = 0.003$ , observed power = 0.073], valance  $\times$  trials [ $F(1, 73) = 0.516, p > 0.05, \eta_p^2 = 0.007$ , observed power = 0.109], and gender of facial actors  $\times$  trials [ $F(1, 73) = 0.401, p > 0.05, \eta_p^2 = 0.005$ , observed power = 0.096]. Average zygomaticus major muscle activity of participants was significantly higher in case bike-2 (pleasant appearance) than the bike-1 (neutral appearance) [ $F(1, 73) = 14.430, p < 0.001, \eta_p^2 = 0.078$ , observed power = 0.691] (See **Figure 5.10**). It was also noticed that mean zygomaticus activity in case of pleasant human face was comparatively greater during third trial than first and second trials. On the other side, no significant variations in zygomaticus activity was observed due to between-subjects effect of gender of facial actors [ $F(1, 73) = 2.501, p > 0.05, \eta_p^2 = 0.033$ , observed power = 0.345].

#### 4.3.3.2 Product face

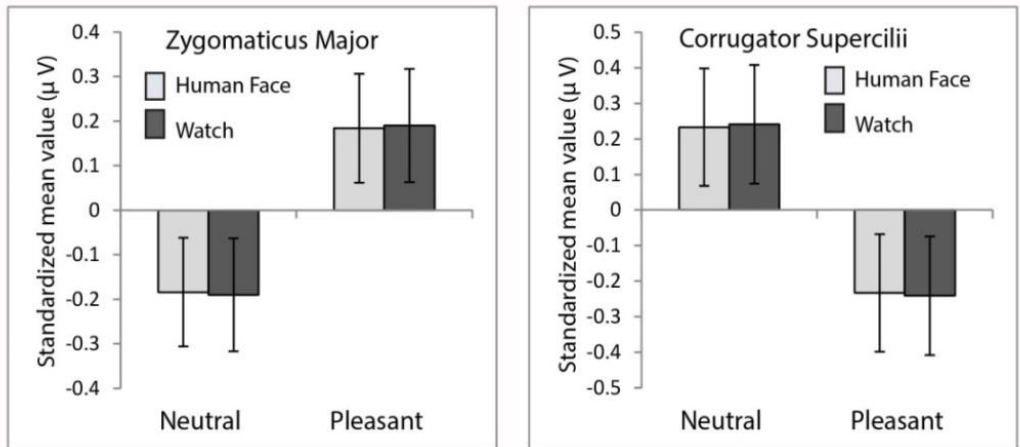
To observe the effect of valance  $\times$  trial ( $2 \times 3$ ) of different human faces on zygomaticus major muscle activity, repeated measure ANOVA was conducted. In case of product face (tiffin box), no significant within subject effect of trials [ $F(1, 58) = 0.000, p > 0.05, \eta_p^2 = 0.000, \text{observed power} = 0.050$ ] and interactive effect of valance  $\times$  trials [ $F(1, 58) = 0.029, p > 0.05, \eta_p^2 = 0.000, \text{observed power} = 0.053$ ] were found on zygomaticus major muscle activity. Zygomaticus major muscle activity was significantly different due to valance of tiffin box faces (neutral vs. pleasant) [ $F(1, 58) = 5.926, p < 0.018, \eta_p^2 = 0.093, \text{observed power} = 0.668$ ]. It was observed that zygomaticus activity was always greater in case of pleasant tiffin box than neutral tiffin box (See **Figure 5.10**). Zygomaticus activity in case of pleasant tiffin box was comparatively lesser during first and third trials, whereas, it was comparatively higher in second trial.

In case of product face (watch), no significant within subject effect of trials [ $F(1, 58) = 0.000, p > 0.05, \eta_p^2 = 0.000, \text{observed power} = 0.062$ ] and interactive effect of valance  $\times$  trials [ $F(1, 58) = 0.111, p > 0.05, \eta_p^2 = 0.002, \text{observed power} = 0.052$ ] were found on zygomaticus muscle activity. Zygomaticus activity was significantly different due to valance of watch faces (neutral vs. pleasant) [ $F(1, 58) = 4.444, p < 0.039, \eta_p^2 = 0.071, \text{observed power} = 0.545$ ]. It was observed that mean zygomaticus activity was higher in case of pleasant watch than neutral watch (See **Figure 5.10**). Zygomaticus activity in case of pleasant watch was comparatively lesser in third trial, whereas, it was comparatively higher during first and second trials.

### Tiffin Box Study



### Watch Study



### Bike Study

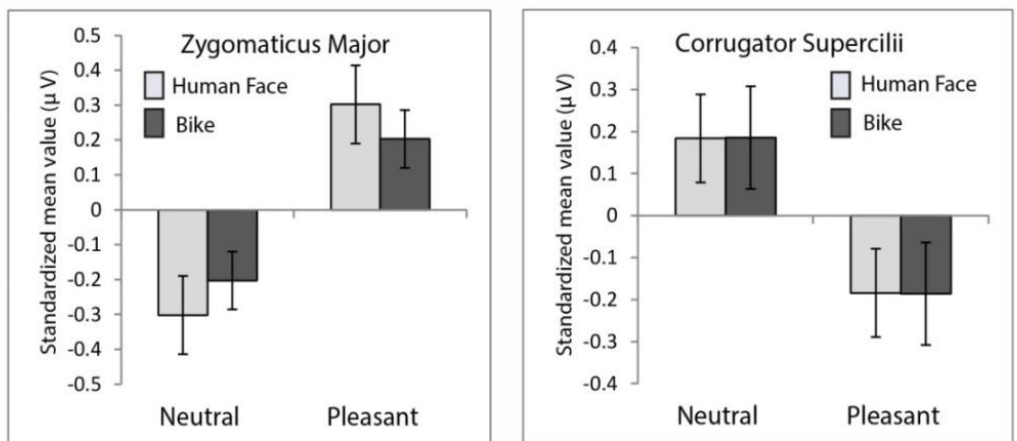


Figure 5.10 Changes in facial muscles activities.

In case of bike headlight study, no significant within subject effect of trials [ $F(1, 74) = 0.000, p > 0.05, \eta_p^2 = 0.000$ , observed power = 0.050] and interactive effect of valance  $\times$  trials [ $F(1, 74) = 2.102, p > 0.05, \eta_p^2 = 0.028$ , observed power = 0.299] were found on zygomaticus muscle activity. Though, zygomaticus muscle activity was significantly different due to different valance in bike headlights (neutral vs. pleasant) [ $F(1, 74) = 12.092, p < 0.001, \eta_p^2 = 0.140$ , observed power = 0.929]. It was observed that mean values of zygomaticus major activity were always greater in case of pleasant bike than neutral bike among trials (See **Figure 5.10**). Zygomaticus major activity in case of pleasant bike was comparatively higher in third trial, whereas, it was comparatively lesser during first and second trials. Please see ‘**Appendix-4**’ for detailed results of repeated measure ANOVA.

#### 4.4. Discussion

In unconscious facial mimicry task, corrugator muscle activity was comparatively higher in case of neutral human faces than pleasant human faces presented as control. On contrary, zygomatic muscle activity was higher in case of pleasant human face than the neutral human face (see **Figure 5.10**). Similar observations were also reported by other researchers in facial mimicry task (Deschamps et al., 2012; Korb, 2010; Laparra-Hernández et al., 2009; Sato, Fujimura and Suzuki, 2008; van den Broek, & Westerink, 2009). These results suggest that participants might have perceived more pleasure in pleasant/ happy human faces than the neutral human faces and due to this fact zygomaticus muscle activity was more in case of happy human faces than neutral human faces.

From subjective ratings it was clear that tiffin box-2, watch-2 and bike-2 had pleasant appearance; whereas; the tiffin box-1, watch-1 and bike-1 had neutral appearance though all products were anthropomorphic in nature. Therefore, facial muscles activity was similar to human faces. Zygomaticus activity was higher in all product faces having pleasant appearance (in cases of tiffin box-2, watch-2 and

bike-2) than the neutral product appearance (in cases of tiffin box-1, watch-1 and bike-1). Opposite activity was observed in case of corrugator muscle i.e. corrugator activity was higher in case of neutral product faces (as in cases of tiffin box-1, watch-1 and bike-1) than the happy product faces (as in cases of tiffin box-2, watch-2 and bike-2) (see **Figure 5.10**). Therefore, it is proved that facial muscles (corrugator and zygomaticus) activities significantly vary with levels of pleasant look in anthropomorphic products ( $H_{a3}$ ). In addition, the study showed that participants reacted to product faces in a similar way as they reacted against human faces. Hence, it can be concluded that facial mimicry task may be fruitful for evaluation of anthropomorphic products having different emotional valence. Van den Broek, and Westerink (2009) also reported that corrugator supercilii, and zygomaticus major activities can be recorded to evaluate emotion aware consumer products. It was revealed from a facial EMG study of car faces that the overall zygomaticus major activity was larger for babyfaced car fronts than for the original BMW cars as babyfaced car fronts were pleasant (Miesler, Leder, & Herrmann, 2011). So, these literatures also support the present study results.

## **5. Study 2: Eye-tracking study for pleasurable product appearance design**

### **5.1. Background**

Visual attractiveness is an essential factor in product design and it is closely related with product appearance. It is well accepted that visual appearance of products plays a significant role in determining consumers' product choice (Creusen and Schoormans, 2005) and the commercial success of a product (Crilly et al., 2004). Recently scholars are referring physical beauty of the product as attractiveness of the product as beauty is related to attractiveness (Hekkert, Snelders, and VanWieringen, 2003; Mugge and Schoormans, 2012). In addition, Khan and Sutcliffe (2014) reported that humanlike agent was more attractive as it was beautiful. Hence, it can also be said that if an anthropomorphic product is beautiful it will be attractive. According to aesthetic principle, if a product is aesthetically good then it would be visually attractive/ appealing. Tonkin et al. (2011) suggested that products which are more visually attractive grab more

attention to it when many products are placed simultaneously in shopping mall environment. Therefore, evaluation of visual attention analysis is necessary when aiming for visually attractive product design. Results of 'Chapter-3' of this thesis showed that people perceived a product more attractive if higher level of anthropomorphism is attributed by human like features in product. It has been also established that the visual attractiveness of anthropomorphic product is positively related with perceived pleasure through anthropomorphic product appearance. Even, facial EMG study revealed the fact that pleasant product appearance could be made through anthropomorphic attributes. According to Tavassoli (2008), selective attention may be diverted towards emotionally valenced stimuli. Therefore, if a product is positively valenced (pleasant in appearance) then there is chance to grab more attention to it. Similarly, an anthropomorphic product having pleasant appearance may grab more attention than the neutral anthropomorphic product. Hence, consumers may easily find out the pleasant anthropomorphic products in shopping mall environment. Now, the eye-tracking study may be able to unveil the role of pleasant anthropomorphic product in in-shop visual behaviour in a virtual shop environment. In this context it may be reasonable to highlight that average fixation duration, fixation count and first fixation duration on a particular area of interest are related with human attention and cognitive processing (Inhoff, 1984; Nuthmann et al., 2010; Singh & Das, 2010; Sun et al., 2014; Tavassoli, 2008; Windhager et al., 2008; Windhager et al., 2010). To study the eye-movement behaviour in virtual shop environment a hypothesis and three working hypotheses were stated. These were as follows:

**H<sub>a4</sub>: Anthropomorphic appearance of the product significantly influences the visual attention of users; and, thus, this visual attention in turn may affect the anthropomorphic product purchase intention during in shop/ on shelf visual search behavior.**

*Working hypotheses:*

H<sub>a4.1</sub>: Mean fixation time/ duration on product(s) significantly varies with anthropomorphic product appearances.

H<sub>a4.2</sub>: Fixation counts on product(s) significantly vary with anthropomorphic

product appearances.

H<sub>a4.3</sub>: First Fixation duration on product(s) significantly varies with anthropomorphic product appearances.

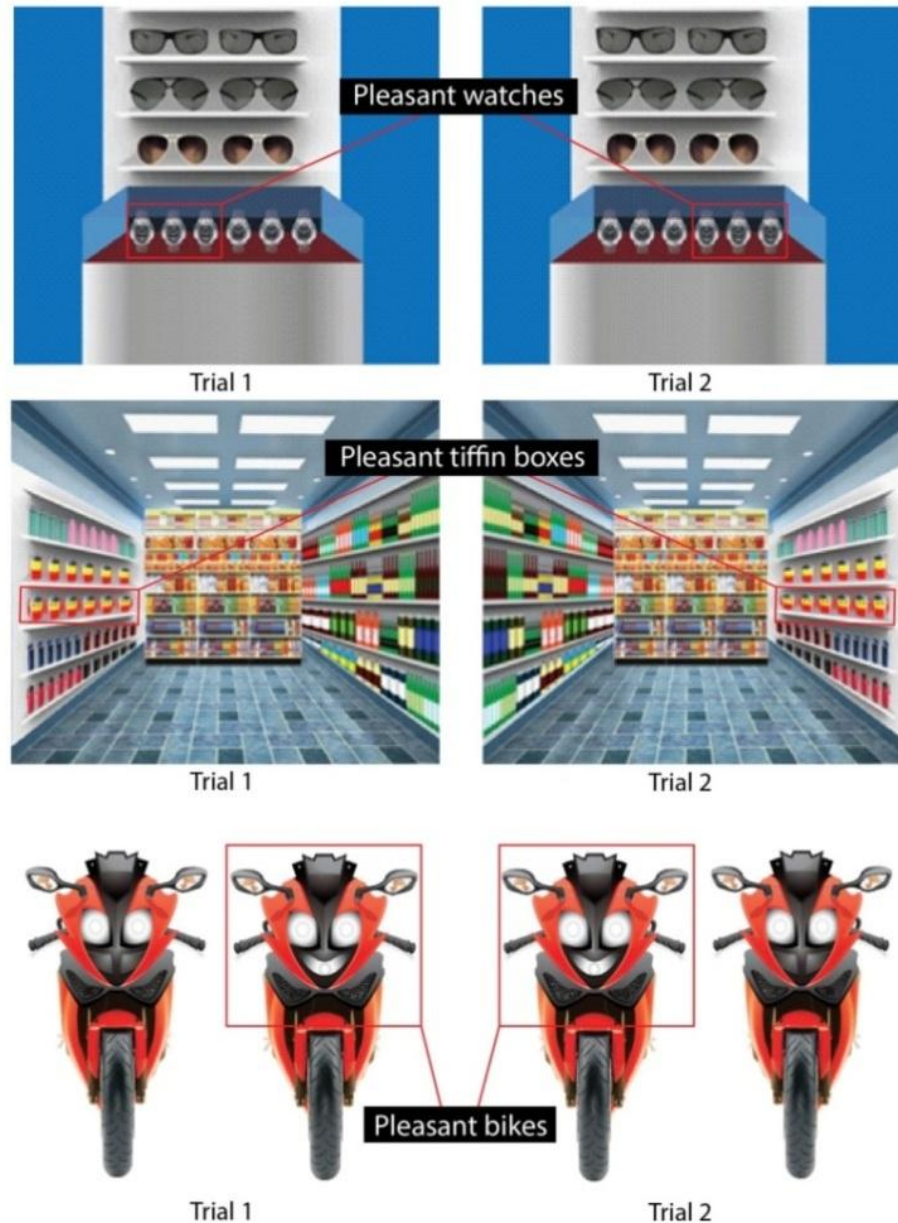


Figure 5.11 Stimuli for eye-tracking study.

## 5.2. Method

### 5.2.1. Stimuli preparation

To study the effect of valance of product face (pleasant vs. neutral) on visual attention, products (tiffin boxes, watches and bikes) with both types of valances

were placed in virtual shopping mall environment like **Figure 5.11**. Products such as tiffin boxes, watches are usually displayed in similar fashion in shopping mall and people are trying to choose products in this environment. However, people might take different purchase decision in different shopping mall environment (Baker et al., 2002; Turley and Milliman, 2000). Even, visual attention is influenced by shopping mall environment (Clement, 2007; Wedel and Pieters, 2008; Tonkin, Ouzts, and Duchowski, 2011). Therefore, it was decided to keep same shopping mall environment for products with different levels of anthropomorphism to get the proper effect of anthropomorphic product appearance on visual attention/ attractiveness. This was the reason for presentation of these anthropomorphic products in same shopping mall environment. A total of 12 tiffin boxes (six pleasant and six neutral) were presented in shelves of a shopping mall environment, total 6 watches (three pleasant and three neutral) were presented in a showcase of a shopping mall environment and two bikes were presented together in a single slide. Products (tiffin boxes, watches and bikes) were presented two times with different placements as presented in **Figure 5.11**.

### 5.2.2. Apparatus

Eye movements were recorded against the stimuli using SMI-iView-X- HED eye-tracking system. The eye movement recorder was monocular (right eye active) and its sampling rate was 50 Hz. This SMI-eye-tracking system had two hardware parts: a cap bearing two cameras (for both front view and eye movement capture) and an 'IR-sensor'; and, a laptop workstation for storing and analyzing the video data.

Eye-tracking system was first calibrated before the actual recording for the stimuli. Five points were used in calibration mode as the SMI eye-tracking system requires a five point calibration. The experimenter first asked the participant to maintain an upright seated posture at a comfortable viewing distance of 67.0 cm (i.e. within range 60 to 100 cm) from a LCD computer monitor (Marmaras, Nathanael, & Zarboutis, 2008; Sommerich, 2005) placed with in a comfortable

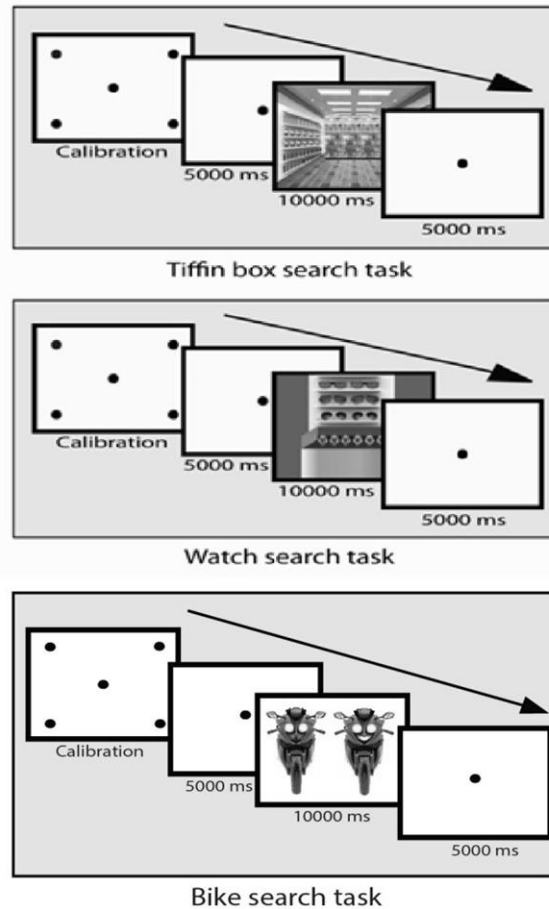
gaze angle of 10 to 17.5 degrees to the center of the monitor, relative to horizontal (Psihogios et al., 2001; Sommerich, 2005) and the five point calibration process was started accordingly. During the calibration process the participants were instructed to hold their head steady on a chin rest while seated in an upright posture and to concentrate with their eyes at a particular point marked previously.

Eye movements were recorded using 'iView-X-50' software. After recording and saving the video data of each participant, area of interest (AOI) study was carried out using 'Be-gaze 0.3' software. During AOI analysis in this software platform, two areas of interest were fixed on headlights of 'Bike-1' and 'Bike-2'. The fixation duration/ time and fixation counts per AOI were computed and compared between bike headlights.

All stimuli for the present study were presented on a computer monitor (FLATRON-L1752S; screen size: 17 inches diagonally; resolution: 1280×1024 px; Microsoft Windows TM seven, 32 bit operating system).

### **5.2.3. Participants, Measures and Procedure**

A Total of 42 participants (47.62% females and 52.38% males) participated in the study of watches. Their age ranged from 19-28 years. Average age of the participants was  $23.74 \pm 2.67$  years. On the other side, a total of 30 participants (40.0 % females and 60.0 % males) participated in the study of tiffin boxes. Their age ranged from 19-28 years. Average age of the participants for tiffin box evaluation was  $24.46 \pm 1.78$  years. A total of 47 bike riders ( $M_{age} = 22.34$  years,  $SD = 3.84$  years; Age range = 18-39 years; Male: 80.85, Female: 19.15) participated in bike appearance study. All participants were assigned randomly for this study (Howell, 2012).



**Figure 5.12 Stimuli arrangement for eye-tracking study.**

Static images of the above mentioned stimuli were presented on a computer screen independently to all the participants in the laboratory; and, three eye-tracking variables were measured viz. fixation time, first fixation duration and fixation count which are positively related with visual attention. Stimulus presentation time and sequence was presented in the **Figure 5.12**.

### 5.3. Results

As trials were taken twice from the same participants by changing two different placement of stimuli (left vs. right) and pleasantness had two levels (neutral vs. pleasant),  $2 \times 2$  repeated measure ANOVA was conducted considering fixation count/ fixation time as a dependent variable; and, AOI type (e.g. 'watch-1' vs. 'watch-2', headlights of 'Bike 1' vs. 'Bike-2' etc.) and number of trials as independent variables.

### 5.3.1. Changes in fixation time

#### 5.3.1.1. Tiffin box

There was no significant within subject variation observed in fixation time due to stimulus placements (left vs. right) [ $F(1, 58) = 1.237$ ;  $p > 0.05$ ;  $\eta_p^2 = 0.021$ ; observed power = 0.194]. Similarly, no significant variation was found in fixation time due to interactive effect of stimulus placements (left vs. right) and level of pleasantness (neutral vs. pleasant) in tiffin boxes [ $F(1, 58) = 0.685$ ;  $p > 0.05$ ;  $\eta_p^2 = 0.012$ ; observed power = 0.129]. There are significant variations in fixation time with different levels of anthropomorphism [ $F(1, 58) = 18.918$ ,  $p < 0.001$ ,  $\eta_p^2 = 0.246$ , Observed Power = 0.990]. Mean value of fixation time was higher on AOI for tiffin boxes having pleasant anthropomorphic look than the AOI for tiffin boxes with neutral anthropomorphic appearance (See **Figure 5.13**).

#### 5.3.1.2. Watch

There was no significant within subject variation observed in fixation time due to stimulus placements (left vs. right) [ $F(1, 82) = 0.232$ ;  $p > 0.05$ ;  $\eta_p^2 = 0.003$ ; observed power = 0.076]. On contrary, significant variation was found in fixation time due to interactive effect of stimulus placements (left vs. right) and level of pleasantness (neutral vs. pleasant) in tiffin boxes [ $F(1, 82) = 7.005$ ;  $p < 0.01$ ;  $\eta_p^2 = 0.079$ ; observed power = 0.744]. There are significant variations in fixation time with different levels of anthropomorphism [ $F(1, 82) = 64.897$ ,  $p < 0.001$ ,  $\eta_p^2 = 0.442$ , Observed Power = 1.000]. Mean value of fixation time was higher in case of watch with higher level of anthropomorphism/pleasantness than the watch with lower level of anthropomorphism/pleasantness (See **Figure 5.13**).

#### 5.3.1.3. Bike

There was a significant variation in mean values of fixation time per AOI observed due to interactive effect of levels of pleasantness and stimulus placements (AOI types  $\times$  trials) [ $F(1, 92) = 7.997$ ;  $p < .006$ ;  $\eta_p^2 = 0.08$ ; observed power = 0.799]. Although no within subject variation was observed due to trials

[ $F(1, 92) = 0.351$ ;  $p > 0.05$ ;  $\eta_p^2 = 0.004$ ; observed power = 0.090]. On the other side, there was significant variation in mean values of fixation time per AOI was observed due to bike headlights (AOI types) [ $F(1, 92) = 4.621$ ;  $p < 0.05$ ;  $\eta_p^2 = 0.048$ ; observed power = 0.566]. Mean value of fixation time per AOI was higher in case of headlight of 'Bike-2' than the headlight of 'Bike-1'. Difference of mean value of fixation time (per AOI) was higher in 'Trial 2' (placement 2) than the 'Trial 1' (placement 1) (See **Figure 5.13**).

### 5.3.2. Changes in fixation count

#### 5.3.2.1. Tiffin box

There was significant within subject variation observed in fixation count due to stimulus placements (left vs. right) [ $F(1, 58) = 12.657$ ;  $p < 0.001$ ;  $\eta_p^2 = 0.179$ ; observed power = 0.938]. On contrary, no significant variation was found in the fixation count due to interactive effect of stimulus placements (left vs. right) and level of pleasantness (neutral vs. pleasant) in tiffin boxes [ $F(1, 58) = 0.971$ ;  $p > 0.05$ ;  $\eta_p^2 = 0.016$ ; observed power = 0.163]. There are significant variations in the first fixation duration with different levels of anthropomorphism [ $F(1, 58) = 6.936$ ,  $p < 0.01$ ,  $\eta_p^2 = 0.107$ , Observed Power = 0.736]. Mean value of first fixation duration was higher on the AOI of tiffin boxes with pleasant anthropomorphic expression than on the AOI of tiffin boxes having neutral anthropomorphic appearance (See **Figure 5.13**).

#### 5.3.2.2. Watch

There was significant within subject variation observed in fixation count due to stimulus placements (left vs. right) [ $F(1, 82) = 4.482$ ;  $p < 0.05$ ;  $\eta_p^2 = 0.052$ ; observed power = 0.553]. On contrary, no significant variation was found in fixation count due to interactive effect of stimulus placements (left vs. right) and level of pleasantness (neutral vs. pleasant) in tiffin boxes [ $F(1, 82) = 0.061$ ;  $p > 0.05$ ;  $\eta_p^2 = 0.001$ ; observed power = 0.057]. There are significant variations in first fixation count with different levels of anthropomorphism [ $F(1, 82) = 25.831$ ,  $p < 0.001$ ,  $\eta_p^2 = 0.242$ , Observed Power = 0.999]. Mean value of first fixation duration was higher in case of watch with higher level of anthropomorphism than

the watch with lower level of anthropomorphism (See **Figure 5.13**).

### 5.3.2.3. *Bike*

There was no significant within subject variation observed in case of fixation counts due to stimulus placements [ $F(1, 92) = 0.200$ ;  $p > 0.05$ ;  $\eta_p^2 = 0.002$ ; observed power = 0.073] or due to interactive effect of stimulus placements and AOI (trials  $\times$  AOI types) [ $F(1, 92) = 0.644$ ;  $p > 0.05$ ;  $\eta_p^2 = 0.005$ ; observed power = 0.107]. Mean values of fixation count per AOI was significantly higher in case of headlight of 'Bike 2' than the headlight of 'Bike-1' [ $F(1, 92) = 7.980$ ;  $p < 0.006$ ;  $\eta_p^2 = 0.080$ ; observed power = 0.798]. In case of headlight of 'Bike 2', mean value of fixation count (per AOI) in second trial was higher than the first trial; whereas, opposite tendency was observed in case of AOI placed on headlight of 'Bike 1' (See **Figure 5.13**).

### 5.3.3. *Changes in first fixation duration*

#### 5.3.3.1. *Tiffin Box*

There was no significant within subject variation observed in first fixation duration due to stimulus placements (left vs. right) [ $F(1, 58) = 2.799$ ;  $p > 0.05$ ;  $\eta_p^2 = 0.046$ ; observed power = 0.377]. Similarly, no significant variation was found in the first fixation duration due to interactive effect of stimulus placements (left vs. right) and level of pleasantness (neutral vs. pleasant) in tiffin boxes [ $F(1, 58) = 1.494$ ;  $p > 0.05$ ;  $\eta_p^2 = 0.025$ ; observed power = 0.225]. There was significant variations in first fixation duration with different levels of anthropomorphism [ $F(1, 52) = 4.320$ ,  $p < 0.05$ ,  $\eta_p^2 = 0.069$ , Observed Power = 0.534]. Mean value of first fixation duration was higher on AOI of tiffin boxes with pleasant anthropomorphic appearance than the AOI on tiffin boxes with neutral anthropomorphic appearance (See **Figure 5.13**).

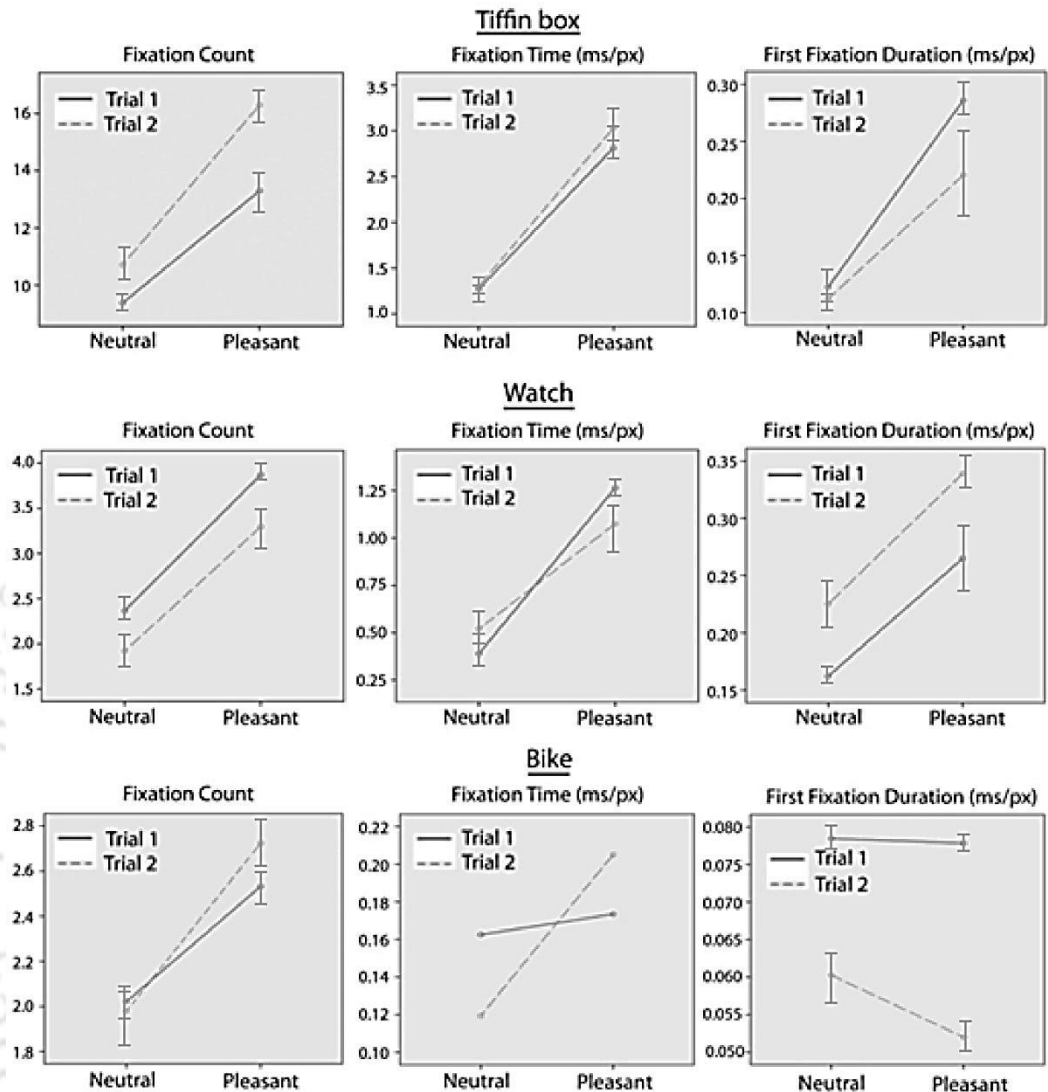


Figure 5.13 Mean differences among eye-tracking parameters representing visual attention.

### 5.3.3.2. Watch

There was no significant within subject variation observed in first fixation duration due to stimulus placements (left vs. right) [ $F(1, 82) = 2.895$ ;  $p > 0.05$ ;  $\eta_p^2 = 0.034$ ; observed power = 0.390]. Similarly, no significant variation was found in the first fixation duration due to interactive effect of stimulus placements (left vs. right) and level of pleasantness (neutral vs. pleasant) in tiffin boxes [ $F(1, 82) = 0.019$ ;  $p > 0.05$ ;  $\eta_p^2 = 0.000$ ; observed power = 0.052]. There are significant variations in the first fixation duration with different levels of anthropomorphism [ $F(1, 82) = 5.441$ ,  $p < 0.05$ ,  $\eta_p^2 = 0.062$ , Observed Power = 0.635]. Mean value

of the first fixation duration was higher in case of watch with higher level of anthropomorphism than the watch with lower level of anthropomorphism (See **Figure 5.13**).

#### 5.3.3.3. *Bike*

There was significant within subject variation observed in the first fixation duration due to stimulus placements (left vs. right) [ $F(1, 92) = 4.682$ ;  $p < 0.05$ ;  $\eta_p^2 = 0.048$ ; observed power = 0.572]. Although no significant variation was found in the first fixation duration due to the interactive effect of stimulus placements (left vs. right) and level of pleasantness (neutral vs. pleasant) in bike face [ $F(1, 92) = 0.140$ ;  $p > 0.05$ ;  $\eta_p^2 = 0.002$ ; observed power = 0.066]. Though mean value of first fixation duration was higher on neutral bike face than the pleasant bike face the mean values were not significantly varied due to level of pleasantness/ valance [ $F(1, 92) = 0.091$ ;  $p > 0.05$ ;  $\eta_p^2 = 0.001$ ; observed power = 0.060] (See **Figure 5.13**).

### 5.4. Discussion

Average fixation time/ duration per area of interest (AOI) can be defined as the mean of time spent on a particular AOI (generally fixed on object of interest). Literature suggests that fixation time is more on the object of interest (on which AOI was fixed) if the object is more attractive (Chowdhury et al., 2012; Duchowski, 2007; Lee, Tang, & Tsai, 2005; Robinson-Riegler, & Robinson-Riegler, 2008). Similarly, if fixation counts per AOI are more, if the object is more visually attractive on which AOI was fixed (Chowdhury et al., 2012; Duchowski, 2007). Fixation counts per AOI means the total frequencies of fixation on a particular AOI. In the present research, average fixation duration, fixation count and the first fixation duration significantly varies with levels of valance expressed through anthropomorphic appearance (exceptional result was only found on the first fixation duration variation in case of bike study).

It was noticed that both mean fixation counts, mean fixation time, and the first fixation duration were more on the AOI which was fixed on tiffin boxes

(tiffin box-2), and watches (watch-2) which had a pleasant appearance than the AOI which was placed on neutral tiffin boxes (tiffin box-1), and watches (watch-1) (see **Figure 5.13**). Similarly, mean fixation counts, and mean fixation time were higher on the AOI of bikes having pleasant appearance (bike-2) than the neutral bikes (bike-1) (see **Figure 5.13**). On the contrary, more first fixation duration was found on AOI of neutral bikes than the AOI of pleasant bikes. This observation indicates that our alternative assumption - 'The first fixation duration on pleasant product is always higher than the first fixation duration on neutral product' is not always correct as first fixation duration may be influenced by other factors ( for more details please refer **Table 2.4** in '**Chapter-2**'). Therefore, it can be stated that the first fixation duration on AOI may not be an appropriate marker for visual attention analysis to understand in-shop visual behaviour.

The fixation count and fixation time per AOI variation study results suggest that products with pleasant anthropomorphic appearance were more attractive. Moreover, appearances of these anthropomorphic products had more pleasurable look as pleasure related element (smiling lip like light) was used in the design. Therefore, the proposed hypothesis for the eye-tracking study (**H<sub>a4</sub>**) is proved. From the eye-movement study results, it was also proved that if pleasant anthropomorphic products will be placed in shelf or in a shop floor it will grab more attention than the products with a neutral appearance. Available literature suggests that the product will be much more visually attractive if a product appearance is pleasurable (Tavassoli, 2008). In addition, people are generally willing to spend much time to see the product if they experience the product as pleasurable (Tavassoli, 2008). Similar phenomenon was also observed in the present research. Some researchers also argued that there is more chance of product choice if a product is more visually attractive than other products (Maughan, Gutnikov, & Stevens, 2007). Therefore, there is a chance to increase the purchase intention of products which have pleasant anthropomorphic appearance. Even, results of '**Chapter-3**' and '**Chapter-4**' regarding purchase intention concluded the same about pleasant anthropomorphic product.

**Key points**

- ☞ Facial EMG and eye-tracking techniques are very sensitive neurocognitive techniques applicable for anthropomorphic product appearance design and concept validation.
- ☞ Facial EMG study may be applicable for anthropomorphic and pleasurable product design.
- ☞ Zygomaticus and corrugator activities were sensitive markers for pleasurable product design.
- ☞ Eye-tracking technique might be fruitfully applied to visual attractiveness evaluation of anthropomorphic product.
- ☞ Fixation count and average fixation time are important eye-tracking measures for visual attention analysis of products with anthropomorphic appearance.



## Chapter -6: General Discussion and Design Guideline

### Abstract

Results and observations from ‘Chapter-1 to Chapter-5’ have been described briefly in present chapter with special emphasis on key findings of the overall research work. This chapter also demonstrates a framework for anthropomorphic product appearance evaluation based on both traditional and neurocognitive techniques. According to this framework designers need to consider context of anthropomorphic product appearance design as well as cognitive human factors such as attractiveness, pleasure and apparent usability for better market acceptance. Following research findings, designers are suggested to follow eye-tracking and facial EMG techniques for better understanding phenomena of anthropomorphic product choice. Step wise design strategies provided in this chapter, would be helpful for designers to take decision for finalizing concept model towards creating anthropomorphic appearance. This chapter ends with the limitations and future scopes of the present thesis work.

**Keywords:** *Consumer model; design decision; design strategy; eye-tracking; facial EMG; pleasure*

### 1. Introduction

In the present thesis work, influence of anthropomorphic appearance on product purchase intention has been described by establishing the roles of three underlying human factors viz. visual attractiveness, perceived pleasure and apparent usability. Previous studies were unable to unveil the interactive effects of visual attractiveness, pleasure and apparent usability in the context of anthropomorphic product choice. However, few studies employed the techniques of pleasurable product design such as product personality assignment (Chelho, Versos, & Silva, 2013), evaluation of perception regarding anthropomorphism through eye-tracking (Windhager et al., 2008; Windhager et al., 2010) and facial EMG (Miesler, Leder, & Herrmann, 2011). Present thesis demonstrates the methodology to increase pleasure using attractive anthropomorphic attributes and also the strategy to improve apparent usability using anthropomorphic attributes. Now, the current chapter elaborates the key outcomes from ‘Chapter-1 to Chapter-5’ and provides an overview of this thesis work. In addition, a systematic approach to evaluate the anthropomorphic product appearance is presented herein this chapter, to increase product purchase intention and better market acceptance, have been presented in this chapter.

## 2. Description on each chapter

Each chapter of this thesis provides some key findings. These findings of one particular chapter have connections with the findings of other chapters and thus helped to continue the whole research in a systematic way. Findings of first five chapters are presented as follows:

### *2.1. Findings of 'Chapter – 1: Introduction to anthropomorphic product design'*

This chapter described literatures about anthropomorphic products. Based on these literatures and practical situations, it was supposed that consequences of anthropomorphic product appearance may be positive or negative in the context of product use and product purchase (Choi & Kim, 2009; Kiesler, 2006). It is quite natural that a product having attractive anthropomorphic appearance may contribute pleasure to consumers (Jordan, 1997; Jordan, 2000; Norman, 2004). According to “What is beautiful is good” principle (Dion et al., 1972), users/consumers would perceive an anthropomorphic product good if it is beautiful. Here, the goodness means aesthetic goodness which may be defined as attractiveness, beauty and visual appeal. Though many products available in the market have humanlike (anthropomorphic) appearance, but still might not have pleasurable look. In other case, visually attractive products are not always usable (Hassenzahl, 2004). Sometimes, it may happen that users/consumers perceive an anthropomorphic product usable before purchase but the same product may not actually be useful because of low level of actual usefulness which can only be perceived after product use (generally after purchase the product). In this context, if users may not be satisfied after product use. As a consequence users may be undergone through external search for other product options which is not expected by marketers (Engel, Blackwell, & Miniard, 1995). Therefore, usability perception before anthropomorphic product use should match with the post-purchase usability perception. In addition to these facts, design strategy for anthropomorphic appearance design has been less described and fewer empirical evidences are available on anthropomorphic product design. Hence, it has been concluded in ‘Chapter-1’ that visual attractiveness, apparent usability and thus

pleasure perception may be affected by anthropomorphic product appearance and it may have influence on the product purchase intention. It has been found to be feasible to study the effect of anthropomorphic product appearance on cognitive and affective consequences; and, their subsequent effects on product purchase intention.

## ***2.2. Findings of 'Chapter – 2: Cognitive and emotional consequences of anthropomorphic product appearance'***

In 'Chapter-2' a detailed literature review was conducted on cognitive and affective consequences of product appearance considering cognitive human factors viz. visual attractiveness, apparent usability and perceived pleasure. As anthropomorphic product appearance design is related with semantic and emotional product design, the first portion of this chapter covered the theories of emotion and principles of emotional product design. It has been reported in the literature that emotion may be generated due to cognitive or non-cognitive causes. Therefore, cognitive and affective systems are cross-talking with each other (Helander & Khalid, 2012). Emotion can be explained through subjective feelings as well as by bodily changes (Morgan et al., 2008). People may perceive six different emotions through facial expressions (Ekman & Friesen, 1971). According to 'Circumplex Model', emotion is a state which can be explained with two dimensions. These are 1) level of arousal (comparatively low or high) and 2) valance (pleasure vs. displeasure) (Kuppens, et al., 2013; Russell, 2003; Yik, M. et al., 2011). Pleasure may cause positive affect in product choice or vice-versa (Helander & Khalid, 2012). If it is possible to get positive affect through anthropomorphic appearance, there is a chance to improve product acceptance in the market. In addition, pleasure or displeasure can be measured not only through standard questionnaire but also using facial EMG (Laparra-Herna'ndez et al., 2009; Miesler, Leder, & Herrmann, 2011; van-den-Broek & Westerink, 2009). Therefore, an approach can be taken to evaluate an emotionally valanced anthropomorphic product through facial EMG to achieve better market acceptance as facial EMG is a technique with high precision.

A product is visually attractive when it is aesthetically good. Literature indicates that visual aesthetics is an important criterion for enriching the product value in the market through product's appearance (Bloch, 1995; Bloch, Brunel, & Arnold, 2003; Creusen, & Schoormans, 2005). In addition, an object grabs more attention which is visually more attractive (Maughan, Gutnikov, & Stevens, 2007). Therefore, if a product is attractive in appearance then there is an ample of chance to grab visual attention and the visual attention in turn has an effect on product choice (Tonkin, Ouzts, & Duchowski, 2011). Literature survey reveals that visual attractiveness and visual attention can be measured through standard questionnaire and eye-tracking technique respectively (Chen & Pu, 2014; Chowdhury et. al., 2012; Chowdhury et. al., 2013). Hence, in this chapter, similar approaches have been taken for evaluation of visual attractiveness of anthropomorphic products.

According to Creusen & Schoormans (2005) ergonomics value of a product may be conveyed through product appearance and ergonomics value has an effect on product choice. Product appearance related meaning such as apparent usability (representing ergonomics value) is important because consumers are often not able to use and interact with products before purchase (Thompson et al., 2005). Moreover, Pelzer et al. (2007) also emphasized the importance of apparent usability and its significant influence on consumer preferences in comparison to inherent usability aspects. Thus, it is expected that anthropomorphic product attributes in product appearance may also affect the apparent usability perception which in turn may have influence on product choice.

Creusen & Schoormans (2005) reported that aesthetics value, emotional value and ergonomics value could be expressed in terms of visual semantic in product appearance. Even, in Sheth-Newman-Gross model (1991), it was highlighted that both emotional value and functional value might impact on the product choice decision (Mazumdar, 2011; Sheth, Newman, & Gross, 1991). According to Nielsen (1993), product functionality is related to product usability. Therefore, it was envisaged that visual attractiveness, apparent usability and pleasure may have role in an anthropomorphic product purchase intention.

From the preliminary study results it was revealed that the product which had a positive product personality also had a higher level of perceived usability through human-product-physical interaction (both visual and tactile senses were involved in such interaction). Hence, it can be argued that pleasure is positively related with perceived usability in human-product-physical interaction as positive product personality is a marker of pleasurable product design (Jordan, 2000). Preliminary study also highlighted that product personality and usability were co-varied simultaneously with product attributes (functional and visual). Therefore, product personality would vary if product usability related attributes are varied.

Product appearance is closely associated with both pre-purchase and post-purchase decision making. In most of the product buying contexts, human-product-physical interaction is possible only after product purchase due to less access to well packaged product. Again, in case of online product purchase, products are not accessible physically to consumers/ users. Thus, there is a lack of absence of human-product-physical interaction. Hence, designers should be more careful about product appearance design. They should concentrate more on visually perceived pleasure and apparent usability which might be important in pre-purchase product decision/ product purchase intention.

Based on the literature review and preliminary study results, four hypotheses have been stated at the end of the 'Chapter-2', and these hypotheses have been proved in subsequent chapters.

### ***2.3. Findings of 'Chapter – 3: Anthropomorphic product appearance enhances product acceptance in the market: Influence of visual attractiveness and pleasure'***

In Chapter-3, effects of anthropomorphic attributes (in product appearance) on visual attractiveness and visually perceived pleasure have been investigated along with unfolding of their influence on purchase intention. Key findings of this chapter include the followings: (1) level of anthropomorphism depends on a number of anthropomorphic attributes used in product form; (2) incorporation of anthropomorphic features in product appearance is very useful to enhance the visual attractiveness of the product; (3) anthropomorphic attributes which are

associated with positive emotions (e.g. smile like facial expressions) not only helps to increase the visual attractiveness but also visually perceived pleasure and these two factors in turn influence purchase intention and (4) influence of visual attractiveness on anthropomorphic product purchase intention is mediated via visually perceived pleasure. All these findings in this chapter proved the ‘Hypothesis-1( $H_{a1}$ )’ i.e. “Visual attractiveness and perceived pleasure (due to anthropomorphic product appearance) significantly affects the anthropomorphic product purchase intention”.

#### ***2.4. Findings of ‘Chapter – 4: Anthropomorphic appearance to enhance product purchase intention: Role of apparent usability and pleasure’***

Findings of ‘Chapter 4’ were interesting. Following findings have been stated in this chapter: Firstly, strategy of incorporation of anthropomorphic attributes in product appearance significantly affects perception of apparent usability and pleasure. Secondly, users found a product more pleasurable in which apparent usability was not negatively affected by anthropomorphic attributes. In other words, strategy of incorporation of an anthropomorphic attributes moderated the perception of apparent usability and pleasure among users because of anthropomorphic attribute which might interfere with product use. Hence, there is a chance of low market acceptance of anthropomorphic product, if humanlike attributes used in product affects apparent usability and visually perceived pleasure. Third observation was that the anthropomorphic attribute (e.g. smiling lip) which was associated with positive affect/ emotion not only helped to increase visually perceived pleasure but also the apparent usability. These two factors in turn influenced the purchase intention of anthropomorphic product. According to Jordan (2000), pleasure can be perceived through visual attributes of the product. Norman (2004) stated that positive emotion can be evoked through smiling face like attribute in the product. Results of this chapter empirically prove these facts. Fourthly, it was observed that influence of pleasure on an anthropomorphic product purchase intention is mediated via apparent usability. Jordan (2000) stated a model of hierarchy of user needs. This model demonstrated the fact that a user gives priority to usability before the pleasure. Fourth result

proves this fact empirically, as the effect of pleasure on anthropomorphic product purchase intention is mediated via apparent usability. Therefore, anthropomorphic product designers need to concentrate more on apparent usability of the product than the pleasure for better product outcome when both of these two factors are varying simultaneously with anthropomorphic product attributes. Thus results of this chapter established the 'Hypothesis-2 ( $H_{a2}$ )' of this thesis that "Apparent usability and visually perceived pleasantness (due to anthropomorphic product appearance) significantly affects the anthropomorphic purchase intention".

### ***2.5. Findings of 'Chapter – 5: Neurocognitive approach to anthropomorphic product appearance evaluation'***

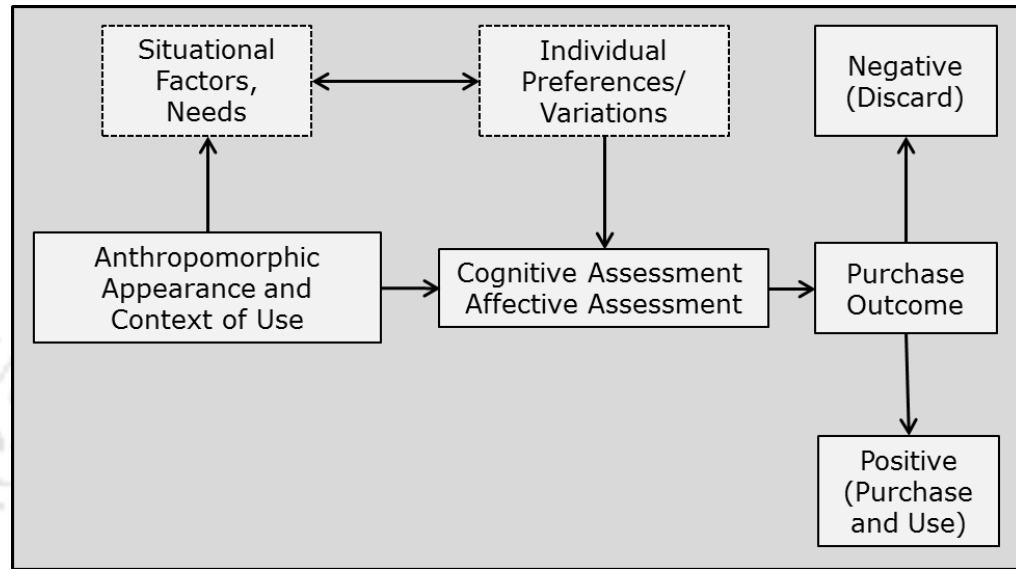
In 'Chapter-3', mediation model of pleasure was established in which pleasure was mediating the influence of visual attractiveness (due to anthropomorphic appearance) on anthropomorphic product purchase intention. Accordingly, pleasure is more important factor than visual attractiveness to improve anthropomorphic product purchase intention. However, levels of visual attractiveness (anthropomorphic appearance), levels of visually perceived pleasure and anthropomorphic product purchase intention were positively related with each other. Unlike the mediation model of pleasure, mediation model of apparent usability proves that apparent usability is mediating the influence of visually perceived pleasure on anthropomorphic product purchase intention. Hence, apparent usability is a more valuable predictor than the visually perceived pleasure for anthropomorphic product choice; though, apparent usability, visually perceived pleasure and anthropomorphic product purchase intention are closely related. Between the mediation model of pleasure and mediation model of apparent usability, pleasure is a common factor for the improvement of anthropomorphic product purchase intention.

To validate the questionnaire based results about the perceived pleasure, facial EMG study was conducted using three product types (tiffin boxes from 'Chapter-3', watches from 'Chapter - 4' and bikes as a newly introduced product type). Facial EMG studies on these products prove that the facial muscles (viz.

corrugator supercilii and zygomaticus major) activity significantly varies with levels of pleasantness expressed through anthropomorphic product appearance. Facial EMG study revealed that zygomaticus muscle activity was significantly higher in case of pleasant anthropomorphic products than the anthropomorphic product with neutral valance. Completely opposite phenomenon was observed in case of corrugator muscle activity. Activities of zygomaticus major and corrugator supercilii in case of product faces were similar to activities of these muscles as in the case of human faces. Similar observations were also reported by other researchers in facial mimicry task with human faces (Deschamps et al., 2012; Korb, 2010; Laparra-Hernández et al., 2009; Sato, Fujimura and Suzuki, 2008; van den Broek, & Westerink, 2009). Thus, ‘Hypothesis-3 (**Ha3**)’ of present thesis work is proved.

According to Tavassoli (2008), selective attention may be diverted towards emotionally valanced stimuli. Therefore, if a product is positively valanced (pleasant in appearance) then there is chance to grab more attention to it than a product with either neutral or unpleasant appearance. Similarly, anthropomorphic product having a pleasant appearance may grab more attention than the neutral anthropomorphic product in an in-shop environment. To prove this fact an eye-tracking study was conducted with proposed ‘Hypothesis-4 (**Ha4**)’ i.e. ‘anthropomorphic appearance of the product significantly influences visual attention of users; and, thus, anthropomorphic product purchase intention during in shop/ on shelf visual search behavior’. It was noticed that both mean fixation counts and mean fixation time were significantly higher at AOIs which were placed on pleasant anthropomorphic products in comparison to the neutral anthropomorphic products. Literature suggests that if fixation time is more on the object of interest (on which AOI was fixed) then the object is more attentive (Chowdhury et al., 2012; Duchowski, 2007; Lee, Tang, & Tsai, 2005; Robinson-Riegler, & Robinson-Riegler, 2008). Similarly, if fixation counts per AOI are more, the object is more visually attractive on which AOI was fixed (Chowdhury et al., 2012; Duchowski, 2007). These study results again support the fact that it is possible to increase the visual attractiveness and the visually perceived pleasure

using anthropomorphic appearance. In addition, it can also be concluded that facial EMG study and eye-tracking technique are fruitful for anthropomorphic product appearance evaluation as these techniques were sensitive enough in response to different anthropomorphic product appearance.



**Figure 6.1** Consumer process for anthropomorphic product purchase.

## 2.6. Consumer Process

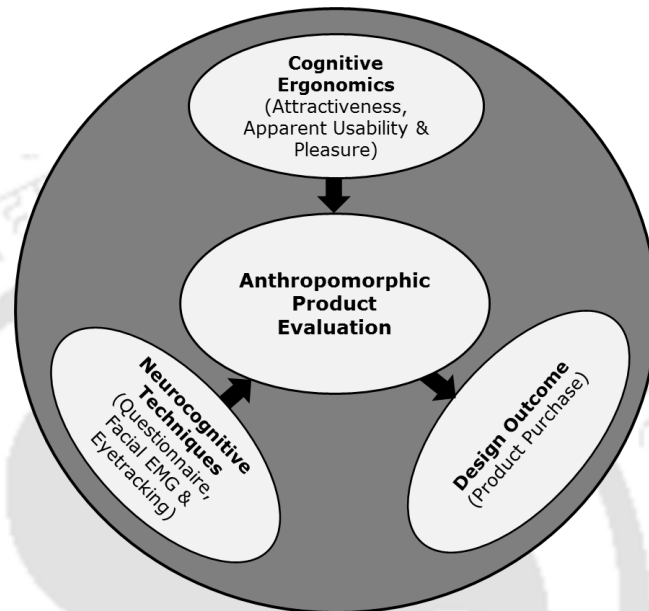
Based on the observations of this thesis work a framework of consumers' process for anthropomorphic product choice decision was proposed. Results of the present thesis work suggests that anthropomorphic attributes may influence product purchase intention; and, attractiveness, apparent usability and pleasure are underlying factors for anthropomorphic product purchase intention. Therefore, it is clear that users/ consumers assessed anthropomorphic products in two ways, viz. 1) cognitive assessment, and, 2) affective assessment. During cognitive assessment consumers/ users are assessing functional values, aesthetics values and ergonomic/ usability related values of the product in relation to product use context. On the other side, users/consumers are assessing emotional/affective values of the product during affective assessment. Furthermore, both cognitive and affective assessments help to take purchase decision of an anthropomorphic product (**Figure 6.1**). Results of the present study explain this fact. If an

anthropomorphic product is able to convey attractiveness, pleasure and apparent usability through product appearance then there is a chance of positive purchase outcome (purchase and use of product). Negative purchase outcome of anthropomorphic product becomes true if the product does not convey attractiveness, pleasure and apparent usability through product appearance. Hence, designers may manipulate anthropomorphic appearance using human like attributes in order to increase positive purchase outcome. In addition, designers need to consider about attractiveness, pleasure, and apparent usability while incorporating humanlike attributes in product appearance. However, present thesis work does not presented any significant effect of other influential factors such as situational factors, need in market and individual preferences/ individual variations (e.g. effect of CVPA) which may influence the anthropomorphic product purchase outcome.

### **3. Design guidelines for anthropomorphic product appearance design**

A frame work for anthropomorphic product appearance evaluation had been developed based on all the study results. Study results showed that attractiveness, apparent usability, and pleasure perception depends on anthropomorphic attributes embedded in product appearance. Hence, designers need to consider these cognitive human factors when deigning the anthropomorphic product appearance (**Figure 6.2**). According to this framework, user-centered designers also need to evaluate the users' perception about these factors. Attractiveness, apparent usability and pleasure embedded in anthropomorphic appearance could be evaluated through questionnaire. Further evaluation of anthropomorphic product appearance will be fruitful using neurocognitive techniques such as facial EMG (especially for pleasure and apparent usability evaluation) and eye-tracking (especially for visual attention/ attractiveness evaluation). It is possible to predict the market outcome of anthropomorphic products more accurately from the results of eye-tracking (Duchowski, 2007; Wedel, and Pieters, 2008; Tonkin, Ouzts, and Duchowski, 2011) and facial EMG studies (Laparra-Hernández et al.,

2009; Miesler, Leder, & Herrmann, 2011; van den Broek and Westerkink; 2009) as these two techniques might be sensitive enough for the prediction of product choice. Thus, the proposed framework (**Figure 6.2**) will be helpful for designers to take anthropomorphic product appearance decision for better market outcome.



**Figure 6.2 Framework for better anthropomorphic product design outcome considering factors related to cognitive ergonomics.**

A step wise strategy for anthropomorphic product appearance design evaluation is described in **Table 6.1**. These strategies will be helpful for designers to design anthropomorphic shapes and to decide and finalise design concept for further design process such as product detailing, manufacturing etc.

#### **4. Relevance of the present research work**

Present research findings have a very practical relevance to industrial product design and ergonomics. The knowledge gained from current research may be used by product innovation management experts, cognitive scientists, ergonomists and industrial designers to increase visual attractiveness, apparent usability and visually perceived pleasure of a product using anthropomorphic attributes in product form wherever it may be applicable. Design researcher and academicians may follow similar approaches in product appearance design and its evaluation. In

addition, theories built in this thesis work could be beneficial to guide design students about anthropomorphic form/ appearance design. The neurocognitive methods/ protocols used for evaluation of product appearance may be beneficial for understanding neuropsychophysiological basis of product choice and prediction of product purchase outcome. Thus, these protocols will be helpful to develop neuromarketing strategies.

**Table 6.1 Strategies for anthropomorphic product appearance design evaluation.**

<i>Stages</i>	<i>Strategies</i>
1. Appearance design	<ul style="list-style-type: none"> <li>• Conceptualize and design product appearances using human like shape (s) according to design context.</li> </ul>
2. Anthropomorphism check	<ul style="list-style-type: none"> <li>• Check levels of anthropomorphism using standard questionnaire to make sure that users are able to perceive humanness through product appearance.</li> </ul>
3. Attention	<ul style="list-style-type: none"> <li>• Make product appearance aesthetically good to make it attractive and to gain consumers' / users' attention towards the product.</li> <li>• Perceived attractiveness can be measured through standard questionnaire.</li> </ul>
4. Apparent usability	<ul style="list-style-type: none"> <li>• Measure apparent usability using standard questionnaire to make sure that anthropomorphic attributes are not negatively impacting the apparent usability perception.</li> </ul>
5. Pleasure	<ul style="list-style-type: none"> <li>• Measure pleasure using standard questionnaire as pleasure affects product preference. Make sure that anthropomorphic appearance is pleasant.</li> </ul>
6. Correlate cognitive and affective variables	<ul style="list-style-type: none"> <li>• Correlate perceived attractiveness, apparent usability and pleasure with anthropomorphic attributes used in the product.</li> </ul>
7. Apply facial EMG	<ul style="list-style-type: none"> <li>• Evaluate anthropomorphic product appearance by measuring facial muscle activities for users' / consumers' affect/ valance (pleasure vs. displeasure).</li> <li>• Correlate findings of facial EMG study with the findings of questionnaire based study done before to evaluate apparent usability and pleasure.</li> </ul>
8. Apply eye-tracking	<ul style="list-style-type: none"> <li>• Place anthropomorphic products with varying attractiveness and pleasure in virtual shop environment and conduct eyetracking study.</li> <li>• Correlate results of eye-movement study with the findings of questionnaire based earlier study where visual attractiveness and pleasure have been evaluated.</li> </ul>
9. Product decision	<ul style="list-style-type: none"> <li>• Choose a concept of anthropomorphic appearance which expresses higher level of pleasantness and attractiveness.</li> </ul>

**Note:** All these strategies for anthropomorphic product evaluation should be carried out with targeted consumer/ buyer group.

## 5. Limitations of present research and future scopes

In this thesis work, only the effects of anthropomorphic shapes related variations were observed but the study of the effect of colour on anthropomorphism perception and its effect on cognitive human factors (attractiveness, pleasure and apparent usability) are not covered in this study. Hence, effects of colours on anthropomorphism perception and its subsequent effects on cognitive human factors may be evaluated in future. There are products, available in the market, which are following concepts similar to anthropomorphism but are not exactly in anthropomorphic in nature. For example, concept of animacy is quite similar to anthropomorphism. Animacy could be defined as attribution of non-human animal like behaviour or appearance. As humans and many non-human animals having similar physical attributes and appearance, therefore, there may be chance of acceptance of animal like attributes in product appearance by users/ consumers. Further, concepts of many bikes and cars are based on animal attributes. Hence, one study can be done to observe the differences in product choice due to change in product shapes (Animacy vs. anthropomorphism).

All studies presented here does not considered the effects of users' personal characteristics such as gender, age group variations, users' innovativeness, educational background, users' personalities, users' cultural backgrounds etc. Other influential factors such as individual preferences of anthropomorphic product appearance may also influence the product purchase intention. For example, black magic practitioner may like anthropomorphic products with evil and displeasing appearance. Another example is bike riders/ rash riders who especially passionate for bikes (Harley Davidson Skull) having unpleasant and evil anthropomorphic appearance.

Extensions of this research may be in the broad spectrum of interaction design. The concepts of anthropomorphism can be used in future to develop interactive sensor based tangible products/ package design. It may be possible to develop anthropomorphic products having human like intelligence due to advancement of knowledge in the area of artificial intelligence (evolved from

electronics and computer science). For instance, a sensor based food package can be designed in such a way that chromatic change of food package may occur if food is spoiled. Therefore, opportunities for research on anthropomorphism are many more.

Though present research works showed the way to design of an attractive, pleasant and apparently usable anthropomorphic product appearance, still there are enough scopes to apply anthropomorphic appearance in different other product contexts. It is expected that framework and design strategies mentioned here will help designers and design researchers to evaluate cognitive and affective aspects of anthropomorphic product appearance; and, these would also help to finalize the product appearance for better market acceptance.

**Key points**

- ☞ Questionnaire technique along with eye movement study and facial EMG study will be fruitful for anthropomorphic product evaluation in better way.
- ☞ Product designers should follow design strategies (considered attractiveness, apparent usability and pleasure as cognitive human factors) noted in this chapter for better market acceptance.

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# Brief Curriculum Vitae

Anirban Chowdhury; M.Sc. (Cal)

*Assistant Professor, User Experience Design,  
MAEER's MIT- Institute of Design, Rajbaug,  
Next to Hadapsar, Loni Kalbhor, Pune-412201, India.*

E-mail: *chowdhuryanirban14@gmail.com* OR *anirbanchowdhury@mitid.edu.in*

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## Teaching and Research Interest

*Ergonomics in Product Design; Cognitive Ergonomics, Neuromarketing and Neuroeconomics;  
Applied Ergonomics; Usability Engineering and User Experience Design; Interaction Design;  
Design Research; Pleasure Engineering/ Kansei Engineering; Visual Interaction Design.*

## Educational Qualifications

- **Ph.D** : **Pursuing in Design** from Department of design, Indian Institute of Technology (IIT) Guwahati.
- **M. Sc.** : **First Class** in Human Physiology from University College of Science and Technology, University of Calcutta (2010).
- **B. Sc.** : **Hon's** in Physiology, from Serampore College, University of Calcutta (2008).

## Awards and Fellowships

- ❖ Selected for **Young Scientist Award** (Prof. Sacchidananda Banerjee Memorial Research Prize, 2014), generally given for significant research contribution in the field of **Ergonomics** by **The Physiological Society of India**.
- ❖ **DBT Senior Research Fellowship**- June 2013 to June 2014.
- ❖ **DBT Junior Research Fellowship**- June 2011 to June 2013.
- ❖ **DST (WB) Junior Research Fellowship**- Oct 2010 - June 2011.

## Honors and Memberships

- ❖ Life member of "**Indian Science Congress Association**" (Life membership no.: **L-18128**).
- ❖ Life member of "**Indian Society of Ergonomics**" (Life membership no.: **L-376**).

- ❖ Life member of “**Physiological Society of India**” (Life membership no.: **L-574**).
- ❖ Life member of “**International Association of Engineers**” (Life membership no.: **L-145739**).

#### **Other Scholastic and Professional Services**

- ❖ Invited as Reviewer for the ‘Special Issue on Interaction and Experience Design’, *Journal of Engineering Design*, **Taylor and Francis Group**.

#### **Personal Information**

- **Date of Birth** : 08/07/1987
- **Age** : 28 years
- **Gender** : Male
- **Category** : General
- **Nationality** : Indian

#### **Declaration:**

Information given above is correct and true to the best of my knowledge and belief.

#### **Signature:**

(ANIRBAN CHOWDHURY)

**Date:**

**Place:** Guwahati

## List of Thesis Related Publications

### *Journal Publications*

1. **Chowdhury, A.**, Karmakar, S., Reddy, S.M., Ghosh, S., and Chakrabarti, D., **2014**. Usability is more valuable predictor than product personality for product choice in human-product physical interaction. *International journal of Industrial Ergonomics*, 44 (5), 697-705. [ISSN: **0169-8141**]
2. **Chowdhury, A.**, Karmakar, S., Chakrabarti, D. and Ghosh, S., **2014**. Purchase intention of anthropomorphic chair is influenced by visual attractiveness and pleasure. *International Review of Applied Engineering Research (Special Issue)*, 4(2), 133-140. [ISSN **2248-9967**]
3. **Chowdhury, A.**, Karmakar, S., Chakrabarti, D. and Ghosh, S., **2014**. Anthropomorphic product appearance enhances product acceptance in the market: Influence of visual attractiveness and pleasure. *International Journal of Design Creativity and Innovation* [ISSN: **2165-0357**] (Under Review)
4. **Chowdhury, A.**, Singh, D., Chakrabarti, D., Karmakar, S., **2014**. Anthropomorphic appearance to enhance product purchase intention: Role of apparent usability and pleasure. *Applied Ergonomics* [ISSN: **0003-6870**] (Under Review)

### *Book Chapters*

5. **Chowdhury, A.**, Reddy, S.M., Chakrabarti, D., and Karmakar, S., **2015**. Cognitive theories of emotion and its applications in pleasurable product design. *In Smart Innovation, Systems and Technologies, ICoRD'15- Research into Design Across Boundaries Volume 1(A. Chakrabarti Ed.)*, pp. 329-340. [ISBN **978-81-322-2231-6 (Print)**; ISBN **978-81-322-2232-3 (eBook)**; DOI: **10.1109/ICHCI-IEEE.2013.6887784**]
6. **Chowdhury, A.**, Sahoo, S. P., Chakrabarty, D., Karmakar, S., **2014**. Designing of Anthropomorphic Bike Headlight Using Cognitive Ergonomics Approach. *In Use Centered Design and Occupational Wellbeing* (D. Chakrabarti, S. Karmakar, S. Pal and A. Chatterjee Eds.), pp. 228-233. McGraw Hill Education Pvt. Ltd.: New Delhi. [ISBN (13): **978-93-392-1970-3**, ISBN (10): **93-392-1970-8**]
7. **Chowdhury, A.**, Reddy, S.M., Karmakar, S., Ghosh, S. and Chakrabarti, D., **2013**. Is perception of product personality related with product usability? A cognitive ergonomics perspective. *In Ergonomics for Enhanced Productivity* (P. Parimalam, M. R. Premalatha and P. Banumathi Eds.), pp. 177-182. Excel India Publishers: India. [ISBN **978-93-82880-43-1**]
8. Reddy, S.M., **Chowdhury, A.**, Chakrabarti, D., and Karmakar, S., **2015**. Role of colour and form in product choice and variation of preferences across product categories: A Review. In

Smart Innovation, Systems and Technologies, ICoRD'15- Research into Design Across Boundaries Volume 1(A. Chakrabarti Ed.), pp. 631-640. [ISBN 978-81-322-2228-6 (Print); ISBN 978-81-322-2229-3 (eBook); DOI: 10.1007/978-81-322-2229-3]

9. Reddy, S.M., **Chowdhury, A.**, Chakrabarti, D. and Karmakar, S., **2012**. Need of visual behavioural study of Indian consumers. In Emerging Issues in Management and Behavioral Sciences (A. Kumar, Arshdeep, K.Singh Eds.), pp. 285-293. Bharti Publications: India. [ISBN 978-93-81212-17-2]

#### *Conferences proceedings*

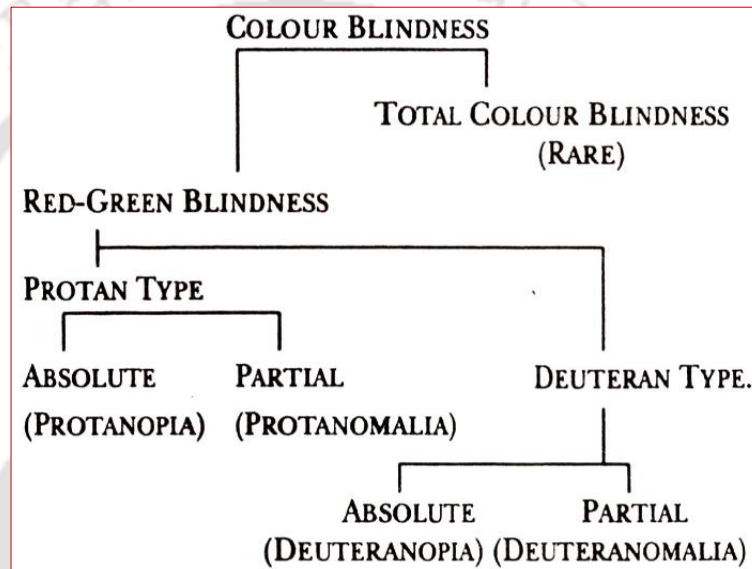
10. **Chowdhury, A.**, Chakrabarti, D., and Karmakar, S., **2014**. Facial EMG and Eye-tracking are useful techniques for evaluation of pleasure generated by product appearance. *In* Proceedings of XXVth Annual National Conference of The Physiological Society of India, 19th -21st December, 2014, Berhampore Girls' College, Murshidabad, West Bengal, India, p-18.
11. **Chowdhury, A.**, Reddy, S.M., Karmakar, S., Ghosh, S., and Chakrabarti, D., **2013**. An anthropomorphic product grabs more visual attention during in shop visual search. *In* Proceedings of International Conference on Ergonomics and Human Factors, "Ergo 2013: Ergonomics for Rural Development" HWWE-2013, (11th ISE annual Conference), Vidyasagar University, West Bengal, 4-6 December, p-49.
12. **Chowdhury, A.** and Karmakar, S., **2013**. Electromyographic correlation of perceived product personality in human-product physical interaction. *In* Proceedings of 100th Indian Science Congress, Part-11, 3rd-7th January 2013, Calcutta University, Kolkata, India, p-170.
13. Reddy, S.M., **Chowdhury, A.**, Chakrabarti, D. and Karmakar, S., **2012**. Visual Behaviour of Indian Consumers in Product Selection. *In* Proceedings of 99th Indian Science Congress, Part-11, 3rd-7th January 2012, KITT University, Bhubaneswar, India, p-178.

## Appendix-1

### **Ishihara's Colour Plate Test**

#### **1. Introduction**

Defects in colour vision are almost invariably congenital in origin. In this thesis work, Ishihara's Type colour test plates (Eye Care, 38 Palates Edition) were used to test colour defects of participants and to provide a quick & fairly accurate assessment of colour vision defects.



**Figure A1.1.** Classification of colour vision defects (adapted from instruction manual of Eye Care, 38 Palates Edition)

#### **2. Method:**

- a) The each participant was asked to seat in a room which was adequately lit by white fluorescent light.
- b) The TEST PLATE was held at a distance of 75 cm from the participant's eye and he/ she was asked to read out the numerals written on the test plate.
- c) Test results were interpreted based on the performance of readability of the numerals written on the test plate.

### 3. Results:

Number of participants who read numerals correctly the plates in Ishihara's Colour Plate Test (Eye Care Edition) has been presented in Table A1.1. In the present thesis work, participants who were able to read correctly the all numerals written on the test palates were selected for further study. Therefore, all participants had normal colour vision.

**Table A1.1.** Number of participants read numerals correctly in plates in Ishihara's Colour Plate Test (Eye Care Edition)

Palate no.	Normal Person visualize	Number of participants who were able to correctly read the specific plate					
		Study-1 (Chapter-3)	Study-2: Tiffin Box (Chapter-3)	Study-2: Chair (Chapter-3)	Study-1 (Chapter-4)	Study-2: Watch (Chapter-4)	Study-3: Chair (Chapter-4)
1	12	120	210	195	35	65	125
2	8	120	210	195	35	65	125
3	6	120	210	195	35	65	125
4	29	120	210	195	35	65	125
5	57	120	210	194	35	65	125
6	5	120	210	195	31	65	125
7	3	120	210	195	35	63	125
8	15	120	210	193	35	65	123
9	74	120	210	190	32	65	120
10	2	120	210	195	35	65	125
11	6	120	210	195	35	65	125
12	97	120	210	195	35	65	125
13	45	120	210	195	35	65	125
14	5	120	210	195	35	65	125
15	7	120	210	195	35	65	125
16	16	120	210	195	35	65	125
17	73	120	210	195	35	65	125
18	U	120	206	195	35	64	125
19	U	118	208	195	35	62	125
20	U	120	210	195	35	65	125
21	U	120	210	195	35	65	125
22	26	120	210	195	35	65	125
23	42	120	210	195	35	65	125
24	35	120	210	195	35	65	125
25	96	120	210	195	35	65	125
<b>Number of participants selected for the study</b>		118	206	190	31	62	120

## **Snellen Test for Visual acuity**

### **1. Introduction**

Snellen test is generally conducted to test visual acuity of the test subject. Snellen chart is available in the market in standard format. In this thesis work, a standard snellen chart was used to test visual insight status of each participant.

### **2. Method**

- a) The Snellen chart was hanged on the wall of the laboratory and participants were asked to place themselves 6 meters (or 20 feet) away from the chart.
- b) Their eyes were tested one eye at a time. The test was started with the right eye, covering the left one without pressing on it.
- c) Then, the left eye was examined by doing the opposite.
- d) Each participant was asked to read the letters from the largest to the smallest in the chart.
- e) If the participant can read the letters of the 8th line (please see Figure A1.2.) on Snellen chart, his/ her sight is optimal (visual acuity 20/20).
- f) If participant's visual acuity is less than 20/20 or if he/ she has doubts about their sight, they should visit their ophthalmologist.

### **3. Results**

In this thesis work, all participants were able to read letters of the 8th line (please see Figure A1.2.) on Snellen chart from a distance of 6 meters (or 20 feet) either without any eye lenses or with eye lenses. Therefore, participants either had optimal visual acuity/ corrected visual acuity. Please see Table A1.2.

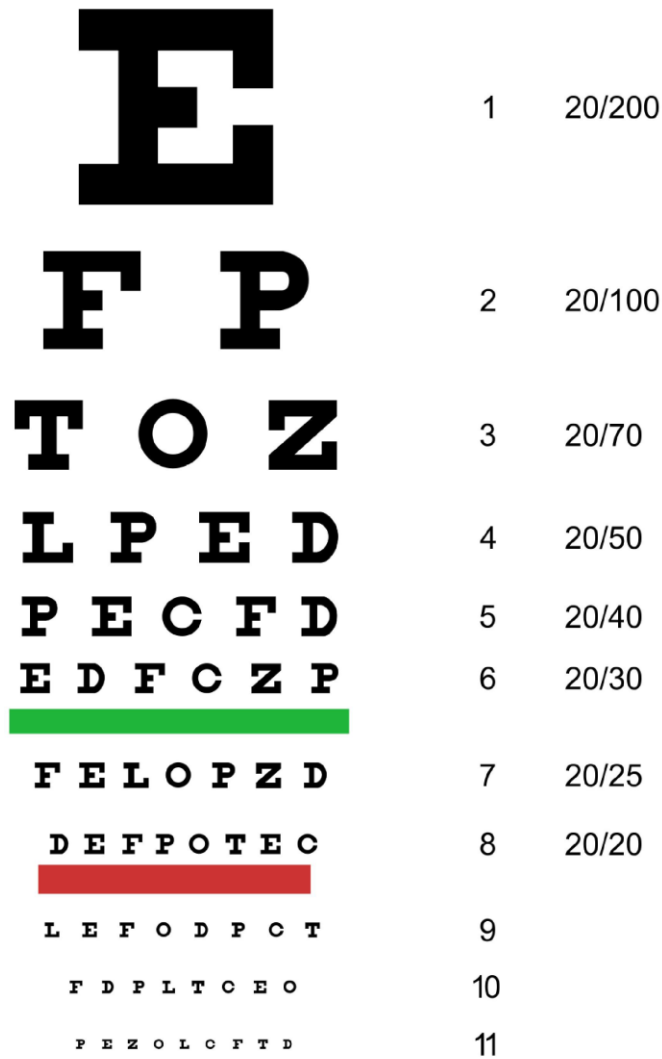


Figure A1.2. The Snellen chart

Table A1.2. Variations of visual acuity levels of participants.

Line no.	Critical Visual Acuity	Study-1 (Chapter-3)	Study-2: Tiffin Box (Chapter-3)	Study-2: Chair (Chapter-3)	Study-1 (Chapter-4)	Study-2: Watch (Chapter-4)	Study-3: Chair (Chapter-4)
1 to 7	-	120	210	195	35	65	125
8	20-20	<b>120</b>	<b>210</b>	<b>195</b>	<b>35</b>	<b>65</b>	<b>125</b>
9	-	110	200	195	35	65	122
10	-	90	189	181	33	64	113
Number of participants qualified in test		120	210	195	35	65	125

## Appendix-2

### ANOVA results of Stimulus Manipulation Check of Study-1 of Chapter-3

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	46.891	2	23.445	13.634	.000
Within Groups	130.692	76	1.720		
Total	177.583	78			

### Multiple comparison test results of Stimulus Manipulation Check of Study-1 of Chapter-3

Dependent Variable:AM AVG

	(I) Tiffin box	(J) Tiffin box	Mean Difference (I-J)	Std. Error	Sig.
Tukey HSD	1	2	-.3052381	.3608335	.676
		3	-1.7619048*	.3571487	.000
	2	1	.3052381	.3608335	.676
		3	-1.4566667*	.3673215	.000
	3	1	1.7619048*	.3571487	.000
		2	1.4566667*	.3673215	.000
LSD	1	2	-.3052381	.3608335	.400
		3	-1.7619048*	.3571487	.000
	2	1	.3052381	.3608335	.400
		3	-1.4566667*	.3673215	.000
	3	1	1.7619048*	.3571487	.000
		2	1.4566667*	.3673215	.000

\*. The mean difference is significant at the 0.05 level.

### ANCOVA results of hypothesis testing of Study-1 of Chapter-3

#### Tests of Between-Subjects Effects

Dependent Variable:VA AVG

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	38.293 <sup>a</sup>	5	7.659	5.422	.000	.271
Intercept	27.687	1	27.687	19.600	.000	.212
GENDER	.185	1	.185	.131	.718	.002
AGE	2.717	1	2.717	1.924	.170	.026
CTAV_AVG_New	.012	1	.012	.008	.928	.000
Tiffinbox	33.754	2	16.877	11.948	.000	.247
Error	103.116	73	1.413			
Total	2099.778	79				
Corrected Total	141.409	78				

a. R Squared = .271 (Adjusted R Squared = .221)

### Appendix-3

#### ANOVA results of Stimulus Manipulation Check of Study-1 of Chapter-4

Dependent Variable: Level of anthropomorphism (AM\_AVG)

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	9.568 <sup>a</sup>	2	4.784	5.393	.007	.135
Intercept	1986.250	1	1986.250	2239.053	.000	.970
WATCH	9.568	2	4.784	5.393	.007	.135
Error	61.209	69	.887			
Total	2057.028	72				
Corrected Total	70.777	71				

#### Multiple comparison test results of Stimulus Manipulation Check of Study-1 of Chapter-4

Dependent Variable: AM\_AVG

(I) WATCH	(J) WATCH	Mean Difference (I-J)	Std. Error	Sig.
1	2	-.694444*	.2718906	.039
	3	-.833333*	.2718906	.009
2	1	.694444*	.2718906	.039
	3	-.138889	.2718906	1.000
3	1	.833333*	.2718906	.009
	2	.138889	.2718906	1.000

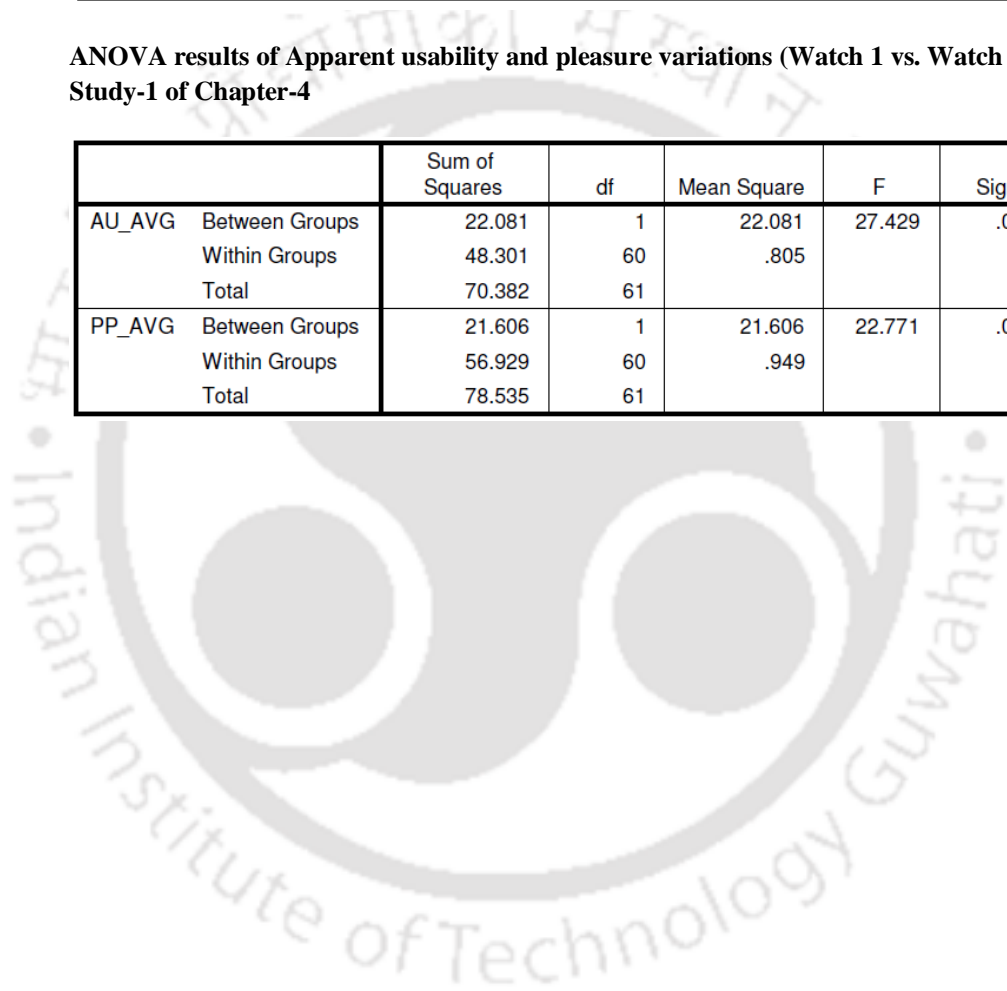
\*. The mean difference is significant at the .05 level.

**ANOVA results of Apparent usability and pleasure variations (Watch 1 vs. Watch 2) of Study-1 of Chapter-4**

		Sum of Squares	df	Mean Square	F	Sig.
AU_AVG	Between Groups	40.862	1	40.862	93.256	.000
	Within Groups	26.290	60	.438		
	Total	67.152	61			
PP_AVG	Between Groups	4.883	1	4.883	4.242	.044
	Within Groups	69.076	60	1.151		
	Total	73.959	61			

**ANOVA results of Apparent usability and pleasure variations (Watch 1 vs. Watch 3) of Study-1 of Chapter-4**

		Sum of Squares	df	Mean Square	F	Sig.
AU_AVG	Between Groups	22.081	1	22.081	27.429	.000
	Within Groups	48.301	60	.805		
	Total	70.382	61			
PP_AVG	Between Groups	21.606	1	21.606	22.771	.000
	Within Groups	56.929	60	.949		
	Total	78.535	61			



## Appendix-4

### 1. Human face control trial (for tiffin box/ bike) facial EMG results

#### Tests of Within-Subjects Contrasts

Measure: Corrugator activity

Source	factor1	Sum of Squares	df	Mean Square	F	Sig.
factor1	Linear	.004	1	.004	.023	.880
factor1 * Gender	Linear	.007	1	.007	.046	.831
factor1 * StimulusCode	Linear	1.767	1	1.767	11.567	.001
Error(factor1)	Linear	8.705	57	.153		

#### Tests of Between-Subjects Effects

Measure: Corrugator activity

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	.027	1	.027	.011	.917	.000
Gender	.053	1	.053	.022	.883	.000
StimulusCode	9.807	1	9.807	3.978	.051	.065
Error	140.511	57	2.465			

**Tests of Within-Subjects Contrasts**

Measure: Zygomaticus Activity

Source	factor1	Sum of Squares	df	Mean Square	F	Sig.
factor1	Linear	.183	1	.183	.219	.641
factor1 * Gender	Linear	.365	1	.365	.438	.511
factor1 * StimulusCode	Linear	.546	1	.546	.655	.422
Error(factor1)	Linear	47.523	57	.834		

**Tests of Between-Subjects Effects**

Measure: Zygomaticus Activity

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	.141	1	.141	.106	.746	.002
Gender	.282	1	.282	.212	.647	.004
StimulusCode	6.125	1	6.125	4.594	.036	.075
Error	75.998	57	1.333			

**2. Human face control trial (for watch) facial EMG results**

**Tests of Within-Subjects Contrasts**

Measure: Zygomaticus Activity

Source	factor1	Sum of Squares	df	Mean Square	F	Sig.
factor1	Linear	.000	1	.000	.000	1.000
	Quadratic	.000	1	.000	.000	1.000
factor1 * Stimuluscode	Linear	.856	1	.856	1.034	.313
	Quadratic	.009	1	.009	.011	.917
Error(factor1)	Linear	48.002	58	.828		
	Quadratic	46.179	58	.796		

**Tests of Between-Subjects Effects**

Measure: Zygomaticus Activity

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	.000	1	.000	.000	1.000	.000
Stimuluscode	7.341	1	7.341	5.706	.020	.090
Error	74.614	58	1.286			

**Tests of Within-Subjects Contrasts**

Measure: Corrugator Activity

Source	factor1	Sum of Squares	df	Mean Square	F	Sig.
factor1	Linear	.000	1	.000	.000	1.000
factor1 * Stimuluscode	Linear	.244	1	.244	1.418	.239
Error(factor1)	Linear	9.969	58	.172		

### Tests of Between-Subjects Effects

Measure: Corrugator Activity

Transformed Variable: Average

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	.000	1	.000	.000	1.000	.000
Stimuluscode	13.404	1	13.404	5.830	.019	.091
Error	133.349	58	2.299			

### 3. Tiffin box trial facial EMG results

#### Tests of Within-Subjects Contrasts

Measure: Zygomaticus Activity

Source	factor1	Sum of Squares	df	Mean Square	F	Sig.
factor1	Linear	.000	1	.000	.000	1.000
factor1 * Stimuluscode	Linear	.012	1	.012	.029	.866
Error(factor1)	Linear	24.961	58	.430		

**Tests of Between-Subjects Effects**

Measure: Zygomaticus Activity

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	.000	1	.000	.000	1.000	.000
Stimuluscode	13.153	1	13.153	5.926	.018	.093
Error	128.744	58	2.220			

**Tests of Within-Subjects Contrasts**

Measure: Corrugator Activity

Source	factor1	Sum of Squares	df	Mean Square	F	Sig.
factor1	Linear	.000	1	.000	.000	1.000
factor1 * Stimulus code	Linear	1.003	1	1.003	2.451	.123
Error(factor1)	Linear	23.737	58	.409		

**Tests of Between-Subjects Effects**

Measure: Corrugator Activity

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	.000	1	.000	.000	1.000	.000
Stimuluscode	18.220	1	18.220	8.909	.004	.133
Error	118.615	58	2.045			

#### 4. Watch trial facial EMG results

##### Tests of Within-Subjects Contrasts

Measure: Corrugator Activity

Source	factor1	Sum of Squares	df	Mean Square	F	Sig.
factor1	Linear	.000	1	.000	.000	1.000
factor1 * Stimulus Code	Linear	.003	1	.003	.016	.900
Error(factor1)	Linear	9.296	58	.160		

##### Tests of Between-Subjects Effects

Measure: Corrugator Activity

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	.000	1	.000	.000	1.000	.000
StimulusCode	10.465	1	10.465	4.194	.045	.067
Error	144.718	58	2.495			

##### Tests of Within-Subjects Contrasts

Measure: Zygomaticus Activity

Source	factor1	Sum of Squares	df	Mean Square	F	Sig.
factor1	Linear	.000	1	.000	.000	1.000
factor1 * StimulusCode	Linear	.075	1	.075	.111	.740
Error(factor1)	Linear	39.060	58	.673		

**Tests of Between-Subjects Effects**

Measure: Zygomaticus Activity

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	.000	1	.000	.000	1.000	.000
StimulusCode	6.492	1	6.492	4.444	.039	.071
Error	84.739	58	1.461			

**5. Bike trial facial EMG results**

**Tests of Within-Subjects Contrasts**

Measure: Corrugator Activity

Source	factor1	Type III Sum of Squares	df	Mean Square	F	Sig.
factor1	Linear	.000	1	.000	.000	1.000
factor1 * Stimuluscode	Linear	2.269	1	2.269	3.272	.075
Error(factor1)	Linear	51.319	74	.694		

**Tests of Between-Subjects Effects**

Measure: Corrugator Activity

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	.000	1	.000	.000	1.000	.000
Stimuluscode	7.890	1	7.890	4.687	.034	.060
Error	124.574	74	1.683			

### Tests of Within-Subjects Contrasts

Measure: Zygomaticus Activity

Source	factor1	Sum of Squares	df	Mean Square	F	Sig.
factor1	Linear	.000	1	.000	.000	1.000
factor1 * Stimulus code	Linear	1.842	1	1.842	2.102	.151
Error(factor1)	Linear	64.859	74	.876		

### Tests of Between-Subjects Effects

Measure: Zygomaticus Activity

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	.000	1	.000	.000	1.000	.000
Stimuluscode	9.421	1	9.421	12.092	.001	.140
Error	57.653	74	.779			

## 6. Tiffin box eyetracking results

### Tests of Within-Subjects Contrasts

Measure: FT/ AOI

Source	factor1	Sum of Squares	df	Mean Square	F	Sig.
factor1	Linear	.463	1	.463	1.237	.271
factor1 * AOI	Linear	.256	1	.256	.685	.411
Error(factor1)	Linear	21.701	58	.374		

**Tests of Between-Subjects Effects**

Measure: FT/ AOI

Source	Sum of Squares	df	Mean Square	F	Sig.
Intercept	530.921	1	530.921	125.369	.000
AOI	80.117	1	80.117	18.918	.000
Error	245.623	58	4.235		

**Tests of Within-Subjects Contrasts**

Measure: FFD / AOI

Source	factor1	Sum of Squares	df	Mean Square	F	Sig.
factor1	Linear	.043	1	.043	2.799	.100
factor1 * AOI	Linear	.023	1	.023	1.494	.227
Error(factor1)	Linear	.889	58	.015		

**Tests of Between-Subjects Effects**

Measure: FFD / AOI

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	4.117	1	4.117	32.064	.000
AOI	.555	1	.555	4.320	.042
Error	7.448	58	.128		

**Tests of Within-Subjects Contrasts**

Measure: FC/ AOI

Source	factor1	Sum of Squares	df	Mean Square	F	Sig.
factor1	Linear	2.077	1	49.077	12.657	.000
factor1 * AOI	Linear	19.487	1	2.487	.971	.190
Error(factor1)	Linear	619.252	56	11.058		

**Tests of Between-Subjects Effects**

Measure: FC

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	559.952	1	559.952	4.595	.036
AOI	636.643	1	636.643	6.936	.006
Error	6823.538	56	121.849		

**7. Bike eyetracking results**

**Tests of Within-Subjects Contrasts**

Measure: Fixation Time/ AOI

Source	factor1	Sum of Squares	df	Mean Square	F	Sig.
factor1	Linear	332136.191	1	332136.191	.351	.555
factor1 * AOI	Linear	7571287.149	1	7571287.149	7.997	.006
Error(factor1)	Linear	87105181.660	92	946795.453		

**Tests of Between-Subjects Effects**

Measure: Fixation Time / AOI

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	648018752.362	1	648018752.362	234.725	.000	.718
AOI	12758769.021	1	12758769.021	4.621	.034	.048
Error	253989739.617	92	2760758.039			

**Tests of Within-Subjects Contrasts**

Measure: Fixation Count / AOI

Source	factor1	Sum of Squares	df	Mean Square	F	Sig.
factor1	Linear	.261	1	.261	.200	.655
factor1 * AOI	Linear	.644	1	.644	.495	.483
Error(factor1)	Linear	119.596	92	1.300		

**Tests of Between-Subjects Effects**

Measure: Fixation Count / AOI

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	1006.516	1	1006.516	433.786	.000	.825
AOI	18.516	1	18.516	7.980	.006	.080
Error	213.468	92	2.320			

**Tests of Within-Subjects Contrasts**

Measure: FFD/ AOI

Source	factor1	Sum of Squares	df	Mean Square	F	Sig.
factor1	Linear	2938000.021	1	2938000.021	4.792	.031
factor1 * AOI	Linear	104670.723	1	104670.723	.171	.680
Error(factor1)	Linear	56406001.255	92	613108.709		

**Tests of Between-Subjects Effects**

Measure: FFD / AOI

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	106799591.511	1	106799591.511	86.323	.000	.484
AOI	124604.255	1	124604.255	.101	.752	.001
Error	113823396.234	92	1237210.829			

**8. Watch eyetracking results**

**Tests of Within-Subjects Contrasts**

Measure: Fixation Time / AOI

Source	factor1	Sum of Squares	df	Mean Square	F	Sig.
factor1	Linear	.036	1	.036	.232	.631
factor1 * AOI	Linear	1.080	1	1.080	7.005	.010
Error(factor1)	Linear	12.647	82	.154		

**Tests of Between-Subjects Effects**

Measure: Fixation Time / AOI

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	110.910	1	110.910	335.102	.000	.803
AOI	21.479	1	21.479	64.897	.000	.442
Error	27.140	82	.331			

**Tests of Within-Subjects Contrasts**

Measure: Fixation Count / AOI

Source	factor1	Sum of Squares	df	Mean Square	F	Sig.
factor1	Linear	17.849	1	17.849	4.482	.021
factor1 * AOI	Linear	.169	1	.169	.061	.793
Error(factor1)	Linear	201.236	82	2.484		

**Tests of Between-Subjects Effects**

Measure: Fixation Count / AOI

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	18.408	1	18.408	5.511	.021	.064
AOI	86.286	1	86.286	25.831	.000	.242
Error	270.576	82	3.340			

**Tests of Within-Subjects Contrasts**

Measure: FFD / AOI

Source	factor1	Sum of Squares	df	Mean Square	F	Sig.
factor1	Linear	.197	1	.197	2.895	.093
factor1 * AOI	Linear	.001	1	.001	.019	.891
Error(factor1)	Linear	5.583	82	.068		

**Tests of Between-Subjects Effects**

Measure: FFD / AOI

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	10.323	1	10.323	114.048	.000	.582
AOI	.492	1	.492	5.441	.022	.062
Error	7.422	82	.091			