Chapter 4
Emotions and Emotions in Design

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Abstract This chapter discusses and clarifies the concepts and definitions of emotion, feeling, and mood. Although they refer to distinct phenomena, these concepts are normally used indiscriminately when someone refers to emotions. This is followed by a brief review of the literature on the main theories applied to the study of emotions. This reference to the study of emotions will serve as the basis for the introduction and exploration of the concept, purpose, and application of Emotional Design.

Keywords Emotions · Emotion theories · Design

4.1 Introduction

Emotions play a key role in an individual's behavior within the social context (Plutchik 1991). The study of emotions and their influence on human behavior took a leap forward in 1872, when Darwin published *The Expression of Emotions in Man and Animals*. However, and despite emotions having been studied for almost a century and a half, there is still no consensual definition. For example, Plutchik noted in 2001 that there were more than 90 definitions of emotions (Plutchik 2001a).

Over time, various theories and models about emotions have emerged, based on different perspectives, such as the evolutionary theory (e.g., Darwin 1872), the physiological theory (e.g., James 1884) and the cognitive theory (e.g., Schachter and Singer 1962), among others. The different theories of emotions are supported by other existing theories of Psychology (among other areas) and, due to this, differ in

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their definitions, as well as on the role and importance they play in the life of the individual.

However, before presenting some of these theories, we shall discuss and clarify some concepts: emotion, feeling, and mood. Although they refer to different phenomena, these concepts are used by all of us as if they referred to a single one—emotion.

4.2 Emotions, Feelings, Moods, and Sentiments

Before focusing on emotions and their main theories, it is important to define and clarify other concepts. Individuals usually refer to feelings, moods, or sentiments as if they were emotions (e.g., Beedie et al. 2005; Ekman 1994a). However, these three concepts refer to different phenomena.

Feelings can be defined as the subjective experience of emotions (e.g., Scherer 2005). They are states of mind, which derive from the evaluation that the individual makes about an event, such as the level of its pleasantness or unpleasantness (e.g., pain) (TenHouten 2007). According to Damásio (2003), feelings occur after emotions. In this sense, feelings are less visible at the behavioral level than emotions, and are therefore considered more private than emotions (TenHouten 2007). The duration of a feeling is short, usually seconds, and is less intense than an emotion (Damásio 2003).

According to Ekman (1999), the emotions are the result of a specific cause (i.e., specific event). However, mood may or may not ensue from a specific cause (e.g., Ekman 1990; Beedie et al. 2005). Contrary to emotions, moods can have a long duration (i.e., hours, days) (e.g., Ellis and Ashbrook 1988), change frequently, alternating with other mood states (Desmet 2015), and have a medium intensity (e.g., Morris 1992; Scherer 2005). Frijda et al. (1991) explained moods as continuous feeling states without a specified object. However, both emotions and moods have a high impact on the individual's behavior, since they can stop one behavior and start another one that is more effective for that event (Scherer 2005).

Turner (1970) called sentiments a socially defined complex of feelings that vary across cultures. Frijda et al. (1991) defined sentiments as emotional dispositions to a certain product. Nass and Brave (2007) argued that sentiments are not a person's state but characteristics that are designated to a product; and while emotions last for seconds and moods for hours/days, sentiments can remain indefinitely.

The concept of emotion has been described in a varied way by different authors, according to the theory they follow. The emotions correspond to a construct that the individual creates, allowing for the emotional evaluation of the event, and because of this, the emotions are relatively constant for each individual (Lazarus 1999). Emotions, it is argued, trigger a set of behavioral (e.g., run), physiological (e.g., sweat), and cognitive responses (e.g., evaluation of the event), and these changes allow the individual to adapt and respond appropriately to an event (e.g., Nesse 1990). From all these definitions, we identify with and have adopted the definition proposed by Frijda (1987), which defines emotions as the tendency that the individual

has to establish, maintain, or terminate a relationship with the environment or with others. According to this author, emotions are characterized by high intensity and short duration (i.e., seconds, minutes) (Frijda 1994).

Although, as mentioned earlier, there are several theories about emotions, there is agreement on the two dimensions for measuring them: *Arousal* and *Valence* (e.g., Lang et al. 1997; Russell and Barrett, 1999). *Arousal* refers to the psychophysiological condition caused in the individual by the presence of a stimuli, product, or object (Lang 1995). It may be high when the stimulus produces a high activation in the subject (e.g., seeing a snake) or low when the stimulus produces low activation (e.g., listening to music for relaxing). *Arousal* is characterized by an activation of the autonomic nervous system (e.g., running away), and the activation of the endocrine system (e.g., increased heart rate) enabling the individual to respond appropriately to the stimuli. *Valence* concerns the positivity (e.g., happiness) or negativity (e.g., sadness) that a stimulus or situation elicits in the individual (e.g., Lewin 1935).

As mentioned above, the definition of emotion depends on the theoretical current that the authors follow. Over the years, various theories about emotions have emerged. The next section presents the basic principles of what we consider to be the most significant theories in the field.

4.3 Theories About Emotions

This section is not intended to be exhaustive. It has a selection of the theories considered most influential or controversial in the study of emotions: Psychoevolutionary Theories of Emotion; Physiological Theories of Emotions; and Cognitive Theories of Emotion.

4.3.1 The Psychoevolutionary Theories of Emotion

According to Darwin (1872), emotions are not a specific characteristic of humans, since other animals, even insects, have them. In his studies about emotions, Darwin (1872) concluded that their function was to ensure the adaptation, communication, and survival of species in different environments. It is on the basis of this assumption that the first great theory in the area was created: the Evolutionary Theory of Emotions.

One of its main followers was Robert Plutchik, who developed The Psychoevolutionary Theory of Emotion (Plutchik 1962). Plutchik, like Darwin, argues that emotions play an important role in the evolution of species and supports the principle of antithesis.

According to this theory, emotions result from a cognitive interpretation/evaluation that is made in relation to a particular event or stimulus. It is this interpretation that triggers a physiological reaction, which enables the action (e.g.,

running away) (Plutchik 1977). In the light of this theory, emotions are adaptive responses to dangerous events/situations. Some situations or events that jeopardize the survival and adaptation of the individual cause imbalance, and the function of the emotions is to reestablish that balance. For Plutchik (2001b), the emotions are activated in response to four types of problems that are commons to all species: temporality, identity, hierarchy, and territoriality.

For Plutchik (1979, 1980), the first problem, temporality, is related to the reproduction of the species. For humans, it is related to the building and continuity of the family and its community, involving positive emotions such as joy if the mission is accomplished, and sadness if not.

The problem of identity corresponds to the fact that individuals/animals accept (or not) other individuals/animals as being part of the same species. Although the definition of this problem has not been thoroughly explored by Plutchik, he has associated it with acceptance and disgust emotions. In other words, the solution of this problem is the acceptance or rejection of other members of the species.

The problem of hierarchy is related to power and dominance within the same species. The strongest/dominant members have privileged access to food or sexual partners, ensuring the survival of the species. To overcome this problem, humans/animals have two possible solutions: to fight and to resist, which is expressed through the emotion anger; or give up, expressed through the emotion fear.

Finally, territoriality concerns the struggle for control and defense of a space that is safe for the species, ensuring its survival. For Plutchik, this problem has two possible solutions: spatial control by thinking ahead of the enemy—anticipation or losing control of that space to the enemy—surprise.

Plutchik (1980) argues that there are eight basic emotions—two per problem: joy, fear, anticipation, acceptance, anger, sadness, disgust, and surprise. In the same year, Plutchik created the Wheel of Emotions model to explain the relation between the emotions (see figure XX). According to this model, the eight basic emotions follow the principle of antithesis, with each emotion having an opposite emotion: joy versus sadness; fear versus anger; disgust versus trust; anticipation versus surprise. Each of the basic emotions can manifest itself in different intensities and form combinations with other emotions (e.g., disgust and sadness = remorse).

Along with the eight emotions, Plutchik (1980) considered the existence of 24 secondary emotions that derive from the various possible conjugations between the basic emotions: ecstasy, admiration, terror, amazement, grief, loathing, rage, vigilance, serenity, acceptance, apprehension, distraction, pensiveness, boredom, annoyance, interest, optimism, love, submission, awe, disapproval, remorse, contempt, and aggressiveness.

Another author who based his theory of emotions on Darwin's arguments and on the evolutionary theory of emotions is Paul Ekman. Ekman (1994b) argues that there are basic emotions that play an important role in the adaptation and evolution of species. In 1969, Ekman et al. argued for the existence of six basic emotions: sadness, happiness, fear, surprise, disgust, and anger (as Darwin had argued in 1872). For the authors, these emotions are innate, present from birth and universally recognized.

In this sense, each emotion has a specific function that allows adaptation to certain contexts (Ekman 2003). According to Ekman (1973), the basic emotions are manifested through facial expressions, which distinguish them, and each expression is universal. Darwin (1872) had argued that some emotions had a universal facial expression and were also expressed in animals. Based on this argument, Ekman dedicated himself over the years to the study of the facial expression of emotions in humans (e.g., Ekman 1972, 1992, 1994b). The facial expression of emotions will be explored in more detail in Chap. 7.

Although the importance of evolutionary theory in explaining emotions is undeniable and is still argued by some authors, other explanatory theories of emotions have emerged over the years. In the nineteenth century, William James and Carl Lange argued that emotions result from physiological responses to external stimuli. This idea runs counter to the Psychoevolutionary argument that emotions are the response to an evaluation made in relation to a stimulus.

4.3.2 The Physiological Theories of Emotions

4.3.2.1 The James–Lange Theory

In *Psychology: The Briefer Course*, published in 1892, William James distinguished emotions from instincts. For James, instincts are considered the tendency to act, whereas emotions are defined as the tendency to feel, although these are also expressed through the body.

James (1884) argued that bodily changes (visceral and muscular) derive from adjustments that the nervous system makes in response to stimuli, and it is the awareness of those changes that constitutes an emotion. According to this theory, if the individual is in the presence of a snake, the individual is not afraid of the snake. They are afraid because they tremble: the individual is aware of the bodily changes that the presence of the snake has triggered.

Thus, physical changes (i.e., emotion) are felt immediately upon contact with the stimulus that triggers it and prior to its cognitive perception. It is possible to distinguish between different emotions because each of them has a different bodily change (James 1892: 245).

James was not an apologist for experimental methodologies, so all his investigations were made on the basis of self-observation, strongly based on personal memories of the mental processes experienced. This approach was highly criticized, since phenomena based on self-observation could not be replicated by other researchers. James' theory is counterintuitive because the emotion is not interpreted as a response to a stimulus but rather as the awareness of the physiological changes that this stimulus has provoked.

In 1885, Carl Lange presented his theory of emotions. Although they worked independently, Lange and James built similar theories about emotions, and so their theories became known as the James–Lange Theory. In addition, for Lange (1885),

when a stimulus is presented, there is a physical arousal and the reaction of the nervous system to that arousal is an emotion. This theory has been criticized because, for James and Lange, emotions do not have any function (e.g., Damásio 1994; Plutchik 1962), and it ignored the influence of previous experience in the evaluation of emotions, in other words, the cognitive dimension of emotions (e.g., Damásio 1994).

One of the main critics of the James–Lange Theory was Walter Cannon (1914), a student of William James. According to Cannon, the brain played a vital role in the emotional process. For this author, (together with Philip Bard), the James–Lange Theory presents some problems, such as the fact that the body takes between 1 and 2 s to respond to a stimulus, so the physiological changes associated with an emotion are not immediate. Furthermore, the fact that many emotions produce similar visceral responses means it is not possible to distinguish and recognize emotions through physiological response/change. The Cannon–Bard Theory emerged as an attempt to deal with these problems.

4.3.2.2 Cannon–Bard Thalamic Theory of Emotions

In the first decade of the 1990s, Cannon devoted himself to the study of emotions in healthy animals, measuring their physiological changes, and strongly influenced by the James–Lange Theory. This approach resulted in the distinction between sympathetic visceral patterns and parasympathetic visceral patterns. According to Cannon, emotions can be distinguished through these two visceral patterns, i.e., if visceral expression of an emotion (body changes) occurs in the thoracic-lumbar zone, it belongs to the sympathetic visceral patterns; whereas if it occurs in the cervico-sacral zone, it belongs to the parasympathetic visceral patterns. As the nerves constituting the autonomic nervous system are antagonist, the emotions expressed by each of these patterns are also antagonistic (Cannon 1914).

In 1925, Cannon and Britton began studying emotional expression in animals that had had a part of the cerebral cortex removed. They thus determined that the thalamic region was responsible for emotional expression, since some emotional expressions were compromised or disappeared when the thalamus was removed.

Later, Cannon (1927) and Bard (1928) investigated the level at which emotional expressions were integrated into the brain, which would give rise to the Cannon–Bard Thalamic Theory of Emotions. These authors verified that there was no significant alteration in the emotional response of animals that had had a part of their sympathetic nervous system removed. In other words, the emotional response is not a merely visceral process as argued by the previous theory.

Moreover, Cannon and Bard found that viscera are less-sensitive structures than James and Lange believed (e.g., during the digestive process we do not account for all responses and visceral movements that occur) (Cannon 1927).

This theory argues, as already mentioned, that there is an area of the brain (the thalamus) responsible for emotional expression. In addition to this idea, the authors also argued that arousal does not have to be prior to emotion. On the contrary, arousal and emotion occur at the same time, which contradicts the key idea of the

James–Lange Theory of Emotions. Thus, in the presence of a stimulus, the receptors are activated and send the information to the cortex, where the response to that stimulus is decided. This response will activate the thalamus, producing an emotional expression at same time as the bodily and visceral changes occur (Cannon 1927).

However, other studies soon demonstrated that the thalamic region was not the center of control of emotional expression, or at least it was not the only area of the brain involved in that process. An example was Papez (1937), who created a circuit of emotion. For Papez (1937), the emotions and their expression come from the interconnections between some brain structures, such as: hypothalamus, anterior thalamic nuclei, gyrus cinguli, and hippocampus. The expression circuit is due to the fact that Papez argued the emotional process begins and ends in the hypothalamus, traversing a circuit between different structures constituting the limbic system.

Although these theories have contributed significantly to the understanding of the emotional process from the physiological and neurological point of view, the cognitive component of emotion was neglected or even ignored. In the second half of the twentieth century, however, some theories began to emerge based on the importance of cognition in the emotional process. An example was that of Schachter and Singer.

4.3.2.3 Schachter-Singer: The Two-Factor Theory of Emotions

Contrary to the theoretical currents about the emotions that had emerged based essentially on their physiological component, Schachter and Singer (1962) argued that emotions are the result of physiological arousal but also of cognitive factors. According to these authors, physiological arousal and physiological changes are not sufficient to distinguish emotions, since some of them produce very similar physiological changes. This theory argues that emotion depends on two factors: physiological arousal, and the way that arousal is interpreted—cognition. Thus, when our body undergoes some physiological change, we are able to perceive these changes and through them, perceive the emotion we are experiencing. In this sense, the emotions result from the individual's interpretation of internal and external changes.

To test this theory, Schachter and Singer (1962) developed a complex experiment. Some participants were injected with a placebo substance (i.e., did not produce any arousal), while others were injected with a drug that produced physiological arousal. Some of the participants injected with the drug were informed about its effects and others were not. The results revealed that participants who received information about the effects of the drug did not experience emotions because, according to the authors, participants interpreted the physiological changes as an effect of the drug and not as an emotion. That is, emotion does not depend only on physiological changes. In contrast, participants who received no explanation about the effects of the drug experienced physiological arousal and interpreted it cognitively as an emotional state. That is, emotional experience depends on the cognitive interpretation given to physiological changes.

This theory constituted a change in the paradigm of the study of emotions. If until then, the focus had been on the physiological changes, from here onwards, cognition gained relevance, in particular the importance of the thought for the emotional process.

4.3.3 Cognitive Theories of Emotion

4.3.3.1 Appraisal Theories of Emotions

According to this theory, emotions derive from the evaluations and interpretations that individuals make of a stimuli, i.e., appraisal. The emotion thus stems from the appraisal, with no physiological arousal being necessary. Emotions are regarded as an adaptive response of individuals to the environment. Over the years, several authors have contributed to the development of these theories (e.g., Arnold 1960; Lazarus 1968; Frijda 1986). Since appraisal may differ between individuals, the same stimuli may have different emotional responses; but if the appraisal is the same, the expressed emotion is the same. It was Arnold who introduced the term appraisal of emotions with his Appraisal Theory of Emotions (Arnold 1960). According to this author, individuals, when faced with a stimuli, evaluate it automatically and immediately as good or bad, and stimuli evaluated as indifferent are ignored. This evaluation is made on the basis of past experiences (i.e., memory) with the same or similar stimulus. In this sense, appraisal represents the tendency for the individual to act in a certain way when faced with a situation. According to Arnold, whenever this tendency is strong, an emotion is being expressed. So appraisal is the beginning of emotional experience followed by physiological changes.

In 1968, Lazarus carried out a set of studies whose main objective was to understand the determinants of appraisal. As a result of these studies, Lazarus argued for the existence of three types of appraisal: primary, secondary, and re-appraisal. Primary appraisal corresponds to the recognition of the stimuli and their importance for the well-being of the individual. Secondary appraisal is the analysis the individual makes of the resources that can be used to respond to the stimulus. Finally, re-appraisal is the changes that the individual makes to the primary and secondary appraisals after interaction with the stimulus. This process of continuous (re) evaluation attributes a continuous and nonstatic character to emotion (Lazarus 1968).

Another researcher who contributed actively to the development of this theory was Frijda, who argued that emotions are cognitive states representing action dispositions (Frijda 1986). For this author, the emotions also correspond to responses to stimuli appraised as relevant for individual concerns (Frijda 1986). By concerns, Frijda (1986, 1988) means the individual's motives and values. Emotions initially involve the perception of the stimulus, which follows an evaluation (i.e., appraisal) made on the basis of the individual's concerns, which activates a set of actions (i.e., arousal). Emotions, therefore, involve all these stages of preparation for action (Frijda 1986).

Finally, another author who made important contributions to this theory was Scherer. For him, the emotions are a set of synchronized changes between several subsystems in the organism of an individual (Scherer 2001). For Scherer (1984), emotions have five components: appraisal, physiological changes, motor expression (e.g., facial expression), action tendency and subjective feelings (i.e., emotional experience).

As has been seen, a number of theories on emotions have appeared over the years, although we have only referred to those that we consider most significant. While some theories are based on evolutionary arguments (e.g., Plutchik 1962), others are based more on physiological (e.g., James 1884) or cognitive arguments (e.g., Scherer 1984). However, other theories that were not mentioned here are based on cultural (e.g., Malatesta and Haviland 1982), social (e.g., de Rivera 1977), or developmental (e.g., Giblin 1981) factors. If, on the one hand, the interest in the study of emotions has served areas such as Psychology, Philosophy, or Sociology; since the beginning of this century, we have seen an increased interest in the role of emotions in Design, as we explore next.

4.4 Design and Emotions

The combination of design and emotion has been gaining interest within design practice and design research over the last 20 years (e.g., Desmet and Pohlmeyer 2013; Fokkinga and Desmet 2012; Yoon et al. 2014 and Yoon et al. 2016). Emotions play an important role in the generation, development, production, purchase, and final use of products that we surround ourselves with. When an object or a product is idealized, it should take into account not only its usability and functionality, but also the user's pleasure (Jordan 2000). Aesthetically pleasing objects attract people, and it is sometimes possible to establish an emotional connection between the individual and the object (Helander and Khalid 2006).

One of the first authors to be interested in studying the importance of emotions in design was Pieter Desmet. Basing his approach on the *Appraisal Theory of Emotions,* he began studying the emotional connection between the user and the product. Desmet (2002) argues that individuals extract meaning from their relationship with the product. Therefore, products that contribute to the well-being of the user trigger positive emotions and pleasure. Besides this, when the user's relationship with the product is assessed as harmful or unpleasant, negative emotions are triggered. According to Desmet, it is the designers' purpose to develop products capable of eliciting positive emotions from the user, or to avoid certain negative emotions (e.g., sadness).

Desmet (2003) proposed five categories of product emotions (i.e., instrumental, aesthetic, social, surprise, and interest emotions). Instrumental emotions relate to the function of a product. Aesthetic emotions address the physical characteristics of a product. Social emotions are associated with products that are used by a specific group. Surprise emotions astonish users by novelty/innovation in products. Interest

emotions are the result of products that stimulate and motivate users into producing a creative action or thought.

Although Desmet categorizes product emotions, he also states (2003; 2004) that products can elicit all kinds of emotions and that they are elicited not only by the product's appearance, but also by its function, brand, behavior, and associated meanings. Desmet (2004) also argues that individuals experience different emotions about the same product because they are personal and one product can elicit mixed emotions simultaneously. For Desmet (2012), users can experience 25 positive emotions during their interaction with objects/products. These emotions are: sympathy, kindness, respect, hope, surprise, anticipation, energized, pride, confidence, courage, dreaminess, admiration, love, lust, desire, worship, euphoria, joy, amusement, satisfaction, relief, relaxation, fascination, inspiration, and enchantment.

Producing objects capable of eliciting emotions (particularly positive emotions) in the user is therefore the main objective of Emotional Design (Norman 2004). Emotional design, sometimes also referred to as hedonic design, affective design, affective human factors design, human-centered design, and empathetic design is, in a simple way, the inclusion of emotions as an influencing factor in the way that individuals interact with objects and products (Aumer-Ryan 2005). Throughout this book, the term Emotional Design refers to the emotional component involved in the interaction between human and product (i.e., robot).

Based on a neurobiological theory of emotions, Norman (2004) proposed the existence of three levels in Emotional Design: visceral, behavioral, and reflective. According to Norman, it is not possible to design without all three levels. The visceral level is about the initial impact of a product, about its appearance, touch, and feel. The behavioral level concerns the pleasure and effectiveness of use, the experience with a product. Experience, however, has different facets: function (i.e., what the product is meant to do), performance (i.e., how well the product carries out the desired functions) and usability (i.e., how easily the user can understand how it works and how to get it to perform). Finally, the reflective level is related to the rationalization and intellectualization of a product (e.g., creating good memories for the user).

For Aumer-Ryan (2005), emotions are quick at the visceral level (e.g., fear and disgust); at the behavioral level, emotions coincide with bodily activity, and include such feelings as frustration, aggravation, and annoyance; finally, at the reflective level, emotions, are removed, contemplative, and include feelings such as pride, embarrassment or guilt.

Though interest in studying the emotions in the design process is still recent, its principles have now been applied not only to object design but also to robots, in order to facilitate Human-Robot Interaction (HRI). We will return to the theme of Emotional Design in that context, in Chap. 8, in particular to its HRI application.

4.5 Conclusion

Emotions play a key role in an individual's behavior within the social context (Plutchik 1991). Over time, various theories and models about emotions have emerged, based on different perspectives, as explored at the beginning of this chapter.

Although the earliest theories about emotions date back to the nineteenth century, only recently, have emotions come to be regarded as an important component of cognitive functioning (e.g., decision-making), and not just as something that negatively affects rational thought (e.g., Damásio 2003; Goleman 1995; Norman 2004). Norman (2004) suggested that the Psychology assumptions related to the study of emotions were applied to Design, specifically product design. Therefore, this author argues for the importance of emotions in product design, and how this is reflected in the user's interaction with the product/object. Emotional Design arose out of this new argument that, over the last decade, has proved to be a major innovation in the way designers conceive and develop their products: hence the recent history of emotions in the design field. In recent years, there has been an increase in the importance of emotions applied to this area—Emotional Design. Emotional Design aims to elicit (e.g., pleasure) or prevent (e.g., displeasure) determined emotions during the human product interaction. In other words, it regulates the emotional interaction between the individual and the product. One of the most significant developments of emotion in technology was to create products, objects, and machines capable of expressing, recognizing and feeling/showing emotions. The importance of the individual establishing an emotional and empathetic relationship with the products through design has become evident, thus giving rise to Emotional Design.

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