OCC model: application and comparison to the dimensional model of emotion

Naseem Ahmadpour[1]

[1] *Department of Mathematics and Industrial Engineering, Polytechnique Montréal, naseem.ahmad-pour@polymtl.ca*

Abstract: This paper presents a review and comparison between the model of cognitive structure of emotions (also known as OCC) and the dimensional circumplex of core affect for consumer products. The numbers of emotion types in each emotion group of OCC is compared and associated to those of circumplex of product emotion. Prospect-based group represents the highest number of emotions in the circumplex followed by well-being, Fortune-of-others, and well-being/attribution-compound group. Considering that the addressed circumplex originally targeted emotions generated by products' appearances and the prominent presence of prospect-based and well-being emotions on the circumplex, it is concluded that people judge the personal benefits of using products (consequences of events for self, in OCC terms) by their appearance. That is also confirmed by the eminent representation of attraction emotions on the circumplex, demonstrating the effect of visual aesthetics (as a product aspect) on attraction. Some of the differences between the two models were also established. It is asserted that OCC model uncovers the antecedents of emotions subscribing to the adapting function of emotions as a coping mechanism with the world while dimensional model is concerned with describing the nature of emotions and their dimensions. The significance of each model for the design practice is therefore determined by the design purpose in addressing emotions and the context of use.

Keywords: Emotion, OCC model, Circumplex of core affect, dimensional model.

1. INTRODUCTION

A major part of our everyday experiences in interaction with people, objects or situations is emotions. Emotions are considered to signal a person about their surrounding and motivate appropriate responses to situations (Frijda, 1986). Therefore they are necessary informants for our wellbeing, our everyday experiences and even cognitive processes (Schwarz and Clore, 1983; Ortony, Clore and Collins, 1988). Our enjoyment in using products or services is often attributed to the pleasant emotions that they generate and vice versa, our negative reactions entail negative emotions. Consequently it comes as no surprise that a lot of research in the field of product and interaction design is dedicated to the study of emotions and feelings (Desmet, 2008; Demir et al., 2009; Thüring and Mahlke, 2007, to name a few), measuring them (Desmet, 2005) and investigating their association with positive and pleasurable experiences (Jordan, 1998; Desmet, 2012). Recently, Desmet (2012) investigated 25 product-evoked positive emotions (e.g., confidence, desire,

fascination, etc.) and their six sources including object-focus, activity focus, meaning focus, etc. With regard to interactive systems, Agarwal and Meyer (2009) argued that emotional responses are central to user's overall judgment of the experience and perceived usability. Mahlke and Lindgaard (2007) similarly linked the perception of instrumental qualities of interactive products (e.g. usability) to emotional reactions.

One of the main concerns in emotion studies is its evaluation. In order to design products and interfaces which generate positive emotional responses, one must be able to understand the nature of these responses. In order to improve those designs, one must be able to evaluate those responses as well (Sacharin et al., 2012). Here we are faced with two issues, first to describe the process underlying emotions and second, to evaluate them.

A number of emotion theories were advanced in the past leading to development of a number of evaluation techniques for measuring emotions. This paper does not intend to provide a comprehensive review of all available emotion theories. Instead, it offers an overview and comparison of two theories that are selectively recognized as useful in the field of design and product development. The first is the model of *cognitive structure of emotions* by Ortony, Clore and Collins (1988) (the model is simply regarded as OCC model in this document) which was further adopted by Desmet and Hekkert (2002) for product emotions. The second is the dimensional model of emotions namely *Circumplex of affect for consumer products* developed by Desmet (2008) as a basis for designing PrEmo (Desmet, 2005), a tool for evaluating product emotions. The aim was to compare the above and determine their similarities and differences.

1.1. Emotions

Before starting a discussion on emotion theories and evaluation techniques, it is important to first establish a definition for emotions. Ortony, Clore, and Foss (1987) provided an operational definition which described emotions as internal, mental states which are elicited when people react to an ongoing situation that is perceived good or bad for their concern. Clore, Schwarz and Conway (1994) mentioned that this characterization is not sufficient because it does not distinguish emotions from other affective states such as moods. They performed an overview of a number of related definitions and concluded that emotions also need to be focused on something (for instance an object, e.g., proud *of* someone, distress *about* something, etc.), deal with present time (rather than future or past) hence short term reactions and that cognitive processes (also known as appraisal) are integral parts of emotions. Later Ortony, Clore, and Collins (1988) defined emotions as valenced reactions (i.e., an affective reaction based on the perceived goodness or badness of things) and asserted that an emotion is determined by how the eliciting situation is understood by a person. This definition and the OCC model that followed categorizes emotions based on their focus (i.e., what emotions are about) and their exclusive appraisal patterns.

A number of researchers emphasized that emotions involve a level of physiological arousal (Russell, 1980, 2003; Ortony, Clore, and Collins, 1988; Yik, Russell, and Steiger 2011). Scherer (2005) have considered emotions as a multi-component phenomenon involving cognitive component, physiological reactions, motivational changes, motor behaviors, and subjective feelings, all of which take part in forming an emotional experience. Sacharin et al. (2012) regarded the feeling component as the central component of emotions which is inherently subjective and accessible through self-reports.

It seems that most researchers agree on some underlying factors of emotion which could be summarized as follows; first, emotions are elicited in reactions to our surrounding environment meaning they have a particular focus, second, they involve subjective feelings that are available to a us on a conscious level, third, they involve an appraisal process, i.e., an assessment of the benefits or harms of the situation for our personal concerns, forth, they involve physiological reactions (e.g. arousal). The OCC model and dimensional theory of emotions each rely on some of these factors in describing emotions and so an overview of these two models is necessary.

1.2. OCC model

OCC model, similar to most cognitive views (e.g. Arnold, 1960; Lazarus, 1966; Scherer, 1984), considers emotions to arise from affective or valenced reactions (i.e., subjective feelings) subsequent

to the appraisal of a stimulus as being beneficial or harmful to one's concern (Ortony, Clore, and Collins, 1988). The model differentiates and categorizes emotions based on their underlying appraisal patterns, i.e., the cognitive structural logics a person employs for evaluating the situation. Those patterns involve the person's focus at the time, their concern, and their appraisal preceding an affective reaction. The main building blocks of OCC model are summarized in Figure 1.

As shown in the model, a person could alternatively have three types of focus which are consequence of events, actions of agents, and aspects of objects. Once one evaluates the significance of those for their personal concern, an affective reaction is elicited resulting in an emotion. Various combinations of these elements create specific patterns demonstrating six main groups of emotions, each comprising several emotions types. All emotion types in a group share the same unique cognitive pattern.

Emotion groups are *fortune-of-others, prospect-based, well-being, attribution, well-being/attribution-compound,* and *attraction*. In total, the model introduces 22 emotion types accounting for all ranges of human emotions. These emotions are introduced each as a representative of a family of similar emotions with various intensities. The reason is that Ortony and colleagues speculated that relying on a list of discrete emotions that is understood by everyone equally is impossible due to language barriers and people's different interpretations of a word. As an example, emotion *happy* may be referred to by other emotion terms for instance cheerful, glad, delighted or other similar terms but they all share the same eliciting conditions. Thus the emotion types used in the model (e.g. resentment, joy, pity, etc.) are meant to represent an emotional experience rather than a lexical or folk taxonomy. The emotion groups are discussed in more details below.

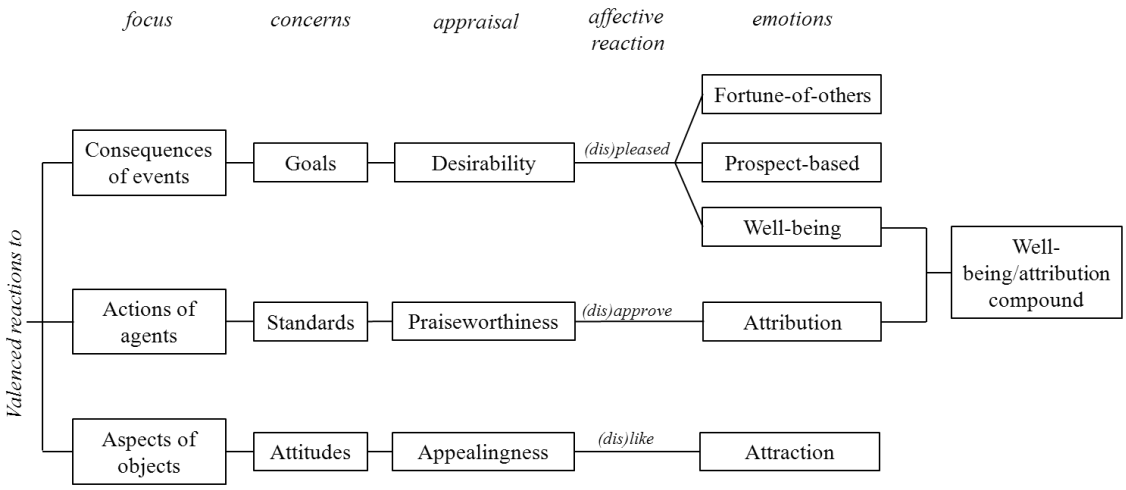

Figure 1. A simple visualization of OCC model (adapted from Ortony, Clore and Collins, 1988)

The appraisal criterion for consequences of event's is their desirability for achieving one's goals. This generates the affective reaction of being pleased (if consequences are beneficial to one's goals) or displeased (if consequences are harmful to one's goals). The resulting emotion groups are, as named and classified by Ortony and colleagues, fortune-of-others (e.g., gloating, pity), prospect-based (e.g., satisfaction, relief), and well-being (e.g., joy, distress). For instance, one's goal (concern) might be to get recognized by his boss upon delivering a 3D render of a model using certain software. The consequence of using that particular software might not turn desirable (an appraisal) as it does not encompass certain shades intended for the final rendering. The person feels displeased (an affective reaction) and the emotion dissatisfaction (in prospect-based group) is generated as his hopes are not confirmed.

Appraising the praiseworthiness of the actions of an agent, evaluated against one's personal standards, results in affective reaction of approving (if actions meet one's standards) or disapproving (if actions do not meet one's standards) and subsequently evokes emotions in attribution group(e.g., pride, shame). The agent here is not always necessarily a human agent and is also understood as

objects in terms of their instrumentality. For instance, a person might disapprove of the actions of a computer software (here, the agent) which does not follow his commands whereas his standards for that type of software is to be responsive and quick. As the result, an emotion of reproach (in attribution group) may be elicited.

OCC model also accounts for the situation where one evaluates the actions of an agent in terms of their consequences, suggesting well-being/ attribution compound (e.g., anger, gratitude) emotion group. This is the case of the simultaneous occurrence of the eliciting conditions for well-being and attribution emotion group. These emotions are not mere compounds of emotions but rather the compounds of eliciting conditions. For instance OCC suggest that the emotion anger (belonging to well-being/attribution compound) is experienced when the eliciting conditions of two other emotions namely reproach (an attribution emotion) and distress (a well-being emotion) are experienced concurrently.

Finally when the aspects of objects are appraised as appealing, affective reaction of liking or disliking is resulted and emotions in attraction group (e.g., love, hate) are evoked. For instance one who finds the visual aesthetic [attitude] of a cell-phone cover appealing, develops a liking for it.

Having distinguished all types of emotions that a person could possibly experience when encountering events, agents or objects, the OCC model introduces some global variables of their intensity as follows: 1) *Sense of reality* (i.e., the degree to which the event, agent or object in focus appear real to the person), 2) *Proximity variable* (representing the psychological proximity of event, agent or object), 3) *Unexpectedness* (different from one's expectations, this represents how unexpectedly one is taken by surprise, either positive or negative), 4) *Arousal* (representing the physiological arousal). According to OCC, each emotion necessarily bears a minimum level of intensity determined by these global variables implying that they are necessary for one to potentially FEEL the emotions (Ortony, Clore, and Collins, 1988). For instance a desirable consequence of an event does not automatically result in an emotion (e.g. joy) unless there is a sense of reality to it meaning that a certain level of intensity is necessary for an emotion to be significant to the person. Consequently intensity variable are best described as determinants of the emotion's magnitude however they do not differentiate one state from another.

OCC as a cognitive theory of emotions imply that there is order to emotions and emotions attend to particular purposes for the human organism which is to adapt to the world, the environment and different situations. For this reason, the model has been employed by other fields as discussed in the next section.

1.3. Influence of cognitive structure of emotions on other fields

OCC model has been very influential in the fields other than psychology. In aircraft cabin design, Ahmadpour et al. (2014) studied the experience of aircraft interior and developed a model for analyzing passenger's emotional reaction during the flight based on OCC model. In computer science Steunebrink, Dastani, and Meyer (2009) adapted the model, differentiating the emotions types furthermore and specifying their underlying hierarchical processes with more details. Their model differs from the original OCC in that they eliminated those branches of the hierarchy which differentiate emotions in terms of one's focus on the consequences of events for self or others. They recognize the significance of the model for building computer systems using emotional reasoning and for incorporating emotions in artificial characters. Moldt and von Scheve (2001) discussed emotional agents in human-computer interaction and extended the physical context of cognitive structure of OCC model to social contexts and introduced *emotional agents* which react based on user's emotional state.

In the field of product design, Desmet and Hekkert (2002) used OCC model to explain emotional responses to the perception of consumer products. They proposed a framework within which products are appraised in terms of their consequences (of events), their agency, and attitudes as such, and generate emotions accordingly. The framework, however, acknowledges those three perspectives on products as relevant only when products are perceived with one of the senses

without physical interaction. The reason for this delimitation, as described by authors, is to be able to go beyond the view point of objects as such. It must be noted that without physical interaction, users could only appraise the *prospect* of consequences of events (e.g. perceived usability rather than experienced usability). Therefore emotional responses are limited to what is commonly regarded as perception of non-instrumental qualities of products, i.e. aesthetic aspects, symbolic aspects, and/or motivational aspects (Mahlke and Thüring, 2007). The study details specific user concerns and gives illustrative examples of the expected emotional responses to each. These are listed in Table 1. For instance Desmet and Hekkert (2002) gave an example as follows: “the thought of using this Kangaroo ball makes me enthusiastic”. According to Table 1, appraising the desirability of consequences of an event (i.e., playing) taking place through the product (i.e., the Kangaroo ball) to attain goals (i.e., having fun), elicits the emotion response of enthusiasm. Other examples are also provided for products as agents and objects.

Table1. Details related to model of product emotions, as described in Desmet and Hekkert (2002)

Stimulus	Concern	Concern types	Appraisal	Emotional response
Product as event	Goal	To be attractive To have fun To be the first	Desirability	Desire Enthusiastic Jealous
Product as agent	Standard	Social standard Design standard	Praiseworthiness	Indignant Disappointed
Product as such (object)	Attitude	Aesthetic attitude Relationship attitude Social attitude	Appealingness	Attracted Appreciate Despise

The elements of this model promise an interesting interpretation of people’s reaction to products, systems or environments. The underlying process of interaction-induced emotions could inform designers to deliberately targeted specific emotional responses or in other words design for emotions. It also enables designers to predict the possible reactions to a product. Indeed further research could create a more comprehensive structure to adapt OCC model in product and interaction design.

1.4. Dimensional models of emotions

The components and dimensions of emotions were the subject of much speculation since the 19th century (e.g., Wundt, 1896). Two dimensions that are commonly proposed to describe emotions are valence and physiological arousal (Arnold, 1960; Lazarus, Averill, and Opton, 1970; Russell, 1980).

The dimensional model of emotions was popularized by Russell’s (1980) model of circumplex of core affect. He suggested that affective states (and psychological states, for that matter) are all related to each other systematically through what is called *core affect* (Russell, 1980, 2003) and emotions are best described as a change in core affect which, in turn, is describable as a point in a space between two bipolar dimensions. One dimension is valence or the intrinsic attractiveness or aversiveness of objects and events, as Frijda (1986) defined it, ranging from pleasant to unpleasant and the other dimension is the physiological arousal, ranging from calm to excited (or activated). Russell (1980; 1989; 2003) pinned a number of prototypical affective states around a circular space between those two dimensions, i.e., a circumplex, representing the variety of core affects. Depicting discrete emotion-related categories (i.e., distinct categories denoted by emotion words, each representing a range of similar emotions) in relation to their dimensions has inspired the design and development of a product-specific model of emotions by Desmet (2002) which is discussed in the following.

Desmet (2002) proposed the circumplex model of core affect for emotional responses to consumer products (see Figure 2). A selection of discrete emotions is positioned around the circumplex to outline the potential reactions to the product’s appearance. The selection process of these emotions involved eliminating irrelevant emotion terms from a pool based on the degree to which they correspond to valence (on a nominal scale of pleasant, neutral, and unpleasant) and arousal (on a

nominal scale of excited, average, and calm). This process gave 24 emotion terms in eight categories of valence and arousal level combination (e.g., excited-pleasant, calm-unpleasant, neutral-excited) which are very confirmatory of Russell (2003) in terms of the selected used terms. The circular model that stemmed from this process was later used to develop a tool, called PrEmo, which uses cartoon characters symbolizing emotion terms in a non-verbal manner (Desmet, 2005).

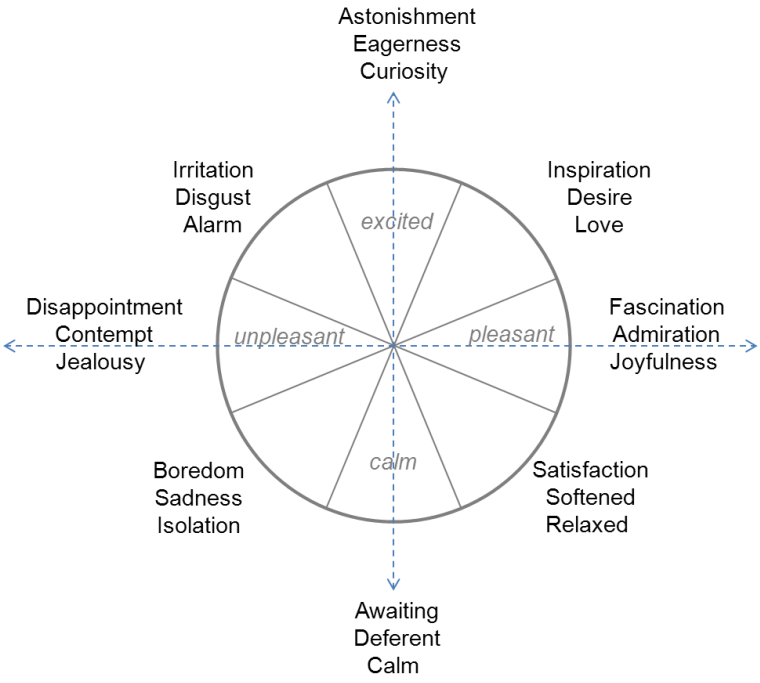

Figure 2. Circumplex of core affect for consumer products (adapted from Desmet, 2002)

2. DISCUSSION

In this section, a comparison is made between OCC model and the circumplex of core affect for consumer products (Desmet, 2002) as a dimensional model. First the similarities and difference between their approaches towards study of emotion are outlined and then a comparison is made with regards to their representation of emotion categories. The aim is to understand how they compare when applied in the field of product and interaction design.

2.1. Similarities and differences of OCC and dimensional models

The major similarity between the models presented earlier is that they all consider emotions to descend from valenced reactions to stimuli or situations. Moreover, they acknowledge the role of arousal in determining emotional reactions in one way or another. Russell (1980) and Desmet (2002) consider arousal as one of the two key dimensions of emotions which could be used to discriminate emotional states to some extent. On the other hand, OCC model recognizes arousal as a necessary condition for emotions which rather gives rise to valence to generate an emotion. The former also accounts for it as a determinant of emotion's intensity, distinguishing among various emotions of a particular type (for instance between fearful, petrified, and scared).

Scherer (2005) argued that arousal dimension in valence-arousal models is relatively fuzzy in definition as it could refer to both the physiological arousal as well as the perceived activation in the situation. He speculated that arousal gives little information about the underlying appraisal of the elicited emotion and proposed to replace it with coping potential which is an appraisal dimension referring to one's perceived control in the situation.

Furthermore, dimensional approach pursued in circumplex of core affect is based on joint features

of emotional reactions (Scherer, 2005) while OCC is based on patterns of antecedent of emotions (Ortony, Clore, and Collins, 1988). This is the fundamental difference between OCC and the circumplex approach of Russell and Desmet. In comparison, OCC model employs causation, attribution and eliciting conditions in order to distinguish emotions while the eliciting conditions or attribution are not directly accessible from dimensional approach. This is likely to be a consideration when choosing an emotion model in product design. A dimensional model might fall short in establishing why certain emotions are elicited. However, when the objective is to identify the generated emotions and their level of pleasantness and intensity, circumplex model brings about a perfect opportunity.

2.2. Emotion representation on OCC and dimensional models

The representation of emotion types on each model could be linked to their sensitivity to language. Ortony et al. (1988) asserted that self-reports of emotions bear a limitation due to innate restrictions of language and our personal reading of emotion words. In addition, it is difficult to control whether a person's use of a certain word corresponds to a feeling or a state. For instance they make an example of the difference between "feeling neglected" and "being neglected". The latter is not an affective state. For that reason, OCC model does not rely on discrete emotion words but rather the cognitive process preceding emotions in order to categorize them. However, the emotion terms on circumplex of affects for products (Desmet, 2002) are discriminated on basis of raters' perception of each word.

OCC employs a cognitive structure to define emotions consistent with the (un)pleasantness of the eliciting condition relative to various concerns (i.e., goals, standards, attributes). This corresponds to the first question in appraisal process as "how beneficial is it relative to the person's concern?" The answer establishes a unique cognitive pattern for each emotion group. However, OCC engages only positive or negative affective reactions in discriminating emotions while leaving neutrally valanced emotions intact. This implies a critical discrepancy between the structural and dimensional points of view. Structural models necessitate positive and negative valence as two basic affective reactions, deviation from which accounts for differentiation of more complex emotions. Dimensional models (such as circumplex of affects by Desmet, 2002), on the other hand, address two neutrally valenced emotion groups namely excited (consisting emotions curiosity, astonishment and eagerness) and calm (consisting awaiting, deferent and calm).

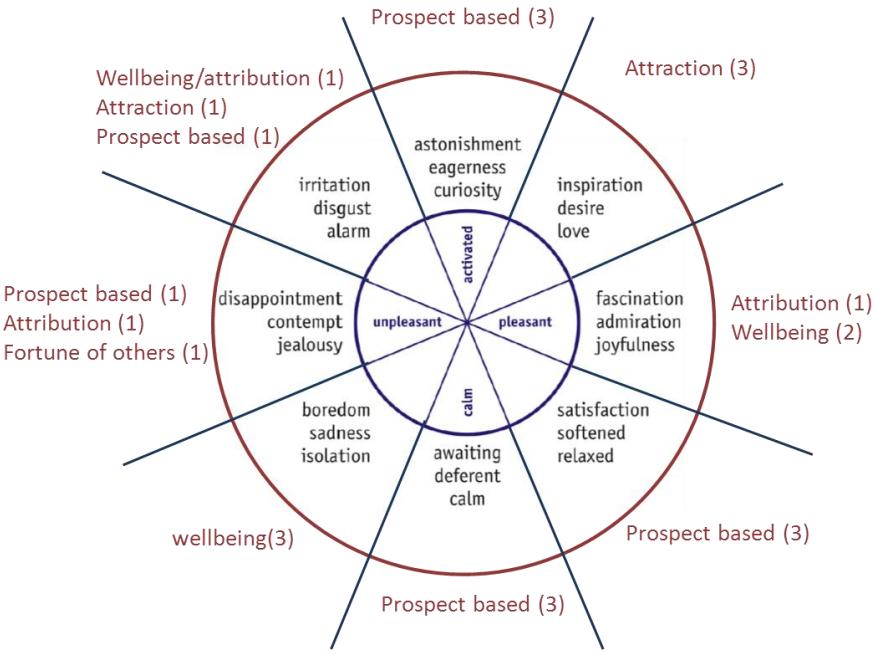

Figure 3. A rough projection of emotion groups of OCC on the circumplex of affect for products (Desmet, 2002). The number of emotions in a section of Desmet's circumplex that fall into an emotion group of OCC are shown

in parentheses. For instance all three emotions on the top section (highly excited-neutrally valenced emotions) fall into prospect based emotion group, hence number (3) is indicated.

To compare the representations of various emotion groups that emerge from the two abovementioned takes on emotion categorization, a comparative study is performed. A rough projection of emotion groups as described in OCC is conducted on the circumplex of affect for products (Desmet, 2002), as shown in Figure 3. The emotion groups from OCC that correspond to each of the eight sections on the circumplex are specified. A discussion of the comparison follows.

Each of the 24 emotions on the circumplex of product emotions was compared to the emotion types provided by Ortony, Clore and Collins (1988) and the emotion group to which they belonged was identified. For instance emotion satisfaction was found under prospect-based group and jealousy under fortune-of-others. In Figure 3, the numbers of emotions that fall within the specified groups are shown in front of them. For instance all the three highly excited-neutrally valenced emotions on top of the circumplex belong to prospect-based group.

Furthermore, the numbers of emotion types in each group are compared for OCC and circumplex of product emotion and summarized in Table 2. Prospect based group contains the highest number of emotions in the circumplex with 11 emotions while there are only four of those emotions on OCC. This is followed by well-being group with five emotions on the circumplex and two on OCC model. Fortune-of-others and well-being/attribution-compound each contains one emotion on the circumplex which makes them the least represented groups.

The study by Desmet was originally performed to elicit emotions generated by products' appearances. Considering this fact and the prominent presence of prospect-based and well-being emotions on the circumplex, it appears that people judge the personal benefits of using products (consequences of events for self, in OCC terms) by their appearance. The eminent presence of attraction emotions also confirms this, proving the effect of visual aesthetics (as a product aspect) on attraction.

Table 2. Comparison of emotions groups as represented on OCC model and circumplex of core affect for consumer products (Desmet, 2002)

Emotion group from OCC	**No. of emotion families mentioned in Circumplex of product affect (Desmet, 2002)**	**No. of emotion types in each group on OCC model**
Fortune of others	1	4
Prospect based	11	6
Well-being	5	2
Attribution	2	4
Well-being/attribution compound	1	4
Attraction	4	2
Total	*24*	*22*

Moreover, certain prospect-based emotions on the circumplex fall within excited-neutral (e.g. astonishment) and calm-neutral (e.g. calm) suggesting that pleasantness does not account for emotions within this group while arousal does. On the other hand, OCC clearly described all emotions as valenced reactions (i.e. positive or negative reactions to stimuli) and considered arousal as a global dimension for all emotions types and groups. In particular, prospect-based emotions are regarded by OCC as the result of evaluating the pleasantness of the consequences of an event when relevant to one's prospect. For instance the emotion relief (similar to calm on the circumplex of Desmet) is experienced due to finding consequences of an event a pleasant when it is relevant to one's expectations.

The above differences between the two models suggest that attempts towards analyzing and

evaluating emotions should be performed cautiously and with great consideration for the context. While OCC model elucidates the structural logic of emotions and why they were emerged in variety of situations, it requires more time and analysis. The circumplex of product emotion by Desmet, however, paints an accessible picture of emotional reactions but bears some limitations including its reliance on product appearance as the informant of emotions. Although giving partial information about how and why a certain emotion is evoked, the circumplex model is a valuable tool to compare and benchmark the emotional response to products or interactive systems, compare them with the design objectives and examine whether the product evokes as much valence and arousal as was initially intended.

3. CONCLUSION

This paper showed that both the OCC and dimensional models view emotions as valanced reactions but they have some differences regarding emotion representation. OCC essentially adopts the appraisal process as the necessary condition for emotions and puts an emphasis on the cognitive structures preceding emotional experiences whereas the dimensional model describes discrete emotions in relation to two dimensional references and is thus sensitive to the selection process and context. As the result, prospect-based and well-being emotions have stronger presence in dimensional model.

The result suggests that the choice of method or model for investigating emotional evaluation to products, should take into account the pursued design approach and convoy a clear plan for integrating the findings into the design process. The OCC model could potentially uncover the conditions that elicit the emotions and consequently shed light on their context. This information could inform the changes that should be implemented into the design in order to serve that context. The dimensional model described the nature of emotions and could inform the design efforts in terms of user experience.

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BIOGRAPHY

Naseem Ahmadpour is Ph.D. candidate in Human Factors at the Department of Industrial Engineering, Polytechnique Montréal, Canada. She has received her M.Sc. in Human Factors from Chalmers University of Technology, Sweden. Her doctorate research is titled "aircraft passenger comfort experience and wellbeing" for which she collaborates with Bombardier Aerospace. Keen

about understanding human responses to the social and environmental inputs, her goal is to develop a theory of comfort that accounts for various aspects of passengers' experience. As part of her research, she employs the principles of cognitive structure of emotions to study the appraisal patterns of passengers' emotional responses to the contextual elements.