MEASURING EMOTIONAL STATES AND BEHAVIORAL RESPONSES TO INNOVATIVE DESIGN

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ABSTRACT

Because it is often what people see first, design is a particularly relevant feature for evaluating objects especially those with an innovative design. Research has shown that perceived visual appeal and perceived prototypicality generate cognitive and affective states which give direction to users' behavior. Using the Stimulus-Organism-Response model, this study investigates how design triggers emotions and emotional behaviors, in this case approach-avoidance and action readiness. Participants observed two objects of innovatory design – an interactive terrestrial globe and a non-touch tablet – and rated their visual and haptical experience with a questionnaire measuring visual appeal and prototypicality and evaluating their emotions and action readiness. Results indicate that the perception of an innovation is very complex. On the one hand innovation focuses attention and interest but in the other side it triggers avoidance behavioral intentions. These findings highlight the ambivalence of innovative design and suggest measuring not only approach-avoidance but also another action readiness mode that focuses on emotional behavior likely to be induced.

Keywords: emotional design, action readiness, innovative product, S-O-R framework, approach-avoidance behavior.

INTRODUCTION

When people look at an object, they firstly evaluate form and appearance. Before using it, they know if an object is good or bad (Norman, 2004). Moreover, this subjective experience will determine their perceptions of how it works and finally if they will buy it or not (Hollins & Pugh, 1990). Aesthetic features significantly influence the commercial success of the mass market (cf. Meyers-Levy & Tybout, 1989). Hence people trigger a first evaluative process from their aesthetical perception and generate both attitudinal and behavioral responses following these assessments (Hong & Wyer, 1998; Ko, Sung & Yoon, 2008). Thus design provides visual cues which activate cognitive patterns to interpret object meanings. However sensory experiences influence cognitions as well as emotions (Rafaeli & Vilnai-Yavetz, 2004). Cognitions and emotions shape the induced behaviors in the interaction with objects (Rindova & Petkova, 2007). For Leder, Belke, Oeberst & Augustin (2004) these appropriation processes were triggered by design features such as complexity and symmetry.
Users' evaluations research suggests a primacy of emotional processes on cognitive ones (Coates, 2003; Crilly, Moultry & Clarkson, 2004). Therefore, given technological innovations and constant development of new products, a key to the commercial success of innovations lies in the analysis of users' process and behaviors (Cooper & Kleinschmidt, 2000).

INNOVATIVE OBJECTS

An innovative object is a combination of technological and esthetical features that affect consumers / users when they see it as new. When uses significantly differ from those triggered by existing products then a new technological feature is innovative.
Aesthetic novelty is related to stylistic criteria and is designed to meet non-functional requirements. Under this definition an aesthetic change is considered as innovative if it includes innovative changes in the object's formal structure (Alcaide-Marzal & Tortajada-Esparza, 2007).The operationalization of innovation assessment is based on users' reactions analysis

during their interactions with objects but few studies were focused on users' triggered processes. Among these studies, three stimulus categories can be distinguished: first the written descriptions (e.g. Olshavsky & Spreng, 1996; Hoeffler, 2003), second the visual representation like drawings, pictures and 3D modeling (e.g. Blythe, 1999; Ziamou, 2002; Leder & Carbon, 2005; Lee, Ha & Widdows, 2011; Blijlevens, Gemser & Mugge, 2012), and third experimentations with real products. Nevertheless studies with real innovative products are isolated because innovations are difficult to implement and to publicize.

ISSUES OF THE PERCEIVED DESIGN: VISUAL APPEAL AND PROTOTYPICALITY

A robust finding in the literature shows an increase of participants' activation and attention when experimenting a novel or complex stimulus (see for example Berlyne 1974; Wohlwill 1976). Users will focus on new features, but only if they have knowledge to understand these features and to make effective choices (Kaplan, 1987; Laroche, Richard & Nepomuceno, 2010).

Among the design features, design visual appeal and prototipicality are major cues for users' evaluations. The visual appeal refers to aesthetic perception of conception factors such as color, shape, proportion, and materials (Bloch, 1995). The typicality or prototypicality is a measure of how an exemplar symbolizes a category (Veryzer & Hutchinson, 1998). The main emotional and cognitive triggered processes are based on an assessment of visual appeal and prototypicality (Mandler, 1982). However, innovations may not match with visual expectations because there may be a gap between these expectations and the typical exemplars. Innovations mismatch with existing schemes because basic innovative features are difficult to conceive instead of common features (Griffith, 1999). This degree of mismatch on visual appeal and prototypicality dimensions with the existing schemes ranged from very low (i.e. almost complete familiarity) to very high (i.e. total dissimilarity). According to these assumptions, levels of mismatch have cognitive and emotional consequences. For example the more an object is innovative, the harder it is for users to understand and appreciate its value. Therefore, to Meyers-Levy and Tybout (1989), when a product is slightly different from a prototype, users' feedback becomes more positive. Their results reveal that users' feedback depends on comparisons with other similar objects. In other words, activation and desire to explore an innovative object occur when there is a moderate incongruity with similar objects available in memory (Mandler, 1982; Frijda, 2000). Thus innovations are likely to trigger strong emotions (Larsen & Diner, 1992) and visual influences of appeal and prototypicality must be investigated.

MODIFICATIONS OF EMOTIONAL STATES

During assessment processes, users shape their attitudes on the perception of innovative features (e.g. design features) whether they are favorable or unfavorable (Fishbein & Ajzen, 1975). These attitudes can be split into multiple underlying dimensions. For example pleasure and activation dimensions describe the emotional reactions to a stimulus (Russell, 1979). This consideration was supported by empirical studies (Donovan & Rossiter, 1982; Baker, Levy & Grewal, 1992; Ward & Barnes, 2001). Pleasure refers to the degree to which a user feels good, happy, and satisfied with the object, whereas the activation measures arousal or stimulation states in this interaction.

Studies (e.g., Adams, Ambady, Macrae & Kleck, 2006) confirm that emotions can be distinguished in interactions (Jordan, 2002; Norman, 2004; Kulviwat, Bruner, Kumar, Nasco & Clark 2007; Mahlke, 2008). Influence of users' affective states has been illustrated in the experiential model of consumer behaviors (Holbrook & Hirschman, 1982; Hirschmann, 1983; Bitner, 1992). For example a negative emotional reaction may happen when the perceived novelty of an innovation triggers bewilderment perceptions that may stimulate particular fears such as perceived adoption risks (Swanson & Ramiller, 1997). Conversely, marketing research reveals that novelty can also promote positive emotional reactions such as pleasure (Cox & Locanda, 1987) and interest (Mukherjee & Hoyer, 2001) which drive behavioral intentions.

BEHAVIORAL IMPLICATIONS

Despite disagreements on the nature of emotions and emotional expressions, most researchers agree that emotions convey basic information that may influence

users' behaviors (e.g., Izard, 1971; Ekman, 1973; Fridlund, 1994; Frijda & Tcherkassof, 1997; Russell, 1997). Emotions and especially positive emotions are able to influence behavioral action readiness directed to an object (Petty, Desteno & Rucker 2001; Rindova & Petkova, 2007). Moreover positive emotions may trigger playful behaviors, willingness to approach, to explore new objects, and to consider future experiences (Fredrickson, 1998, 2001). For example, joy triggers desire to play and to be creative. Overall, positive emotions stimulate exploratory behavior, broaden the scope, and open new ways to experiment object interactions (Daubman & Nowicki, 1987; Kahn & Isen, 1993; Watson, Wiese, Vaidya & Tellegen, 1999).

However these behavioral responses are mostly investigated in the approach-avoidance framework whereas qualifying behavioral intention at a narrower level could be more precise. Thus, data suggest that behavioral intentions can be described as a combination of action readiness modes (Frijda, 1986; Frijda, Kuiper and TerShure, 1989) triggered by emotional states. For example, moving away and rejecting are avoidance's typical action readiness modes.

FRAMEWORK

A modeling of users' process was formalized by Lee, Ha and Widdows (2011) who related features characteristics, emotions, and behaviors. In this study we choose to investigate a similar framework. This study is based on the « stimulus-organism-response » (S-O-R) model (Mehrabian & Russell, 1974) whereby when people assess a stimulus (S), they develop specific internal states (O), which will drive their behavioral responses (R). In other words, the stimulus (e.g., an innovative object) triggers users' cognitive and affective states, which drive behavior in their use (Figure 1). Carver & White (1994) have developed a measure of behavioral and activation inhibition to deepen the fundamental rules of behavior and the link with objects assessment. In that way previous marketing studies describe how use situations trigger approach-avoidance behaviors (e.g., Baker, Levy & Grewal, 1992; Bloch, 1995; Jang & Namkung, 2009). Thus the S-O-R model describes approach-avoidance behaviors as a result of internal processes (Donovan & Rossiter, 1982). Applying the S-O-R model, this study expects that the innovative design of objects (stimuli) triggers cognitive and affective internal changes (organization) driving not only approach-avoidance behavioral intention but also overall action readiness response.

METHOD

According to our hypotheses, emotional and behavioral responses will be different depending on whether products display an innovative or a traditional design. Thus participants were confronted to different products and they self-reported their user experience with these products.

PARTICIPANTS

53 undergraduate students (6 males and 47 females) participated in this study (age *M* = 20.4; *SD* = 2.4).

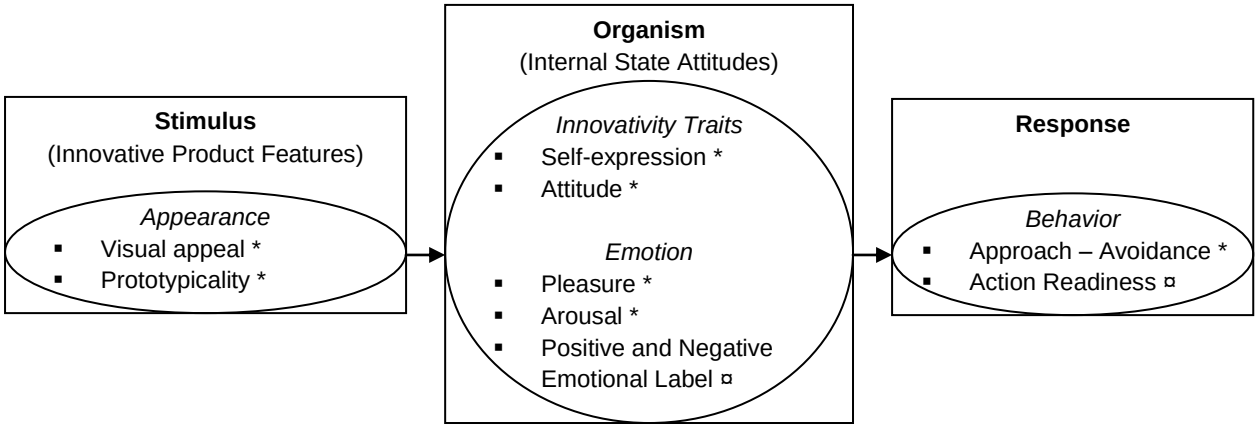

*Figure 1. The conceptual model derived from Lee, Ha and Widdows (2011). Originally used scales are indicated with *, new scales are indicated with ¤. Scales used are taken from the following studies: Innovativeness (Moreau, Lehmann, & Markman, 2001); Visual appeal (Mathwick, Malhotra, & Rigdon, 2001; Tsikriktsis, 2002); Prototypicality (Campbell & Goodstein, 2001); Self-expression (Nysveen, Pedersen, & Thorbjørnsen, 2005); Attitude (Bennett & Rundle-Thiele, 2002); Pleasure and Arousal (Mazaheri, Richard & Laroche, 2011); Emotional Label (Lee, Lee, Lee & Babin, 2008); Approach –Avoidance (Donovan & Rossiter, 1982); Action Readiness (Frijda, Kuipers & Terschure, 1989, see also Tcherkassof, 1998 for a French translation).*

MEASURES

In order to evaluate influences of aesthetic prototype on emotions and behavior, we used the questionnaire elaborated by Lee, Ha and Widdows (2011) with some extensions as emotional labels and action readiness scales. All items are 7-point scales except a 5-point for emotional labels (e.g. *After the discovery of this design, I feel: Annoyed–pleased*; *Unhappy–happy; Dissatisfied–satisfied*…) and a 3-point scale for Action readiness (e.g. *This design stirs up a tendency to approach, to make contact*). The Table 1 describes labels use for emotional scales and the Table 2 describes items use for approach and avoidance measures.

Arousal	*Relaxed–stimulated*
	Calm–excited
Pleasure	*Unhappy–happy*
	Annoyed–pleased
	Dissatisfied–satisfied
	Despairing–hopeful
Negative emotion	*Bored*
	Angry
	Sleepy
	Annoyed
Positive emotion	*Happy*
	Energetic
	Excited
	Peaceful

Table 1. Labels used for dimensional and categorical emotional measures.

Approach	*I want to use this product*
	I want to spend time with this product
Avoidance	*I want to avoid this product*
	I will try to not use this product

Table 2. Items used for approach and avoidance measures

Stimulus

Innovative products were evaluated on their designed appearance with three 4-item scales: perceived innovativeness, visual appeal perceived, and prototypicality scale. Perceived innovativeness and visual appeal items were measured by the participant agreement with sentences on Likert scales. The prototypicality was assessed by semantic differential items.

Organism

The overall participant self- expression and attitude for innovativeness were also measured both with a 4-item scale. The measure of pleasure and arousal was assessed with a 6-item semantic differential scale but in order to deepen emotional assessment made by Lee et al. (2011), we chose to include an 8-item scale measuring participants' emotional feeling by their accordance with emotional words such as bored, angry, sleepy and annoyed for negative emotions and happy, energetic, excited and relaxed for positive ones.

Response

Approach-avoidance behaviors were measured with 4 items. In order to extend the behavioral evaluation we also used a 29-item action readiness scale.

MATERIAL

In order to test our claim, that innovative products elicit emotions and behavior, we chose two object categories to compare participants' reactions. These objects were either innovatively or traditionally designed.

Innovative Stimulus

The innovative object is *Phileas* (Figure 2), a prototype of a digital globe designed by the *Innosens Design Lab (*www.innosens-design.com*). Phileas* is a new generation of smart terrestrial globe.

Figure 2. An example of innovative designed products with Phileas

Using the concept of augmented reality, the minimal surface area of the world is revealed through a virtual digital display. This design was rewarded by getting a distinction in the Design Observer 2011 Congress by

the French Agency for the Promotion of Industrial Creation. Here we used an aesthetical prototype version in order to not influence participants' experience with an innovative working.

Traditional Stimulus

Related to *Phileas* we chose to study a traditional globe with similar function (e.g., they both provide geographic information) and similar interactions to the user (e.g., touching the globe to access to information). The globe we have chosen is a very commonly designed globe with a plastic pedestal and with common colors (Figure 3).

Figure 3. An example of a traditional designed product with a common terrestrial globe.

PROCEDURE

Participants were recruited to participate in product assessment research. They were welcomed into the experiment room, then the experimenter gave them the instructions and they were left alone with one product depending on conditions. From this moment they had to explore the product visually during 2 min and then to explore it haptically during 5 min. Finally participants were asked to fill in a questionnaire concerning product attributes, internal states of attitude, pleasure and arousal, approach- avoidance behavior and action readiness, and demographics. Participants completed the questionnaire based on their visual and haptic experience with the product.

RESULTS

INNOVATED FEATURES

As expected, results indicate a difference between the perceived innovation of *Phileas* and the traditional globe (Table 3; $t_{(52)} = 2.87$; $p < .01$). Surprisingly participants perceived *Phileas* as attractive as the traditional globe but results show a significant difference for the item *"this object displays visually appealing design"*. Finally as expected they strongly saw *Phileas* as more different from other globes than the traditional globe ($t_{(52)} = 4.15$; $p < .01$).

	Innovation		Visual Appeal		Non Prototypic	
	M	*SD*	*M*	*SD*	*M*	*SD*
Tg	2.69	1.31	4.9	1.4	2.9	1.45
Ph	3.55	1.26	5.31	1.12	4.14	1.12
t	2.87**		1.61		4.15**	

*Table 3. Results for Innovation, Visual Appeal and Non Prototypic for the traditional globe (Tg) and Phileas (Ph). ** means p < .01*

ATTITUDES AND EMOTIONAL STATES

Regarding participants attributes, as expected their personal innovativity trait scale and self-expression scale did not reveal any difference between the two groups. These results reveal that attitude toward innovation is consistent in interactive situations. Concerning emotional scales, there was no difference in pleasure and arousal (Table 4) except for the *Despairing–hopeful* item (Ph: $M = 4.81$; Tg: $M = 5.6$; $t_{(52)} = 2.82$; $p < .05$).

According to our hypothesis, we expected that *Phileas* would trigger more emotional states than the traditional globe. Results are ambivalent because on the one hand there is no difference with negative emotion but on the other hand there is an underlying difference with positive emotions ($t_{(52)} = 1.95$; $p < .07$). Specifically the emotional label scale reveals that participants with *Phileas* tend to feel less happy, less energetic and less relaxed.

	Pleasure		Arousal		Neg_Emo		Pos_Emo	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Tg	5.05	1.06	4.3	1	1.28	0.32	2.71	0.5
Ph	4.65	1.13	3.96	1.36	1.36	0.57	2.47	0.64
t	1.73		1.48		1.15		1.95	

Table 4. Results for Pleasure, Arousal, Negative Emotions and Positive Emotions for the traditional globe (Tg) and Phileas (Ph).

APPROACH-AVOIDANCE BEHAVIOR AND ACTION READINESS

In agreement with previous research we suggest that an innovating design significantly triggers more behavioral intentions than the traditional globe. Behavioral responses were measured by approach, avoidance, and action readiness (Table 5).

Regarding the approach scale there is no difference between the *Phileas* group and the traditional group. Nevertheless results indicate a significant difference between the two groups for avoidance intentions ($t_{(52)} = 3.16$; $p < .01$).

	Approach		Avoidance		Action Readiness	
	M	*SD*	*M*	*SD*	*M*	*SD*
Tg	4.17	1.77	1.8	1.32	0.4	0.16
Ph	3.75	1.69	2.98	1.86	0.41	0.16
t	1.35		3.16**		0.88	

*Table 5. Results for Approach, Avoidance, and Action Readiness for the traditional globe (Tg) and Phileas (Ph). ** means p < .01*

Finally the action readiness scale did not reveal any difference between groups. However we can point out several underlying differences for some items like "*to be strained, contracted*", "*to be exuberant*", "*to be excited, to be unable to keep still*", "*you off from the outside*", "*to control the situation*", and "*boiling inside*".

DISCUSSION

Following the assumption that visual experiences of innovative objects might trigger stronger emotional state and behavioral responses we experimentally compared the perception of two terrestrial globes. The first one is a traditional globe (control group) and the second is an innovating designed one called *Phileas* (experimental group).

Results reveal that the perception of an innovation is very complex. For example, even if *Phileas* is perceived as very innovative and original, it is not perceived as visually appealing compared to the traditional globe. These results confirm the assumption of Meyers-Levy and Tybout (1989) that an object must not be too different from the standard – here a traditionally globe – to avoid the risk to be incomprehensible revealed by negative emotions and avoidance tendencies.

Concerning emotional states triggered by *Phileas*, data show that participants feel more negative emotions than positive ones. This can be explained by the non-functioning of the object because participants can be frustrated when confronted to an innovative object but unable to make it work. Nevertheless the use of an aesthetic prototype was necessary to evaluate design only. Another way to understand these results consists in analyzing the comparison between *Phileas* and the traditional globe. Contrary with *Phileas*, participants access directly to geographic information whereas they cannot with *Phileas*. This contradiction may induce a feeling of uncontrollability (Choi & Mattila, 2008) and incompetence (Mittal, 2006).

Even when asked to consider design assessment, participants use the functionality of the traditional globe to give their emotional responses and their behavioral intentions. To Mahlke (2008) emotional feelings are not only elicited by the perception of non-instrumental qualities such as aesthetic, symbolic and motivational aspects but also by the perception of instrumental qualities such as usefulness and usability.

A perspective of future work can be to compare both *Phileas* as aesthetical prototype and as functional prototype with a traditional globe. Our forthcoming studies will aim to test the interactive dimension of the object in its use. We will compare objects that require a touch interaction (e.g., *Phileas*) with other objects requiring a non-touch interaction as a designed non-touch pad with optic-sensors.

Finally we observe not only a strong avoidance response to *Phileas* but also many underlying action readiness. Even if these results deserve more participants to consolidate them, behavioral measures are very encouraging. Just as an emotional measure can be assessed by two dimensions – pleasure and arousal – a behavioral measure can be considered with an approach-avoidance dimension and another perpendicular dimension such as willingness to internalize-externalize behavioral response to innovative products. However further studies are necessary to investigate this hypothesis.

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