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Bottle Shape Elicits Gender-Specific Emotion: A Startle Reflex Modulation Study

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Abstract: Does a bottle elicit a gender-specific emotion response that varies as a function of its shape? The answer to this question is of basic interest as well as of specific interest to the industry. We introduced startle reflex modulation to objectively measure emotion-related aspects of different bottles. This approach was chosen to complete behavioural data with objective physiological data. Three bottles differing only in shape were used as test stimuli. It is well known that the magnitude of an eye blink as a response to acoustic startle stimulation reflects current emotion elicited by a foreground stimulus. Reduced eye blink amplitudes reflect positive emotion, whereas enhanced eye blink amplitudes reflect negative emotion. No significant main effect of bottle shape on eye blink amplitudes was found, but a significant gender effect occurred for one specific bottle shape. Presentation of a medium-sized, polygonal bottle was associated with significantly larger eye blink amplitudes in male participants compared to female participants. We interpret that due to the nature of startle reflex modulation this particular bottle shape elicited a significantly more negative emotion in males than in females. Interestingly, although both genders rated this bottle least attractive only males demonstrated increased negative emotion as assessed with startle reflex modulation. It is difficult to further interpret this finding at this stage, but we discuss it in terms of providing evidence that startle reflex modulation is sensitive to subtle emotion-related differences of different bottle shapes. Thus, this method may become an important tool for product evaluation procedures. We can only speculate on what the gender effect means in terms of psychology. A link between emotion and the appreciation of aesthetics can be made.

Keywords: Unbiased Emotion; Bottle Shape; Gender Difference; Startle Reflex Modulation

Introduction

The role of emotion in the appreciation of aesthetics is unclear, which seems mainly due to neglecting objective (unbiased) measures of emotion in this context. Usually, subjective preference is recorded, which can be biased and thus distort pure emotion-related effects. Our study aimed at demonstrating that objective and unbiased measures can be taken to show gender-specific emotion-related differences related to different bottle shapes. In addition, we aimed at finding a discrepancy between self report and objective measures like it has been found in other previous studies (see later).

Imagine a man buys a bottle of wine for dinner. His choice falls on the one, which in his opinion has the most attractive design since he has no knowledge about wines whatsoever. At home his partner is not only disappointed about the wine, but also asks him if he couldn't have bought a bottle with at least a pretty design. Does this ring a bell? This anecdote highlights well-known variable aspects of perception (and/or the appreciation of aesthetics), which, inter alia, influence human preference (Holbrook & Schindler, 1994). It seems obvious that even the design of a bottle can be evaluated in different ways depending on various factors including the perceivers' gender.

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For the present study we translated this everyday experience into an empirical investigation and focussed on gender-specific objective measures of emotion elicited by differently shaped bottles. In addition, seeing things from a product developers' perspective, we thought it could be useful for marketing and brand management to gain more information about objective design preferences in comparison to usual subjective preferences, which can be biased.

Cognitive aspects play a big role regarding preferences, but in the frame of the present study we focus on emotion-related aspects. While emotion has certainly always been an important topic to investigate, also with respect to product design, it has been very frequently neglected that basic aspects of emotion may not be conscious and more importantly, they may not be accessible to consciousness while still influencing behaviour (see Walla et al., 2002; Walla et al., 2003; Winkielman & Berridge, 2004; Walla, 2008). Explicitly stated answers to questions about subjective preference may not result in reliable information regarding basic rather non-conscious emotion aspects. Although we still lack reliable verification that non-conscious aspects of emotion are better predicting human emotion-based behaviour, there is reason to believe that this is so to a certain extent and under certain circumstances.

Regarding gender differences emotion research revealed

various significant findings (Biele & Grabowska, 2006; Wager et al., 2003). Besides behavioural differences related to emotion perception also different brain activity patterns were found between males and females (Cahill et al., 2001; Cahill et al., 2004; Killgore et al., 2001). Thus, there is reason to expect a gender-specific effect even when emotion elicited by differently shaped bottles is the question of interest. To the best of our knowledge, this question has never been answered yet, especially not by using an objective approach.

In previous studies, qualitative data such as asking for preferences via questionnaires or verbal associations via keyword listings have been used to quantify human emotion or subjective preferences. So far, only a few reports are available demonstrating the usefulness of objective measures during the perception of or during the interaction with actual products (Laparra-Hernandez et al., 2009; Jenkins et al., 2009; Walla et al., 2010; Geiser & Walla, 2011).

In particular, previous findings (Bradley & Lang, 2000) have provided evidence of objective ways to measure emotion by using startle reflex modulation and more recent evidence has been published that self reported emotion does not always match objective measures of emotion (Walla et al., 2010; Geiser & Walla, 2011). In other words, biased emotion valence can be different from unbiased emotion valence even as responses to the same stimulus. It is this discrepancy together with the motivation to study gender differences that is of special interest here. To collect subjective data (biased emotion aspects) we planned to record self reported preference data and among several available objective methods to measure unbiased emotion aspects we decided to use startle reflex modulation. It offers insight into aspects of emotion that are not contaminated by factors such as arousal and/or cognitive interference and thus provide an excellent new approach to evaluate emotion aspects related to commercial products.

Startle Reflex Modulation

The first startle reflex research was conducted with pistol shots and high-speed motion pictures Landis and Hunt, 1939) in animal populations, mostly rodents. Subsequent research revealed that the magnitude of the human startle reflex varies as a function of emotion valence (Bradley et al., 1990; Vrana et al., 1988). Since this discovery, a large number of papers have been written reporting about related findings. In principle, the startle reflex is a defensive reflex to sudden aversive noises. It is meant to be an automatic protection mechanism of the organism against potential danger, comparable to the behaviour of avoidance (escape). Most strikingly, an enhanced startle response during any simultaneous foreground stimulation reflects a negative emotion being elicited by the foreground stimulus, compared to a reduced startle response which reflects positive emotion during foreground stimulation. To date, numerous investigations have been conducted using startle reflex modulation to define emotion aspects; however, this method has been largely neglected in applied settings, such as product evaluation and marketing. Only recently, Walla et al. (2011) showed that it can be used to define emotion aspects related to brand attitude without demanding any explicit responses from study participants (that are usually cognitively polluted; biased). This is particularly interesting with regards to an important methodological issue. It was initially found that foreground stimuli need to be above a certain arousal threshold (Cuthbert et al., 1996) for startle reflex modulation to be sensitive to changes in valence related to them. Although brand attitude as in reading visually presented brand names is associated with rather low levels of arousal, startle reflex modulation was obviously sensitive enough to detect significant valence-related differences reflecting like and dislike related to brands. In addition, valence-related differences were also found during food intake (Walla et al., 2010), during walking through different virtual urban environments (Geiser & Walla, 2011), and during driving through virtual tunnels (Muehlberger et al., 2008) and during viewing gradually increasing anger in facial expressions (Dunning et al., 2010) by using startle reflex modulation. Thus, there is reason to believe that varying emotion aspects of foreground stimuli such as different bottle shapes can be detected via this method as well. However, to increase the chance to detect significant valence-related differences between different bottle shapes we used emotion images (true A4 colour prints) displayed in the background in order to increase the level of arousal. Participants were told that emotion images are displayed in the background while they hold each bottle in their hands to inspect and experience it. No attention had to be paid to the emotion images during this session of the experiment.

However, in a separate experiment, the emotion images (one positive and other negative) were also used without simultaneous bottle exposure to test whether our mobile recording device reliably detects valence-related differences through startle reflex modulation in a usual setting.

After all, the main goal of the present study was to take a closer look at emotion aspects related to the perception of different bottles and to detect gender-related differences. To test our hypothesis, we chose bottles with varying shapes, but same colour and material. To allow for a comparison between males and females, we ensured that the study group included equal numbers of male and female participants.

Method

Participants

Data from 16 university students from different fields were taken to test the hypothesis that different bottle shapes elicit different emotion responses (8 female, 8 male). They were between the age of 20 and 30 years (mean age = 24.88; SD = 2.8). All were right-handed and reported to have no history of neurological or psychological disorder.

Stimuli

Main foreground stimulation comprised 3 different bottles made of transparent glass (see **Figure 1**). These differed only in shape and size. One bottle was short and pyramid-shaped with 4 edges and a normal neck, another bottle was slightly taller and with 4 parallel edges and a normal neck and the third was an even taller, pyramid-shaped bottle with 3 edges and a normal neck. The participants got one of these bottles at a time and were instructed to touch and interact with it for 5 minutes.

In addition, we used two images, one emotionally negative (accident victim) and the other emotionally positive (smiling woman), to test and confirm the reliability of our method with respect to its sensitivity related to different emotion valences (both compared to a neutral condition where only a fixation cross was presented). These images were color prints (A4)

Figure 1.
Bottles: Short pyramid-shaped (1), tall with parallel edges (2) and tall pyramid-shaped (3).

placed in front of all study participants. This was done independent from any bottle presentation.

Furthermore, we used these images to increase the level of arousal during bottle presentation. This idea is based on the fact that it has been shown that startle reflex modulation works best for higher arousing foreground stimuli (Cuthbert et al., 1996). This was done although it has already been shown that even the intake of different food (Walla et al., 2010), walking through different virtual urban environments (Geiser & Walla, 2011) and reading different brand names (Walla et al., 2011) elicit valence-related differences that can be registered via startle reflex modulation.

However, all bottle-related data were analysed across emotion images to focus on effects related to differences in bottle shape only. As a result of this procedure, each bottle was given to the study participants three times, each time with a different background emotion image (pleasant, neutral and unpleasant).

The startle stimulus was a 50ms burst of acoustic white noise delivered via earphones at a sound pressure level of 105 dB (Walla et al., 2010). Sound pressure level was measured with a mobile measuring device (produced by Voltcraft). To achieve respective loudness, a commercial headphone preamplifier was employed (Behringer; MicroAMP HA400).

Startle Response Measurement

Physiological measurements were taken with a 10-channel mobile recording device (Nexus10 from Mind Media BV). Using bipolar electromyography (EMG), muscle potential changes of the musculus orbicularis oculi of the left eye of every study participant were measured and stored on the hard drive of a laptop computer. We used a dual channel electrode cable with carbon coating and active shielding technology for low noise and an additional ground electrode cable attached to the right cheek. The EMG sampling rate was 2048 per s. A band pass filter from 20 Hz to 500 Hz was applied during online recording. Raw EMG data were then recalculated by using the root mean square (RMS) method (epoch-size = 1/16 s) to transform EMG signals into amplitudes. The resulting amplitudes were then subjected to statistical analysis.

Questionnaires

The participants were also asked to complete a simple questionnaire related to subjective bottle preference. This was done to also have their self reported subjective preferences regarding all three bottles (biased emotion).

Procedure

While seated on a comfortable chair, a study participant completed assessments for demographics and filled in the questionnaire concerning their subjective preference ratings related to the bottles. In the following, all sensors were attached and physiological signals were visually inspected to check for acceptable signal-to-noise ratios. The actual experiment consisted of 12 consecutive conditions (3 × emotion image and 3 bottles × 3 emotion images), each 5 minutes in duration. All conditions were counterbalanced between study participants (random condition order). During each condition, six startle probes (1 test stimulus for baseline measurement and 5 target stimuli) were presented with an inter-stimulus interval of 40 s to 70 s to minimise startle habituation (Filion et al., 1998).

Data Pre-Processing

Raw EMG signals from the orbicularis oculi were filtered, rectified and computed into amplitudes by the Root-Mean-Square-method by the software package BioTrace+ provided by Mind Media BV. Through visual inspection only single amplitudes clearly occurring between 50 ms and 150 ms post-startle probe were selected for further analysis. This procedure was done completely unbiased, which means that during the process of visual inspection the link between data and one of the 12 conditions was not obvious. If several peaks occurred, if the EMG signal was distorted by activity with an onset prior to the startle probe or if a response was non-existent altogether, no startle amplitude was calculated. This procedure resulted in a total of less than 1% missing values. The amount of startle reflex modulation was calculated by dividing the mean of the five startle amplitudes elicited during lead stimulus presentation by the baseline amplitude of the corresponding condition, which was the result of the first test startle stimulus (for each condition separately).

Statistical Analysis

All mean relative startle response values were subjected to statistical analysis of variance (ANOVA) and to paired-samples t-tests. This procedure was done separately for images as foreground stimuli and for bottles as foreground stimuli. For bottles as foreground stimuli results are reported independent of background emotion category. Descriptive statistics were drawn up with subjective preference ratings related to all three bottles.

Results

Physiological Data

Emotion Images

A significant main effect of emotion condition [$F(2;28) = 3.393$; $p = 0.047$; $\eta^2 = 0.184$] was found. Most importantly, the difference between the positive and the negative condition [$F(1;15) = 6.929$; $p = 0.019$; $\eta^2 = 0.207$] was significant. This difference is due to a higher mean startle response associated with the negative emotion condition (**Figure 2**). No gender differences were found. The pattern of startle responses to emotion

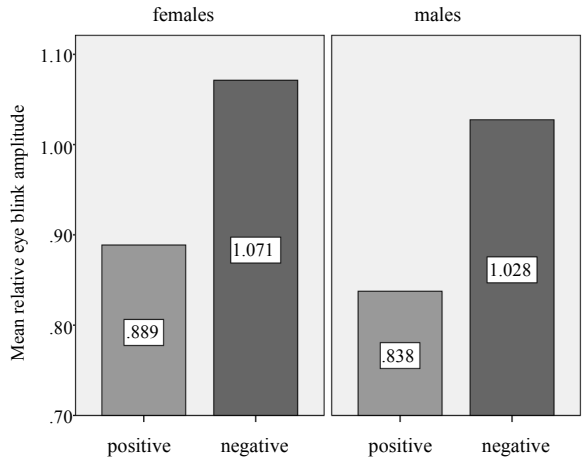

Figure 2.
Mean startle reflex responses to positive and the negative emotion images for females and males separately. Note that the distribution of startle responses across emotion conditions is similar between females and males.

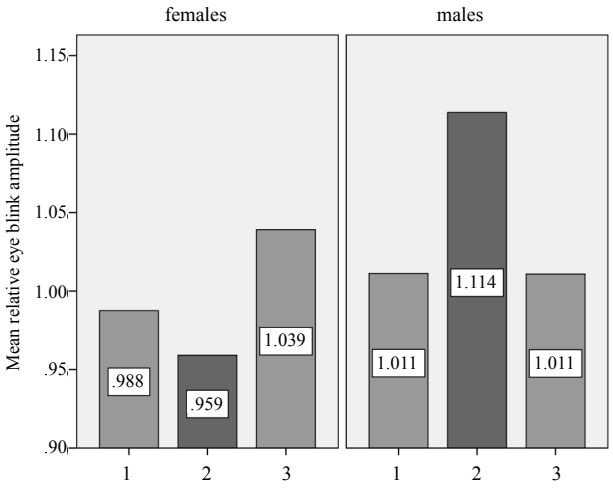

Figure 3.
Mean startle reflex responses related to the 3 bottles (1, 2 and 3). Note that only bottle 2 shows a significant gender difference.

images looked remarkably similar between females and males.

After all, we can conclude that actual emotion valence is reflected in our startle response data. This underlines the principle capacity of startle response modulation, in particular the reliable use of our mobile recording device and justifies the use of this method for the present purpose to measure emotion valence elicited by bottles with different shapes.

Bottles

All calculations were done with averaged startle responses across emotion conditions. No significant main effect of bottle shape on startle responses was found across all study participants. However, descriptive statistics of females and males separately demonstrates an obvious startle response difference in case of bottle 2 (**Figure 3**). While a repeated measures ANOVA, including startle responses to all bottle shapes and "gender" as a between-subject factor revealed no significant gender effect, one-way ANOVAs between groups revealed a significant gender difference [$F = 4.848$; $p = 0.045$; $\eta^2 = 0.257$] for bottle 2. The mean startle response for females was 0.96 (SD = 0.15) whereas for males it was 1.11 (SD = 0.13). For bottle 1 the ANOVA result is ($F = 0.067$; $p = 0.8$) and for bottle 3 the result is ($F = 0.107$; $p = 0.749$).

Behavioral Data

Following the instruction to name the bottle of highest subjective preference, 7 females and 7 males (out of 16) chose bottle 3 (88%). Only 1 female participant chose bottle 1 (6%) and only 1 male participant chose bottle 2 (6%). No gender difference could be found (see **Table 1**). Following the instruction to name the bottle of least subjective preference, 6 females and 7 males (out of 16) chose bottle 2 (81.25%). Only 2 females and 1 male rated bottle 1 as the least preferred (see **Table 2**). Also here, no gender difference could be found.

Table 1.
High subjective preferences—most preferred bottles (gender) N = 16.

	Female		Male		Male and Female	
	n	%	n	%	n	%
Bottle 1	1	12.5	0	0	1	6
Bottle 2	0	0	1	12.5	1	6
Bottle 3	7	87.5	7	87.5	14	88

Table 2.
Low subjective preferences—least preferred bottles (gender) N = 16.

	Female		Male		Male and Female	
	n	%	n	%	n	%
Bottle 1	2	25	1	12.5	3	18.75
Bottle 2	6	75	7	87.5	13	81.25
Bottle 3	0	0	0	0	0	0

Discussion

The functional significance of this study is that it provides evidence for gender-specific unbiased emotion differences related to different bottle shapes. This has two aspects. First, we provide evidence that startle reflex modulation as an objective method is sensitive to subtle valence differences related to design issues such as bottle shape. Second, we provide evidence that emotion elicited during confrontation with distinct bottle shapes can be subject to gender differences. Our study is rather explorative, but does have some basic science implications.

It is believed that emotion- and cognition-related information processing provide our brains with merged outputs that drive decision making and behaviour (Pessoa, 2008; Gray et al., 2002). For our study this means that subjective preference (or the appreciation of aesthetics) related to specific objects is based on the processing of emotion- and cognition-related aspects. Even if we believe a decision is made from a logic and rational perspective, emotion-related information influences our choices (Gray et al., 2002; Ochsner & Phelps, 2007). Usual approaches are not able to detect emotion-related responses in the absence of cognitive influences. The results of our study provide evidence that unbiased emotion responses can be dif-

ferent from cognitively influenced preference ratings and thus provide new insight into emotion impacts of products. In addition, it demonstrates that one stimulus can actually generate at least two different emotions.

Recently, several studies about the design of products focussed on showing different affective responses to various product shapes (Hsia & Chen, 2006). We tried to concentrate on the emotional component of information processing concerning different bottle shapes. As mentioned in the introduction, startle reflex modulation is known for its capacity to measure emotion valence, in particular, appetitive and aversive effects of any foreground stimulation (Vrana et al., 1988). We also wanted to link subjective preference with startle reflex modulation data, because it has already been found that subjective preference does not always match objective emotion measures (Geiser & Walla, 2011; Walla et al., 2010).

In our study we first tested that startle response modulation is able to distinguish between negative and positive emotion in our participant cohort and by using a new mobile recording device. The results clearly demonstrate that this is so. Not only that, we could also demonstrate that no differences occurred between females and males, which shows that no gender difference exists in terms of general image-driven emotion (no bottles). Given that no general emotion-related gender differences were found, the following finding related to different bottle shapes is rather surprising.

Subjective preference related to the three bottles we used clearly showed a strong preference for bottle 3 (88%) which was the slim, tall and triangular pyramid-shaped bottle (see **Figure 1**). Both females and males rated bottle 3 as most attractive. Bottle 2 on the other hand was rated least attractive (81.25%) by both females and males. Crucially, although no subjective preference differences occurred between females and males, our objective investigation revealed a significant gender difference between mean startle responses related to bottle 2. In particular, significantly enhanced eye blink amplitudes in male participants demonstrate that they were more negatively affected by bottle 2 than female participants. Neither of other bottles led to any such differences.

Therefore, our study provides evidence that startle reflex modulation is sensitive to subtle emotion-related (appetitive versus aversive) variations during confrontation with differently shaped bottles. This finding denotes the major output of our study which was intended to be rather explorative than hypothesis-driven. Despite the explorative nature of this study, we want to speculate on some possible interpretations of our specific findings. The shape was the only changed parameter between the bottles we used for this experiment. Thus, it seems appropriate to infer that only the specific shape of bottle 2 affected male and female participants in different ways. For some reason, depending on gender, the specific shape of bottle 2 caused different variations of emotion-related information processing. Comparing the three bottle shapes, it turns out that bottles 1 and 3 do not resemble any bottle commonly-used for the storage of liquids. Only bottle 2, with its parallel edges and quadratic appearance, resembles a true and familiar bottle rather than just an aesthetic object. Further speculation brings us to the point that the design of bottle 2 resembles a bottle that usually contains strong alcohol, such as whiskey. It is nothing more than speculation, but we do wonder whether this could explain why men were more negatively affected than women during exposure to bottle 2. Having that said, we would assume that experience influences objective measures of emotion as assessed via startle response modulation. This would be against the idea that startle responses reflect rather unbiased emotion. Or it could be the result of subconscious conditioning effects that can bias basic emotion-related information processing. However, it is just a speculation anyway. Former studies showed a gender difference in behaviour related to alcohol consumption (Kessler et al., 1994). Usually, it is mentioned that men have a higher alcohol dependence risk than women. If this evidence is linked with our findings, we may interpret that startle reflex modulation data somehow reflect differences in alcohol dependence risk on a subliminal level. Certainly, a follow-up study is needed to test this idea.

From a more design-related perspective, it should be mentioned that men were found to be more image-driven in their preferences for specific designs than women (Xue & Yen, 2007), but with the caveat that further studies will be needed to strengthen this expectation. Assuming that our speculation regarding the link between bottle 2 and alcohol is correct, one could argue that this image-driven influence resulted in the lowest subjective preference for bottle 2 in men. In our study, in men subjective preference and objective measurement matches. In women, this is not the case. Although none of the female startle responses differed significantly between the three bottles in terms of analytic statictics, women had the most appetitive motivation (smallest eye blink response) while experiencing bottle 2. However, women also rated bottle 2 as the least attractive, which is evidence for a discrepancy between subjective preference and objective measures of emotion, a situation that already occurred in previous studies (Geiser & Walla, 2011; Walla et al., 2010).

It is further concluded that our findings show that subjective preference related to bottle shapes involves other brain processes than those measured through startle reflex modulation. However, both measures are claimed to pick up emotion-related information. Whatever aspect of an emotion more obviously drives human behaviour, it may be useful to collect both aspects if, for example, a customer is asked for his disposition to buy a specific product. This link gives this study its applied character. Crilly et al. (2004) created a framework for design as a process of communication between producers and consumers. It involves a component called “context of consumption” in which they differentiate the consumers’ response to a specific product into cognition, affect and behaviour. Their view of cognition could be especially interesting for our study. They separate cognition into aesthetic impression, semantic interpretation and symbolic association. In addition, they differentiate between objective and subjective information with respect to an aesthetic impression related to a specific product. Subjectivity and objectivity related to a specific product is included in their framework; however an effect of emotion on aesthetic impresssion or subjective preference is not integrated. It is mentioned that subjective information is seen as the consumer’s experience and their familiarity with the product, including its shape. This relates to our idea in that men see the second bottle in a different way than women, because of its familiarity and shape. By including objective measures of emotion as a fourth component of a consumer’s response to products, producers and designers could gain important information. All of the components of their framework also seem to be influenced by different characteristics. In this context, Crilly et al. (2004) also mentioned gender similar to us.

The relationship between product-design (or shape) and the emotion caused by it formed a part of some other recent studies, e.g. (Hekkert & Desmet, 2002; Hekkert & Desmet, 2007; Ho & Sju, 2010). However, most often, emotion was seen equivalent to "feelings" (e.g. love or anger) evoked by a product or as signals concerning the appraisal of favourable or harmful events. It is suggested that our study points to a new direction by involving physiological components through measuring emotion via startle reflex modulation. The future may bring us to the point where we replace the term emotion with affective informative processing to highlight non-conscious aspects of emotion-related information processing. Further, we will have to accept that several emotions can occur simultaneously.

Other methodological approaches in the field of product design have however already revealed that, depending on gender for instance, certain differences exist with regard to subjective preferences. For example, one group (Moss & Colman, 2001) used modified business and Christmas card designs to show a significant difference between male and female subjective preferences. Others (Xue & Yen, 2007) attempted to demonstrate a gender difference in the perception of designs by using ten different mobile phones, MP3 players and fragrance bottles. Their qualitative study involved 72 participants and paired selected design objects with a number of product features related to aesthetics, function and social value. To evaluate participants' choices, a number of schemes, references and associated expressions for keywords were employed. They found that men were more concerned with the overall structure of a product, whereas women paid more attention to organic forms, details and textures. Both genders were in agreement regarding the simplicity of a design, although men seemed to view it in more image-related terms, whereas women favoured it over practical issues.

A common method is to study preferences via a collection of keywords and associations. Prior to choosing a product, it is necessary to think about its function, costs, utility, aesthetics and so on. However, every choice is also affected by emotion (as mentioned above). What does "emotion" mean at all? A list of 92 definitions classified into 11 categories (Kleinginna & Kleinginna, 1981) nicely demonstrates common disagreement concerning emotion and its definition. To date, researchers have still been unable to arrive at a simple common definition. However, one would think that exploring emotion requires an idea about what it actually is. Most commonly emotions are explained to be a complex amalgam of behaviour, cognitions, physiological changes and feelings. Thus, emotion is interchangeably used for different things. We suggest that, under certain circumstances, affective information processing may remain entirely non-conscious even when the person is attentive and motivated to describe his or her feelings correctly (see Berridge & Winkielman, 2003). Such affective processing should not be labeled an emotion, although it may drive a person's behaviour while remaining inaccessible to conscious awareness. In short, we propose the existence of genuinely non-conscious affective information processing. In line with that notion, we believe that startle response modulation measures is sensitive to non-conscious affective processing.

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