British Journal of Psychology (2012), 103, 44–57

The British Psychological Society

www.wileyonlinelibrary.com

Aesthetic appraisal of product designs: Independent effects of typicality and arousal

Janneke Blijlevens[1]*, Claus-Christian Carbon[2], Ruth Mugge[1] and Jan P. L. Schoormans[1]

[1]Delft University of Technology, Delft, The Netherlands
[2]University of Bamberg, Germany

Theories differ on how typicality and arousal influence aesthetic appraisal and whether these processes together interact or have independent effects on aesthetic appraisal. This research investigates the simultaneous effects of typicality and arousal on aesthetic appraisal for product designs by manipulating both processes separately: typicality by prototype deviation and arousal by colour saturation levels. We demonstrate that typicality has a curvilinear relationship with aesthetic appraisal. Additionally, arousal has a positive linear relationship with aesthetic appraisal of product designs. Moreover, arousal can influence aesthetic appraisal independent from typicality.

Consumers' aesthetic appraisal of products depends on the presence of certain product design properties in the product design (e.g., colour, shape). These properties can put different cognitive and affective processes in motion that influence aesthetic appraisal. The perception of typicality is such a cognitive process (Veryzer & Hutchinson, 1998) and the experience of arousal is an affective process that influences aesthetic appraisal (Berlyne, 1960). Although past research has found supporting evidence that both perceived typicality and experienced arousal affect aesthetic appraisal, contradictory theories exist with regard to the direction of these effects and their combined effect. The present research specifically focuses on understanding aesthetic appraisal of product designs. We argue that the literature on aesthetic appraisal has certain limitations for understanding aesthetic appraisal of product designs, which may also explain prior contradictory findings on the combined effect of typicality and arousal. This research contributes by investigating the effects of typicality and arousal on aesthetic appraisal of product designs by systematically manipulating both processes in product designs.

Typicality

In this research, we define typicality as the degree to which an object is representative of a category. From this perspective, typicality is considered as a measure of

*Correspondence should be addressed to Janneke Blijlevens, Department of Product Innovation Management, Delft University of Technology, Landbergstraat 15, 2628 CE, Delft, the Netherlands (e-mail: J.Blijlevens@TUDelft.nl).

DOI:10.1111/j.2044-8295.2011.02038.x

goodness-of-example (Hekkert, Snelders, & Van Wieringen, 2003; Veryzer & Hutchinson, 1998). Past research has found opposing effects of typicality on aesthetic appraisal. One line of research has proposed that people prefer typical over less typical objects, because people have a tendency to enjoy what matches their current knowledge (Veryzer & Hutchinson, 1998). A positive relationship of typicality with aesthetic appraisal arises due to the successful preservation of existing knowledge (Armstrong & Detweiler-Bedell, 2008). When a perceiver is confronted with a typical stimulus, the cognitive apparatus easily recognizes and categorizes the stimulus. Indeed, research showed that typical stimuli are processed more fluently than atypical ones, resulting in a more positive appraisal (McClelland, Rumelhart, & PDP Research Group, 1986; Posner & Keele, 1968). Similarly, when the brain has trouble fitting new information in its existing knowledge system, this has a negative effect on a product's aesthetic appraisal (Mandler, 1982). However, this positive relationship of typicality with aesthetic appraisal has mostly been found in psychological research using polygons, patterns, musical melodies, or art (e.g., Kunst-Wilson & Zajonc, 1980, Leder, Belke, Oeberst, & Augustin, 2004). Products serve utilitarian and symbolic purposes and are not purchased for aesthetic pleasure only (Creusen & Schoormans, 2005). Accordingly, products are evaluated with different goals in mind than artificial stimuli, which may influence the effect of different product design properties on aesthetic appraisal of the object (Armstrong & Detweiler-Bedell, 2008).

From consumer research, we know that people may consciously search for atypical product designs (Baumgartner & Steenkamp, 1996; Holbrook & Hirschman, 1982), and that people consider atypical product designs as more attractive than highly typical designs (Schoormans & Robben, 1997). Atypical product designs are positively appraised as a result of successfully expanding knowledge (Armstrong & Detweiler-Bedell, 2008). An atypical stimulus that cannot easily be categorized, urges a perceiver to solve a 'puzzle' and he/she will actively pursue information internal or external to the existing knowledge system, to solve the problem at hand (Heckler & Childers, 1992). The mere activity of problem solving, but also the feeling of reward afterwards, may lead to positive feelings, which are then attributed to aesthetic appraisal of the stimulus (Venkatesan, 1973). These findings seem to contradict the positive relationship of typicality and aesthetic appraisal as found in psychological research. We reconcile these opposing effects by proposing that an optimum level of typicality exists. People aesthetically appraise product designs that slightly deviate from the prototype more than highly typical designs. However, if the product design is highly atypical, people are not able to fit the product in their existing knowledge system, resulting in negative aesthetic appraisal. Accordingly, we hypothesize that a curvilinear relationship exists between typicality and aesthetic appraisal for product designs (Hypothesis 1).

Arousal

Arousal is the psychobiological state of alertness or excitation of a person (Berlyne, 1960). Arousal can be associated with a stimulus, which then leads to positive or negative aesthetic appraisal of that stimulus. With respect to product designs, a person can feel aroused as a result of the product's stimulating properties. In general, the higher the arousing potential of a stimulus, the higher the experienced arousal will become (Berlyne, 1971). Experienced arousal, in turn, affects aesthetic appraisal of a stimulus. The relationship between experienced arousal and aesthetic appraisal is described as curvilinear (Berlyne, 1960). According to Berlyne (1971), two different systems are involved in the processing of arousal and its influence on aesthetic appraisal

of a stimulus. First, the primary reward system is activated as arousal increases. When the primary reward system activates, it signals to someone that the state he/she is in, is pleasurable. As a result, these positive feelings are associated with the stimulus, resulting in positive appraisal. However, the second system, the primary aversion system, is also activated with increasing levels of arousal (Berlyne, 1971; Silvia, 2005). When the primary aversion system activates, it signals to someone that the state he/she is in, is unpleasant. Because the primary aversion system has a much higher activation threshold than the primary reward system, only extremely high arousal levels will decrease aesthetic appraisal (Berlyne, 1971). For some properties (e.g., fear ads or stimuli related to sexual appetite), a curvilinear relationship of arousal and aesthetic appraisal has been found (Steenkamp, Baumgartner, & Van der Wulp, 1996). However, within those studies, arousal was induced by a source external to the stimulus and not by the product itself. Products can induce arousal themselves through their appearance. It is expected that for the design of the appearance of consumer products, extremely high levels of arousal are not easily reached. When introducing a new product on the market, it is important that the product remains within the limits of what consumers can handle and, therefore, products are hardly ever designed to be extreme in any way. Hence, we expect that for most product designs only the primary reward system will be activated, suggesting that a positive linear relationship exists between arousal induced by a product design and aesthetic appraisal of this design (Hypothesis 2).

The combined effect of typicality and arousal

Empirical research on the combined effect of typicality and arousal on aesthetic appraisal is limited and results seem contradictory. On the one hand, it is suggested that it is the conscious perception of arousal together with the cognitive processing of the arousal-inducing stimulus that is important for aesthetic appraisal of an object (Crucian *et al*., 2000). Congruently, research on social contacts suggests that processing capacity decreases with higher levels of experienced arousal (Gorn, Pham, & Sin, 2001; Paulhus & Lim, 1994). The latter would suggest that arousal influences the effect of typicality on aesthetic appraisal of a product design. However, these studies were performed with stimuli pertaining to social contacts (e.g., scarcely dressed women, famous people), or artificial stimuli, rather than products. Furthermore, arousal was induced by a source external to the stimulus and not by the product itself (e.g., fear ads or stimuli related to sexual appetite). When product designs were used as stimuli, these were taken from the market. However, for these stimuli, typicality and arousal had a strong negative relationship and thus both processes were not independently manipulated (e.g., Hekkert *et al*., 2003). The lack of systematically controlling the manipulations of typicality and arousal might have compromised the search for independent effects of typicality and arousal on aesthetic appraisal of product designs beforehand.

On the other hand, Berlyne (1960) theorized that the arousal experienced for an object can directly influence aesthetic appraisal. Indeed, more recent research has demonstrated that cognitive and affective processes are able to influence appraisal independently in some cases (Homburg, Koschate, & Hoyer, 2006). Moreover, the combined effect of typicality and arousal has not yet been examined for various other arousal-inducing properties (e.g., colour). It is likely that certain arousal-inducing product design properties merely affect aesthetic appraisal in a fast and automatic manner. Based on these last arguments, we hypothesize that typicality and arousal can influence aesthetic appraisal of a product designs independently (Hypothesis 3).

The present research

Following Veryzer and Hutchinson (1998), typicality was manipulated by means of prototype deviation by gradually changing a typical product shape to deviate from the prototype shape. The level of arousal was induced by gradually increasing the saturation of the colour of the product designs. Past research has demonstrated that highly saturated colours result in higher arousal (Valdez & Mehrabian, 1994). In this research, it is important that typicality and arousal are independently manipulated. Therefore, we chose to manipulate arousal by means of colour saturation, because this arousal-inducing property was least likely to affect the typicality of the stimuli.

Our research aims to assess how typicality and arousal affect aesthetic appraisal for consumer products. It is difficult to create realistic stimuli without influencing aesthetic appraisal in more ways than intended. Accordingly, even though designing the stimuli was performed with the greatest care, pre-tests were necessary to check the manipulations. As a first step, a trained designer created three-dimensional (3-D) digital product designs of four different product categories by gradually deviating the product's shape from the category's prototype shape. However, changing the product's shape to deviate from the prototype may also influence perceived functionality or ease of use of this product (Creusen & Schoormans, 2005). As functionality may affect one's appraisal of the product design, this may offer an alternative explanation for an effect of typicality on aesthetic appraisal. Therefore, we conducted a first pre-test to select product designs within one product category that differ in typicality, but not in functionality or ease of use, to serve as stimuli.

STUDY 1

Method

Stimuli

Because they have very strong angular or rounded prototype shapes, teapots, toasters, hand-juicers, and washing machines were selected to generate stimuli for the first pre-test. Accordingly, level of angularity could be used to manipulate typicality. The shapes of new 3-D digital models of each product category were changed by a trained designer in the level of angularity in four steps. Specifically, toasters and washing machines were deviated from the prototype by making them more rounded, and teapots and hand-juicers were made more angular, resulting in 20 stimuli products (including the original).

In pre-test 1, all stimuli were rated in an online questionnaire ($N = 22$, mean age = 31, $SD = 10$, 13 women) on their level of typicality in a procedure similar to Veryzer and Hutchinson (1998) (1: not typical – 5: typical). In addition, participants rated the products' functionality (1: not functional – 5: functional) and ease of use (1: not easy to use – 5: easy to use) on 5-point scales[1]. Functionality and ease of use were combined into an overall functionality variable by averaging them ($r_{\text{teapots}} = .665$, $r_{\text{toasters}} = .790$, $r_{\text{hand-juicers}} = .448$, $r_{\text{washing machines}} = .778$, all ps $< .01$). The lowest correlation between typicality and overall functionality was found for toasters ($r_{\text{teapots}} = .424$, $r_{\text{toasters}} = .308$, $r_{\text{hand-juicers}} = .415$, $r_{\text{washing machines}} = .341$, all ps $< .01$). In addition, a repeated measures Analysis of Variance (ANOVA) revealed a significant product category $\times$ prototype

[1] *In all studies, stimuli were randomly presented on a 12- or 14-inch TFT computer screen of an Apple PowerBook. The task was programmed in PsyScope B51 and all stimuli were 10.0 cm $\times$ 9.0 cm (B $\times$ H) in size.*

deviation interaction for overall functionality, $F(12, 252) = 4.0, p < .001$. Teapots, hand-juicers, and washing machines differed significantly in overall functionality, $F(4, 84) = 11.0$, $F(4, 84) = 6.066$, $F(4, 84) = 18.3$, respectively; all $ps < .01$. Toasters did not differ in overall functionality, $F(4, 84) = 2.4, p > .10$. Furthermore, the toasters differed significantly in perceived typicality, $F(4, 84) = 10.5, p < .01$ (mean ranged from 4.14 to 2.64), with the most deviant shape being rated the least typical, suggesting that our manipulation of typicality was successful for the toaster stimuli.

A second pre-test was performed to check whether an increase in the colour saturation of the stimuli induces arousal (Valdez & Mehrabian, 1994). For this pre-test, the toaster stimuli were coloured red. Arousal inducement was operationalized by increasing the saturation of the colour red given to the product designs (in RGB notation: R:230, G:0, B:0) by 10% in five steps. The combination of the arousal and typicality manipulations lead to 25 (5 levels of prototype deviation $\times$ 5 levels of colour saturation) 3-D digital pictures of toasters. In pre-test 2, all stimuli were rated on the level of arousal ($N = 31$, mean age = 19, $SD = 1.5$, 21 men). Rating the level of arousal that is experienced when seeing a stimulus is a relatively abstract and difficult task, because arousal is processed affectively, and thus difficult to recognize and to describe, especially for stimuli that only slightly differ in arousal. To assist the participants in accomplishing this task, they were asked to compare the arousal experienced for the product stimuli to a combination of words (not stimulating, not exciting, and calm – stimulating, exciting, and not calm), and pictures of different categories (men doing a sports activity, animals, buildings, and landscapes), illustrating the five-arousal levels. All pictures were selected from the validated International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 1999). Accordingly, the pictures were validated to differ in arousal (five levels), but not in affective tone. The words used are equal to those that were used to explain arousal when validating the IAPS pictures with Self-Assessment Manikin (Lang *et al.*, 1999). A regression analysis showed that colour saturation significantly influenced arousal measures, but no effect for prototype shape deviation on arousal was found, $R^2 = .878$, $F(2, 22) = 78.8$, $B = .354$, $p < .001$. These results indicate that our manipulation of arousal was effective.

The two pre-tests indicated that the created designs for the product category toasters fulfil all necessary preconditions. We therefore selected these stimuli for the main study (see Figure 1).

Participants

A total of 60 participants, selected from a consumer household panel, were included in Study 1 (mean age = 55.7, $SD = 6$, 34 men). All participants received a small financial compensation for their participation (2.20 Euros).

Procedure

Participants were asked to rate their aesthetic appraisal of all stimuli on a 7-point scale (1: not at all attractive – 7: very attractive) (based on Page & Herr, 2002). In addition, participants performed a categorization task in which reaction times were measured. Testing for the presence of an interaction effect between typicality and arousal on aesthetic appraisal would only provide an indirect test for Hypothesis 3. Nevertheless, a categorization task provides us with a direct assessment of whether arousal influences processing fluency and thus with an alternative test. Reaction times to verify category membership are positively related to the distance of each object from the structural

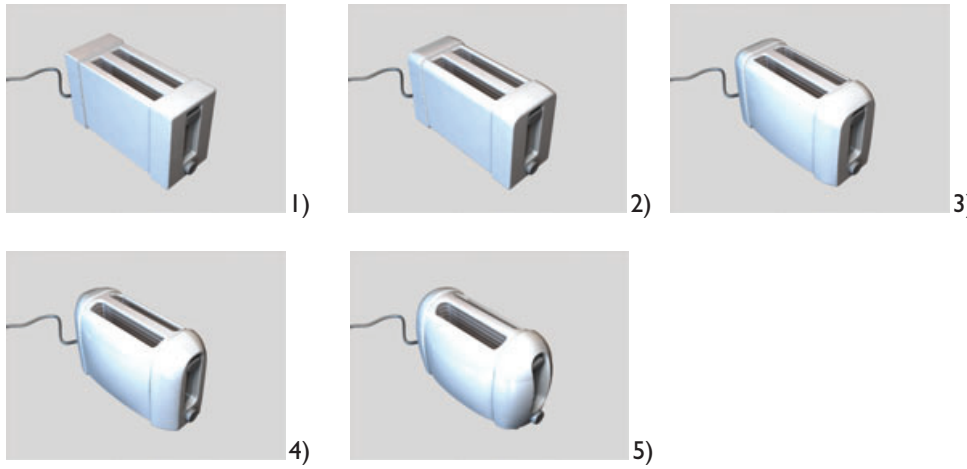

Figure 1. Digital three-dimensional (3-D) designs of toasters deviating from the angular prototype in four steps used as stimuli in Study 1.

type of a category (Rosch, Simpson, & Miller, 1976). Reaction times for verifying category membership are thus a measure of cognitive information processing. Because we hypothesize that arousal and typicality influence aesthetic appraisal independently (Hypothesis 3), the level of experienced arousal for a product design should not affect reaction times in a categorization task.

After a practice exercise, participants performed the categorization task. In this task, participants were asked to judge as fast and accurate as possible whether the product that appeared on the screen (25 different versions of a toaster: 5 levels of prototype deviation $\times$ 5 levels of saturation) was a toaster or not. To prevent response biases, the 25 toasters were presented together 25 masking stimuli from another product category. Participants confirmed categories with a key press ('d' or 'k'), where 'd' represented 'yes' and 'k' represented 'no'. Next, for each participant, the complete procedure was repeated by using the opposite key presses ('d' = no; 'k' = yes) to eliminate left or right eye-hand coordination influences on reaction times. The order of these two tasks was balanced across participants. Stimulus presentation was fully randomized within the task. For each stimulus, the reaction time for verifying category membership was recorded. This resulted in two reaction time measures per stimulus.

Results

Multiple regression models were fitted to test the effects of the independent variables typicality, arousal, the quadratic terms of typicality and arousal to test for curvilinear relationships, and an interaction variable typicality $\times$ arousal on the dependent variable aesthetic appraisal[2,3]. First, a regression model with the independent variables typicality and arousal entered simultaneously was tested. After that, model comparisons by means of R^2-change were performed by including the quadratic terms for typicality and arousal

[2] *All analyses in this research were performed on aggregated data.*

[3] *We have demonstrated that prototype deviation influences typicality and colour saturation influences arousal. Thus, for clarity reasons, we will refer to typicality and arousal from now on.*

Table 1. Results of equations predicting the effects of typicality and arousal on aesthetic appraisal for Study 1

Variable	*B*	*SE B*	β	*t*
Constant	3.433***	.091		37.805
Arousal	.149***	.020	.665	7.354
Typicality	−.138***	.020	−.615	6.796

Note. $R^2 = .820$, $F(2, 22) = 50.129$, $p < .001$.
*$p < .05$; **$p < .01$; ***$p < .001$.

simultaneously in Step 2 and their interaction variable in Step 3 as extra independent variables. The models including the quadratic terms and interaction variable showed no significant increase in R^2 compared to the first model.

The results revealed that typicality had a negative linear effect on aesthetic appraisal, but the quadratic function of typicality was insignificant, providing partial support for Hypothesis 1. Support for Hypothesis 2 was found: arousal had a significant positive linear effect on aesthetic appraisal for product designs. The quadratic function of arousal was not significant. Furthermore, the interaction effect of typicality and arousal was not significant. Typicality and arousal thus both independently affect aesthetic appraisal of product designs, providing support for Hypothesis 3 (see Table 1).

In order to provide an additional test for Hypothesis 3, reaction time data were analysed. Reaction time scores for verifying category membership were examined and outliers (response of 2.5 *SD*s above the individual's mean value) were excluded from the analysis (Ratcliff, 1993). To avoid statistical problems associated with missing data, missing values were imputed by a value equal to the individual's mean value + 2.5 *SD*s (Bunce, MacDonald, & Hultsch, 2004). Response trials in which participants did not correctly identify stimuli as a toaster were removed. The total number of trials dropped was less than 3%. For the analyses, mean reaction times were aggregated over stimuli.

Regression analyses were employed to test the effects of the independent variables typicality, arousal and their interaction term on the dependent variable mean reaction times. Multiple regression models were performed and compared by means of R^2-change. The regression model in which typicality and arousal were included simultaneously was marginally significant, $R^2 = .223$, $F(2, 22) = 3.2$, $p < .10$; $B_{\text{typicality}} = 4.195$, $p < .05$, $B_{\text{arousal}} = 1.427$, $p > .10$. As expected, typicality significantly affected reaction times in a categorization task, while the effect of arousal was not significant. The regression model including the interaction term showed no significant R^2-change. The finding that arousal does not significantly explain reaction times provides additional support for Hypothesis 3.

Discussion

In Study 1, we demonstrated that arousal has a positive linear effect on aesthetic appraisal. Arousal did not influence processing capacity, and thus, did not interact with the effect of typicality on aesthetic appraisal. Furthermore, partial support was found for Hypothesis 1. A negative linear effect of typicality on aesthetic appraisal was found, while a curvilinear effect was hypothesized. The more a product design deviated from the prototype, the more positively it was appraised aesthetically. Possibly, for consumer products, the optimum level of typicality is not easily reached due to the utilitarian

restriction on using products as stimuli in research. Therefore, it is possible that we did not succeed in creating stimuli that fail to fit in participants' knowledge systems. In Study 1, we selected product designs as stimuli that have similar functionality ratings. However, there is an alternative approach to control for the effect of functionality. In a second study, we explore the curvilinear relationship between typicality and aesthetic appraisal while controlling for functionality by including perceived functionality in the regression analyses. Furthermore, in Study 2, we attempt to replicate our results for a product category with a rounded prototype shape. This will help us to rule out a general preference for rounded objects as an alternative explanation for our findings in Study 1 (Bar & Neta, 2006; cf. Carbon, 2010).

STUDY 2

Method

Stimuli

In Study 2, the same five stimuli from the product category hand-juicers were used as in the first pre-test of Study 1 (see Figure 2). Results from this pre-test showed that hand-juicers significantly influenced perceived typicality, $F(4, 84) = 13.9$, $p < .01$, but also differed in overall functionality, $F(4, 84) = 6.1$, $p < .01$.

An additional pre-test was performed ($N = 31$, mean age = 19, $SD = 1.8$, 21 men) to check the manipulations of arousal and typicality for the hand-juicer stimuli. Arousal and typicality were measured in the same manner as was done in the previous pre-tests. The results showed that only colour saturation influenced arousal significantly, $R^2 = .212$, $F(2, 22) = 3.0$, $p = .073$, $B = .051$, $p < .05$. The effect of prototype deviation on arousal was not significant. Prototype deviation had a negative effect on typicality, $R^2 = .758$, $F(2, 22) = 34.4$, $p < .05$, $B = -0.239$, $p < .001$, but no effect was found for colour saturation, supporting the validity of our manipulations.

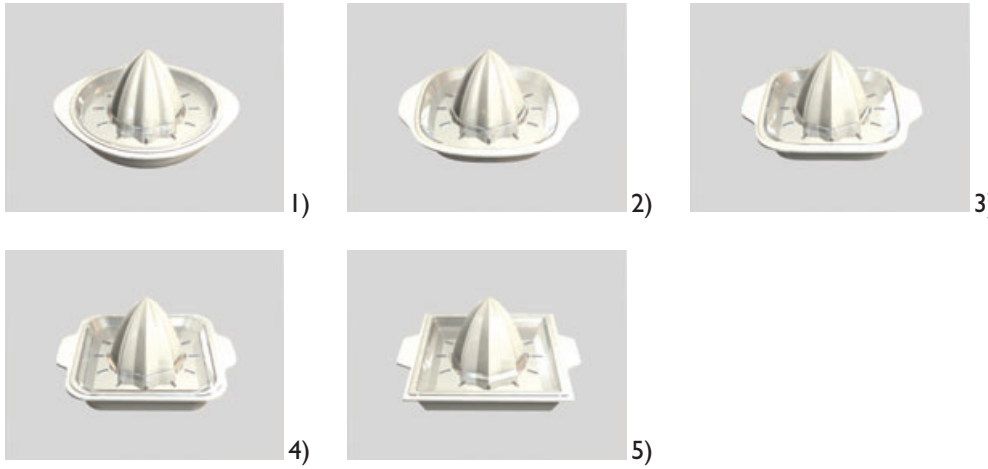

Figure 2. Digital 3-D designs of hand-juicers deviating from the rounded prototype in four steps used as stimuli in Study 2.

Participants

A total of 60 participants, selected from a consumer household panel, were included in this study (mean age = 55.7, $SD = 6$, 34 men). All participants received a small financial compensation for their participation (2.20 Euros).

Procedure

The procedure was the same as that employed in Study 1. Participants were asked to rate the stimuli on their level of aesthetic appraisal and were asked to perform a categorization task in which reaction times were measured. In addition, participants were asked to rate all stimuli on their level of functionality and ease of use on five-point scales together constructing the variable overall functionality ($\alpha = .90$).

Results and discussion

Multiple regression analyses were performed to assess the curvilinear effect of typicality, the positive linear effect of arousal, and their interaction effect on aesthetic appraisal, while controlling for overall functionality by including this variable as an additional independent variable in each regression model. First, a regression model with the independent variables typicality, arousal and overall functionality entered simultaneously was tested. After that, model comparisons by means of R^2-change were performed by including the quadratic terms for typicality and arousal simultaneously in Step 2 and the interaction variable in Step 3 as extra independent variables. Within each regression model these variables were included in a stepwise fashion in the order as mentioned. The regression model including the quadratic terms of typicality and arousal showed a significant R^2-change, which is accounted for by the significant effect of the quadratic term of typicality on aesthetic appraisal. However, the quadratic term for arousal was not significant. The regression model including the interaction term showed no significant R^2-change compared to the other models.

Fully supporting Hypothesis 1, typicality and its quadratic term demonstrated a curvilinear effect of typicality on aesthetic appraisal (see Table 2 and Figure 3). As product designs progress to deviate in typicality, they are positively aesthetically appraised with the middle deviant shape appraised the highest. Aesthetic appraisal of the even more deviating product designs, however, decreases. Again, support for Hypothesis 2 was found: arousal had a significant positive linear effect on aesthetic appraisal for product designs, while its quadratic term was insignificant. As expected in Hypothesis 3, the interaction effect of typicality and arousal was not significant. Thus, typicality and arousal both independently affect aesthetic appraisal of product designs.

Reaction time data were analysed to further test the independent effects of arousal and typicality. Specifically, multiple regression analyses were performed, which included the independent variables typicality, arousal and their interaction term, and the dependent variable mean reaction times. The regression model, in which typicality and arousal were included simultaneously, was significant, $R^2 = .306$, $F(2, 22) = 4.9$, $p < .05$; $B_{\text{typicality}} = 7.191$, $p < .01$, $B_{\text{arousal}} = 1.029$, $p > .10$. As expected, typicality significantly affected reaction times in a categorization task, while the effect of arousal was not significant. The regression model including the interaction term showed no significant R^2-change. Thus, arousal does not significantly explain reaction times. This finding provides additional support for Hypothesis 3.

Table 2. Results of equations predicting the effects of typicality and arousal on aesthetic appraisal for Study 2

Variable	*B*	*SE B*	β	*t*
Step 1				
Constant	−2.018	1.557		−1.296
Arousal	.083***	.017	.495	4.773
Typicality	−.134***	.022	−.803	−6.116
Overall functionality	1.321***	.292	.630	4.525
Step 2				
Constant	.913	1.241		.736
Arousal	.194**	.059	1.163	3.271
Typicality	.205*	.072	1.227	2.820
Overall functionality	.683*	.242	.326	2.820
Typicality × typicality	−.051***	.011	−1.862	−4.780
Arousal × arousal	−.016	.009	−.578	−1.676

Note. $R^2 = .819$, $F(3, 21) = 31.7$, $p < .01$ in Step 1 and $\Delta R^2 = .101$, $F(5, 19) = 43.8$, $p < .01$ in Step 2. $^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$.

Summarizing, in Study 2, we were able to extend the results found in Study 1. Specifically, we demonstrate that a curvilinear relationship between typicality and aesthetic appraisal of product designs exists. Furthermore, we were able to replicate our results for a product category with a rounded prototype shape. Therefore, we can

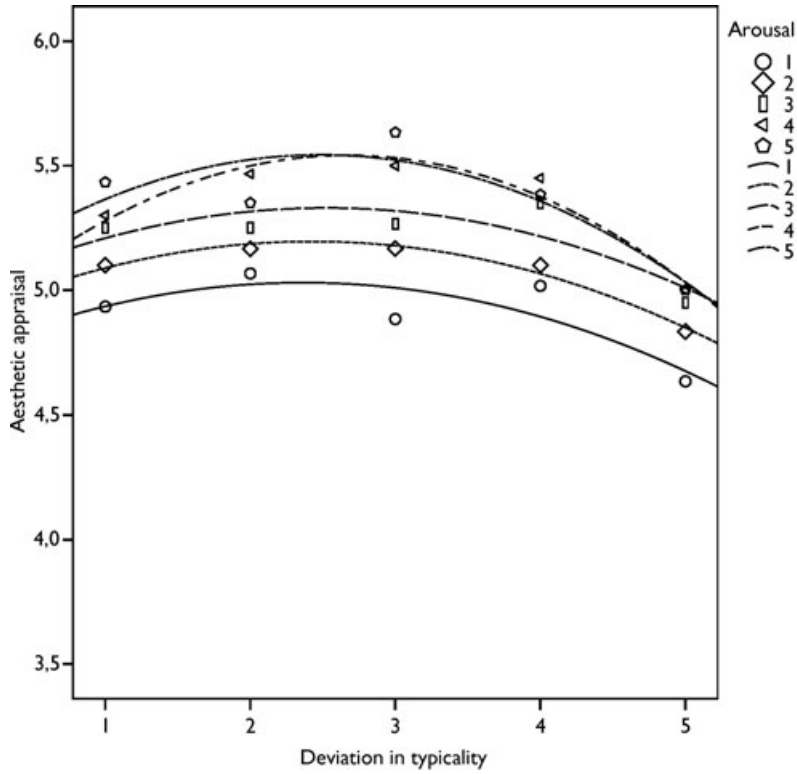

Figure 3. Aesthetic appraisal for different arousal and typicality levels of Study 2. *Note.* The scale representing aesthetic appraisal on the *y*-axis starts at 3.0 and not 0.

rule out a general preference for rounded objects as an alternative explanation for our findings in Study 1 (Bar & Neta, 2006) which is compatible with recent findings of Carbon (2010). Moreover, Study 2 shows that our results can be generalized over product categories.

GENERAL DISCUSSION

In this research, we have examined aesthetic appraisal of product designs. By manipulating typicality and arousal separately by the product design, we were able to test how typicality and arousal influence aesthetic appraisal of product designs.

This research contributes to the existing literature in several ways. First of all, we were successful in providing empirical proof for a curvilinear effect of typicality on aesthetic appraisal of product designs. With respect to product designs, we find that consumers consider atypical product designs more aesthetically pleasing than typical ones, but too deviating designs are less positively appraised. Our results for typicality are in concordance with Heckler and Childers' (1992) theorizing that solving a 'puzzle' is perceived as rewarding. Expanding knowledge is perceived as pleasurable (Armstrong & Detweiler-Bedell, 2008), which is then attributed to aesthetic appraisal of the product design. However, after a certain point, the product design becomes so deviating that it is too difficult to assimilate into the knowledge system and then preserving the knowledge system is desired.

Second, in our research, a choice was made for inducing arousal with a product design property known for its arousal potential: colour saturation (Valdez & Mehrabian, 1994), which has the advantage of being inherently related to the stimulus. We find that aesthetic appraisal of product designs was positively influenced by induced arousal. As expected, for product designs, no curvilinear relationship was found between arousal and aesthetic appraisal. The arousal potential of a product design itself does not seem to be sufficient to exceed the threshold for the primary aversion system to be activated (Berlyne, 1971). Results are compliant with literature wherein a linear effect of arousal was found (Martindale, Moore, & Borkum, 1990; Whitfield, 1983).

Third, our research contributes by investigating the combined effect of typicality and arousal on aesthetic appraisal of product designs. In the present research, physical product design properties were chosen to separately manipulate typicality and arousal. As theorized, our findings show that arousal does not interact with typicality on aesthetic appraisal of product designs. In addition, our manipulation of arousal did not affect reaction times for identifying category membership, a measure of cognitive processing. These findings are in congruence with prior research on the independent effect of cognitive and affective processes on appraisal (Homburg *et al*., 2006). Our results do not concur with the proposed theory that arousal decreases processing capacity limiting the effect of other cognitive processes, such as typicality perception, on aesthetic appraisal (e.g., Gorn *et al*., 2001; Paulhus & Lim, 1994). We argue that whether interaction effects for typicality and arousal on aesthetic appraisal occur is highly dependent on the product design properties that put these processes in motion. When typicality and arousal are induced, both processes can influence aesthetic appraisal independent from each other.

Limitations and future research

Even though this research managed to shed light on how typicality and arousal simultaneously affect aesthetic appraisal of product designs, several questions concerning aesthetic appraisal and the underlying processes remain unanswered.

First, we theorized the existence of an optimum level of typicality. We found a curvilinear relationship of typicality and aesthetic appraisal in Study 2, which suggests that an optimum exists. However, in Study 1, typicality did not exceed the optimum level of typicality. The stimuli in Study 1 were restricted in shape variations by their utilitarian function. Deviating a product design more from the prototype might negatively influence the actual and/or perceived utilitarian function of a product. Once deviation from typicality is accompanied by a change in functionality, the product design is much more difficult to assimilate to our knowledge system than when it is not perceived to change in functionality (Larsen & Diener, 1992). Recent research shows that the effect of processing difficulty (e.g., caused by atypicality) on aesthetic appraisal is moderated by the associations people have with the product (Pocheptsova, Labroo, & Dhar, 2010). In future research, it would be worthwhile to investigate whether functionality associations accompanying typicality change explain whether a linear or curvilinear relationship between typicality and aesthetic appraisal of product designs will occur.

Next, several researchers have addressed the research question whether the effect of arousal on aesthetic appraisal is linear or curvilinear (e.g., Martindale *et al*., 1990; Silvia, 2005). Our research revealed a positive linear effect. We believe that for most consumer products, the primary aversion system is not activated as the arousal potential of product-related design properties is limited. Nevertheless, for a small number of particular product design properties, the primary aversion system can probably be activated and an optimum level of arousal can be reached (e.g., the noise a product produces). For such product design properties, a curvilinear relationship of arousal with aesthetic appraisal is expected. Future research is needed to investigate the linear versus curvilinear effects of arousal induced by particular product design properties on aesthetic appraisal of product designs. Because finding a curvilinear effect of arousal is highly dependent on the amount of stimuli included in the research and the range of differences between them (Berlyne, 1971, 1974), it is advised to include a wide range of stimuli that encompass an extensive variety in arousal in future work.

Finally, in our research, we have manipulated arousal by only one product design property, that is colour saturation, because this was not confounded with the manipulation of typicality. Theoretically, it may be possible that extremely high levels of arousal (e.g., by inducing arousal by multiple product design properties) reduce processing capacity and thus interact with the effect of typicality on aesthetic appraisal. Future research could investigate whether an interaction effect of arousal and typicality on aesthetic appraisal occurs when extremely high levels of arousal are induced.

Summarizing, our results demonstrate a curvilinear effect of typicality and a linear effect of induced arousal on aesthetic appraisal of product designs. Moreover, arousal can influence aesthetic appraisal independent from typicality. This means that when aesthetic appraisal is at a maximum in terms of typicality, it can be further elevated when arousal-inducing properties are intensified (e.g., through colour saturation, colour brightness, sound intensity, or surface texture).

Acknowledgements

We want to express our gratitude to Gael Laurans and Rene van Egmond for providing us with a good experimental setup and Anouk Schoormans with her help in conducting the experiments. Also, we would like to thank Koen Terra for designing the stimuli used in this research. Finally, we would like to thank the anonymous reviewers of the *British Journal of Psychology* for their constructive suggestions.

References

Armstrong, T., & Detweiler-Bedell, B. (2008). Beauty as an emotion: The exhilarating prospect of mastering a challenging world. *Review of General Psychology*, *12*, 305–329. doi:10.1037/a0012558

Bar, M., & Neta, M. (2006). Humans prefer curved visual objects. *Psychological Science*, *17*, 645–648. doi:10.1111/j.1467-9280.2006.01759.x

Baumgartner, H., & Steenkamp, J.-B. E. M. (1996). Exploratory consumer buying behavior: Conceptualization and measurement. *International Journal of Research in Marketing*, *13*, 121–137. doi:10.1016/0167-8116(95)00037-2

Berlyne, D. E. (1960). *Conflict, arousal and curiosity*. New York: McGraw-Hill. doi:10.1037/11164-000

Berlyne, D. E. (1971). *Aesthetics and psychobiology*. New York: Appleton-Century-Crofts.

Berlyne, D. E. (1974). *Studies in the new experimental aesthetics: Steps toward an objective psychology of aesthetic appreciation*. Washington, DC: Hemisphere Publishing Corporation.

Bunce, D., MacDonald, S. W. S., & Hultsch, D. F. (2004). Inconsistency in serial choice decision and motor reaction times dissociate in younger and older adults. *Brain and Cognition*, *56*, 320–327. doi:10.1016/j.bandc.2004.08.006

Carbon, C. C. (2010). The cycle of preference: Long-term dynamics of aesthetic appreciation. *Acta Psychologica*, *134*, 233–244. doi:10.1016/j.actpsy.2010.02.004

Creusen, M. E. H., & Schoormans, J. P. L. (2005). The different roles of product appearance in consumer choice. *Journal of Product Innovation Management*, *22*, 63–81. doi:10.1111/j.0737-6782.2005.00103.x

Crucian, G. P., Hughes, J. D., Barrett, A. M., Williamson, D. J., Bauer, R. M., Bowers, D., & Heilman, K. M. (2000). Emotional and physiological responses to false feedback. *Cortex*, *36*, 623–647. doi:10.1016/S0010-9452(08)70542-2

Gorn, G., Pham, M. T., & Sin, L. Y. (2001). When arousal influences ad evaluation and valence does not (and vice versa). *Journal of Consumer Psychology*, *11*, 43–55. doi:10.1207/S15327663JCP1101_4

Heckler, S. E., & Childers, T. L. (1992). The role of expectancy and relevancy in memory for verbal and visual information: What is incongruency? *Journal of Consumer Research*, *18*, 475–492. doi:10.1086/209275

Hekkert, P., Snelders, H. M. J. J., & Van Wieringen, P. C. W. (2003). 'Most advanced, yet acceptable': Typicality and novelty as joint predictors of aesthetic preference in industrial design. *British Journal of Psychology*, *94*, 111–124. doi:10.1348/000712603762842147

Holbrook, M. B., & Hirschman, E. C. (1982). The experiential aspects of consumption: Consumer fantasies, feelings and fun. *Journal of Consumer Research*, *9*, 132–140. doi:10.1086/208906

Homburg, C., Koschate, N., & Hoyer, W. D. (2006). The role of cognition and affect in the formation of customer satisfaction: A dynamic perspective. *Journal of Marketing*, *70*, 21–31. doi:10.1509/jmkg.70.3.21

Kunst-Wilson, W. R., & Zajonc, R. B. (1980). Affective discrimination of stimuli that cannot be recognized. *Science*, *207*, 557–558. doi:10.1126/science.7352271

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (1999). The international affective pictures system (IAPS): Affective ratings of pictures and instruction manual. In *Technical report A-8*. Gainesville: University of Florida.

Larsen, R. J., & Diener, E. E. (1992). Promises and problems with the circumplex model of emotion. In M. S. Clark (Ed.), *Review of personality and social psychology: Emotions and social behavior* (pp. 25–59). Newbury Park: Sage.

Leder, H., Belke, B., Oeberst, A., & Augustin, D. (2004). A model of aesthetic appreciation and aesthetic judgments. *British Journal of Psychology*, *95*, 489–508. doi:10.1348/0007126042369811

Mandler, G. (1982). The structure of value: Accounting for taste. In M. S. Clarck & S. T. Fiske (Eds.), *Affect and cognition: The seventeenth annual carnegie symposium on cognition* (pp. 3–36). Hillsdale, NJ: Lawrence Erlbaum Associates.

Martindale, C., Moore, K., & Borkum, J. (1990). Aesthetic preference: Anomalous findings for Berlyne's psychobiological model. *American Journal of Psychology*, *103*, 55–80. doi:10.2307/1423259

McClelland, J. L., Rumelhart, D. E., & PDP Research Group (1986). *Parallel distributed processing: Explorations in the microstructure of cognition* (Vol. 1 & 2). Cambridge, MA: MIT Press.

Page, C., & Herr, P. M. (2002). An investigation of the processes by which product design and brand strength interact to determine initial affective and quality judgments. *Journal of Consumer Psychology*, *12*, 133–147. doi:10.1207/S15327663JCP1202_06

Paulhus, D. L., & Lim, D. T. K. (1994). Arousal and evaluative extremity in social judgments: A dynamic complexity model. *European Journal of Social Psychology*, *24*, 89–99. doi:10.1002/ejsp.2420240107

Pocheptsova, A., Labroo, A. A., & Dhar, R. (2010). Making products feel special: When metacognitive difficulty enhances evaluation. *Journal of Marketing Research*, *47*, 1059–1069. doi:10.1509/jmkr.47.6.1059

Posner, M. I., & Keele, S. W. (1968). On the genesis of abstract ideas. *Journal of Experimental Psychology*, *77*, 353–363. doi:10.1037/h0025953

Ratcliff, R. (1993). Methods for dealing with reaction time outliers. *Psychological Bulletin*, *114*, 510–532. doi:10.1037/0033-2909.114.3.510

Rosch, E., Simpson, C., & Miller, R. S. (1976). Structural bases of typicality effects. *Journal of Experimental Psychology: Human Perception and Performance*, *2*, 491–502. doi:10.1037/0096-1523.2.4.491

Schoormans, J. P. L., & Robben, H. S. J. (1997). The effect of new package design on product attention, categorization and evaluation. *Journal of Economic Psychology*, *18*, 271–387. doi:10.1016/S0167-4870(97)00008-1

Silvia, P. J. (2005). Emotional responses to art: From collation and arousal to cognition and emotion. *Review of General Psychology*, *9*, 342–357. doi:10.1037/1089-2680.9.4.342

Steenkamp, J.-B. E. M., Baumgartner, H., & Van Der Wulp, E. (1996). The relationships among arousal potential, arousal and stimulus evaluation, and the moderating role of need for stimulation. *International Journal of Research in Marketing*, *13*, 319–329. doi:10.1016/S0167-8116(96)00013-4

Valdez, P., & Mehrabian, A. (1994). Effects of color on emotions. *Journal of Environmental Psychology*, *123*, 394–409.

Venkatesan, M. (1973). Cognitive consistency and novelty seeking. In S. Ward & T. W. Robertson (Eds.), *Consumer behavior: Theorectical sources prentice hall* (pp. 354–384). Englewood Cliffs, NJ: Prentice Hall.

Veryzer, R. W., & Hutchinson, J. W. (1998). The influence of unity and prototypicality on aesthetic responses to new product designs. *Journal of Consumer Research*, *24*, 374–394. doi:10.1086/209516

Whitfield, T. W. A. (1983). Predicting preference for familiar, everyday objects: An experimental confrontation between two theories of aesthetic behaviour. *Journal of Environmental Psychology*, *3*, 211–237. doi:10.1016/S0272-4944(83)80002-4

Received 11 February 2010; revised version received 31 January 2011