APPLIED COGNITIVE PSYCHOLOGY
Appl. Cognit. Psychol. (in press)
Published online in Wiley InterScience
(www.interscience.wiley.com) DOI: 10.1002/acp.1088

Dimensions in Appreciation of Car Interior Design

HELMUT LEDER[1,2,*] and CLAUS-CHRISTIAN CARBON[1,2]

[1]*Freie Universität Berlin, Germany*
[2]*University of Vienna, Austria*

SUMMARY

We report two studies in which the interplay between stimulus properties and perceiver characteristics in the appreciation car interiors was investigated. In Experiment 1 three design components, complexity, curvature and innovativeness, which are all thought to affect design appreciation were combined in a fully factorial design. All dimensions were confirmed to affect ratings, and *curvature* and *innovativeness* particularly affected the attractiveness ratings. Curved and non-innovative designs were generally preferred. Moreover, participants who were particularly interested in art were more sensitive to curvature and innovativeness. In Experiment 2 two dimensions of Experiment 1 were replicated using similar stimuli. Moreover, the specific effects of a design knowledge treatment were investigated. Results replicated the preference for curved and non-innovative (rather classic) designs. The treatment had only small effects, which support a general rather than dimension-specific effects of cognitive pre-information. Copyright © 2005 John Wiley & Sons, Ltd.

Car interior design allows manufacturers to select from a wide choice of fundamental design principles. Some principles are eminent parts of design philosophy of a certain brand; others represent more abstract decisions about the appearance of single car models. As exterior design is often dominated by technical constraints such as the air drag coefficient, interior design often allows designers to use more individual and aesthetically justified designs (Karlsson, Aronsson, & Svensson, 2003).

In order to sell the product, the appearance nowadays has a major importance for the consumer. Thus, aesthetic and design are decisive buy-arguments in markets in which the technical level of competing products is very similar (Demirbilek & Sener, 2003). This is particularly and increasingly the case with cars. Moreover, the impact of design might also depend on different personalities. People more interested in aesthetics and less attached to technical properties might react more positive to innovative and modern design while others may express rather conservative attitudes in choosing more conventional design products. Consequently, understanding aesthetic appreciation of industrial products is an important aspect of psychology of aesthetics and its application in consumer related fields (Liu, 2003). In psychology, topics of aesthetic appreciation were investigated mainly in the field of empirical or experimental aesthetics.

*Correspondence to: Dr H. Leder, University of Vienna, Faculty of Psychology, Dept. Psychological Basic Research, Liebiggasse 5, A-1010 Vienna, Austria. E-mail: leder@experimental-psychology.com

There are a number of variables known to affect aesthetic appreciation (Berlyne, 1970). Empirical aesthetic followed two main approaches. Research was often concerned with stimulus variables which were systematically investigated using well-defined artificial stimuli (see Liu, 2003). Berlyne (1974) for example, using articial pattern found, that complexity psychologically refers to the arousing potential of a stimulus. According to his findings, preference is related to medium levels of complexity, which do not arouse too much (which on the other hand very complex objects do) and on the other hand are not boring (as very simple objects are). Thus from his studies, Berlyne proposed an inverted U-shape relation between complexity (or arousal potential of a stimulus) and preference. This relation was replicated with various stimulus materials (Saklofske, 1975; see P. Hekkert, unpublished thesis, 1995, for a comprehensive overview) but exceptions have also been reported (Martindale, Moore, & Borkum, 1990). Importantly, the arousing potential of a stimulus somehow is subjective, thus varies between people and somehow depends on their adaptation level.

In the alternative approach of empirical aesthetics, real complex artworks were investigated. This approach makes it more difficult for the researcher to control for stimulus variables such as complexity, balance or prototypicality. Moreover, due to higher order cognitive processing, such as semantic interpretation and attachment of meaning, some effects found with more simple stimuli have often not been found when real artworks were investigated. An example is the lack of mere-exposure (familiarity-) effects with real artworks (Bornstein, 1989).

Variation of complexity in terms of design principles ranges from variation of physical stimulus properties to references of psychological grouping principles such as symmetry. The former include variation in the number of steering elements, number of colours and shapes. The latter include design principles such as symmetry and prototypicality which both affect the perceived complexity but are also known to affect aesthetic preference and cognitive appraisal of visual complexity and balance (Locher & Nodine, 1991; Locher, Cornelis, Wagemans, & Stappers, 2001). In order to understand the role of complexity in the aesthetic appreciation of real design objects, in the first experiment of the present study we used three levels of complexity by variation of the number of displays and elements in the different design versions (see Figure 1).

Recent developments in car design have shown a clear movement towards more curved designs, as compared to straight design approaches, which dominated the late '80s and early '90s. The new edge-design of Ford and the new Beetle are typical examples. The curved design is possible through new methods of production, but also represents a trend towards a deviation from the long term dominant principles of the designers in the '70s and '80s that 'less is more'. However there are also some exceptions such as horizontally straight of the new 7-series product of BMW. The variation on this dimension is strongly related to the need in design to produce innovative products. It is difficult to predict, how variation in curvature is experienced and evaluated psychologically. Studies on the comparison of affective reactions towards different consumer products usually did not explicitly vary this dimension (Snelders & Hekkert, 1999). In our study three levels of curvature in design were used in order to establish, which design variant is preferred and to investigate these basic dimensions in a domain of applied aesthetics. However, we expect that curvature elicits higher positive emotional reactions (and therefore higher ratings of appreciation) because we suppose that softer, curved shapes are more often associated with cuteness, beauty and approach, while sharp, straight designs are presumably more related to technical, analytical and cold reactions. These expectations are in accordance for

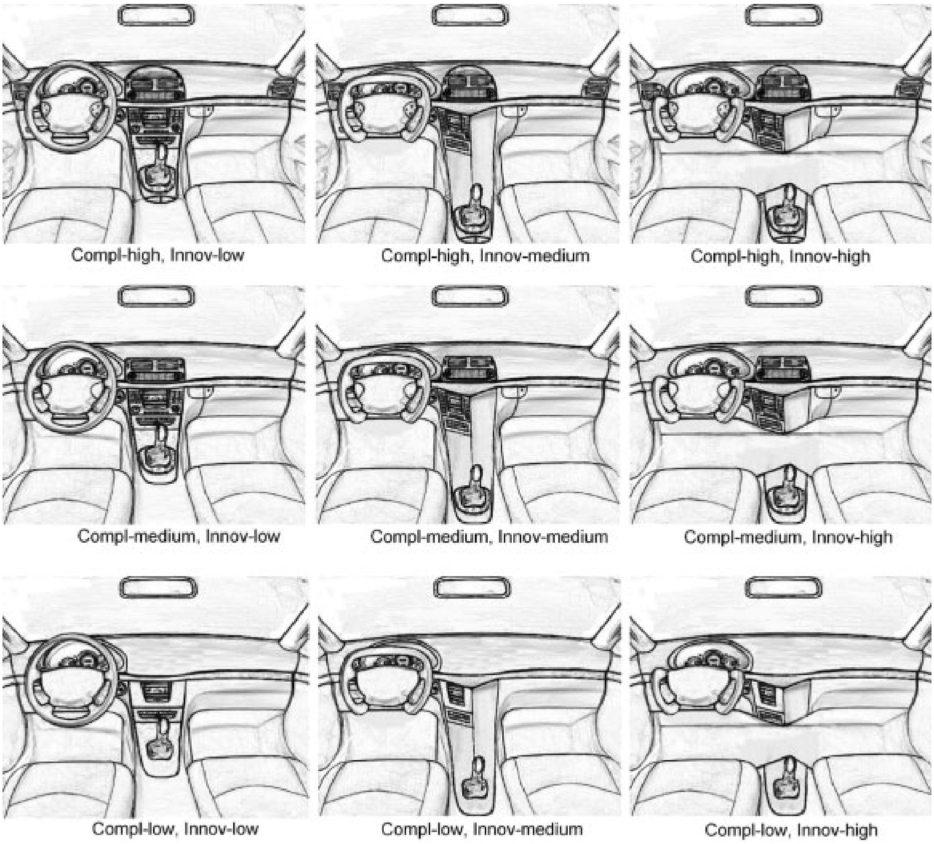

Figure 1. Examples of Form-original stimuli used in Experiment 1. Three levels of complexity (Compl-low, Compl-medium, Compl-high), form (Form-straight, Form-original, Form-curved) and innovativeness (Innov-low, Innov-medium, Innov-high) were used

example with pattern of appreciation in faces (Etcoff, 1999) and descriptions of design principles in the Gestalt-psychologists approaches (Arnheim, 1954).

Preference for a predominant curved style might also reflect the preference for familiarity as expressed in the mere-exposure hypothesis (Zajonc, 1968). In this respect preference for the dominant style presumably is the result of a positive habituation process. Nevertheless, the combination of different levels of curvature with different levels of the other two dimensions (together with individual differences) might uncover modification of this simple familiarity and liking relation.

One of the most important dimensions of aesthetic appreciation in our study is innovation. Innovation in design refers to unusual or indeed new aspects of design, that are unfamiliar to the perceiver. Innovative aspects are particularly important because the reaction to innovation often is essential for the developing course of consumer behaviour. Innovative objects are rarely completely new, incremental developments best describe the progress in product developments (Snelders & Hekkert, 1999). The need to implement innovation in product design is similar to what Leder (2003) identified as one of the major dimensions in modern art. However, art and design differ in that the latter also has to fulfil aspects of usability. In a recent study Hekkert, Snelders, and van Wieringen (2003) have shown that in industrial design novelty and familiarity together affect appreciation and that both components can be seen as being more or less independent. What these authors describe as originality includes meaningful, new elements of innovation in industrial design. Thus, in our study we included three levels of what we call ‘innovation’ using elements that are taken from recent trends and future prototypes in car design.

Importantly, appreciation of innovation might depend on personal characteristics. Not everyone is interested in design, but exposure to and experience with innovation in design or art presumably affects the ability to appreciate these ‘new’ appearances. In respect to perceiver characteristics we might expect to find individual differences in the appreciation of different levels of innovativeness depending on interest and expertise with design or art. This would be in accordance with expected effects of a wider experience (and openness to) aesthetic variation (Eysenck, 1972; Tobacyk, Bailey, & Myers, 1979). Similar effects might be found for the variation of curvature: For example, in our study people who are more interested in design might prefer the less frequently experienced straight versions. On the other hand, an opposite effect would reflect a preference for what actually is fashionable in actual design: a relatively high level of curvature, and would therefore be in accordance with the mere-exposure hypothesis. This finding would not be unexpected because the differences in level of art interest in a homogeneous group such as students is known to be rather small (Leder, 2003). However, the present study used newly designed questionnaires and in this respect was rather explorative.

To summarize the purpose of our study: we investigated the role of curvature, complexity and innovation as well as interest in art and design for the appreciation of modern car-interior design. Importantly we use a design in which the effects of the different design dimensions are investigated simultaneously.

EXPERIMENT 1

In Experiment 1 a fully factorial design was used in which three levels of complexity, three levels of curvature and three levels of innovativeness were combined. The aims of the first study were to validate these dimensions for all 27 stimuli, to establish general relations between these variables and their perceived attractiveness, and to test simple tools to find relevant individual differences in appreciation of these stimuli. Leder (2003) has proposed that it is likely that appreciation of contemporary, complex stimuli, such as artworks or industrial design products, is based on a kind of cognitive fluency. Cognitive fluency describes effects of knowledge-based expertise in processing unusual, style based and innovative features. As innovative products often disrupt the usual expectations, it might be expected that persons who are particularly interested and experienced in art and design, will tend to have cognitive structures, which allow the processing and appreciation of innovative objects. Moreover, people interested in art and design might be more sensitive for the actually fashionable use of curved design.

Method

Subjects

Twenty-four participants took part in this experiment with an average age of 25.6 years, 12 of them were female.

Apparatus and stimuli

Twenty-seven drawings of interior design were produced and used in Experiment 1. Figure 1 shows some examples.[1]

All stimuli consisted of line drawing versions, which varied according to the following dimensions.

Curvature versus straightness: Recent developments in car design reveal that extreme versions of both ends of this dimension are chosen for innovative interior concepts: While for example BMW created a straight horizontal design for the new 7-series models, this rather seems to be an exception. On the other end of the dimension the Smart products, the Audi TT, the New Beetle, or the new Peugeot 306 reveal that curvature is a feature in most new car models and is likely to be seen as innovative. In Experiment 1 three levels of curvature, from straight to curved were used to investigate the effect of this manipulation onto the perceiver.

A second dimension varied complexity in terms of the number of features. This dimension is thought of as representing a trend in car design to simplify the interior, but also corresponds to the psychological concept of complexity. Reducing the number of elements is also a trend to be seen in a number of new innovative concepts, such as the *iDrive* system by BMW.

A third dimension directly addressed the variation of innovativeness. Two elements were each varied in three levels of innovation. The size of the steering wheel, from full to half and some eccentric small version, and the size and protuberance of two functional blocks in the console. New production technologies allow the creation of new protuberant elements, which no longer need to fulfil the functions in terms of stabilization as they had in the past. The new middle console of the 2002 Opel (Vauxhall) Vectra is an example. Modularization in space can give cars a cockpit-like appeal and allows placing important interior segments to the most suitable locations.

In order to analyse data with respect to the principle of cognitive fluency/design expertise/openness to innovation-versus conservative, a sample of questionnaires was developed and used to establish individual differences. These are based on previous studies by Leder (2003) and have been expanded here to the domain of design expertise and interest. A questionnaire, which measured expertise and knowledge in design, was also used. The questionnaires are described in the procedure section.

Procedure

All participants rated all 27 stimuli according to perceived attractiveness, complexity, curvature and innovativeness. Seven-point scales were used; all stimuli were presented on a computer screen (21" CRT) using experimental software Psycope PPC 1.25 (Cohen, MacWhinney, Flatt, & Provost, 1993). All participants started with the ratings of 'attractiveness', as this was the dependent variable of main interest. It was intended to measure attractiveness from spontaneous first impression, without interference from other ratings or explicit awareness of the dimensions involved.

Afterwards, three blocks followed in a full balanced design, which measured the appearance of our three design dimensions in order to validate them. Participants were instructed to respond spontaneously and fast. Therefore analyses of reaction times (RTs) seem to be warranted to support hypothesis of processing fluency. Expertise and interest in art and design might result in faster, more fluent processing of stimuli.

[1]The original stimuli can be found on http://www.experimental-psychology.de/HL/Figures.htm.

After participants finished the tasks in front of the computer, they were asked to answer three paper and pencil questionnaires. First, they were asked sociometric questions. They were given questions about their parents' occupation, and the size of the city they grew up in. Additionally, they were asked questions about their interest in design (on a 7-point Likert scale) and for their frequency in visiting museums and design exhibitions (by telling which Berlin museums they have been visited recently). The second questionnaire was concerned with knowledge about design objects. Pictures of nine famous design-objects were shown to the test subject who had to write down whether they are familiar with the objects. The objects had been chosen on the basis of an empirical survey, testing more than 60 objects with 12 students and selecting those which were familiar and for which different levels of knowledge about stylistic categorization were found.[2]

Afterwards, participants were asked to name the time period (decade or epoch) in which the object had been designed and the name of designer. This part will reveal differences in expertise and knowledge about design. The third questionnaire was concerned with art and aesthetics. Questions about the participants' interest in art (on a 7-point Likert scale) were asked, but also expertise about 20th century artists[3] was questioned.

Results and discussion

The main research question is concerned with the effect of stimulus dimensions on the attractiveness of the different stimuli (Table 1).

A three-way repeated measurement analysis of variance (ANOVA) using the attractiveness ratings per participants with *curvature* (straight, original, curved), *complexity* (low, medium, high) and *innovativeness* (low, medium, high) as within factors revealed main effects of *curvature,* $F(2, 46) = 24.69$, $p < 0.001$, $\eta_p^2 = 0.518$ and *innovativeness*,

Table 1. Attractiveness ratings for Experiment 1 with means and *SDs*

	Straight		Original		Curved	
	Attract.	*SD*	Attract.	*SD*	Attract.	*SD*
High complexity						
Low innovativeness	4.08	1.69	4.67	1.76	4.83	1.58
Medium innovativeness	1.83	0.96	2.96	1.46	3.54	1.50
High innovativeness	1.75	1.45	2.79	1.74	3.17	1.63
Medium complexity						
Low innovativeness	3.83	1.46	4.29	1.57	4.50	1.75
Medium innovativeness	2.17	1.05	2.67	1.13	3.33	1.31
High innovativeness	2.17	1.20	2.58	1.14	3.21	1.67
Low complexity						
Low innovativeness	3.58	1.61	4.41	1.82	4.58	1.79
Medium innovativeness	2.08	1.06	2.71	1.00	3.29	1.65
High innovativeness	1.92	1.21	2.83	1.31	2.63	1.38

[2]Philippe Starck: Costes Chair, Charles Eames: 670 Lounge Chair, Marcel Breuer: Wassily Chair No.B3, Michael Graves: Teakettle, Michael Thonet: Chair A14, Le Corbusier: 702 Lounge Chair, Eero Saarinen: Tulip Chair, Le Corbusier: Grand Comfort Club Chair, Mies van der Rohe: Barcelona Chair.

[3]Henri Matisse, Joseph Beuys, Salvador Dali, Pablo Picasso, Jackson Pollock, Piet Mondrian, Ernst-Ludwig Kirchner, Andy Warhol, Victor Vasarely, Anselm Kiefer. Further information can be requested from the first author.

$F(2,46) = 22.47$, $p < 0.001$, $\eta_p{}^2 = 0.494$ but no other effect nor interaction. Curved versions ($M = 3.68$) received generally higher attractiveness ratings than the medium curved versions ($M = 3.32$), and these were higher than the straight versions ($M = 2.60$). Concerning innovativeness there was a significant attractiveness advantage for the least innovative versions ($M_{\text{low innov}} = 4.31$, $M_{\text{medium innov}} = 2.73$, $M_{\text{high innov}} = 2.56$). Thus—at least for the version used here—innovative versions were not perceived as being attractive. To validate whether the stimulus dimensions were seen as being different in *complexity*, *innovativeness* and *curvature* the analyses of these explicit ratings are reported separately for each rating as a dependent variable.

Analysing the ratings of *complexity* in a three-way repeated measurement ANOVA revealed a strong main effect of *complexity*, $F(2,46) = 137.62$, $p < 0.001$, $\eta_p{}^2 = 0.857$. Moreover, there was a main effect of *innovativeness*, $F(2,46) = 8.56$, $p < 0.001$, $\eta_p{}^2 = 0.271$, as well as an interaction between *complexity* and *innovativeness*, $F(4,23) = 5.57$, $p < 0.001$, $\eta_p{}^2 = 0.195$. The perceived complexity varied with the levels of innovativeness such that low innovative ($M = 4.34$) designs received higher impressions of complexity than medium innovative ($M = 3.65$) or high innovative designs ($M = 3.62$). This is not unexpected because part of our manipulation for the three levels of innovativeness was an omission of the middle element as well as a reduction of the size of the steering wheel. However, it is important that these 'innovations' did not render the interiors more complex.

Analysing the ratings of *curvature* in a three-way repeated measurement ANOVA revealed a strong main effect of *curvature*, $F(2,46) = 140.95$, $p < 0.001$, $\eta_p{}^2 = 0.860$ and a main effect of *innovativeness*, $F(2,46) = 11.607$, $p < 0.001$, $\eta_p{}^2 = 0.335$, as well as an interaction between *curvature* and *innovativeness*, $F(4,23) = 13.368$, $p < 0.001$, $\eta_p{}^2 = 0.368$. Moreover there was an interaction between *complexity* and *innovativeness*, $F(4,23) = 2.713$, $p = 0.025$, $\eta_p{}^2 = 0.106$. However, the ratings validated that curvature ratings increased monotonically with the corresponding stimulus dimension, but the higher levels of *innovativeness* appeared less curved.

Thus the perceived curvature varied with the levels of innovativeness. Again, for the appearance of curvature an interaction with innovativeness was found. As can be seen from Figure 4 (Experiment 2) the perceived curvedness was higher with lower levels of innovativeness, and this was particularly the case when straight designs were rated.

The ratings of *innovativeness* were also analysed in a three-way repeated measurement ANOVA. As expected, the analysis revealed a main effect of *innovativeness*, $F(2,46) = 37.854$, $p < 0.001$, $\eta_p{}^2 = 0.622$. Moreover, there was also a main effect of *curvature*, $F(2,46) = 4.416$, $p = 0.018$, $\eta_p{}^2 = 0.161$, as well as an interaction between *curvature* and *innovativeness*, $F(4,23) = 5.914$, $p < 0.001$, $\eta_p{}^2 = 0.204$, but no other effects. Thus, innovativeness produced a generally lower effect, which however was modified by curvature. While the more innovative designs were seen as being more innovative rather surprisingly the straight versions were seen as being most innovative. As was assumed in our introduction there is a trend in some modern car building towards straightness in very new models, particularly in the new models of BMW. The analysis of the *innovativeness* data confirms that this design principle was indeed seen by our participants as being innovative. Particularly the higher levels of straightness as it was operationalized here were seen as more innovative.

One important aim of our study was the detection of relevant individual differences. We analysed all data from our questionnaires by calculating median splits for interest and expertise in design and art. However, we did not find more than small trends for either variable. It is not excluded that the lack of effects is explainable by the small differences

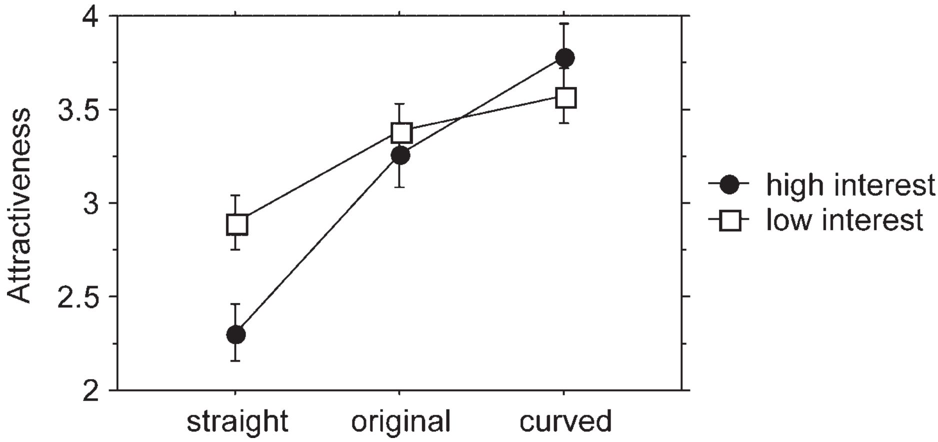

Figure 2. Results of Experiment 1. The interaction between interest in art and curvature on perceived attractiveness. The error bars are SEs (of the mean)

between subjects in these variables. The only significant interaction was found between (post-hoc-classified) participants with more or less interest in art and their ratings of attractiveness for differently curved design ($p < 0.05$). Participants who revealed higher ratings of 'expertise' were more sensitive to differences in curvature and found straight models less attractive than did non-experts. Here, the operationalization of expertise was made by integrating the measures of knowing several art relevant facts (knowing, report to be able to imagine paintings and knowing the style of artists and specific paintings and other art object) and separating experts and novices by the median of this measure. This kind of expertise reveals higher preferences for curved car design (as is revealed by Figure 2).

Leder (2003) has argued that expertise and interest in art might lead to higher interest in innovative stimuli, particularly in art and design. The instruction used here, to give the ratings spontaneously warrants to have a look at the RTs. In order to find evidence for that prediction it might be expected that people more interested in art (dichotomized by the median of the measure 'Are you interested in art?') make their judgments faster than non-experts. However, they might also spend more time on the innovative interiors because these stimuli are more interesting to them. In accordance with this prediction we found a trend that experts spent more time giving their ratings (of attractiveness) for the highly innovative stimuli. However, this result (the interaction) has not been significant in Experiment 1 ($p = 0.073$, *n.s.*). A post-analysis, reduced three-way repeated measurement ANOVA with *innovativeness-reduced* (medium vs. high, see the rectangle in Figure 3), *curvature* and *complexity* as within factors and *interest in art* (low vs. high) as between factor however revealed a significant interaction ($p < 0.02$). The only effect in support of the fluency hypothesis, that experts process innovative designs more fluently, i.e. faster, was found in the innovativeness data. When highly innovative designs were compared with low innovative design then innovativeness ratings were indeed given faster by those participants who often visited museums (median split, analyses over two levels only). However, due to the given task (the participants had to rate the attractiveness in a 7 alternative forced choice), RTs have to be interpreted very carefully.

We have reported results concerning the attractiveness of car interior design, which factorially varied according to *complexity, curvature* and *innovativeness*. The latter two

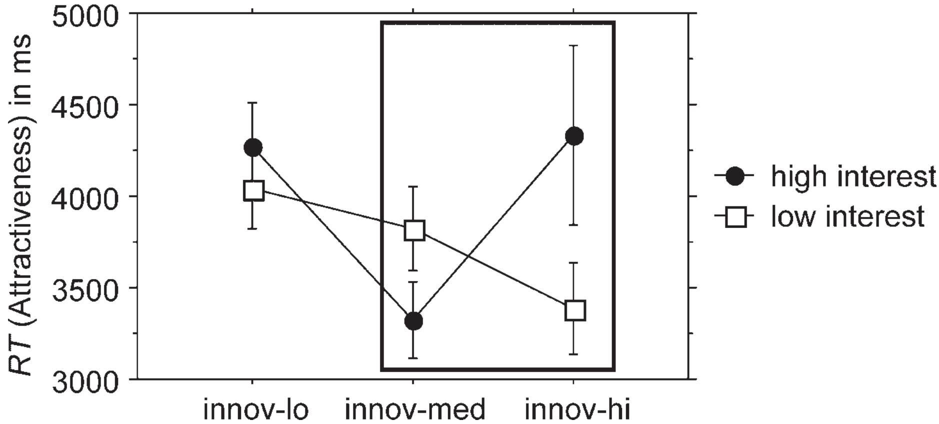

Figure 3. Results of Experiment 1. Interaction based on reaction times (RTs) between innovativeness and interest in art. The error bars are SEs

variables affected the perceived attractiveness, but there was evidence from the validation scales that *complexity* and *innovativeness* both were seen as somehow similar. Nonetheless, complexity did not significantly affect attractiveness as would have been predicted by some theories in empirical aesthetics (Berlyne, 1974). This might be due to the way the different levels of innovativeness have been created here: Both manipulations somehow affected the complexity of the stimuli while leaving curvature rather unaffected. However, we have validated the stimulus dimensions and have shown their effect on aesthetic appreciation. Generally more curved and less innovative versions were seen as being more attractive. This is in accordance with an explanation in terms of familiarity. As most actual car designs tend to be curved and innovation per definition counteracts familiarity the results somehow support a mere-exposure hypothesis (Zajonc, 1968) in that people tend to like what they know.

The effects of individual differences were much smaller than expected. Persons more interested in art preferred curved design more than other people did, and judged innovative designs relatively faster. The latter finding can be taken as a weak support for the predictions of a cognitive fluency hypothesis.

The lack of further effects might be due to the homogeneity of our population, which were all students from the Freie Universität Berlin in a rather narrow age range. For Experiment 2 a more heterogeneous population was investigated in a design, which might be more sensitive to effects of cognitive and perceptual fluency and which included curvature and stronger variations in innovativeness as stimulus dimensions.

EXPERIMENT 2

Experiment 2 is similar to Experiment 1. Due to the results of Experiment 1 complexity was omitted as a dimension and a new version of the highest level of innovativeness was created. Experiment 1 provided only relatively small effects of individual differences in art and design expertise. In order to exclude that this was only due to the homogeneity of the group of participants, in Experiment 2 a broader range of age, and students as well as non-students were tested. Moreover, participants differentially received treatments, each of which was concerned with one pole of the two dimensions, curvature (with straight versus curved) and innovativeness (with classic versus innovative). As in Experiment 1 questionnaires about interest and expertise in design and art were used to establish individual differences in aesthetic attitudes concerning the perception and appreciation of our stimuli.

In Experiment 2 again a fully factorial design was used, in which three levels of curvature and three levels of innovativeness were combined. A first aim was to validate these dimensions for all nine stimuli. This is in part a replication of the findings of Experiment 1. As in Experiment 1 it was aimed to establish general relations between these variables and their perceived attractiveness. Moreover, individual differences were measured to find relevant individual differences in appreciation of our stimuli. Finally the role of prior-to-testing information about dimensions in design was used as an experimental treatment.

Method

Subjects

Forty-eight participants took part in this experiment with an average age of 28.8 years, 24 of them were female. Half the participants were students of the Freie Universität Berlin (mean age: 25.2, half of them were female), the other half were people from outside the university (mean age: 32.4, half of them were female). Only car drivers were tested. The students who participated in the experiment were recruited with the help of advertising posters, at the Freie Universität Berlin. The students got a certificate for joining in the experiment. Non-students received 10 Euro for joining the experiment.

Apparatus and stimuli

Figure 4 shows all stimuli used in Experiment 2. Drawings of interior designs of cars were produced which varied according to the following dimensions.

Curvature versus straightness: As in Experiment 1 three levels of curvature, from straight to curved were used. Moreover stimuli varied according to innovativeness in three levels. Here two elements were selectively changed in three levels. The size of the steering wheel, from full to half and some eccentric small version, and the size, protuberance and location of two functional blocks in the console. As can be seen from a comparison between Figures 1 and 4, the changes in the protuberance of the middle console were more extreme in Experiment 2 as compared with Experiment 1. The same post-test questionnaires as in Experiment 1 were used.

Procedure

The experiments consisted of four different parts. Firstly, the participants received a pre-experimental treatment concerning one of the four dimensional poles of the two dimensions. Each participant was given pre-information, concerned with either curved, straight, innovative or classic design information. The four treatments (which differed between-subjects) stressed the importance of *innovative*, *classic*, *curved* or *straight* features for modern design. The treatments consisted of a short description in which the specific dimension was described as being an important feature of actual design. Each treatment was illustrated by three design objects (a car, a telephone, a chair). In order to ensure an elaborated processing of the pre-information participants were asked to describe

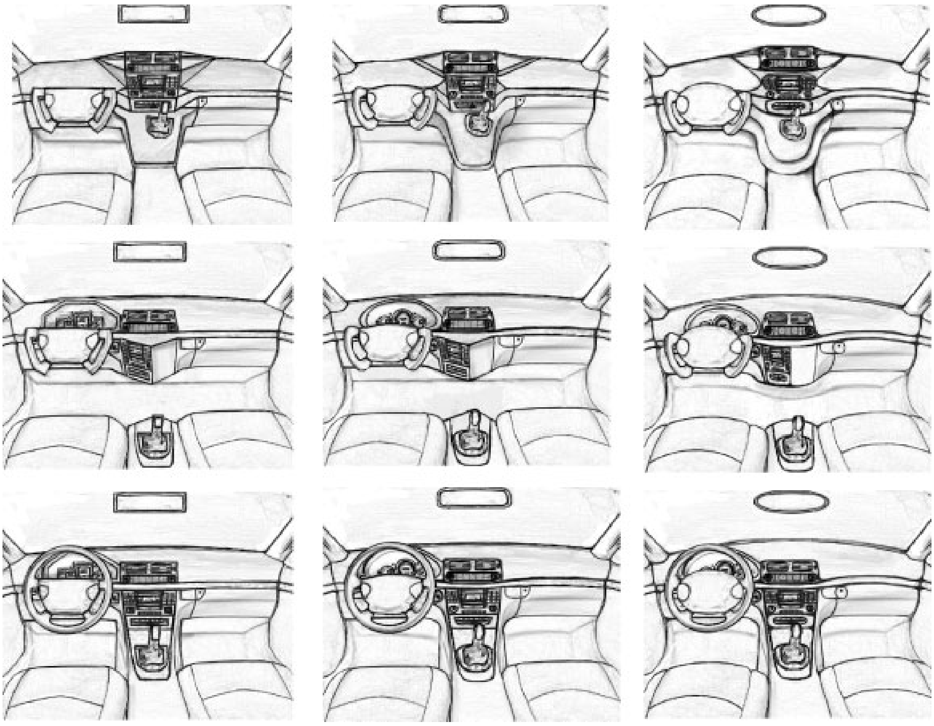

Figure 4. The stimuli used in Experiment 2. The left column shows straight variants, the middle column shows original variants, the right column shows curved variants. From lowest to highest row increasing levels of innovativeness (low, middle, high) are shown

the objects (and how they appeared), and rate the three examples using seven 7-point scales. The scales used in Experiment 2 were unconventional (*ungewöhnlich*), modern, tasteful (*geschmackvoll*), innovative, attractive, openness (*übersichtlich*) and elegant (*elegant*). Participants were randomly assigned to each condition.

After completing the treatment questionnaire, participants were asked to take a seat in front of the computer. They had to evaluate all nine different car interiors (Figure 4) on seven 7-point scales. Participants rated all stimuli block-wise on all seven scales, again, as in Experiment 1 always starting with attractiveness. Afterwards six blocks followed in a full balanced design, which measured the appearance of our two design dimensions. Only the data from the attractiveness and innovativeness ratings are considered in our results and discussion session. Participants tested outside the university ran this block on a mobile computer.

Afterwards, a paper-based questionnaire was handed to the test subject. This questionnaire was very similar to the first one, because it contained the same 7-point-rating scales. But this time, the participant was asked to evaluate the classes of objects they had not seen in the treatment (without the introducing treatment information concerning each dimension). Again, these data are not reported and therefore are not considered in our results and discussion. At the end of the experiment, participants were asked sociometric questions and were given the same questionnaires as in Experiment 1 concerning their knowledge and interest about art and design.

Table 2. Attractiveness ratings for Experiment 2 with means and *SDs*

	Straight		Original		Curved	
	Attract.	*SD*	Attract.	*SD*	Attract.	*SD*
Overall						
Low innovativeness	3.94	1.30	4.73	1.09	4.54	1.25
Medium innovativeness	2.52	1.26	3.29	1.46	3.79	1.34
High innovativeness	2.44	1.24	3.21	1.32	3.52	1.58
Museum expert						
Low innovativeness	3.73	1.41	4.53	1.02	4.47	1.22
Medium innovativeness	2.00	0.94	2.58	1.31	3.32	1.25
High innovativeness	1.90	0.99	2.63	1.17	2.79	1.28
Museum novice						
Low innovativeness	4.07	1.22	4.86	1.13	4.59	1.30
Medium innovativeness	2.86	1.33	3.76	1.38	4.10	1.32
High innovativeness	2.79	1.26	3.59	1.30	4.03	1.57

Results and discussion

Four different analyses are presented in the following results sections, which are concerned with attractiveness (see Table 2), innovation, expertise and the pre-information.

Attractiveness of stimuli

In order to replicate the general pattern of results from Experiment 1 we analysed the data of the attractiveness ratings, sampled over all participants (and treatments). Figure 5 shows the results of this block, the ratings of attractiveness.

A two-way repeated measurement ANOVA with *curvature* (straight, original, curved) and *innovativeness* (low, medium, high) as within factors revealed main effects of *curvature*, $F(2, 94) = 38.81$, $p < 0.0001$, $\eta_p^2 = 0.452$ and *innovativeness*, $F(2, 94) = 30.42$, $p < 0.0001$, $\eta_p^2 = 0.393$ and a significant interaction between *curvature* and

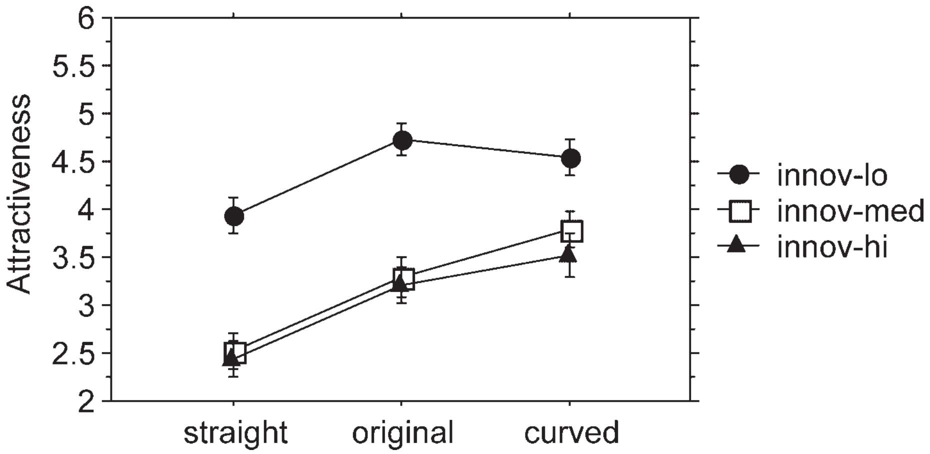

Figure 5. Results of Experiment 2. Interaction between curvature and innovativeness on perceived attractiveness. The error bars are SEs

innovativeness, $F(4, 188) = 3.22$, $p = 0.014$, $\eta_p^2 = 0.064$. Concerning the effect of our stimulus variables on the perceived attractiveness the analyses revealed that the curved versions ($M = 3.95$) received generally higher attractiveness ratings than the medium ($M = 3.74$), and these were higher than the straight versions ($M = 2.97$). Scheffé post-hoc tests revealed that only the curved and the original version were not different. Concerning *innovativeness* there was a significant attractiveness advantage for the least innovative versions ($M = 4.40$). Thus, innovative versions were again not perceived as being attractive ($M_{medium\ innov} = 3.20$, $M_{high\ innov} = 3.06$). These results support the conclusions drawn from Experiment 1.

Validation of innovativeness

To validate whether the stimulus features of the different levels of *innovativeness* used here were seen indeed as being different in their underlying degree of *innovativeness* a separate analysis of these explicit ratings was run with *innovativeness* ratings as a dependent variable. The ratings of *innovativeness* were analysed in a two-way repeated measurement ANOVA (*innovativeness* as dependent variable and the two repeated measured factors *innovativeness* and *curvature* as independent variables). The analysis revealed—as expected—a strong main effect of *innovativeness*, $F(2, 94) = 72.12$, $p < 0.001$, $\eta_p^2 = 0.605$, but no other effects. The analyses of the *innovativeness* data confirm that the design principles applied here were seen by our participants as being innovative. Particularly the higher levels of *innovativeness* were seen as more innovative.

Specific evaluation pattern of 'experts'

One aim of our study was the detection of relevant individual differences. We analysed all data from our questionnaires by calculating median splits for interest and expertise in design and art. One measure (called *MUSEUM expertise*), turned out to be highly selective about subjects concerning their general interest in visiting museums. Due to its strong effect of separating clearly distinguishable sets of participants it was used in the analyses presented below. However, our post analyses revealed that there only was a trend for an interaction between *MUSEUM expertise* and *innovativeness*, $F(2, 92) = 2.52$, $p = 0.086$, *n.s.*) which is illustrated by Figure 6.

Interestingly, *MUSEUM experts not only* gave lower ratings of attractiveness, but also strengthened the evaluation pattern. Thus lower ratings of attractiveness of higher levels of innovation were stronger when the participants were MUSEUM experts (MUSEUM experts: $M_{high\ innov} = 2.42$; MUSEM novices: $M_{high\ innov} = 3.47$).

Influence of the treatment

An independent factor in our design was the treatment of the first questionnaire, which was presented before rating of our stimuli. There were four different treatments as described above. In a three-way ANOVA with *curvature* and *innovativeness* as within factors and *treatment* as between-factor, *treatment (in general)* was not found significant in a repeated measurement design, $F(3, 44) = 1.15$, *n.s.* Thus, in our sample information concerning the importance of a dimensional feature (straight, curved, innovative, classic) as an indicator for 'modern' design did not selectively affect the attractiveness of the corresponding exemplars.

Again, in order to find evidence for a cognitive fluency effect we also looked at the RT data. The factor treatment had a systematic influence on the *speed* (RT) of the rating process. A three-way repeated measurement ANOVA with the response time (excluding outliners of above 8 s; $M = 3860.1$ ms, $SD = 1766.1$, *skewness*: 0.35, *kurtosis*: -0.41) for

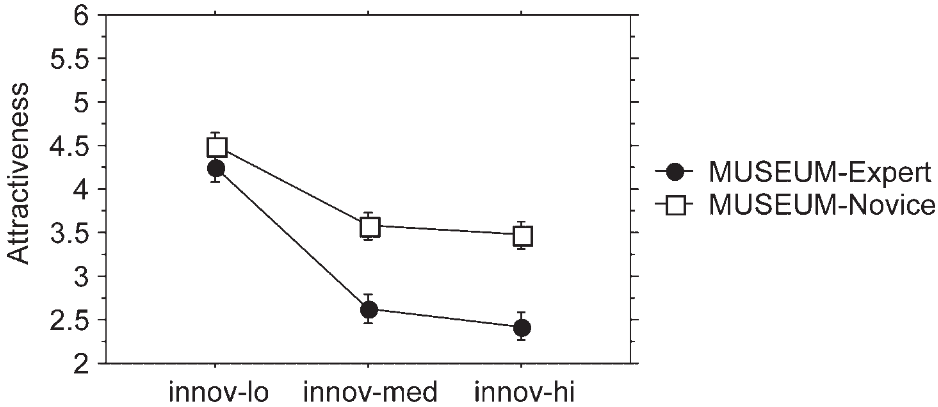

Figure 6. Results of Experiment 2. Interaction of MUSEUM expertise and innovativeness on attractiveness ratings. The error bars are SEs

evaluating the attractiveness of the items as dependent variable and *curvature* as well as *innovativeness* as within factors and *treatment* as between-subjects factor revealed a significant main effect of *treatment*, $F(3, 21) = 3.40$, $p = 0.037$, $\eta_p^2 = 0.327$, but surprisingly no interaction. Post-tests (Bonferroni adjusted, $p = 0.0068$) revealed that the evaluation time was significantly longer after the *straight* treatment ($M = 4320.7$ ms) than after the *innovative* treatment ($M = 3320.2$ ms). However, the effect of the once given pre-information is unexpectedly weak, no interactive affect on perceived attractiveness was found and it therefore seems that design preferences are not easily affected by a single intervention. Although a null effect should be interpreted with great reservations, at least it can be concluded that the treatment used here did not specifically affect design appreciation.

GENERAL DISCUSSION

In Experiment 1 it was found that ratings of attractiveness of car interiors were significantly affected by properties of the stimuli. Curved and less innovative designs were seen as being particularly attractive. Moreover, most participants saw the relatively unusual straight design as being innovative. These findings are in accordance with a mere-exposure explanation. Participants appreciated the actually dominant and therefore more frequent curved design more. The less appreciated straight design appeared innovative in a rather negative sense. There was great consistency in these results, individual differences were rather weak. The differences between straight and curved designs (in respect to attractiveness) were more pronounced for participants with higher interest in art, and these participants took more time to look at the less attractive high-innovative designs.

The stimulus dimensions affecting attractiveness were mainly replicated in Experiment 2. Using more extreme versions of innovation and testing a more heterogeneous population the results were very similar. Moreover, the stimulus dimension *innovativeness* was validated and its effect on aesthetic appreciation was replicated using different levels of innovativeness. Generally, more curved and less innovative versions were seen as being more attractive.

Concerning the design treatments the effects were rather small. However, when individual levels of art expertise (and interest) were considered, then at least one interesting trend was found: There was a trend that persons more interested in art were more sensitive to changes of innovativeness, which presumably was due to higher cognitive design concepts. Thus, in accordance with Leder (2003) it seems that interest in art and design makes it more likely that these persons would be affected by treatment in which conceptual dimensions are stressed.

The present experiments are explorative in that for example the different treatments might not be seen as reliable levels of two dimensions. Pre-experimental information might be more or less effective in dependence of its validity. As mentioned above, the information that 'straight forms' are important elements in actual design—at least for most car makers—is not really true or representative. The possibility that experts were aware of this more than lay people cannot be excluded from our results. Surprisingly the effects of individual differences were much smaller than expected.

Future research therefore has to consider stronger manipulations, to reveal from what exposure shifts in appreciation could be expected. Moreover, the present studies do not exclude, that expertise and interest in design and art might be important mediators in aesthetic appreciation.

The results of the present experiments using students and non-students reveal that at present curved and not too innovative designs are preferred. These findings are in accordance with a mere-exposure hypothesis, which claims that the most frequent versions of car interiors for the moment represent the most appreciated ones. It remains one of the big issues of future research in the area of design and appreciation what the cause for the shift of innovative objects into appreciated and familiar design objects is.

ACKNOWLEDGEMENT

The authors wish to thank Dan Wright for valuable comments on this paper.

REFERENCES

Arnheim, R. (1954). *Art and visual perception: A psychology of the creative eye*. Berkeley: University of California Press.

Berlyne, D. E. (1970). Novelty, complexity, and hedonic value. *Perception and Psychophysics, 8*(5-A), 279–286.

Berlyne, D. E. (Ed.). (1974). *Studies in the new experimental aesthetics: Steps toward an objective psychology of aesthetic appreciation*. London: Wiley.

Bornstein, R. F. (1989). Exposure and affect: overview and meta-analysis of research, 1968–1987. *Psychological Bulletin, 106*(2), 265–289.

Cohen, J. D., MacWhinney, B., Flatt, M., & Provost, J. (1993). PsyScope: a new graphic interactive environment for designing psychology experiments. *Behavioral Research Methods, Instruments, and Computers, 25*(2), 257–271.

Demirbilek, O., & Sener, B. (2003). Product design, semantics and emotional response. *Ergonomics, 46*(13/14), 1346–1360.

Etcoff, N. (1999). *Survival of the prettiest: The science of beauty.* New York, NY: Anchor Books/ Doubleday.

Eysenck, H. J. (1972). Personal preferences, aesthetic sensitivity and personality in trained and untrained subjects. *Journal of Personality, 40*(4), 544–557.

Hekkert, P., Snelders, D., & 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*(1), 111–124.

Karlsson, B. S. A., Aronsson, N., & Svensson, K. A. (2003). Using semantic environment description as a tool to evaluate car interiors. *Ergonomics, 46*(13/14), 1408–1422.

Leder, H. (2003). *Explorationen in der Bildästhetik [Explorations in visual aesthetics]*. Lengerich: Pabst.

Liu, Y. (2003). Engineering aesthetics and aesthetic ergonomics: theoretical foundations and a dual-process research methodology. *Ergonomics, 46*(13–14), 1273–1292.

Locher, P., & Nodine, C. (1991). The perceptual value of symmetry. In I. Hargittai (Ed.), *Symmetry 2: Unifying human understanding* (pp. 475–484). New York: Pergamon Press.

Locher, P., Cornelis, E., Wagemans, J., & Stappers, P. J. (2001). An empirical investigation of the role of balance in the creation of visual designs by adults. *Empirical Studies of the Arts, 19*(2), 213–227.

Martindale, C., Moore, K., & Borkum, J. (1990). Aesthetic preference: anomalous findings for Berlyne's psychobiological theory. *American Journal of Psychology, 103*(1), 53–80.

Saklofske, D. H. (1975). Visual aesthetic complexity, attractiveness and diversive exploration. *Perceptual and Motor Skills, 41*(3), 813–814.

Snelders, D., & Hekkert, P. (1999). Association measures as predictors of product originality. *Advances in Consumer Research, 26*, 588–592.

Tobacyk, J., Bailey, L., & Myers, H. (1979). Preference for paintings and personality traits. *Psychological Reports, 45*(3), 787–793.

Zajonc, R. B. (1968). Attitudinal Effects of Mere Exposure. *Journal of Personality and Social Psychology, 9*(2), 1–27.

