Dynamics of Aesthetic Appreciation for Artificial Categories

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Stella J. Faerber

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Contents

Abstract

Everyday life in westernised countries is characterised by ongoing changes in the environment, for instance, through the introduction of new, innovative designs. Innovative or untypical designs often disrupt the visual habits leading to the rejection of these designs at first sight. However, since humans adapt to new experiences, e.g. through intensive elaboration of such products, the perception and thus the aesthetic appreciation (AA) inherits a dynamic quality leading to changes of AA. In six projects I will demonstrate this dynamic quality of AA, which was implemented as a construct of different variables (e.g. attractiveness, arousal, interestingness, valence, boredom and innovativeness). Dynamic changes of AA were investigated using two main paradigms: the Repeated Evaluation Technique (RET), which emphasises deep elaboration of the stimulus material, and adaptation paradigms massively exposing participants to innovative or untypical exemplars. Results of all projects supported the hypothesis that new experiences trigger dynamics in AA. These dynamics were moderated by primed semantic concepts, the implemented stimulus set and situational effects. Results of the projects using adaptation paradigms supported the hypothesis that adaptation leads to the recalibration of the norm of a category being in line with the norm-based model. In this context, two important moderators were identified - namely the distance of the adaptors to the tested stimuli as well as the similarity of the tested stimuli to the adaptors. These results illustrated the ongoing adaptive changes of AA due to new experiences and underline the adaptive nature of perception and the representation of objects.

General Motivation: Aesthetic appreciation and its dynamics

People enjoy the aesthetics of a wide range of entities from natural categories including flowers, landscapes, bodies or faces to artificial (man-made) categories such as buildings, sculptures, paintings, handcrafts, machinery, habitats and (other) consumer products (Jacobsen, 2010). The aesthetic appreciation (AA) of objects represents the interplay of objective (design) features and the perceiver's subjective factors. Psychological research on AA has mainly focused on different object features to describe general, "objective" preferences for objects such as symmetry (Allesch, 1987; Fechner, 1876; Jacobsen & Hofel, 2002), proportions such as the golden section (Benjafield, 2010; Fechner, 1876), complexity (Berlyne, 1970; Eisenman & Gellens, 1968; Leder & Carbon, 2005), curvature (Carbon, 2010; Leder & Carbon, 2005) or saturation of colour (Blijlevens, Carbon, Mugge, & Schoormans, in press). Subjective factors also play an important role, but are often rather neglected by current approaches of empirical aesthetics. Such subjective factors range from personal characteristics (McManus & Cook, 2007) to personal socialisation, culture (Jacobsen, 2006) and Zeitgeist (Carbon, 2010). Thus, depending on the socialisation, culture or Zeitgeist a person will perceive an object as typical of its category or not. Depending on his or her personal characteristics, he or she would find an object arousing, interesting or boring. Qualitatively different from more objective factors mentioned above, attributes such as typicality, the arousal potential, interestingness or boredom can only be seen as a combination of objective and subjective factors. Thus, AA is characterized by a complex interplay of these factors. Importantly, subjective factors are influenced or triggered by an individual's learning and perception history, which implies that AA inherits a dynamic quality. The experimental investigation of these dynamics of AA frames the topic of this doctoral thesis.

In a real world context such dynamics of AA arise, for example, through the continuous development of consumer products. For instance, in the automobile sector the curvature of car designs as well as their appeal across brands systematically and concordantly changed over time (Carbon, 2010), showing a cycle of synchronized preference. Whereas curved shapes were clearly preferred in the 1950s, angular shapes were preferred in the 1980s leading to a revival of curved shapes at the end of the 20th century. Such a cycle of preference might be triggered by the introduction of new innovative designs in the product market (Moulson & Sproles, 2000) (for a definition of innovativeness see Carbon & Leder, 2005b). These innovative designs are often rejected at first sight (Moulson & Sproles, 2000), however, after a given time of familiarization (Zajonc, 1968) and/or elaboration (Carbon & Leder, 2005b) the AA might change. One possible mechanism behind the dynamics of AA is the constant adaptation of the perceptual system to the ongoing changes in the environment (Carbon & Ditye, 2011).

Although psychological research of AA has a very long tradition, pioneered inter alia by Gustav Theodor Fechner (e.g., Fechner, 1876), the founder of psychophysical research, as well as a very wide-reaching research portfolio (see Chatterjee, 2011) only very rare research approaches deal with its dynamic quality. One major paradigm to investigate changes in AA is through the mere exposure effect (Zajonc, 1968). Thereby, the mere exposure to a stimulus leads to increased liking (Bornstein, 1989). However, this paradigm induces passive viewing, thus a rather shallow processing (Craik & Lockhart, 1972), and does not control the mode of processing and elaboration. To further develop this method and to simulate everyday experiences with consumer products Carbon and Leder (2005b) introduced the *Repeated Evaluation Technique* (RET). This method aids a deep elaboration of the stimulus material by forcing participants to rate the material regarding different attributes, for instance design-relevant items such as elegant, extravagant or futuristic. The first four projects included in this thesis refer to studies using this technique, thereby testing its limits and scopes. Another possible area to investigate the dynamics of AA is the usage of adaptation paradigms. Visual adaptation paradigms test the effect of visual exposure to stimulus material with a specific trait (e.g., extremely curved car designs) on the perception of new stimulus material (e.g., DeBruine, Jones, Unger, Little, & Feinberg, 2007). The integration of stimulus material with an extreme level on one dimension is thought to recalibrate the mental average and therefore to change the perception of typicality, but also liking or attractiveness (Bestelmeyer, Jones, DeBruine, Little, & Welling, 2010). The last two projects introduce studies using visual adaptation paradigms in combination with the aforementioned RET.

Project I concerns the effect of priming semantic concepts on the dynamics of AA (Faerber, Leder, Gerger, & Carbon, 2010). This study investigates, inter alia, the experimental implementation of AA, since a wide range of different implementations is found in the literature. In six experiments using the RET, the dynamics of AA, which was defined as a construct comprising six different variables, were analyzed by activating different semantic networks. **Project II** comprises the article "When the others matter: Context dependent effects on changes in appreciation of innovativeness" (Gerger, Leder, Faerber, & Carbon, 2011), which examined context-effects on the dynamics of AA using different compositions of stimulus sets. **Project III** (Leder, Faerber, Gerger, Forster, & Carbon, in prep. f. resubm.) deals with the semantic concepts activated within the RET and their impact on the dynamics of AA and **Project IV** (Gerger, Leder, Faerber, & Carbon, in prep. f. resubm.) analyses the dynamic interplay between the variables of the concept of AA as introduced by Faerber et al. (2010) and the limiting factor of boredom on the changes in appreciation (Bornstein, Kale, & Cornell, 1990).

Project V and **Project VI** focus on the representation of the appreciation of experimentally processed objects based on the theory of the representation of faces by a "face space" (Valentine, 1991). With an adaptation paradigm originated from Carbon and colleagues (Carbon & Leder, 2005a; Carbon, et al., 2007), the dynamical aspects of AA particularly in terms of changes within the representation space were analyzed. In **Project V** "Dynamics of aesthetic appreciation from a perspective of adaptation in a multidimensional object space" (Faerber & Carbon, subm.-a) we observe the moderating effect of the adaptors' distinctiveness compared to the tested stimuli. Finally, **Project VI** "Jump on the innovator's train: Cognitive principles for creating appreciation in innovative product design" (Faerber & Carbon, subm.-b) deals with transfer-effects regarding the dynamics of AA from an applied perspective, aiming to analyze whether companies can benefit from imitating clear idiosyncratic design features of successful competitors. All the projects mentioned will be introduced with respect to their impact for research in the area of aesthetics and will include short reflections discussing critical points.

In conclusion, this thesis provides new insight into the field of aesthetic perception and appreciation from a dynamic perspective. It critically reflects the Repeated Evaluation Technique (Carbon & Leder, 2005b) and systematically enhances this technique. It additionally concerns adaptation effects for AA for objects (chairs), which, to our knowledge only Carbon (2010) has investigated before. Finally, this thesis suggests an extension of the face-space framework by Valentine (1991), who mainly focused on global similarities of exemplars, towards multidimensional aesthetic spaces and their dynamics.

I. Priming semantic concepts affects the dynamics of aesthetic appreciation

Motivation

What is aesthetic appreciation (AA)? Aesthetic, *aísthesis* means perception. When we appreciate something, it is worthwhile, it means something to us and affects us. AA could therefore be a perception, which itself is worthwhile, pleasurable or pleasing. To some philosophers or scientists it symbolizes beauty (Allesch, 1987), however, others such as Immanuel Kant (1790/2004) thought of AA not (only) as a judgement of specific characteristics of an object. On the contrary, what is aesthetically appreciating is determined by the kind of sensation. Thus, Kant referred to the sensational experience during the perception of an object, which would determine, whether an object is appreciated or not. AA is therefore an appealing sensual experience, it is a pleasure, which someone experiences while looking at an object. When we aesthetically appreciate something it gives us a pleasing or even overwhelming feeling. We aesthetically appreciate objects if they arouse us, however, only to a certain amount (Berlyne, 1970) and if they interest us (Berlyne, 1970; Leder, Carbon, & Ripsas, 2006). An object is aesthetically appreciating if we have to take a second look or cannot turn our gaze away, thus if it fascinates rather than bores us (Bornstein, et al., 1990). We like such objects, seek them, find them attractive, and finally are attracted by them. Such an object can be a great piece of art -whatever that might be - , it could be a well-dressed man, specifically arranged flowers, an innovatively generated piece of concrete or the mere sight of a dead dove in the street; the range of aesthetic objects is virtually unlimited (Allesch, 1987). Two further aspects are very important for an object to be aesthetically appreciated. Firstly, aesthetic appreciation affects us in the way that it suddenly sets itself apart from everyday context and disrupts our perceptual routine (Allesch, 1987). Secondly, an object just being interesting or only being beautiful or not boring, is not necessarily aesthetically appreciated; instead it must be a certain mixture of being attractive, interesting, arousing, not boring and probably should also be to some extent novel to us, therefore innovative (Hekkert, Snelders,

& van Wieringen, 2003; Moulson & Sproles, 2000). Crediting this idea of AA as being a combination of different strong sensations evoked by an object we implemented AA as a construct derived from the literature to base research on already established ideas and the definition of aesthetic appreciation (Faerber, et al., 2010, Table 1). As described in Table 1 seminal works have themselves been observing AA as a construct, although mostly not to such an extent as we did in the first and fourth project.

Variable	Actual scale	Operationalisation for	RE	Source
Attractiveness (as well as beauty, and liking)				
	Attractiveness	AA	Yes	Carbon and Leder (2005)
	Attractiveness	AA	Yes	Carbon, Michael, and Leder (2008)
	Unattractive – attractiveness	Aesthetic preferences	Yes	Cox and Cox (2002)
	Attractiveness	AA	No	Leder and Carbon (2005)
	Ugly – beautiful	Aesthetic preference	No	Hekkert, Snelders, and van Wieringen (2003)
	Like – dislike	Attitude	Yes	Bornstein and D'Agostino (1992)
	Like – dislike	Affective response	Yes	Bornstein, Kale, and Cornell (1990)
	Liking	AA	No	Carbon (2010)
	Likable – not likable	Aesthetic preferences	Yes	Cox and Cox (2002)
	Dislike – like	Attitude	Yes	Fang, Singh, and Ahluwalia (2007)
	Liking	AA	No	Leder, Carbon, and Ripsas (2006)
	Like – dislike	Affective response	Yes	Zajonc, Crandall, Kail, and Swap (1974)
Arousal				
	Emotional affection	AA	No	Leder, Carbon, and Ripsas (2006)
	Arousal	Affective response	No	Gomez and Danuser (2004)
	Arousal	Affective response	No	Redondo, Fraga, Padron, and Pineiro (2008)
	Arousal – nonarousal	Affective response	No	Russell and Mehrabian (1977)
Interestingness				
	Interesting – uninteresting	Hedonic value of novelty	Yes	Berlyne (1970)
	Interesting – boring	Affective response	Yes	Bornstein, Kale, and Cornell (1990)
	Interestingness	AA	No	Leder, Carbon, and Ripsas (2006)
	Boring – interesting	Affective response	Yes	Obermiller (1985)
	Interesting – boring	Affective response	Yes	Zajonc, Crandall, Kail, and Swap (1974)
Valence (as well as pleasantness)				
	Bad – good	Aesthetic preferences	Yes	Cox and Cox (2002)
	Good – bad	Affective response	Yes	Brentar, Neuendorf, and Armstrong (1994)
	Bad – good	Attitude	Yes	Fang, Singh, and Ahluwalia (2007)
	Bad – good	Affective response	Yes	Obermiller (1985)
	Good – bad	Affective response	Yes	Zajonc, Crandall, Kail, and Swap (1974)
	Beneficial – harmful	Affective response to novelty	Yes	Zajonc, Crandall, Kail, and Swap (1974)
	Pleasing – displeasing	Hedonic value of novelty	Yes	Berlyne (1970)
	Pleasing – displeasing	Affective response	Yes	Brentar, Neuendorf, and Armstrong (1994)
	Pleasant – unpleasant	Aesthetic preferences	Yes	Cox and Cox (2002)
	Unpleasant – pleasant	Attitude	Yes	Fang, Singh, and Ahluwalia (2007)
	Pleasantness	Affective response	No	Gomez and Danuser (2004)
	Unpleasant – pleasant	Affective response	Yes	Obermiller (1985)
	Pleasantness	Affective response	No	Redondo, Fraga, Padron, and Pineiro (2008)
	Pleasure – displeasure	Affective response	No	Russell and Mehrabian (1977)
Boredom				
	Interesting – boring	Affective response	Yes	Bornstein, Kale, and Cornell (1990)
	Boredom	AA	Yes	Carbon, Michael, and Leder (2008)
	Boring – interesting	Affective response	Yes	Obermiller (1985)
	Interesting – boring	Affective response	Yes	Zajonc, Crandall, Kail, and Swap (1974)
Innovativeness (as well as novelty, originality, and old/new)				
	Imitative – innovative	Subjective novelty	Yes	Brentar, Neuendorf, and Armstrong (1994)
	Innovativeness	Innovativeness	No	Carbon (2010)
	Innovativeness	Innovativeness	Yes	Carbon and Leder (2005)
	Innovativeness	Innovativeness	Yes	Carbon, Michael, and Leder (2008)
	Innovativeness	Innovativeness	No	Leder and Carbon (2005)
	Familiar – novel	Novelty	No	Cox and Cox (2002): Pretest
	Original – unoriginal	Novelty	No	Cox and Cox (2002): Pretest
	Not original – original	Novelty	No	Hekkert, Snelders, and van Wieringen (2003)
	Unusual – common	Novelty	No	Cox and Cox (2002)
	Old – new	Subjective novelty	Yes	Brentar, Neuendorf, and Armstrong (1994)
	Old – new	Recognition	Yes	Bornstein, and D'Agostino (1992)
	New – old	Novelty	No	Cox and Cox (2002): Pretest
	Old – new	Recognition	Yes	Obermiller (1985)

Table 1. Variables of the construct of aesthetic appreciation (AA) are shown in relation to published articles. This non exhaustive list resembles an excerpt of the literature measuring the attitude towards objects (RE=repeated exposures: in these studies participants saw the stimulus material more than once before rating it) (Faerber, et al., 2010, p. 192).

In these studies different variables were collected to assess the AA or the affective response to various stimulus materials. Innovativeness, however, was not implemented as a part of the AA, but rather to assess the subjective novelty or innovativeness of the stimuli. We implemented innovativeness as part of the construct of AA, since we propose that the perceived novelty of a stimulus is a crucial factor of AA. Concentrating on this idea of AA being a complex construct comprising different variables, we questioned what effect the activation of priming semantic concepts might have on the dynamics of AA. We wondered how activated semantic networks would trigger the elaboration, perception, and finally the AA of objects. Cognitive mechanisms underlying such an effect of priming a semantic network could be a spreading activation (Collins & Loftus, 1975) or pre-activation of parts of the network of AA (Hutchison, 2003). To investigate this possible influence we systematically varied the priming of semantic concepts that were proposed to be a part of a greater neuronal network activated while processing the AA within six experiments. Thus, based on the work of Carbon and Leder (2005b) in Project I we investigated the effect of priming semantic concepts on the dynamics of AA through assessing AA as a construct of the variables: attractiveness, arousal, interestingness, valence, boredom and innovativeness.

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Priming semantic concepts affects the dynamics of aesthetic appreciation

Stella J. Faerber [a,b], Helmut Leder [b], Gernot Gerger [b], Claus-Christian Carbon [a,b,*]

[a] *Department of General Psychology and Methodology, University of Bamberg, Bamberg, Germany*
[b] *Faculty of Psychology, University of Vienna, Vienna, Austria*

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ABSTRACT

Aesthetic appreciation (AA) plays an important role for purchase decisions, for the appreciation of art and even for the selection of potential mates. It is known that AA is highly reliable in single assessments, but over longer periods of time dynamic changes of AA may occur. We measured AA as a construct derived from the literature through attractiveness, arousal, interestingness, valence, boredom and innovativeness. By means of the semantic network theory we investigated how the priming of AA-relevant semantic concepts impacts the dynamics of AA of unfamiliar product designs (car interiors) that are known to be susceptible to triggering such effects. When participants were primed for innovativeness, strong dynamics were observed, especially when the priming involved additional AA-relevant dimensions. This underlines the relevance of priming of specific semantic networks not only for the cognitive processing of visual material in terms of selective perception or specific representation, but also for the affective–cognitive processing in terms of the dynamics of aesthetic processing.

1. Introduction

Have you ever looked at your family photo album thinking, "Oh dear, was I really wearing that back then?" We seem to forget our past preferences, even if sometimes this may be a good thing considering that we could get bewildered looks from others if we wore the same clothes today. Thumbing further through the album, we might also see some objects that we still fancy and would still consider wearing. Obviously, our aesthetic appreciation (AA), and perhaps even our taste, is not static, it changes over time (Carbon, 2010; Cox & Cox, 2002; Moulson & Sproles, 2000; Sproles, 1981).

Most importantly, these changes occur in a rather complex pattern, wherein for one object there may be an increase in appreciation, for another a decrease, and for yet another no changes may occur at all. As most research in the realm of empirical aesthetics focuses on stable properties or relations between key variables of aesthetic experience, we might be misled to believe that aesthetic phenomena operate in a rather static way. This might be an explanation for the divergence that, on the one hand, we experience strong dynamics in AA in our everyday lives, most prominently when the latest fashion trends are often initially rejected, but are later appreciated after a period of familiarization, while, on the other hand, research continuously reports AA of high reliability e.g., for facial attractiveness with internal consistencies of $\alpha \geq 0.9$ and inter-rater reliability of $\alpha \geq 0.9$ (Carbon, Grüter, Grüter, Weber, & Lueschow, 2010), and re-test reliability within short intervals of $r \geq 0.72$ (Knight & Keith, 2005). A meta analysis (Langlois et al., 2000) revealed inter-rater reliabilities of $r = 0.90$ for adults, $r = 0.85$ for children, $r = 0.88$ for cross-ethnic and $r = 0.94$ for cross-cultural agreement when evaluating the attractiveness of others.

Although the static or initial view on AA is indeed important for many domains, for instance, the attractiveness of a face at first glance or the first impression of a consumer product, it is essential to understand the dynamics behind it to be able to predict future preferences. Considering that humans base important decisions, such as what product to buy, or even: which partner to choose, on AA, cognitive psychology is interested in understanding the underlying cognitive processes triggering such dynamics.

1.1. Measuring aesthetic appreciation (AA)

Research on AA has focused on obtaining insight into associated variables such as attractiveness, beauty, liking, emotional affection,

* Corresponding author. University of Bamberg, Department of General Psychology and Methodology, Markusplatz 3, 96047 Bamberg, Germany. Tel.: +49 951 863 1860; fax: +49 951 601 511.
E-mail address: ccc@experimental-psychology.com (C.-C. Carbon).

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interestingness, good–bad, pleasant–unpleasant, boredom and many more (e.g., Carbon & Leder, 2005; Cox & Cox, 2002; Hekkert, Snelders, & van Wieringen, 2003; Leder, Carbon, & Ripsas, 2006). Also the 'affective response' has been measured according to a sample of variables partly in line with the aforementioned ones including liking, arousal, interesting–boring, good–bad, and pleasantness (e.g., Bornstein, Kale, & Cornell, 1990; Redondo, Fraga, Padron, & Pineiro, 2008; Zajonc, Crandall, Kail, & Swap, 1974). What is particularly interesting for the present study is that some researchers did not focus on one key variable only to assess the attitude towards certain stimuli, but instead measured a combination of variables (see for an overview Table 1).

For instance, Zajonc et al. (1974) pointed out that since the publication of the seminal finding of the mere exposure effect (Zajonc, 1968) the "enhancement of attractiveness" (p. 667) has been observed

Table 1
Overview of variables of the construct aesthetic appreciation (AA) as used in related literature implementing more than one scale. This list is not exhaustive, it can only be considered as an excerpt from the literature on measuring the attitude towards objects (RE = repeated exposures: in these studies participants saw the stimulus material more than once before submitting their ratings).

Variable	Actual scale	Operationalisation for	RE	Source
Attractiveness (as well as beauty, and liking)				
	Attractiveness	AA	Yes	Carbon and Leder (2005)
	Attractiveness	AA	Yes	Carbon, Michael, and Leder (2008)
	Unattractive – attractiveness	Aesthetic preferences	Yes	Cox and Cox (2002)
	Attractiveness	AA	No	Leder and Carbon (2005)
	Ugly – beautiful	Aesthetic preference	No	Hekkert, Snelders, and van Wieringen (2003)
	Like – dislike	Attitude	Yes	Bornstein and D'Agostino (1992)
	Like – dislike	Affective response	Yes	Bornstein, Kale, and Cornell (1990)
	Liking	AA	No	Carbon (2010)
	Likable – not likable	Aesthetic preferences	Yes	Cox and Cox (2002)
	Dislike – like	Attitude	Yes	Fang, Singh, and Ahluwalia (2007)
	Liking	AA	No	Leder, Carbon, and Ripsas (2006)
	Like – dislike	Affective response	Yes	Zajonc, Crandall, Kail, and Swap (1974)
Arousal				
	Emotional affection	AA	No	Leder, Carbon, and Ripsas (2006)
	Arousal	Affective response	No	Gomez and Danuser (2004)
	Arousal	Affective response	No	Redondo, Fraga, Padron, and Pineiro (2008)
	Arousal – nonarousal	Affective response	No	Russell and Mehrabian (1977)
Interestingness				
	Interesting – uninteresting	Hedonic value of novelty	Yes	Berlyne (1970)
	Interesting – boring	Affective response	Yes	Bornstein, Kale, and Cornell (1990)
	Interestingness	AA	No	Leder, Carbon, and Ripsas (2006)
	Boring – interesting	Affective response	Yes	Obermiller (1985)
	Interesting – boring	Affective response	Yes	Zajonc, Crandall, Kail, and Swap (1974)
Valence (as well as pleasantness)				
	Bad – good	Aesthetic preferences	Yes	Cox and Cox (2002)
	Good – bad	Affective response	Yes	Brentar, Neuendorf, and Armstrong (1994)
	Bad – good	Attitude	Yes	Fang, Singh, and Ahluwalia (2007)
	Bad – good	Affective response	Yes	Obermiller (1985)
	Good – bad	Affective response	Yes	Zajonc, Crandall, Kail, and Swap (1974)
	Beneficial – harmful	Affective response to novelty	Yes	Zajonc, Crandall, Kail, and Swap (1974)
	Pleasing – displeasing	Hedonic value of novelty	Yes	Berlyne (1970)
	Pleasing – displeasing	Affective response	Yes	Brentar, Neuendorf, and Armstrong (1994)
	Pleasant – unpleasant	Aesthetic preferences	Yes	Cox and Cox (2002)
	Unpleasant – pleasant	Attitude	Yes	Fang, Singh, and Ahluwalia (2007)
	Pleasantness	Affective response	No	Gomez and Danuser (2004)
	Unpleasant – pleasant	Affective response	Yes	Obermiller (1985)
	Pleasantness	Affective response	No	Redondo, Fraga, Padron, and Pineiro (2008)
	Pleasure – displeasure	Affective response	No	Russell and Mehrabian (1977)
Boredom				
	Interesting – boring	Affective response	Yes	Bornstein, Kale, and Cornell (1990)
	Boredom	AA	Yes	Carbon, Michael, and Leder (2008)
	Boring – interesting	Affective response	Yes	Obermiller (1985)
	Interesting – boring	Affective response	Yes	Zajonc, Crandall, Kail, and Swap (1974)
Innovativeness (as well as novelty, originality, and old/new)				
	Imitative – innovative	Subjective novelty	Yes	Brentar, Neuendorf, and Armstrong (1994)
	Innovativeness	Innovativeness	No	Carbon (2010)
	Innovativeness	Innovativeness	Yes	Carbon and Leder (2005)
	Innovativeness	Innovativeness	Yes	Carbon, Michael, and Leder (2008)
	Innovativeness	Innovativeness	No	Leder and Carbon (2005)
	Familiar – novel	Novelty	No	Cox and Cox (2002): Pretest
	Original – unoriginal	Novelty	No	Cox and Cox (2002): Pretest
	Not original – original	Novelty	No	Hekkert, Snelders, and van Wieringen (2003)
	Unusual – common	Novelty	No	Cox and Cox (2002)
	Old – new	Subjective novelty	Yes	Brentar, Neuendorf, and Armstrong (1994)
	Old – new	Recognition	Yes	Bornstein, and D'Agostino (1992)
	New – old	Novelty	No	Cox and Cox (2002): Pretest
	Old – new	Recognition	Yes	Obermiller (1985)

not just by measuring good–bad scales but was also measured using scales such as interesting–boring, beneficial–harmful, good–bad, and like–dislike. Besides the key variable 'attractiveness' research on the enhancement of attractiveness has focused on the variable boredom, since it is seen as a limiting factor for the mere exposure effect (Bornstein et al., 1990). Interestingness, a rather cognitive variable, was identified as an important factor for AA, too. For instance, Zajonc et al. (1974) argued that inanimate stimuli in particular are liked, because they are interesting and Day (1967) showed a complex interplay between interestingness and complexity, both related to preferences for visual objects. Although interestingness and boredom are strongly (inversely) related, interestingness is an activating and engaging characteristic, whereas boredom is not the absence or a low degree of interestingness, but rather a limiting factor for appreciation (Berlyne, 1970). Apparently, boredom is found on a different scale of time perspective. Regarding the dynamics of AA both variables are very promising since interestingness primarily shows short-termed effects while boredom might have a more lasting influence. The variables 'arousal' and 'valence', on the other hand, are important for assessing the affective response (e.g., Russell & Mehrabian, 1977) and were found to be related to preferences, too (e.g., Berlyne, 1970). Furthermore, a number of authors included scales such as innovativeness, novelty, and originality as important variables for AA (e.g., Brentar, Neuendorf, & Armstrong, 1994; Carbon, Michael, & Leder, 2008; Cox & Cox, 2002), since novelty and subjective familiarity are joint predictors for AA (Hekkert et al., 2003).

To summarise, research on AA reflects a multitude of dimensions which add to the whole construct of AA. Consequently, we assessed AA through the following six key variables derived from the literature: attractiveness, arousal, interestingness, valence, boredom and innovativeness (see for details Table 1). This way we were able to obtain a more comprehensive pattern of the AA than in previous studies simply investigating attractiveness (e.g., Carbon & Leder, 2005), which can only be seen as one, though important, aspect of the complex concept of AA (Leder, Belke, Oeberst, & Augustin, 2004). While we refer to these six variables as the (whole) construct of AA within the context of the present paper, we do note that these six concepts can only be seen as a part of the whole semantic network of AA. Therefore, they cannot be assumed to cover every aspect of aesthetic perception.

1.2. Dynamics of aesthetic appreciation (AA)

As mentioned above, aesthetic research mainly focuses on static phenomena. One way to overcome this limitation was Robert Zajonc's "mere exposure" paradigm, where participants were repeatedly exposed to certain stimuli (Zajonc, 1968). Zajonc and colleagues showed that mere exposure to a stimulus enhances the attitude towards it (Zajonc, 1968), especially when stimuli are presented subliminally (Kunst-Wilson & Zajonc, 1980). In a meta analysis Bornstein (1989) revealed that indeed mere exposure works most efficiently when viewers are not aware of having seen the stimuli. Experiments on mere exposure were particularly fruitful in investigating the connection between cognitive and affective evaluations, but rather limited with respect to higher aesthetic processes involving elaboration, understanding or mastering of a given material. For instance, elaborative processes of artworks through specific entitling (Leder et al., 2006) or effects of ambiguity, and the overcoming of such ambiguity, in portraits such as Leonardo's Mona Lisa (Bohrn, Carbon, & Hutzler, 2010) or long-termed cycles of taste (Carbon, 2010), cannot be adequately explained by the mere exposure approach.

Carbon and Leder (2005) developed a paradigm for elaborating material in a controlled way. By forcing participants to evaluate the given material on a variety of variables participants incidentally elaborated the stimuli in a deep way. Using this *Repeated Evaluation Technique* (RET) they identified the design property "innovativeness" as a key variable for triggering dynamics in appreciation for object evaluation (see Table 1) and defined innovativeness as "originality by virtue of introducing new ideas" (p. 587). As innovative products include highly novel object properties, or at least an uncommon combination of known properties (Leder & Carbon, 2005), they often break common visual habits. This characteristic is probably the reason why people are often overwhelmed by highly innovative product designs or pieces of art. Without any further familiarization with such material, this often leads to rejection or avoidance of such objects. Moulson and Sproles (2000, p. 47) explicitly speak of a consumer's "inherent conservatism" toward new styles. Most importantly, the appreciation process does not necessarily stop at this stage. Dealing with innovative products is accompanied by modifications of the processing systems for these product representations and leads to the integration of these new experiences into the perceptual system. At the same time, as the object representations are modified, associative areas of the neural network of perception will register these configurations and will in turn be modified (Versace, Labeye, Badard, & Rose, 2009). Since networks of visual object perception and emotional neuronal networks are closely linked (Pessoa, 2008), this might lead to the aforementioned multidimensional dynamics of AA for innovations in everyday life.

The RET typically consists of three test phases, an initial test phase (T1) where participants are asked to rate the attractiveness of/ liking of/ preference for the material, the repeated evaluation phase (RET phase) where participants have to evaluate the material on a variety of dimensions (e.g., comfortable or stylish) and a final test phase (T2) where the ratings of T1 are repeated. Due to the active elaboration, RET stands in contrast to Zajonc's (1968) mere exposure approach, where participants are exposed to the material in a rather passive way. Bornstein (1989, Table 1) already noted that mere exposure was rather ineffective when highly complex patterns such as paintings, drawings or matrices were used as stimulus material. One explanation for this is based on the finding that more complex material requires active processing which should be linked to deeper processing according to the "levels of processing" theory (see Craik, 2002; Craik & Lockhart, 1972). In everyday life we indeed experience novel material, for instance, new consumer products or unfamiliar works of art, by testing, using, considering or discussing it—a behaviour which the active elaboration approach of RET aims to simulate in a controlled way. Indeed, by using RET we could demonstrate typical dynamics of AA (Leder & Carbon, 2005) known to take place in real contexts: highly innovative material is often initially rejected and later appreciated, while low innovative, highly familiar material is perceived as boring over time, with the result of being finally rejected. These basic patterns were supported by Carbon and colleagues who investigated eye movements (Carbon, Hutzler, & Minge, 2006) and pupillometry (dilatation of the pupil) (Carbon et al., 2006) and observed changes in electrodermal activity (Carbon et al., 2008) while inspecting the material.

1.3. The impact of semantic concept activation

Until now, the question which remains unanswered is what underlying mechanisms trigger such dynamics of AA. According to the spreading-activation theory of semantic networks one could argue that the specific initial phase (T1) of a typical RET experiment, assessing attractiveness and innovativeness—itself—had an impact on the following repeated elaborations of the stimuli and thus on the dynamics of AA (cf. Collins & Loftus, 1975). In this respect the activation or priming of these nodes or concepts (attractiveness and innovation) would have prepared further elaborations, since activation of a node spreads out along the path of the (semantic) network. During further processing of the target material the networks of the concepts attractiveness and innovativeness might still have been activated and the later processing of the stimuli could therefore have been influenced by these activations. Aside from this automatic spreading of activations, Chwilla, Hagoort, and Brown (1998) described additional mechanisms concerning semantic priming, among them expectations that participants generate. For instance, participants might form expectations after the ratings of attractiveness and innovativeness for the associated topics and therefore further elaborations of the stimulus material will be primed to these two concepts.

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According to this rationale, the initial evaluations of the stimulus material on attractiveness and innovativeness led to priming activations of these concepts which had a determining influence on the subsequent final ratings. As attractiveness is a key variable of AA, we were interested in the impact of the primed semantic concept of attractiveness. The priming of this concept could further lead participants' thoughts, expectations and attention to AA itself. This would keep emotional as well as cognitive networks active during the RET phase and could particularly trigger dynamics of AA. As mentioned above, we know that innovativeness is an influential variable concerning AA and is closely linked to novelty, familiarity and typicality, which was identified as a predictive variable for AA (see also Hekkert et al., 2003). Activating the network of processing innovativeness could lead to awareness of innovative/novel features within the used stimuli and facilitate the integration of novel features into the processing system of these objects. Furthermore, we hypothesised that a combination of concepts such as that of the construct AA (attractiveness, arousal, interestingness, valence, boredom, and innovativeness) could have an even greater impact on the further aesthetic processing than the activation of just one singular concept. Therefore, we assumed that the semantic network of AA integrates different concepts such as attractiveness, arousal, interestingness, valence, boredom, and innovativeness and that priming parts of this network could impact the dynamics of AA. Within this framework we varied the quality and the quantity of the primed parts of the semantic network of AA. Note: Here, we only aim to determine whether there is a difference between qualities, without specifying these qualities in the semantic network of AA. To our knowledge no other study has investigated the impact of priming semantic concepts on the dynamics of AA in a systematic way.

1.4. The present study

In the present study we focused on the influence of primed semantic concepts on the development of dynamics of AA. We hypothesised that depending on the specific primed concepts different degrees of dynamics of AA arise. To ensure the possibility of such dynamics to emerge, we used carefully manipulated material differing in the degree of innovativeness, a variable known to evoke such dynamics (Carbon & Leder, 2005). We used car interiors as stimulus material for two reasons: (1) they are highly complex visual stimuli which can be plausibly varied on the dimension of "innovativeness", (2) they can be plausibly manipulated on a variety of further design properties in a systematic way: while we were mainly interested in manipulating the stimuli on the dimension innovativeness, we controlled the degree of properties known to influence AA such as complexity (Berlyne, 1970) or curvature (Bar & Neta, 2006; Carbon, 2010). Previous studies (Carbon & Talker, 2006) with the currently used stimulus material indeed revealed clear dynamics as in former experiments using the Repeated Evaluation Technique (RET), namely, an increase in attractiveness for highly innovative car interiors, but a decrease in attractiveness for low innovative car interiors over time.

Our experiments were structured in two phases: (1) the pre-processing phase (priming of the semantic concept and RET phase) and (2) the (final) test phase (rating of the construct AA). Fig. 1 gives an overview of the experimental designs of the whole series of the performed experiments. Altogether, we carried out six experiments varying the priming of semantic concepts before the stimulus material was elaborated with the RET to assess the impact of these activations on the development of the dynamics of AA, which we collected in the final test phase.

To systematically investigate the possible impact of a primed semantic concept we started the experimental series with a procedure where no semantic concept was implemented (Experiment 1). In the second experiment we used the semantic concept "attractiveness", in the third experiment the semantic concept "innovativeness" and in the fourth experiment the above mentioned most complex construct of AA including all six concepts related to AA. Since due to the ratings of six concepts in the fourth experiment the whole pre-processing phase in this experiment inherently provided more opportunities for elaborating the material, a fifth experiment was carried out as a control experiment to investigate whether effects regarding the findings of Experiment 4 were due to a mere longer processing stage of the stimulus material or due to specific priming of semantic concepts. In Experiment 5 again no specific semantic concepts were enforced, although more scales in the RET phase were used to equate the length of the pre-processing phase with Experiment 4. Furthermore, to assess the contribution of the RET to

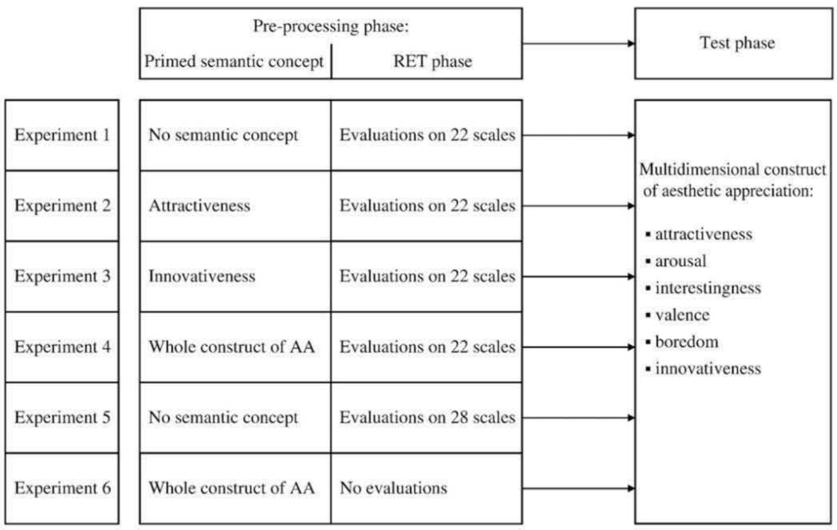

Fig. 1. Experimental designs of the series of six experiments. All experiments consisted of a pre-processing phase and a test phase. The pre-processing phase comprised the specific priming of a varying semantic concept (except for Experiments 1 and 5 where this activation did not occur) and the elaboration of the stimulus material by employing the Repeated Evaluation Technique (RET; exept for Experiment 6 where the RET was not used) (Carbon & Leder, 2005). The semantic concept activation occurred through asking the participants to rate the stimulus material on the specific attribute, for example, in Experiment 2 participants rated the stimuli on attractiveness. The test phase included the ratings of the construct aesthetic appreciation (AA; containing the variables *attractiveness, arousal, interestingness, valence, boredom* and *innovativeness*).

Table 2
Description of participants per experiment: total number of participants, number of females, number of males, as well as mean (*M*) and standard deviation (*SD*) of age. For sample information of the base rates see Experiment 6 (as the same sample was used for the base rates and Exp. 6).

	Participants			Age	
	Total	Female	Male	*M*	*SD*
Exp.1	24	21	3	22.8	3.9
Exp.2	24	19	5	22.3	3.3
Exp.3	24	21	3	21.8	4.2
Exp.4	24	19	5	22.4	4.7
Exp.5	24	22	2	20.9	2.1
Exp.6	24	20	4	22.1	2.4
Total	144	122	22	22.1	3.5

the results of priming the whole construct of AA in Experiment 4, we implemented a further control experiment (Experiment 6). Here, we used the same design as in Experiment 4 (priming the whole construct of AA), but omitted the entire RET phase, so that the priming was followed immediately by the test phase.

In the context of this paper, we operationalise AA as the attitude towards an object, which is characterised by an integrative nature of AA-relevant affective and cognitive components. As described in detail above, we measure this construct through six variables: attractiveness, arousal, interestingness, valence, boredom, and innovativeness. The dynamics of AA are operationalised by interactions between time and innovativeness as proposed by Carbon and Leder (2005).

2. Method of Experiments 1–6

2.1. Participants

A total of 144 undergraduate students participated for course credit. This sample consisted of 122 women and 22 men with a mean age of 22.1 years ($SD = 3.5$) (for detailed information on the individual experiments see Table 2). All of them had normal or corrected-to-normal vision assured by the standard Snellen Eye test. None of the participants took part in more than one of the reported experiments.

2.2. Apparatus and stimuli

The stimulus material consisted of 18 photo-realistic images of artificial car interiors (see Fig. 2 for exemplary stimuli) with a size of 800×513 pixels presented on a 17-inch Apple eMac CRT monitor with a resolution of 1024×768 pixels. The stimuli, generated with Adobe Photoshop 7.0, varied on two levels of innovativeness (low, high) and were carefully controlled for further design properties known to affect AA, complexity and curvature. For both levels of innovativeness we systematically varied fully crossed complexity and curvature on 3×3 levels (low, medium, high) (for a detailed description of these dimensions see Carbon & Leder, 2005; Leder & Carbon, 2005). Several previous studies were used to ensure equal degrees of complexity and curvature for both levels of innovativeness using 7-point Likert scales (Carbon & Talker, 2006).

2.3. Procedure

The experiments consisted of two phases: the pre-processing phase and the test phase. While the test phase was exactly the same in all experiments, the pre-processing phase varied across the experiments (see Fig. 1 for a graphic overview of the experimental designs).

2.3.1. Pre-processing phase

The pre-processing phase consisted of two parts: the priming of the semantic concept and the RET phase. We implemented the priming of the specific concept(s) by asking the participants to rate the stimuli in terms of the respective specific concept(s) (e.g., attractiveness) on a 7-point Likert scale (1 = "least significant", 7 = "most significant"). The 18

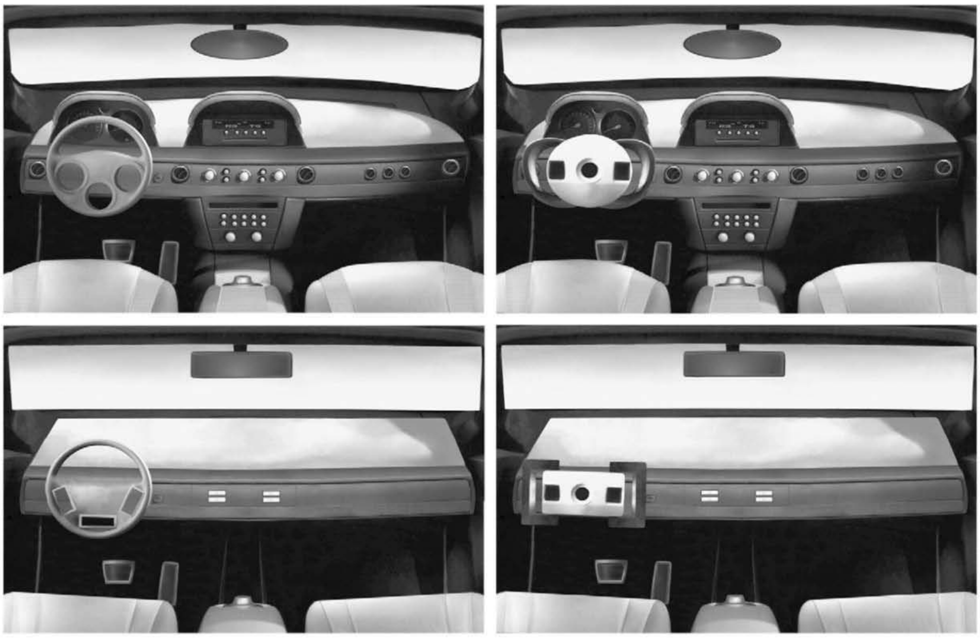

Fig. 2. Examples of the stimulus material, given here by typical low (left) versus highly innovative (right) designs where the levels of curvature and complexity were both fixed to a high degree (above) and a low degree (below), respectively. The stimulus material varied systematically regarding innovativeness, curvature and complexity by alternating elements of the car interiors such as steering wheel, mirrors, dashboard, switches, fresh air nozzles, middle console and seats.

stimuli were presented one after the other on the screen in randomised order for 2.6 s and rated one after the other by pushing buttons 1–7.

In the RET phase participants rated the stimuli on different scales. These scales met two requirements: (1) they asked for low emotionality and low arousal,[1] thus assessing rather cognitive attributes; (2) none of them were identical with one of the variables included in the construct of AA used here (attractiveness, arousal, interestingness, valence, boredom and innovativeness). We used attributes which rely on shape and form features of the designs and should therefore facilitate the integration of specific design features into the perceptual system through activating the object-selective cortex (Op de Beeck, Torfs, & Wagemans, 2008). The attributes we used were: rectangular (*rechteckig*), oblong (*länglich*), oval (*oval*), continuous (*ebenmäßig*), factual (*sachlich*), uniform (*gleichförmig*), homogenous (*homogen*), anonymous (*anonym*), sober (*nüchtern*), schematic (*schematisch*), angled (*winklig*), minimalist (*schlicht*), concrete (*konkret*), solid (*solide*), regular (*regelmäßig*), formal (*förmlich*), rounded (*abgerundet*), compact (*kompakt*), neat (*ordentlich*), conventional (*konventionell*), classic (*klassisch*) and restrained (*dezent*). The six additional attributes of Experiment 5 were: straight (*geradlinig*), simple (*einfach*), systematic (*systematisch*), purposeful (*zweckmäßig*), precise (*präzise*), and well-arranged (*übersichtlich*). The order of the scales was randomised for each participant. For each scale, all 18 stimuli were presented one after the other for 2.6 s in a randomised order and thereby rated on a 7-point Likert scale (1 = "least significant", 7 = "most significant").

In Experiment 1 the pre-processing phase consisted of only the RET phase and no priming was implemented. In Experiment 2 the concept attractiveness was primed. Thus, the pre-processing phase consisted of 23 scales including attractiveness which was presented as the first scale followed by the 22 randomised scales used in Experiment 1. Experiment 3 was identical with Experiment 2, but the concept innovativeness served as a prime. In Experiment 4 we implemented a more extensive semantic concept including the whole construct of AA. Thus, participants first rated the stimuli according to the scales attractiveness, arousal, interestingness, valence, boredom and innovativeness in a fixed order (semantic concept(s) activation) followed by the randomised order of the 22 RET scales. Also, to reduce anchor effects, in this experiment as well as in Experiments 5 and 6 the participants previewed the stimuli (without rating) by simultaneously viewing one half of the items on the screen for 6 s followed by the other half of the items for another 6 s. The positions of the stimuli for the preview phase were pseudo-randomised and held constant for all participants. After that the pre-processing phase and the test phase followed. No concept was primed in Experiment 5, however we implemented a prolonged RET phase with 28 scales (see above). Finally, in Experiment 6, as in Experiment 4, the whole construct of AA served as a prime but we did not apply the RET to rule out the explanation that dynamic effects in Experiment 4 were solely based on the extensively primed concept of AA.

2.3.2. Test phase

The test phase followed immediately after the pre-processing phase. Participants rated all stimuli one after the other in randomised order for each variable of the AA variables presented in the following order: *attractiveness* (*attraktiv*), *arousal* (*anregend*), *interestingness* (*interessant*), *valence* (*positiv*), *boredom* (*langweilig*) and *innovativeness* (*innovativ*). All variables were assessed on 7-point Likert scales (1 = "least significant", 7 = "most significant"). The presentation duration was again fixed at 2.6 s. The next stimulus appeared automatically after the participant had submitted his/her rating. Participants were instructed to respond to the respective question as spontaneously as possible. Trials for each rating block were fully randomised. All experiments were presented by PsyScope 1.25 PPC (Cohen, Macwhinney, Flatt, & Provost, 1993). All participants were tested individually.

2.4. Base rates

In Experiments 1–6 we tested the construct aesthetic appreciation (AA) after the pre-processing phase. To investigate whether dynamics in AA occurred we compared each experiment with base rates of the stimulus material. We collected base rates from the priming phase of Experiment 6. Accordingly, the sample was the same as in Experiment 6. The stimulus material and apparatus were the same as in all experiments. The procedure for collecting the ratings of the AA variables was the same as in the test phase of the experiments. Also, to reduce anchor effects, the participants previewed the stimuli as described above. The participants were tested individually. Results of the descriptive analysis are presented in Fig. 3.

2.5. Test of dynamics of aesthetic appreciation

In order to test the hypotheses describing effects of the different semantic concept primes, we concentrated on changes in the ratings for both levels of innovativeness. To investigate whether dynamics in AA occurred we compared the ratings of each experiment with the base rates. We first averaged data over complexity and curvature levels resulting in means of the two levels of innovativeness per variable and per subject. We then conducted a mixed-design analysis of variance (ANOVA) with innovation (low, and highly) as within-subject factor, time (T1: from the base rates; T2: from the final test phase of a given experiment) as between-subject factor, and the ratings as dependent variable. Such an ANOVA was calculated for each experiment and for each variable separately. The subjects needed for collecting the base rates and the ones who participated in Experiment 6 were the same. Nonetheless, we also conducted a mixed-design ANOVA with time as between-subject factor instead of a within-subject factor for Experiment 6 to ensure comparability of statistics across all experiments.

2.6. Boredom scale

The scale of the variable *boredom* was reversed for all analyses and illustrations in all figures, since this was the only scale that was negatively correlated with appreciation.

3. Results and discussion of Experiments 1–6

3.1. Reliability of the construct aesthetic appreciation (AA)

We tested the implemented construct of AA for its reliability using data of the base rates. Inter-rater reliability was assessed separately for each variable using calculations of Cronbach's alpha. Reliability was very high for all variables (*attractiveness*: $\alpha = 0.956$; *arousal*: $\alpha = 0.956$; *interestingness*: $\alpha = 0.944$; *valence*: $\alpha = 0.952$; *boredom*: $\alpha = 0.956$; *innovativeness*: $\alpha = 0.954$) indicating high internal consistency.

3.2. Results and discussion

In the following we will first conduct descriptive analyses of the test phases for every single experiment, which are presented in Fig. 3.

[1] In the RET phase of the original paper, where the RET concept was introduced (Carbon & Leder, 2005), participants elaborated the target material on multiple scales including attributes such as futuristic ("futuristisch") and conservative ("konservativ"). The ratings of the stimuli regarding these attributes might themselves activate networks closely related to innovativeness that we introduced in Experiment 3 as a semantic concept. To rule out such confounding activations in the RET phase and to increase the control over the impacts of the specific semantic concepts, we selected attributes for the RET phase from a pre-study with scales referring to adjectives of neutral valence, low arousal (strength of emotion) and low subjectivity (the degree to which ratings would differ between subjects: highly subjective, e.g., "fascinating"; low subjective, e.g., "rectangular"). The selected scales consisted of rather "cognitive" attributes mostly concerning aspects such as form and shape of the designs. We are indebted to Dave Perrett for providing this idea in a discussion at the ECVP 2005 in La Coruña.

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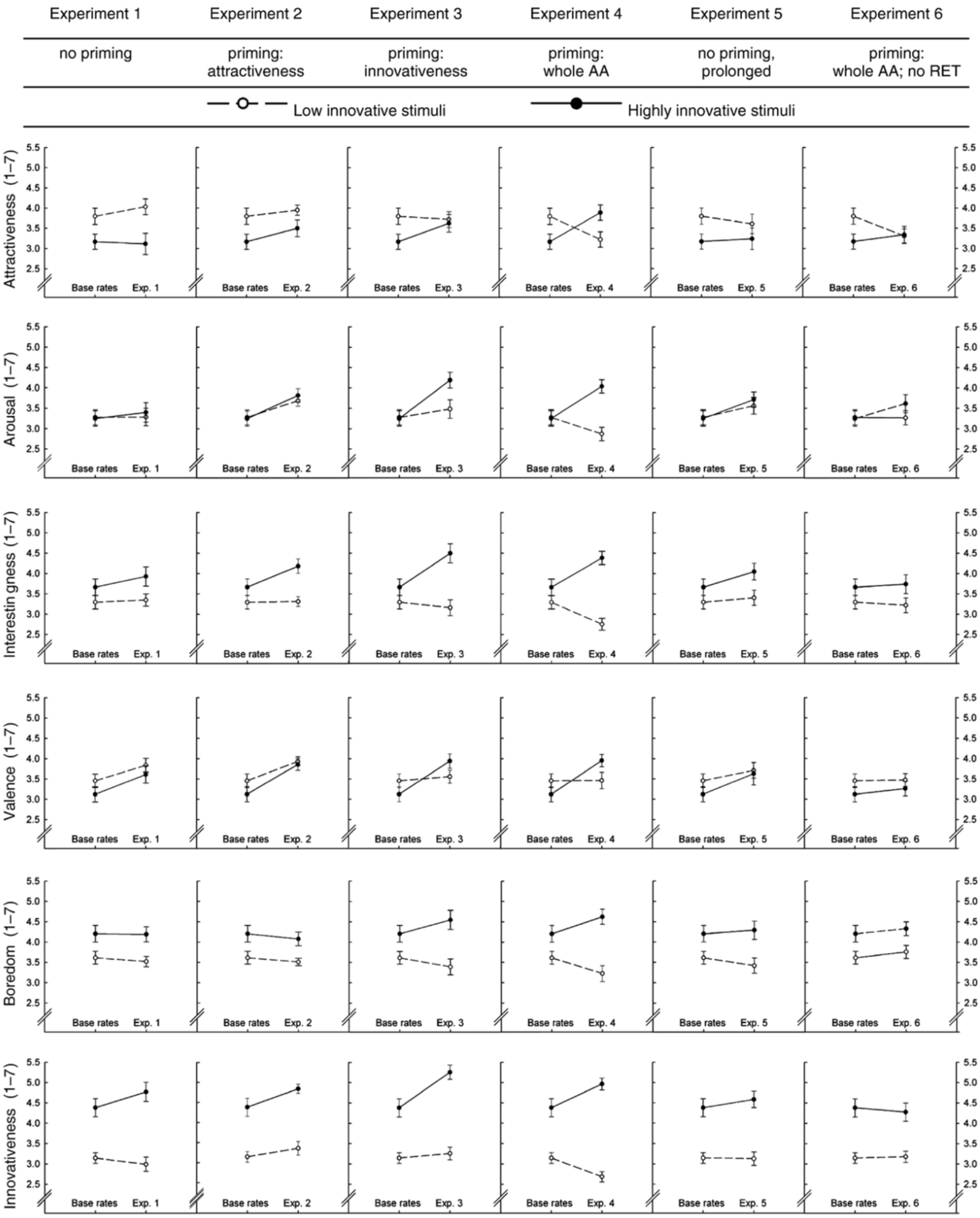

Fig. 3. Comparisons of Experiment 1 (first column from left), 2 (second column from left), 3 (third column from left), 4 (fourth column from left), 5 (fifth column from left) and 6 (sixth column from left) with the base rates: The different AA variables (*attractiveness, arousal, interestingness, valence, boredom* and *innovativeness*) are displayed per rows. For each variable and each comparison with the base rates the interaction between time and innovativeness is indicated by mean and standard error of the mean. *) for reasons of better readability, the scale boredom was inverted to be concordant with the other scales.

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Table 3
Test of dynamics of aesthetic appreciation: Comparative analyses of base rates and experiments 1–6 for all variables (VAR): attractiveness (ATT), arousal (ARO), interestingness (INT), valence (VAL), boredom (BOR) and innovativeness (INN). Effects (EFF) for Innovativeness (I) as well as the interactions between innovativeness and time (T1 = base rate; T2 = regarding experiment ; I×T) are indicated. Significant interactions between I and T are in bold. Degrees of freedom for all *F*-tests are 1/46. For a more detailed description, see Section 2.5. *Test of dynamics of aesthetic appreciation.*

VAR	EFF	Base vs. Exp.1 (no priming)				Base vs. Exp.2 (priming: attractiveness)				Base vs. Exp.3 (priming: innovativeness)				Base vs. Exp.4 (priming: whole AA)				Base vs. Exp.5 (control exp. for Exp. 4)				Base vs. Exp.6 (control exp. for Exp. 4)			
		df	*F*	η_p^2	*p*	*df*	*F*	η_p^2	*p*	*df*	*F*	η_p^2	*p*	*df*	*F*	η_p^2	*p*	*df*	*F*	η_p^2	*p*	*df*	*F*	η_p^2	*p*
ATT	I	1	15.1	0.25	0.001	1	11.2	0.20	0.002	1	4.4	0.09	0.041	1	<1	0.01	0.919	1	5.7	0.11	0.022	1	3.7	0.07	0.061
	I×T	1	<1	0.01	0.474	1	<1	0.01	0.578	1	2.5	0.05	0.125	**1**	**12.8**	**0.22**	**0.001**	1	<1	0.01	0.541	**1**	**4.5**	**0.09**	**0.039**
ARO	I	1	<1	0.01	0.801	1	<1	0.01	0.749	1	3.3	0.07	0.074	1	11.4	0.20	0.002	1	<1	0.01	0.747	1	<1	0.02	0.352
	I×T	1	<1	0.01	0.674	1	<1	0.01	0.621	1	3.9	0.08	0.054	**1**	**12.5**	**0.21**	**0.001**	1	<1	0.01	0.642	1	1.2	0.03	0.275
INT	I	1	8.4	0.16	0.006	1	15.9	0.26	0.001	1	21.3	0.32	0.001	1	40.0	0.47	0.001	1	8.2	0.15	0.006	1	6.6	0.13	0.014
	I×T	1	<1	0.01	0.527	1	2.6	0.05	0.115	**1**	**6.8**	**0.13**	**0.012**	**1**	**15.9**	**0.26**	**0.001**	1	<1	0.01	0.444	1	<1	0.01	0.672
VAL	I	1	2.4	0.05	0.125	1	1.8	0.04	0.189	1	<1	0.01	0.888	1	<1	0.01	0.617	1	<1	0.02	0.381	1	3.2	0.07	0.081
	I×T	1	<1	0.01	0.768	1	<1	0.02	0.401	1	4.0	0.08	0.052	**1**	**6.9**	**0.13**	**0.011**	1	<1	0.01	0.588	1	<1	0.01	0.696
BOR	I	1	16.9	0.27	0.001	1	13.6	0.23	0.001	1	19.7	0.30	0.001	1	33.6	0.42	0.001	1	11.3	0.20	0.002	1	15.4	0.25	0.001
	I×T	1	<1	0.01	0.799	1	<1	0.01	0.942	1	2.1	0.04	0.159	**1**	**5.5**	**0.11**	**0.023**	1	<1	0.01	0.521	1	<1	0.01	0.951
INN	I	1	76.9	0.63	0.001	1	89.2	0.66	0.001	1	94.1	0.67	0.001	1	142.8	0.76	0.001	1	92.2	0.67	0.001	1	48.6	0.51	0.001
	I×T	1	2.5	0.05	0.122	1	<1	0.02	0.398	**1**	**5.3**	**0.10**	**0.026**	**1**	**12.6**	**0.22**	**0.001**	1	<1	0.01	0.432	1	<1	0.01	0.680

After that we will compare every experiment with the base rates (see method section of Experiment 1, *Test of dynamics of aesthetic appreciation*) to test the occurrences of dynamics of AA. All effects of and interactions with innovativeness are reported in Table 3 (Experiments 1–6). The interaction between time and innovativeness indicates whether changes over time for low and/or highly innovative stimuli, thus dynamics of AA, occurred. Therefore, to increase the readability and to focus on the hypotheses concerning the dynamics of AA, we will only discuss in the following any interactive effects of time and innovativeness for every dependent AA variable. We will not report further possible main effects of the between-subject factor time, since they are not part of our specific research question in this study and no specific hypotheses are stated concerning these effects. The detailed statistics of all the following analyses are presented in Table 3.

The analyses between the base rates and Experiment 1 revealed no significant interaction for time and innovativeness for *attractiveness*, *arousal*, *interestingness*, *valence*, *boredom* and *innovativeness*. We could not detect any difference in aesthetic appreciation after a pre-processing phase consisting of only the RET phase in comparison with the base rates (Fig. 3 (first column from left). When Experiment 2 was compared with the base rates again no interaction was significant for any AA variables. Thus, priming the semantic concept attractiveness had no significant effect on the development of dynamics in AA either (Fig. 3, second column from left). In Experiment 3 we found significant interactions for time and innovativeness for the variables *interestingness* and *innovativeness* as well as trends for *arousal* and *valence*. No other interaction was significant. So, the priming of the concept innovativeness in the pre-processing phase resulted in dynamics in two of the six AA variables (Fig. 3, third column from the left). After priming the whole construct of AA dynamics (Experiment 4) we found dynamics in all AA variables (Fig. 3, fourth column from the left). Conversely, we found no dynamics of AA after a prolonged RET phase when no concept was primed (Experiment 5; Fig. 3, fifth column from the left). Priming the whole construct of AA (Experiment 6), however, without including an RET phase produced dynamic changes for low and highly innovative material in *attractiveness* (Fig. 3, sixth column from the left).

In sum, we observed no dynamics in Experiments 1, 2, and 5, but we found dynamics in *attractiveness* in Experiment 6 and dynamics in *interestingness* and *innovativeness* as well as trends for *arousal* and *valence* in Experiment 3. Most importantly, we obtained significant dynamics of the whole AA construct in Experiment 4. This indicates that no dynamics of AA were observed when no concept was primed—even with the prolonged RET phase in Experiment 5. Regarding the quality of the primed concept we received different results: while we found *no* dynamics, indicated by non-existing interactions for time and innovativeness, when attractiveness was primed as the only concept, we *did* observe dynamics for interestingness and innovativeness after priming the concept innovativeness. This indicates that the quality of the primed concepts was important to trigger dynamics of AA. The most extensive dynamics of AA occurred after increasing the quantity of the primed semantic network when the whole construct of AA variables was primed and the RET procedure was implemented. As a result, significant interactions between time and innovativeness were obtained for all variables of AA and, thus, Experiment 4 demonstrated the strongest dynamics in AA. It should be noted that this effect was not due to the longer pre-processing phase, since we did not find any dynamics in Experiment 5 which was created as a control experiment with the same length of the pre-processing phase as in Experiment 4. Neither was it the impact of priming the AA concept(s) alone, because we received less dynamics in Experiment 6 (only in *attractiveness*) with a pre-processing phase consisting only of priming the whole construct of AA, without an RET phase. Therefore, results showed an effect of priming as well as an effect of the RET on the dynamics of AA.

4. General discussion

We investigated the impact of priming semantic concepts related to aesthetic appreciation (AA) in combination with elaborations of the stimulus material (via RET) on the dynamics of AA. We measured AA as a multidimensional construct derived from the literature through *attractiveness*, *arousal*, *interestingness*, *valence*, *boredom* and *innovativeness* (see Table 1) and demonstrated high internal consistency of the multidimensional construct of AA using base rates collected from 24 subjects (initial testing). Possibilities of developing dynamics of AA were realised by using car interior stimuli that varied in the dimension "innovativeness", which is a key dimension identified for triggering dynamics of appreciation. Thereby, an interaction between time and innovativeness indicated whether dynamics of AA occurred. Our hypothesis that priming of semantic concepts related to AA impacts further processing, thereby triggering the dynamics of AA, was strongly confirmed, since dynamics only occurred when priming of semantic concepts related to AA was implemented. Clear dynamics occurred after having primed the concept innovativeness (Experiment 3) and even stronger dynamics were revealed after having primed the whole construct of AA (Experiment 4). Also we observed weak dynamics, only for attractiveness (Experiment 6) when the whole construct of AA was primed but no RET was conducted. Most importantly, we could show differential impacts of the quality and the quantity of the primed semantic concepts. Concerning the quality, when only one single concept related to AA was primed (Exp. 2: attractiveness; Exp. 3: innovativeness) only the concept innovativeness triggered dynamics of AA. Testing the quantity we observed the strongest dynamics in Experiment 4 with the most extensive semantic concept(s) primed including the multidimensional construct of AA.

Concerning the priming of semantic concepts one could argue that it is very important that parts of the semantic networks which are involved in the aesthetic processing are activated during processing to trigger strong dynamics of AA. This conclusion was indeed supported by the comparison between Experiments 4 and 5. With exactly the same number of scales assessed within the pre-processing phase strong dynamics only developed when the complex semantic concept of AA in Experiment 4 was activated. Elaboration of the stimulus material exclusively on the basis of rather cognitive design features such as those concerning form and shape might prevent deeper aesthetic processing. In contrast, after priming semantic concepts strongly (and specifically) related to AA, participants probably had associations and expectations in the direction of the activated semantic networks during further processing, which facilitated dynamics of AA.

We found that the primed semantic concept of innovativeness had a greater impact on the development of the dynamics than that of attractiveness and thus, that the quality of the network is essential. Although both concepts seemed to be promising semantic concepts for triggering further aesthetic processing, innovativeness might be more important for producing dynamics of AA, especially with the stimuli employed. The activation of this semantic concept fosters the awareness of this characteristic in the stimulus material and also promotes the integration of that specific dimension including novel, innovative, and unusual features in the designs. This could lead to an update of object representations which may influence the aesthetic appreciation of the stimulus material. The most successful semantic concept in triggering dynamics of AA combined several concepts related to AA, among others, the concepts attractiveness and innovativeness (Experiment 4). This might indicate that the quantity, thus the extension, of the implemented semantic network had a specific impact, revealed by broader and stronger dynamics than either in Experiment 2 or 3. It could alternatively be interpreted as a qualitative change, too. Only the specific combination of these scales related to AA could generate such pronounced dynamics as observed in Experiment 4. Moreover, these effects were not due to differences in the mere length of the pre-processing phase, nor can they be solely attributed to priming since we found less strong dynamics in Experiment 6. According to Collins and Loftus (1975), this indicates that the spreading activations of the construct AA had further influence on the processing, elaboration and, not to forget, the *appreciation* of the stimuli. This in turn indicates possible expectancies of the participants in the direction of the processing of specific aesthetic dimensions when evaluating the stimuli during the Repeated Evaluation Technique (RET; Carbon & Leder, 2005) phase. As the semantic networks for elaborating the stimulus material regarding cognitive design features such as form and shape, assessed in the RET phase, are connected to those of the processing of AA, a reactivation of the AA-related processing network during the RET phase is also possible. In this sense a possible explanation is that associated networks such as that for emotional processing registered modifications of the processing system (e.g., object representations) during the RET phase (Versace et al., 2009) and thus, that the networks for processing AA (which probably includes parts of the emotional processing network) were modified indirectly. These associated networks required, at least partly, a pre-activation, since we observed clearly reduced, in fact statistically insignificant, dynamics in Experiments 1 and 5, where such priming was not employed.

In sum, our results reflect the plasticity of perception and appreciation. In line with Versace et al.'s (2009) concept of a multimodal, dynamic, functional and situational concept of memory, our appreciation apparatus seems to be constantly modified and adapted to newly processed stimuli, and thus new experiences. Most importantly, we showed that priming AA-related concepts influenced the AA over time. In line with many studies reported in the priming literature, we showed further evidence that priming affected the re-assessment of given stimuli or, in our case, the aesthetic processing (Experiment 6). But even more interestingly, we found that priming specific concepts had an impact on further processing of the stimuli, thus the following elaborations of the material via RET, which lasted about half an hour, and therefore directly influenced the development of AA over time (Experiments 3 and 4). This could lead to the interpretation that priming affected the reorganization or adaptation of the perceptual system.

However, further research is necessary to define the semantic network of AA in more detail. Also, it would facilitate the interpretation of priming effects if distances between concepts of the semantic network of AA were known. For example, up to now it is unclear why priming innovativeness led to dynamics in the variables innovativeness and interestingness as well as trends in arousal and valence. Varying distances between the concepts used in our study could account for differences in the development of the dynamics. Furthermore, a more detailed knowledge of the semantic network of AA could explain why we found changes due to the priming of innovativeness but not attractiveness.

We did not observe dynamics of AA in Experiments 1 and 5, in which the pre-processing phase *only* consisted of the RET phase, contrary to previous studies also using the RET (Carbon & Leder, 2005). There are two major differences between both approaches: (1) in Carbon and Leder's study participants were asked to rate the stimulus material regarding attractiveness and innovativeness before the RET, which could be interpreted as a priming on two specific semantic networks. (2) In the present series of experiments we purposely used attributes in the RET phase, which were related to rather superficial and shallow aspects of the designs (for more detail on scale qualities see also footnote 1); the original study of Carbon and Leder (2005), however, used a combination of elaborative, cognitive and emotional scales within the RET phase. The authors introduced the RET to simulate everyday life experiences with objects such as consumer products or works of art, which are able to evoke aesthetic experiences. The usage of a variety of scales in the initial study had the disadvantage of losing control of which semantic concepts are specifically primed and which dimensions of cognitive processing are particularly triggered. In the present study, we explicitly used scales related to AA only in a priming phase and excluded all aesthetically relevant scales from the RET phase to be able to minimise confounding factors of priming of aesthetically relevant processing. However, even with the scales used in the present study we found an impact of the RET procedure since we observed clearly reduced dynamics in Experiment 6 (no RET phase) compared to Experiment 4 (with RET phase).

Another critical point for our study concerns the generalization of our findings to other object classes. We used car interiors in this study since we can control a series of aesthetically relevant factors rather easily. It is questionable whether strong dynamics in AA can also be observed with natural material such as faces or nature scenes. Here, more biologically driven programs for assessing the aesthetic value might be at work. It would also be interesting to look at the duration of the dynamics which we obtained in the current study. We know from the face literature that adaptation effects can be quite sustained lasting up to days and weeks (Carbon & Ditye, in press), but we also have indications from artificial objects such as car exteriors that dynamics of aesthetic appreciation do occur over periods of several years and decades (Carbon, 2010). Systematic research seems promising to reveal not only the ingredients for dynamics in AA but also their limits and scopes.

It is obvious that the revealed dynamics of AA modulated by the specific usage of priming of semantic networks are not only relevant for cognitive basic research, but offer insight for applied research, too. In the field of market research as well as for the consumer product industry our results highlight the importance of developing tests for the appreciation of new products, which involve deep processing of the material. Simple consumer tests with only one presentation of the products which do not give consumers the chance to really understand these products and integrate them into their visual habits seem inadequate. A more dynamic view regarding this key problem of consumer research plus a clear strategy which encourages consumers to engage with the products seems mandatory. One possibility to assess such changes experimentally is to use the Repeated Evaluation Technique (RET) in combination with systematic priming of semantic networks beforehand. This enables intense elaboration of the target material and could lead to deeper insights into what kind of novel features frustrate or overwhelm consumers. As pointed out by Fournier, Dobscha, and Mick (1998) this could help to predict which design innovations will eventually be appreciated, and which products will ultimately be bought.

In our present research we demonstrated the importance of the activation of semantic networks linked to AA for further aesthetic processing of stimuli. We observed differential influences on these dynamics due to the quality and the quantity of the primed semantic networks. It is now important to get further insights into additional variables modulating aesthetic appreciation. The variables in question should focus more on the processing of the stimuli versus the mere properties of the stimuli themselves. Of particular interest of future aesthetic research will be the dynamics underlying these variables to solve questions we never cease to wonder about: what will we like in the future?

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Critical Reflection

In line with the initial study on the Repeated Evaluation Technique by Carbon and Leder (2005b) results of Project I showed that AA for car interiors exhibits a dynamic quality as well as that elaboration of stimulus material can trigger such dynamics. However, observing priming effects on the dynamics of AA, we found clear effects of the quality and the quantity of the primed semantic network on the dynamics of AA. Since results of Project I demonstrated the influence of priming the semantic concept of innovativeness, results of the seminal paper by Carbon and Leder (2005) could partly be explained by priming the specific semantic concept of innovativeness.

As mentioned in the section motivation of Project I, we implemented AA as a multidimensional construct, since it seems rather naïve to think of AA as a mere judgement of like/dislike or about the beauty of an object. This way we pronounced the multidimensionality of AA, which highlighted the complexity of AA, but also pointed out that AA as it has been used in the literature before was operationalised ambiguously and vaguely, therefore leaving open room for speculations how former results can be interpreted and integrated into the canon of results.

We primed different aspects of AA within the reported experiments, while investigating its impact on the dynamics of AA. We found significant effects on these dynamics due to priming the semantic network innovativeness as well as due to priming the whole set of AA. However, it is yet unclear which distance each of the implemented semantic networks has to AA. Therefore further research is needed to investigate relevant variables and their networks for AA to find out, which variables impact the network of AA the most. In line with this critical point of Project I, which aimed to contrast the RET and priming semantic concepts, the RET itself triggers the dynamics of AA through the activation of semantic concepts. Although we carefully collected the attributes used in the RET phase of Project I (Faerber, et al., 2010, footnote 1, p. 196) we included, inter alia, the scale "classical", which itself could be an important variable for AA.

How did priming semantic concepts effect the dynamics of AA? Different theories for the representation of different concepts within a semantic network exist, for instance, holistic models versus distributed models. Holistic models (Collins & Loftus, 1975) suggest that holistic representations of concepts construct the semantic networks. These concepts share connections with each other, which represent learned associations (Hutchison, 2003). The more properties two concepts have in common, the more connections are shared. Thus, the concept apple and cherry both are connected to the properties “red”, “sweet”, “fruit”, “tree” and so on. In contrast, distributed models suggest that concepts are not themselves units, but a combination of weighted highly interconnected properties. Thus, a certain pattern of weighted properties (red, sweet, growing on a tree) would represent a specific concept. In this manner a distributed model would not suggest that the priming of specific concepts would spread links in a semantic network, but instead that the activation of one concept would facilitate the processing of similar ones, because the properties pertaining to both concepts overlap (Hutchison, 2003). In Project I we argued in favour of a holistic model, however, results of Project I could be interpreted in favour of both models. The design of Project I, however, was not generated to test these different models. Further research on AA as a construct could be promising: firstly, to further test for different models of semantic networks, secondly to further define which variables must be mandatorily included in the construct of AA, and thirdly, to observe the importance or distance of the different parts of the construct for the AA.

II. When the others matter: Context dependent effects on changes in appreciation of innovativeness

Motivation

In real life contexts we judge objects (e.g. consumer products) frequently in comparison with other exemplars of their category, for example, during a purchase decision. Simulating such events Carbon and Leder (2005b) investigated innovative designs together with less innovative ones in within subject designs. However, Faerber et al. (2010) reported the impact of priming innovativeness on the dynamics of aesthetic appreciation (AA) and thus, that the awareness of innovativeness might be important to trigger dynamics in the perception of such stimulus material where innovativeness is an important property. These studies revealed a dissociation between low and highly innovative stimuli over time and in the latter case (Faerber, et al., 2010) found a full cross-over interaction of innovativeness and time for attractiveness. These results reproduced real life changes in preference for innovative objects described, for example, in Moulson and Sproles (2000). However, up to now, it was unclear whether such triggered dynamics in AA depend on the awareness of innovativeness. Of major importance for Project II was the systematic combination of experimental stimuli in sets and their susceptibility for showing typical dynamics of aesthetic appreciation.

In Bornstein’s (1989) meta-analysis of the mere exposure effect he discussed different results for homogenous and heterogeneous stimulus sets using low versus highly complex stimuli. He reported studies using heterogeneous stimulus sets (within subject designs) which found complex stimuli being rated more positively, however, one study using homogeneous stimulus sets (between subject design) found the reverse effect. He interpreted the differential findings as such that participants might have been able to compare their reactions to both types of stimuli over time and concluded that in this situation simple and complex stimuli had been rated in relation to each other. In comparison the complex stimuli might produce a stronger mere exposure effect, since they are compared to the simple stimuli and thus are perceived as being more interesting or pleasing. To find out whether this interpretation is the likely explanation he suggested analysing ratings on affective variables for simple and complex stimuli under identical conditions using both between and within subject designs. In Project II we followed this idea by using the variable innovativeness instead of complexity as recent research qualified this variable as being mostly responsible for triggering dynamics of AA of products (Leder & Carbon, 2005; Moulson & Sproles, 2000). Table 2 provides an overview of the implemented experiments.

Experiment	Design	Condition	Quantity and innovativeness of stimuli
1	Within	1	9 low and 9 highly innovative stimuli
2	Between	1	9 low innovative stimuli
		2	9 highly innovative stimuli
3	Within	1	4 low and 4 highly innovative stimuli

Table 2. Overview of experiments carried out in Project 2. In Experiments 1 and 2 nine low and highly innovative stimuli were used. Differences between Experiments 1 and 2 could be due to the mere length of the elaboration of the stimulus material (18 versus 9 stimuli per participant). To exclude this interpretation we implemented Experiment 3 with 8 stimuli per participant.

Original Paper

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Original Communication

When the Others Matter

Context-Dependent Effects on Changes in Appreciation of Innovativeness

Gernot Gerger[1], Helmut Leder[1], Stella J. Faerber[2], and Claus-Christian Carbon[2]

[1]Faculty of Psychology, University of Vienna, Vienna, Austria, [2]University of Bamberg, Germany

Abstract. Although innovativeness is an important variable in product design, we know little about its appreciation. We studied how appreciation of innovativeness and its dynamics depends on the heterogeneity of the context in which it appears. We employed a test-retest design in which appreciation of car interior designs was tested before and after repeated evaluations. We tested heterogeneous stimulus sets (highly *and* lowly innovative designs together; Experiment 1) and homogeneous stimulus sets (highly *or* lowly innovative designs; Experiment 2). The known effect (Carbon, Hutzler, & Minge, 2006; Carbon & Leder, 2005) of a selective increase in attractiveness ratings for highly innovative stimuli after repeated evaluations was only obtained for heterogeneous sets. In homogeneous sets, both highly and lowly innovative interiors were rated similarly and showed similar dynamics. Experiment 3 was a shorter version of Experiment 1, which ruled out differences in experimental design (more ratings and longer duration in Experiment 1) as the cause of the differences. High innovativeness was found to show a specific increase in attractiveness ratings only when innovativeness was made apparent by presenting stimuli in heterogeneous sets. Thus, awareness of variation in innovativeness as a relevant stimulus dimension is a key feature regarding its effect on appreciation.

Keywords: attractiveness, innovativeness, dynamics, repeated evaluation, context, consumer psychology

Product esthetics are essential in modern consumer markets (Hekkert & Leder, 2008). For example, Apple's success has been attributed to its intense focus on attractive and innovative product design. Product design that is attractive through innovativeness (Carbon & Leder, 2005; Hekkert, Snelders, & Van Wieringen, 2003) can obviously be a key for distinguishing between winners and losers in a market (Liu, 2003; Mairesse & Mohnen, 2002). It could be quite costly for a company if innovativeness was not found attractive by customers (Cooper, 2001; Moulson & Sproles, 2000). In consequence, innovativeness is often stressed as being essential for consumer products and a driving force in cultural and industrial progress (see Cox, 2005; and for the arts, Leder, Belke, Oeberst, & Augustin, 2004).

Psychologically, innovativeness is not a very well-defined dimension. The specific nature of innovativeness makes it an interesting dimension regarding attitude formation (Schwarz, 2007). Innovativeness can be defined as "originality by virtue of introducing new ideas" (Carbon & Leder, 2005, p. 587). It involves novel and sometimes unusual stimulus features. Different from novelty, innovativeness remains innovative for some time, while novelty cannot persist (Carbon & Leder, 2005). In design, innovativeness can be extracted from expert knowledge or from concept design studies. However, because what is seen as innovative might differ between perceivers, the effects of innovativeness in empirical studies warrant individual assessment (Carbon & Leder, 2005). In a series of studies using car interiors, systematically varying in innovativeness, Carbon and Leder (2005), Leder and Carbon (2005), and Carbon et al. (2006) found that innovativeness was often rejected at first. When seen for the first time, lowly innovative car interiors were appreciated more than highly innovative car interiors. However, after active elaboration through repeated evaluations (Carbon & Leder, 2005; Carbon et al., 2006), attractiveness selectively increased for the highly innovative car interiors. Critically, in these studies, because highly and lowly innovative stimuli were rated together in one set, innovativeness might have been made apparent through the heterogeneity of the evaluated set. The present study addressed whether an increase in appreciation for highly innovative designs requires explicit awareness of innovativeness as an important dimension, relative to other stimuli. We tested whether heterogeneity in innovativeness is necessary to selectively increase attractiveness for high innovativeness. For example, the perceived attractiveness of a new, innovative car design depends on the other cars that one knows or on the other cars that are presented during the evaluation. Alternatively, innovativeness might also be evaluated independently of either. Understanding under which conditions innovative designs become appreciated would inform us about the nature

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of cognitive-affective evaluations and whether the formation of attitudes is automatic or stimulus-/context-dependent.

The present study used a dynamic test paradigm of repeated evaluations (Carbon & Leder, 2005) and compared homogeneous (only highly or only lowly innovative car interiors) and heterogeneous (highly and lowly innovative car interiors) stimulus sets. Differences should reveal whether an appreciation of high innovativeness requires a direct comparison between highly and lowly innovative stimuli or whether innovativeness, when it is seen, produces effects per se, and thus relies on an internal standard of comparison. The latter would be in accordance with effects of an independent, inner standard, similar to specific responses to stimulus features – such as absolute pitch (Takeuchi & Hulse, 1993). The former would be in accordance with effects that depend on differences with other stimuli in the set (Helson, 1948; Parducci, 1995) or, as in paradigms of mismatch negativity, when effects are only measured when a deviating stimulus suddenly appears (Cammann, 1990; Tiitinen, May, Reinikainen, & Näätänen, 1994).

We employed a paradigm devised by Bornstein, Kale, and Cornell (1990), in which set homogeneity was varied with respect to how demanding the visual stimuli were and whether they were shown repeatedly. By using two classes of stimuli – visually demanding optical illusions and simple geometrical line drawings – they found that the effects of stimulus repetition on attractiveness ratings depended on the homogeneity of the stimulus set. Using a between-subjects design in which only one homogeneous stimulus class was shown repeatedly and then evaluated, they found that attractiveness ratings linearly increased for both classes. Additionally, the attractiveness ratings for both classes of stimuli were similar when seen for the first time. However, when both classes of stimuli were shown together in one set when they were evaluated for the first time, the simple figures received lower ratings of attractiveness than the optical illusions. In this heterogeneous set, stimulus repetition resulted in increased attractiveness ratings for the optical illusions, but not for the simple geometric figures. Additionally, after repetition, both classes of stimuli showed a decrease in attractiveness ratings, which was interpreted as the effect of boredom (Berlyne, 1970b; Stang, 1974). Thus, regarding the dimension of visual demands, complexity-dependent changes in attractiveness only emerged when differences in stimulus features were made apparent by simultaneous presentation of the stimuli. Applying a similar design, we test whether the effects of innovativeness (as in Carbon & Leder, 2005) also depend on such context or set effects.

Esthetic appreciation is often studied by measuring attractiveness (Hekkert & Leder, 2008). Attractiveness is a summarizing evaluation representing affective and cognitive aspects (Leder, Augustin, & Belke, 2005; Leder et al., 2004) in which a number of related concepts are involved. Regarding the structure of esthetic evaluations, Faerber, Leder, Gerger, and Carbon (2010) showed how the activation of specific attractiveness-related concepts produces different effects with regard to esthetic appreciation. They tested a semantic network approach to esthetic appreciation by comparing different priming conditions. In these studies, when participants had been primed for innovativeness, changes in attractiveness were observed. However, it is unclear whether these changes depend on the range of innovativeness in the stimulus sets. Different theoretical explanations make different predictions regarding set effects when stimuli are presented in either homogeneous or heterogeneous sets.

The following theories propose that appreciation of innovativeness could depend on a kind of internal, pre-existing standard of comparison: prototype, evolutionary-novelty, and two-factor theory. According to prototype theory (e.g., Halberstadt, 2006; Halberstadt & Rhodes, 2003; Rosch, 1978), each stimulus is matched against an internal prototype (based on previous experiences). Innovative stimuli might be more dissimilar to an internal prototype because they are more dissimilar to familiar (see prototypical) stimuli. If so, then low prototypicality is not preferred (Halberstadt, 2006). Repeated evaluation increases familiarity and might cause minor changes in the internal prototype (Rhodes, Jeffery, Watson, Clifford, & Nakayama, 2003) toward greater innovativeness (Carbon & Leder, 2005). Therefore, appreciation of highly innovative designs will increase over time. Because stimuli are matched to a pre-existing internal prototype, one might expect to find similar evaluations and dynamics regardless of whether a homogeneous or heterogeneous set is used. However, recent data from the domain of face research have questioned this theory, at least for the process of assessing attractiveness of faces by matching them with an internal prototype (Carbon, Grüter, Grüter, Weber, & Lüschow, 2010).

Evolutionary accounts claiming that stimulus novelty (see innovativeness) results in ambiguity or uncertainty (Lee, 2001; Robinson & Elias, 2005) make the same predictions. A perceiver cannot know whether a novel (see innovative) stimulus is potentially harmful. As a consequence, approach and avoidance behaviors would be triggered simultaneously, resulting in attenuated attractiveness judgments. If this initial ambiguity is overcome through repeated evaluations, then attractiveness judgments eventually increase. Regardless of set combination, one might find lower attractiveness ratings for highly innovative than for lowly innovative stimuli when rated for the first time. After repeated evaluation, the attractiveness of innovative stimuli would increase.

The two-factor theory of Berlyne (1970b) and Stang (1974) arrives at the same conclusions. According to this theory, the more a stimulus is embedded in our cognitive system, the more positively it will be evaluated until boredom sets in, which then affects evaluations. Embedding occurs through repeated evaluations and results in positive habituation (Berlyne, 1970b) and increased familiarity (Zajonc, 2001). Moreover, processing fluency of the stimulus also increases (Bornstein & D'Agostini, 1994; Reber, Schwarz, & Winkielman, 2004). All of these factors increase attractiveness evaluations (Carbon, 2010) until boredom sets in, at which point the positive evaluations begin to wane (Berlyne, 1970b; Stang, 1974). Because of their relative novelty, highly innovative stimuli are less embedded in our cognitive system than lowly innovative stimuli. Consequently, the two-factor theory would predict increases for highly but not for lowly innovative stimuli, regardless of whether innovative stimuli are shown within a heterogeneous or homogeneous set.

However, if appreciation of innovativeness depends on a relative standard of comparison, this would be in accordance with a different rationale of the two-factor model (Berlyne, 1970b; Stang, 1974) or arousal theory (Berlyne, 1970a). According to the two-factor theory, effects of habituation and boredom on attractiveness ratings could also be *relative* depending on the stimulus set. After repeated evaluations, the highly innovative stimuli might be perceived as less boring compared to the lowly innovative stimuli. But if only one set is rated, then the boredom effects within the set will be similar and independent of level of innovativeness. Thus, different dynamics might develop when the range of innovativeness is different.

Arousal theories (Berlyne, 1970a) also predict that attractiveness ratings depend on relative differences between the stimuli. They assume that medium levels of arousal result in the highest attractiveness ratings. Importantly, according to the arousal account, evaluations critically depend on the *relative* arousal level induced by different stimuli. Highly innovative stimuli – because of their novelty, unexpectedness, and unusualness – when seen for the first time might produce higher suboptimal arousal levels than lowly innovative stimuli. Through repeated evaluations, this initially high arousal might be reduced to a medium level, while the arousal level of the lowly innovative stimuli might be reduced to a suboptimal level. Thus, when both innovativeness levels are judged together, arousal differences due to innovativeness might be highly apparent and determine their attractiveness. On the other hand, in a homogeneous set, the arousal levels associated with the stimuli might be similar, which would result in more similar attractiveness evaluations and dynamics. Evidence for such changes in arousal was also found in Carbon, Michael, and Leder (2008), who measured electrodermal activity indicative of arousal. Highly innovative material showed physiological effects in accordance with maintaining positive arousal after repeated evaluations.

Thus, the present experiments will test the following hypotheses: If prototype, novelty, or two-factor explanations account for the effects of innovativeness, we should find similar effects in heterogeneous and homogeneous stimulus sets. However, if the appreciation of innovativeness depends on relative differences as suggested by arousal or based on the relative boredom level (according to the two-factor theory), then effects should differ between the conditions.

Experiment 1

A heterogeneous stimulus set was used in Experiment 1. It was based on Carbon and Leder's (2005) experimental paradigm, the "repeated evaluation technique" (RET). Car interiors were judged for attractiveness and innovativeness before and after a phase of repeated stimulus evaluations. Thus, Experiment 1 served as a baseline replication of Carbon and Leder but used photorealistic instead of line-drawing stimuli.

Method

Participants

Twenty-seven participants (19 female, 8 male) enrolled in various introductory psychology courses at the University of Vienna, Austria, participated in the experiment for partial course credit. The participants' mean age was 21.7 years (range: 18 to 28 years).

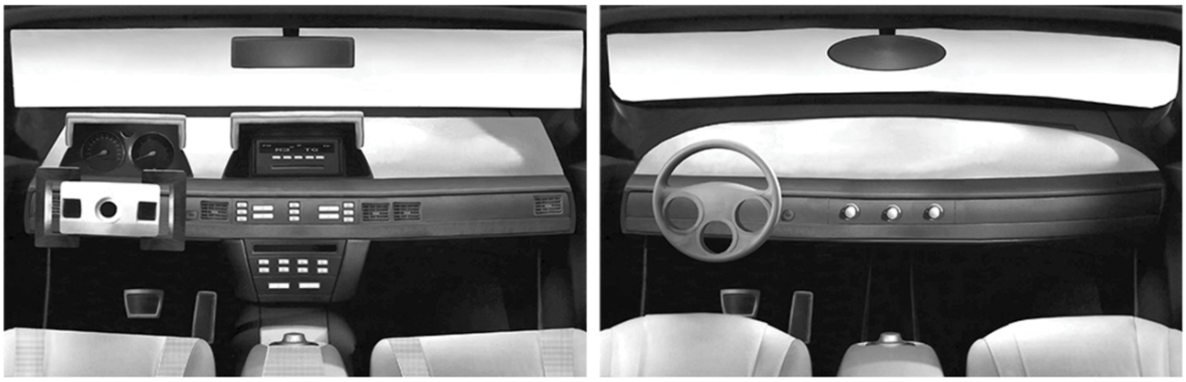

Figure 1. Examples of stimuli used: a highly innovative car interior (left) and a less innovative car interior (right).

Table 1
Mean attractiveness and innovativeness ratings for experiments 1, 2, and 3, separately for T1 and T2

	Experiment 1 heterogeneous set – long		Experiment 2 homogeneous set		Experiment 3 heterogeneous set – short	
			Attractiveness			
	T1	T2	T1	T2	T1	T2
Lowly innovative	3.35 (1.00)	3.32 (0.85)	2.96 (1.00)	3.60 (0.80)	3.15 (0.80)	3.47 (0.85)
Highly innovative	2.90 (0.72)	3.75 (1.18)	3.26 (1.02)	3.77 (0.80)	3.06 (1.16)	4.98 (1.00)
			Innovativeness			
Lowly innovative	3.11 (0.76)	3.05 (0.69)	3.41 (0.97)	3.62 (0.69)	3.20 (0.91)	3.40 (1.16)
Highly innovative	4.44 (1.05)	4.63 (0.94)	3.58 (1.00)	3.84 (1.02)	3.87 (0.90)	4.44 (0.78)

Note. Standard deviations are in brackets.

Stimuli

Eighteen photorealistic grayscale depictions of car interiors were created in Adobe Photoshop 7. These differed in two levels of innovativeness (Carbon & Leder, 2005) as confirmed by pretests (for examples, see Figure 1). As in Faerber et al. (2010), the two levels of innovativeness (low, high) were fully crossed with levels of complexity and curvature on 3 × 3 levels (low, medium, high) (for a detailed description of these dimensions, see Carbon & Leder, 2005, and Leder & Carbon, 2005). Several previous studies ensured equal degrees of complexity and curvature for the two levels of innovativeness using 7-point Likert scales (Carbon & Talker, 2006).

Apparatus

The experiment was administered using PsyScope PPC 1.2.5 (Cohen, MacWhinney, Flatt, & Provost, 1993) on Apple eMac computers. Stimuli were centrally presented on a 17-inch monitor at a size of 678 × 438 pixels with a screen resolution of 1024 × 768 pixels.

Procedure

Experiment 1 consisted of three consecutive parts. In an initial rating phase (Test phase 1: T1), participants first rated all of the car interiors with respect to their attractiveness and then their innovativeness. In the second part, all stimuli were evaluated on 25 different scales. This repeated exposure phase was used to ensure that participants actively elaborated the stimuli. The stimuli were rated on the following dimensions (as in Carbon & Leder, 2005; German terms in parentheses): repellent (abschreckend), pleasant (angenehm), appealing (ansprechend), unsophisticated (bieder), carefully designed (durchdacht), inviting (einladend), elegant (elegant), overwhelming (erdrückend), extravagant (extravagant), funky (flippig), futuristic (futuristisch), dignified (gediegen), tasteful (geschmacksvoll), of high quality (hochwertig), tacky (kitschig), easily operated (komfortabel), conservative (konservativ), luxurious (luxuriös), modern (modern), plain (nüchtern), functional (praktisch), stylish (stilvoll), cluttered (unübersichtlich), ornamental (verspielt), and overloaded (überladen). The presentation order of these scales was randomized across participants. Finally, the participants rated all of the stimuli again for attractiveness and innovativeness (Test phase 2: T2). All ratings were made on 7-point Likert scales anchored with 1 = *hardly* (*wenig*) and 7 = *very* (*sehr*). The presentation order of the stimuli was randomized within each scale. Participants were not given time constraints for their ratings.

Results and Discussion

In Experiment 1, participants judged a set of stimuli that were heterogeneous in innovativeness (as in Carbon & Leder, 2005). As can be seen in Table 1, lowly innovative stimuli were rated higher on attractiveness than highly innovative stimuli at T1. However, after repeated evaluations, only highly innovative stimuli showed an increase in attractiveness at T2 (see Table 1 and Figure 2). As for the innovativeness ratings, the data showed a clear pattern (see Table 1): Highly and lowly innovative stimuli differed at T1 and T2. In order to analyze these effects, we calculated repeated measures ANOVAs with the factors time (T1, T2) and innovativeness (high, low) separately for the attractiveness and innovativeness ratings. For a sample of 27 participants, an effect size of $f = 0.36$ (i.e., between a medium, $f = 0.25$, and a large, $f = 0.40$, effect as defined by Cohen, 1988) can be detected with a probability of $1 - \alpha = .95$ (Faul, Erdfelder, Buchner, & Lang, 2009). For the follow-up dependent *t*-tests, a posteriori effect sizes were calculated according to equation 3 in Dunlap, Cortina, Vaslow, and Burke (1996).

Attractiveness Ratings

A 2 × 2 (time × innovativeness) repeated measures ANOVA for the attractiveness ratings revealed a significant main effect of time, $F(1, 26) = 10.99, p < .01, \eta_p^2 = 0.30$. Importantly, the effect of time was qualified by a significant interaction of

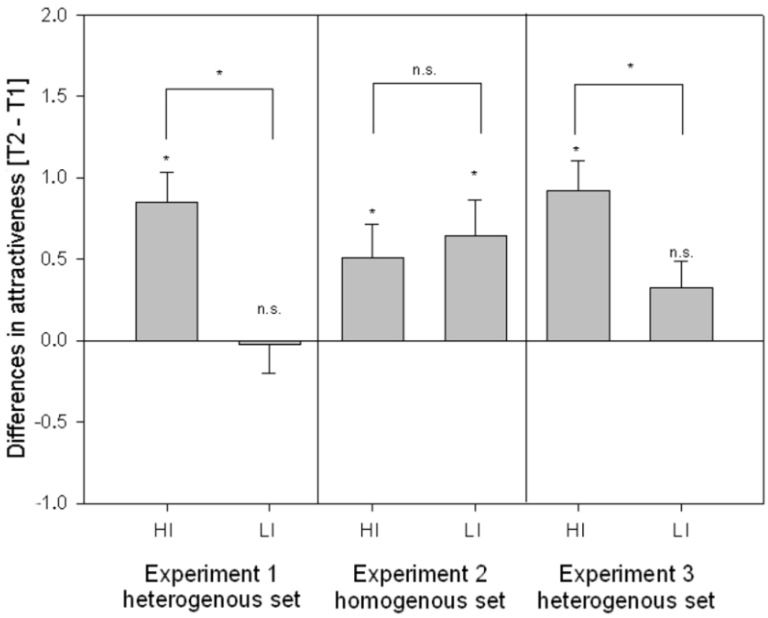

Figure 2. Interaction and main effects of the repeated measures ANOVAs expressed as change scores (T2 minus T1) in the attractiveness ratings of highly innovative (HI) and lowly innovative stimuli (LI). *significant differences at a $p = .05$ level. Error bars depict one standard error of the mean.

time and innovativeness, $F(1, 26) = 10.55$, $p < .01$, $\eta_p^2 = 0.29$, reflecting attractiveness dynamics that were dependent on the innovativeness level of the stimuli (see Figure 2). Dependent *t*-tests showed that this interaction was due to the highly innovative stimuli receiving significantly higher attractiveness ratings at T2 than at T1, $t(26) = 4.50$, $p < .01$, $d = 0.81$; it was not due to changes in the attractiveness of the lowly innovative stimuli, $t(26) = 0.14$, *ns*, $d = 0.03$. The results regarding the attractiveness ratings replicated (using more realistic stimuli) Carbon and Leder's (2005) findings. Highly innovative stimuli were initially rejected, but following repeated evaluations, they received higher attractiveness ratings than lowly innovative stimuli.

Innovativeness Ratings

A repeated measures ANOVA revealed a significant main effect for innovativeness, $F(1, 26) = 85.85$, $p < .01$, $\eta_p^2 = 0.77$, but no other effect. Thus, innovativeness ratings differed along our preclassification and remained stable over time (again as in Carbon & Leder, 2005).

Experiment 2

In Experiment 2 we tested the critical condition: In order to explore whether innovativeness – when not made apparent – influences attractiveness and its dynamics, participants evaluated a set of stimuli that were homogeneous in innovativeness (either only lowly or only highly innovative stimuli).

Method

Participants

Fifty-four participants (41 female, 13 male) enrolled in various introductory psychology courses at the University of Vienna participated in the experiment for partial course credit. The mean age of the participants was 22.5 years (range: 18 to 38 years). Participants were randomly assigned to one of two conditions (Experiments 2a and 2b) with the restriction that approximately the same amount of men were in each condition (six in Experiment 2a and seven in Experiment 2b).

Stimuli and Apparatus

The stimuli and apparatus used were the same as in Experiment 1. In Experiment 2a, only the lowly innovative stimuli (9 stimuli) were presented to the participants. In Experiment 2b, only the highly innovative stimuli (9 stimuli) were presented to the participants.

Procedure

Again, Experiments 2a and 2b consisted of three consecutive phases (T1, evaluation phase, T2). All ratings were given on 7-point Likert scales and were self-paced.

Results and Discussion

Attractiveness ratings were clearly different from those in Experiment 1. Comparing the results of Experiment 2a and

2b, highly innovative stimuli were judged to be slightly more attractive than lowly innovative stimuli. Over time, attractiveness ratings increased consistently for both the highly and lowly innovative stimuli (see Table 1 and Figure 2). Also, innovativeness evaluations did not reveal differences between the two conditions. To analyze these effects, we conducted a 2 × 2 repeated measures ANOVA with innovativeness (high, low) as a between-subjects factor and time (T1, T2) as a within-subjects factor, separately for the attractiveness and innovativeness ratings. Given the sample size of 54 participants (27 evaluating only the highly innovative, 27 only the lowly innovative stimuli), we could expect to detect medium-sized effects with $f = .25$ (Cohen, 1988) with a probability of $1 - \alpha = .95$ (Faul et al., 2009).

Attractiveness Ratings

A repeated measures ANOVA for attractiveness ratings alone yielded a significant main effect of time, $F(1, 52) = 14.86$, $p < .01$, $\eta_p^2 = 0.22$. After the repeated evaluations, attractiveness ratings for both innovativeness levels increased in a concordant manner (see Figure 2). No specific effects for either level of innovativeness were found. Thus, the effects of innovativeness on attractiveness clearly depend on which set combination was evaluated. Differential effects were only found in a heterogeneous set (in Experiment 1) in that attractiveness ratings for highly innovative stimuli increased after repeated stimulus evaluations.

Innovativeness Ratings

A repeated measures ANOVA for innovativeness ratings revealed no significant effects. However, the factor time showed a trend toward significance: $F(1, 52) = 4.03$, $p = .051$, $\eta_p^2 = 0.07$. Thus, innovativeness of the stimuli did not significantly affect the corresponding innovativeness ratings. So, if the variation on the dimension innovativeness is not made explicit and thus awareness is not specifically raised by showing highly and lowly innovative stimuli together, then innovativeness does not show a specific effect.

Experiment 3

Experiments 1 and 2 differed in two respects. First, participants were asked to provide more ratings in Experiment 1 as compared to Experiment 2. This was due to the different numbers of stimuli (18 in Experiment 1 vs. 9 in Experiment 2). Second, Experiment 1 had a longer total experiment duration. In order to rule out that the different dynamics in attractiveness ratings with a selective gain for highly innovative stimuli in Experiment 1, but not in Experiment 2, was due to the different experimental procedures, Experiment 3 employed the same experimental design as Experiment 1, but used a subset of only four highly and four lowly innovative stimuli. This resulted in approximately the same number of evaluations and the same experiment duration as Experiment 2.

Methods

Participants

Twenty-seven participants (24 female, 3 male) from the University of Vienna participated in the experiment for partial course credit. The participants' mean age was 22.2 years (range: 19 to 45).

Stimuli and Apparatus

In Experiment 3, only a subset of the stimuli from Experiment 1 was used. Stimuli with medium levels of complexity and curvature were omitted. Thus, the set consisted of four highly and four lowly innovative stimuli. The apparatus was the same as in Experiments 1 and 2.

Procedure

The same experimental procedure as in Experiments 1 and 2 was used.

Results and Discussion

In Experiment 1, attractiveness ratings selectively increased for highly innovative stimuli, but not for lowly innovative stimuli. Experiment 3 was conducted to rule out the possibility that the differences between Experiments 1 and 2 in the results regarding attractiveness were due to different experimental procedures. Descriptively, the results replicated the findings of Experiment 1. At T1, lowly innovative stimuli were preferred over highly innovative stimuli (although the difference was not as large as in Experiment 1). Importantly, following repeated evaluations, attractiveness ratings for highly innovative stimuli increased more than for lowly innovative stimuli (see Table 1). As in Experiment 1, innovativeness ratings between highly and lowly innovative stimuli were clearly different (see Table 1). In order to analyze these effects, we calculated repeated measures ANOVAs with the factors time (T1, T2) and innovativeness (high, low) separately for attractiveness and innovativeness ratings. With a sample size of 27 participants, we could expect to detect middle to large effects of $f = .36$ (Cohen, 1988) with a probability of $1 - \alpha = .95$. Effect sizes for the dependent *t*-tests were calculated according to Formula 3 in Dunlap et al. (1996).

Attractiveness Ratings

The repeated measures ANOVA for the attractiveness ratings showed a significant main effect of time, $F(1, 26) = 23.72$, $p < .01$, $\eta_p^2 = 0.48$, and a significant interaction of time and innovativeness, $F(1, 26) = 6.03$, $p = .021$, $\eta_p^2 = 0.18$ (see Figure 2). Follow-up dependent *t*-tests showed that the attractiveness ratings for the highly innovative stimuli increased significantly from T1 to T2, $t(26) = 4.90$, $p < .01$, $d = 0.88$. In contrast, they remained rather stable for the lowly innovative stimuli, $t(26) = 2.00$, *ns*, $d = 0.41$. These results replicated the findings of Experiment 1 and showed that, in a heterogeneous stimulus set, highly as compared to lowly innovative stimuli showed a greater increase over time. Awareness of innovativeness, resulting from the evaluation of highly and lowly innovative stimuli within one set, seems to be critical for the appreciation of innovativeness over time.

Innovativeness Ratings

The repeated measures ANOVA for innovativeness ratings yielded a significant main effect of innovativeness, $F(1, 26) = 21.78$, $p < .01$, $\eta_p^2 = 0.46$, and a main effect of time, $F(1, 26) = 6.32$, $p = .018$, $\eta_p^2 = 0.20$, which was due to an increase in innovativeness (see Table 1). However, there was no interaction between the two factors. Highly and lowly innovative stimuli were clearly different with regard to their innovativeness ratings. This suggests that the innovativeness of the stimuli was apparent in this smaller set.

General Discussion

It was known from previous studies that highly innovative designs increase in attractiveness after a series of explicit evaluations, while lowly innovative designs decrease or remain constant (Carbon et al., 2006; Carbon & Leder, 2005). Whether innovativeness per se produces the effects or whether these effects depend on the set was not clear, so variation on this stimulus dimension was tested in the present study. We found that context, in terms of set homogeneity, strongly affected the appreciation of innovativeness. In a set of stimuli with heterogeneous innovativeness including highly and lowly innovative stimuli (Experiments 1 and 3), we replicated this known effect of innovativeness (see Figure 2). In contrast, when only one level of innovativeness – high or low innovativeness – was repeatedly evaluated (Experiment 2), then attractiveness ratings after repeated evaluations increased for both stimulus classes. Thus, innovativeness only affected attractiveness when both highly and lowly innovative stimuli were evaluated within one set. That is, when innovativeness was made apparent and was distinctive in the stimulus set. This was reflected in the innovativeness ratings and suggests that innovativeness was differentially apparent in the different stimulus sets. In Experiments 1 and 3, when heterogeneous sets were used, the innovativeness ratings between the two stimulus classes were clearly and significantly different. This was not the case in Experiment 2.

One might argue that the lack of differences in the attractiveness and innovativeness ratings for the differently innovative stimuli in Experiment 2 might have been due to participants using the scale differently: Participants might have used the whole scale for their ratings in Experiment 2 because they were judging the stimuli relative to each other (Helson, 1948; Parducci, 1995) or they might have felt obliged to use the whole scale for their judgments in order to provide information for the researcher (Schwarz, 1999). These explanations would be confirmed by higher standard deviations in Experiment 2 than in Experiments 1 and 3. However, as revealed in Table 1, the standard deviations were similar across experiments. Thus, we believe that the effects of innovativeness depend on the characteristics of the stimulus set being judged. Additionally, different dynamics with selectively stronger increases in attractiveness for highly innovative stimuli in Experiments 1 and 3 developed only in heterogeneous sets.

In all three experiments, innovativeness was also evaluated as a dimension during the first stimulus exposures. The differences in results therefore suggest that the effects of innovativeness on attractiveness require a distinctive variation in the stimulus set, not just the awareness that the dimension exists. The effects of innovativeness and attractiveness can also be seen in correlations between attractiveness and innovativeness for the highly innovative stimuli in T1. These (simple Pearson correlations) were $r = .48$ in Experiment 1 and $r = .46$ in Experiment 3, but only $r = .15$ in Experiment 2. These correlations are in accordance with the arousal theory (Berlyne, 1970a) as well as the two-factor theory (Berlyne, 1970b; Stang, 1974): Relative differences in arousal level (Berlyne, 1970a) or in boredom (Berlyne, 1970b; Stang, 1974) only affect attractiveness ratings and its dynamics when innovativeness is apparent. The attractiveness ratings for the lowly innovative stimuli at T2 in Experiments 1 and 3 are in accordance with an explanation based on boredom. The longer experiment duration and the higher number of ratings in Experiment 1 showed more boredom-like effects (O'Hanlon, 1981). In Experiment 3, attractiveness ratings for lowly innovative stimuli slightly increased toward T2 while in Experiment 1 their attractiveness slightly decreased. However, these interpretations should be further tested using psychophysiological measures that are sensitive to arousal and boredom, such as electro-dermal activity (Dawson, Schell, & Filion, 2000).

Conclusions

The present study demonstrated that the attractiveness and the dynamics of the attractiveness of innovativeness develop only when innovativeness is apparent through the stimulus set and distinct in the stimuli. A mere evaluation of innovativeness alone, as was explicitly asked for in all experiments in the first phase, did not trigger such specific changes in attractiveness. These findings are in accordance with theories emphasizing the relative nature of evaluations in general (e.g., Helson, 1948) and with theories emphasizing the relative nature of attractiveness evaluations (Berlyne, 1970a, 1970b; Stang 1974). From a basic research perspective, our findings emphasize the importance of explicitly considering stimulus dimensions, which affect evaluations. Moreover, they stress that evaluations are made in situations and context (Smith & Semin, 2004) and – at least as shown for innovativeness here – do not rely on internal and independent standards.

These findings also have implications for applied contexts, such as for testing the appreciation of innovative product designs that are to be introduced into the market. Our results suggest (1) that in order to create awareness of the appreciable aspects of innovativeness, innovative designs should be tested together with lowly innovative designs; and (2) that innovativeness profits when evaluated after a phase of repeated evaluations. Testing only once, as often done in one-shot marketing studies, may not capture the possible dynamics of attractiveness. This procedure of presenting heterogeneous stimulus sets and using repeated evaluations seems to be a good approximation of processes that occur under real-life exposure conditions. For example, when one sees an innovative car, one might automatically judge the car in relation to other cars on the streets. Moreover, one might repeatedly see the car in print and TV advertisements, and in person, and one might talk to friends about it. So, if you want an innovative product to be found attractive for its innovativeness, present it with its less innovative competitors!

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Gernot Gerger

University of Vienna
Faculty of Psychology
Liebiggasse 5
1010 Vienna
Austria
gernot.gerger@univie.ac.at

Critical Reflection

Results of Project II showed the impact of homogeneous and heterogeneous stimulus sets on the dynamics of AA. In Experiments 1 and 3 the dynamics for low and highly innovative stimuli were comparable with results in former studies using a heterogeneous stimulus set. Whereas we found an interaction between innovativeness and time for attractiveness using heterogeneous sets, as done in the seminal paper by Carbon and Leder (2005), we observed a simple increase of attractiveness for low as well as highly innovative stimuli using homogeneous sets, which is in accordance with the mere exposure effect (Zajonc, 1968). Thus, the different dynamics for low and highly innovative stimuli observed in different studies (Carbon, Hutzler, & Minge, 2006; Carbon & Leder, 2005b; Carbon, Michael, & Leder, 2008; Faerber, et al., 2010) seem to be in part an effect of the heterogeneity of the stimulus set.

The differential effects caused by the mere combination of stimuli within the experimental test set might be caused by the awareness of innovativeness. This interpretation is in line with the results of Project I, where the priming of innovativeness triggered dynamics in AA, but not the priming of attractiveness. However, in Project II participants in all experiments rated the stimuli for attractiveness and innovativeness at test times 1 and 2, which makes this interpretation rather unlikely. As mentioned above Bornstein (1989) recommended investigating set effects by contrasting between and within subject designs for the variable complexity, which we did for the stimulus variable innovativeness. Bornstein interpreted the differential ratings of the stimulus classes (low versus highly complex) due to the possibility for participants to rate the stimuli in relation to each other (within subject condition). Similarly, low and highly innovative stimuli could have been rated in relation to each other in Experiments 1 and 3 of Project II. Thus, the attractiveness ratings for the highly innovative stimuli could have increased in these experiments, because they were found to be more interesting or pleasing and less boring in comparison to the low innovative stimuli. Tversky (1977) accordingly highlighted that every judgement depends on the context and frame of reference and reported differential similarity ratings in dependence of the implemented stimulus set.

In Project II we not only found further set effects on judgements, attractiveness and innovativeness, but we also showed that test sets had an impact on the dynamics of AA. In the homogeneous conditions (Experiment 2, see also Table 2), participants rated the stimulus material in relation to each other and thereby probably were aware of the difference in complexity and curvature, but not of innovativeness, since the stimuli did not differ regarding this variable. During the procedure they familiarized themselves with the stimulus material leading to a mere exposure effect for both between subject conditions including low or highly innovative material (increase in attractiveness). In contrast, in Experiments 1 and 3 the highly innovative stimuli increased in attractiveness, but remained stable for low innovative stimuli. While observing both very unusual and very usual exemplars of a category, the integration of the unusual exemplar into the visual habits leads to their increase in attractiveness (Carbon, 2010). The attractiveness of the more common and already integrated exemplars, in contrast, stays stable or even decreases over time due to boredom or saturation effects (Faerber, et al., 2010). For innovativeness ratings we found an interactive effect of pre-experimentally fixed innovativeness with time in Experiments 1 and 3, but not in Experiment 2. This again could be interpreted in terms of a set effect. In Experiments 1 and 3 participants probably judged the innovativeness by comparing the innovative and unusual features within the designs, contrary to Experiment 2 where stimuli lacked innovative features, on the basis of differences they assessed on the residuary variables complexity and curvature. In sum, the observed dynamics in Project II were probably a combination of matching with and adjusting of internal representation moderated by the implemented stimulus sets.

III. Danger or fascination? Situated effects on the appreciation of innovation

Motivation

The procedure of the Repeated Evaluation Technique (RET) was introduced to simulate everyday experiences with objects and to trigger dynamics in aesthetic appreciation (AA) through the explicit elaboration of the stimuli via rating tasks on different variables. As perception, emotion and cognition are influenced by the situational context (Smith & Semin, 2004; Versace, Labeye, Badard, & Rose, 2009) the elaboration of the stimulus material during the RET phase could as well be influenced by it. If, for example, only negative attributes were used, participants would probably become particularly aware of negative aspects of the stimulus material, which could impact the dynamics in AA, concretely towards more negative interpretations of the material. Thereby, especially highly innovative stimulus material might be affected, since innovative objects (e.g. consumer products) in the beginning are not part of our visual habits and might need more time and elaboration to be successfully integrated into them. Highly innovative objects therefore are likely to be rejected at first sight (Leder & Carbon, 2005). Novelty, a key property of innovative stimuli, might induce uncertainty and could therefore evoke fear (Zajonc, 1968). However, after the mere exposure to or the elaboration of novel stimuli this is likely to change (e.g., Carbon, et al., 2008). Importantly the integration of innovative design aspects into the perceptual habits and thus, the increase for liking, could be modulated by a situational context (Versace, et al., 2009), which induces for instance fear, uncertainty or discomfort.

To observe such situational effects we introduced an RET which included an experiment with two conditions. In the first condition participants rated low and highly innovative stimulus material on the scales: dangerous, breakdown probable, error-prone, unsafe, risky, user unfriendly, difficult to get used to, exhausting, unclear, inconvenient, and inexpedient. With these attributes we aimed to make participants especially aware of possible dangers inherited in the designs, possible discomfort or uncertainty. In the second condition we sought to enhance the participants' awareness of the fascinating and emphasizing aspects of the stimulus material by implementing the attributes: exciting, arousing, thrilling, stimulating, surprising, ground-breaking, progressive, novel, fascinating, ingenious, and terrific.

Original Paper

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Danger or Fascination? Situated effects on the appreciation of innovation

Helmut Leder[1], Stella J. Faerber[1,2], Gernot Gerger[1], Michael Forster[1] & Claus-Christian Carbon[2,1]

[1] University of Vienna, Faculty of Psychology, Vienna, Austria

[2] University of Bamberg, Department of General Psychology and Methodology, Bamberg, Germany

Please send correspondence to:

Helmut Leder. University of Vienna, Faculty of Psychology

Liebiggasse 5, 1010 Vienna, Austria, email: helmut.leder@univie.ac.at

Author note

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Abstract

Appreciations as attitudes can change over time. In order to show that aesthetic appreciation is an adaptive mode of evaluation, evidence that object features and situational demands interact in a specific way is required. We show how the ambiguous quality of innovativeness, being potentially fascinating due to its novelty but also being potentially dangerous due to its unfamiliarity, specifically interacts with changes in aesthetic appreciation after repeated evaluations. Specific appreciation for high innovative designs was only found after elaboration on the basis of scales associated with fascinating aspects; when the evaluations stressed the possible dangers of innovation, changes lasted longer, which supports the role of fear-related processing. The findings clearly underline the adaptive function of aesthetics.

Word count: 116

Keywords: Aesthetics; Danger; Fascination; Attitudes; Preference; Innovation; Situated Cognition

Danger or Fascination? Situated effects on the appreciation of innovation

Humans have the ability to evaluate their environment on the basis of aesthetics. Aesthetic appreciation of object dimensions is somehow context-specific (Leder, Belke, Oeberst, & Augustin, 2004), it is Zeitgeist-dependent (Carbon, 2010), related to expertise (Vogt & Magnussen, 2007), and supposedly, modulated by the state of the perceiver in respect to situational demands (Leder, Tinio, Fuchs, & Bohrn, 2010). Aesthetic appreciation involves the expression of attitudes towards objects. For a long time, aesthetics focused on object-inherent features that determine how beautiful or aesthetically pleasing an object is. However, it has become more and more apparent that the more fascinating aspects of such attitudes are the changes that occur depending on the context of evaluations. Regarding adaptation, Schwarz (2007) stated that "to serve action in a given context, any adaptive system of evaluation should be informed by past experiences, but highly sensitive to specifics of the present. Moreover, it should overweight recent experience at the expense of more distant experience"(p. 640). Therefore, in accordance with situational demands, changes in appreciation presumably refer to specific experiences and consequently actions.

In order to demonstrate that aesthetic appreciation is adaptive in this sense, we showed how the appreciation of innovativeness as an object feature develops as a function of two different situational demands. We examined the aesthetic appreciation of cars varying in degree of innovativeness, a key factor in product design and an important feature in aesthetic appreciation in general (Leder, Belke, Oeberst, & Augustin, 2004; Färber, Leder, Gerger & Carbon, 2010). Innovation is twofold, it is new and attractions attention and –particularly in product design- might even cause fascination; but due to its novelty it also bears some uncertainty. In order to show the situational sensitivity of the aesthetic sense, we examined the impact of two different types of active evaluations (Leder & Carbon, 2005), each of which stresses a particular facet of innovation: fascination due to novelty (as in Biederman & Vessel, 2006) and danger due to unfamiliarity.

The adaptive nature of aesthetics was stressed by Dissanayake when she stated that aesthetics is "an adaptive behavior that promotes selective attention and positive emotional responses to components of the environment that lead to 'good' decisions and problem solving" (Dissanayake, 2007, p. 4). Consistent with this view is the positive correlation among beauty, appreciation, and positive values. For example, beautiful bodies indicate positive reproductive value, and beautiful faces represent parasite-free and healthy development (Grammer & Thornhill, 1994). The variety of possible evolutionarily fostered functions makes it likely that aesthetic appreciation is sensitive to a complex interplay of perceiver, object, and situation.

But this is not the whole story of aesthetic attributes. Dissanayake (2007) stated that an essential function of aesthetic processing is that it produces relief in a world of uncertainty and threat. In short, that it reduces fear. In this sense, aesthetics also provides a way of dealing with uncertainty. This is particularly the case within the domains of the arts, design, and fashion, in which attributes that are potentially dangerous or threatening are sometimes explicitly used in innovative designs (Carbon, 2010). How can we explain that we can also appreciate things such as artistic objects or products such as cars even though they have much of the innovative essence of being unfamiliar, uncertain or ambiguous? In addition to cognitive and affective factors (Leder et al., 2004), the situational context seems essential for the interpretation of such phenomena. Which and when objects are aesthetically appreciated therefore should depend on an interplay of object features and the attributes of the situation.

To show such influence of situational context on aesthetic appreciation, we used a paradigm that had shown to be sensitive to effects of innovation. In the repeated evaluation technique (RET; Carbon & Leder, 2005), the usual finding that people generally dislike innovative materials (e.g., Leder & Carbon, 2005) was shown to only reflect an initial attitude. Although the disliking of innovative materials may be due to fear of novelty (Bronson, 1968), it is not consistent with people's everyday appreciation of brand new iPods, concept cars at motor shows, or fancy clothes from the latest haute couture collection. The RET compensates the initial dislike of such materials by asking people to explicitly elaborate the materials—evaluate them on different scales. Several studies have shown that following such evaluations, people showed increased appreciation of high innovative designs (Carbon, Hutzler, & Minge, 20006; Carbon, Michael, & Leder, 2008). Moreover, Faerber, Leder, Gerger, and Carbon (2010) showed that the dynamics that favor preference for innovation depend on the kind of aesthetic concept that is primed by dimensions activated by aesthetic evaluations. In the present study, we systematically changed the situational context by using two different sets of scales within the RET procedure. Innovation is particularly interesting because it somehow bridges the old and the new, the familiar and the unfamiliar, and the present and the future. Innovation means that the elements of an object are somehow fresh, unusual, and unexpected, but without being so new that they would require a new schema. When something appears innovative, it has the potential to challenge habits. Thus, it is particularly fascinating as innovation simultaneously represents these two aspects: novelty and uncertainty. In the present study, we used these two aspects of innovation, and consistent with Carbon and Leder's (2005) repeated evaluation technique, we showed how different kinds of evaluations produced situations in which innovation is differentially appreciated. We addressed the ambiguous nature of innovation, in that the scales used for evaluation were either concerned with the fascinating aspects of or the possible dangers and risks associated with the materials.

Through the different phases, the experiment will show, in accordance with Schwarz (2007), whether the first (before the repeated evaluations) and second (after the repeated evaluations) aesthetic evaluations will differ in a manner that would be expected if the aesthetic sense were adaptive. If the first evaluation is based on the past experiences, it will rely on existing standards of evaluation and will show the typical positive response to familiar and low innovative materials (Carbon & Leder, 2005; Zajonc, 1968). On the other hand, the second evaluation should be based on recent experience, and would thus depend on the nature of recently performed evaluations.

Aesthetic appreciation relies on a complex multi-dimensional semantic concept that is comprised of a number of dimensions (Faerber, et al., 2010). To capture changes beyond attractiveness, we also included a measure of interestingness, as interestingness might even be more sensitive novel and challenging materials (Jakesch & Leder, 2009; Silvia, 2005). We also used two additional scales that addressed the expression of two additional components related to preference. These two scales are also oriented more towards action. Situational demands might affect an action-related component, which in the case of a consumer products, would be reflected in the wish to own (cf. Kirmani, Sood, & Bridges, 1999; Moreau & Herd, 2010). Thus, in order to include variations of preference measures, we also asked how much participants wish to own a particular design, under the assumption of (a) unlimited resources, or (b) under more realistic restricted conditions. The former refers to judgments without restrictions, and could favor a more aesthetic orientation. In contrast, the latter rather devalues aesthetic orientation.

A second aspect of the present study was concerned with the longer-term consequences of situational adaptations. In order to capture long-term adaptations and possible changes in the evaluation structure, we tested all participants in a multiple test-retest design, twice on identical measures with a one-week break. This reveals whether the effects of the situational context are long lasting, or whether they are more indicative of short-term adaptations. A comparison of the first ratings in both conditions (first and after a week) should indicate the long-term stability of danger- or fascination-related experiences. If the danger-related evaluations elicit negative affect or even fear, and if fear consolidates experiences strongly in memory, then changes in evaluations in this condition might be more persistent; consequently changes in this condition might still be observable after a week. Similar effects might also be found in the fascination condition. Because of the special effects of fear on human memory, changes in aesthetic evaluations in the fascination condition might have less temporal stability. Therefore, such differences between the two conditions would be evidence that our attitudes are strongly influenced by negative, fear-related experiences; and would be further evidence for the special influence of fear on memory (LeBar & Cabeza, 2006; LeDoux, 2000).

Method

Participants

Fifty-one undergraduate students of the University of Vienna participated for course credit. Twenty-seven (19 women and 8 men; mean age = 22.0) took part in the *Danger* condition, and 24 participants (17 women and 7 men; mean age = 21.6) took part in the *Fascination* condition. All participants had normal or corrected-to-normal vision.

Apparatus and Stimuli

The stimuli consisted of 18 photo-like images of artificial car-interiors sized to 800 x 513 pixels, and presented on a 17-inch Apple eMac CRT monitor with a resolution of 1024 x 768 pixels. The stimuli had been generated using Adobe Photoshop 7.0. According to pre-tests, these varied systematically on innovativeness (low, high). In order to create a sufficiently large sample, they also varied on complexity (low, medium, high), and curvature (low, medium, high). The three dimensions were fully balanced and their different levels were validated by several pre-studies. Importantly, in contrast to the line-drawing versions used in Leder and Carbon (2005), the stimuli used in the present study consisted of grayscale, photographic like versions of car interiors.

Procedure

The experiment consisted of two testing sessions that were separated by a one-week break. Each session consisted of three parts. The three parts were: Test-time 1 (T1), evaluation phase, and Test-time 2 (T2). After one week, there were three additional parts: Test-time 3 (T3), again, an evaluation phase, and Test-time 4 (T4). In T1, the set of stimuli was evaluated block-wise according to the following variables: *attractiveness*, *innovativeness*, *interestingness*, *owning interest unlimited*, and *owning interest limited*. All scales in the study were seven-point Likert scales (1 = least significant, 7 = most significant). For each scale, the stimuli were presented in randomized order, and the rating tasks were self-paced. The initial ratings (T1) were immediately followed by the evaluation phase as in Carbon and Leder (2005). Participants rated the stimuli on 11 different scales (the order was randomized for each participant). The types of scales were specific to each of the conditions, emphasizing possible dangers and risks, and negative aspects of usability in the *Danger* condition, and emphasizing the fascinating, novel and stimulating aspects of the designs in the *Fascination* condition[1].

The procedures for T1, T2, T3, and T4 were the same. Participants were instructed to use the full range of the scale if possible, and to respond spontaneously to the questions. Trials were presented using PsyScope 1.25 PPC (Cohen, MacWhinney, Flatt, & Provost, 1993). All participants were tested individually. After a one-week break, participants were tested again using the same procedures as in session 1.

Results

We examined the effects of variation in the evaluation phase on attractiveness. Attractiveness ratings were sampled over participants separately for highly and low innovative stimuli, with the four different times as within-sample measures, and the two types of evaluations (stressing danger of or fascination for design) as between conditions. Figure 1 shows the effects of changes in attractiveness, sampled over the two levels of innovation at T1 and T2, T3 and T4, for the two different situational conditions, *Danger* (top) or *Fascination* (bottom). Results indicated an interaction between innovativeness level and time but only in the *Fascination* condition.

[insert Figure 1 about here]

After the evaluation phase, attractiveness of highly innovative stimuli increased while attractiveness of low innovative stimuli decreased, but was not significantly different from T1. Moreover, the mean ratings of attractiveness in the *Fascination* condition after the one-week break interval showed an interesting pattern: while highly innovative stimuli started at a similar level as in T1, the low innovative stimuli had lost attractiveness from T1 to T3, and were evaluated in T3 as in T2. The pattern of results in the *Danger* condition was very different: while the attractiveness of high and low innovative stimuli differed in T1 as in the *Fascination* condition, after evaluations in T2, attractiveness significantly increased for both levels of innovativeness. This appears to be mere exposure-like effect (Zajonc, 1968), in that repeated evaluations generally increased attractiveness. After a one-week break, both types of stimuli started at similar levels as in T2. However, the second evaluation had no effect on attractiveness at T4, evaluations remained as in T3.

A mixed-design analysis of variance (ANOVA) was conducted with time (1, 2, 3, and 4) and innovation (low, high) as within-subject factors, condition (*Danger, Fascination*) as between-subject factors, and ratings of attractiveness as dependent variable. Results revealed a significant effect of time, F (3, 147) = 3.90, p<.05, η_p^2 = .07. There were significant interactions between time and situational condition, F (3, 147) = 3.70, p < .05, η_p^2 = .70; and among time, innovation, and condition, F (3, 147) = 3.49, p<.05, η_p^2 =.67. No other effects were significant.

To further explore these interactions, we performed separate analyses for block 1 (T1 and T2) and block 2 (T3 and T4), which were separated by a one-week delay. For the first block, we conducted a mixed-design ANOVA with time (T1 and T2) and innovation (low, high) as within subject factors, condition (*Danger, Fascination*) as between-subject factor, and attractiveness as dependent variable. Results showed significant effects of time, F (1, 49) = 6.87, p<.05, η_p^2 = .12 and innovation, F (1, 49) = 4.59, p<.05, η_p^2 = .09. There was also a significant three-way interaction among time, innovation and condition, F (1, 49) = 5.33, p<.05, η_p^2 =.10, but no other significant effects. The same analysis for T3 and T4 showed a significant interaction between time and innovation, F (1, 49) = 6.11, p < .05, η_p^2 = .11. As revealed by Figure 1 (lower right), this effect is due to the lack of difference between highly and low innovative materials at T3, but no other significant effects.

Regarding the long-term effects of changes after evaluation we analyzed differences regarding the temporal stability of danger- or fascination-related experiences, a week after T2 at T3. As can be seen in Figure 1, evaluations of high and low innovative designs after a week in the danger condition started at the same level as after the repeated evaluations. The change in appreciation due to the first phase of evaluations remained.

Different results were obtained in the fascination condition. The pattern of results resembles the first evaluation, with low innovative stimuli being slightly higher in attractiveness. However, data in this condition before and after the one-week break looked as if the low innovative designs had temporal stability, while the high innovative designs lost the increase in attractiveness previously gained through repeated evaluations. We confirmed these interpretations with separate analyses for the fascination and danger conditions, in which we separately analyzed T1 and T3, and T2 and T3.

In the danger condition, the comparison between T2 and T3 revealed that there was no effect of time, but as expected, there was an effect of innovation, F(1, 26) = 4.39,

$p < .05$, $\eta_p^2 = .15$. In the fascination condition, there was only an effect of time, $F(1,23) = 6.89$, $p < .01$, $\eta_p^2 = .23$. No other effect was found. On the other hand, the analyses of T1 and T3 revealed no effect in the fascination condition. However, in accordance with the above interpretation, there was an effect of time, $F(1,26) = 6.43$, $p < .05$, $\eta_p^2 = .20$, and innovation, $F(1,26) = 7.26$, p $< .05$, $\eta_p^2 = .22$, in the danger condition., but no other effect. These results show that changes were longer lasting in the context of danger.

Concerning the perceived innovativeness, an ANOVA with time (1, 2, 3, and 4) and innovation (low, high) as within-subject factors, and condition (*Danger, Fascination*) as between subject-factor revealed a significant effect of innovativeness, F (1, 49) = 47.02, $p < .01$, $\eta_p^2 = .49$, but no other effects. Thus, innovative designs were seen as significantly more innovative in all conditions, and this did not change over time.

The analysis of interestingness data showed a significant effect of innovativeness, F (1, 49) = 31.06, $p < .01$, $\eta_p^2 = .39$, with highly innovative materials being seen as more interesting. There were no other significant effects. Analysis of the owning interest unlimited data revealed a significant effect of time, F (3, 147) = 4.12, $p < .01$, $\eta_p^2 = .08$, indicating a slight increase over time for the variable. Analysis of the owning interest limited data showed a significant effect of innovativeness, F (1, 49) = 30.74, $p < .01$, $\eta_p^2 = .39$. No other effects were significant.

Discussion

We investigated aesthetic appreciation's dependence on situational contexts. Using car interior designs of varying levels of innovation, we compared two kinds of situational contexts, stressing either the dangerous or the fascinating aspects of car interior designs. We observed mere exposure-like effects for both stimulus classes in the

Danger condition over time. In contrast, in the *Fascination* condition, we found cross-over interactions for low versus highly innovative materials in both sessions (T1 vs. T2 and T3 vs. T4). Importantly, the analysis of innovativeness evaluations showed that changes in appreciation were not due to changes in perceived innovativeness.

Previous studies have shown that the appreciation of highly innovative materials increased after explicit evaluations, while the appreciation of low innovative materials decreased (Carbon & Leder, 2005). Our study demonstrated the importance of situational context on such dynamics of aesthetic appreciation. We demonstrated the critical role of the quality of evaluations. In T1, in both conditions, low innovative materials were preferred over highly innovative materials. However, aesthetic appreciation developed differently over time depending on situational context. When the participants evaluated the materials in terms of dangers, risks, and negative aspects of usability, attractiveness ratings for both innovativeness classes developed in a parallel manner from T1 to T4, thus showing a mere exposure effect. We observed the highest increase in attractiveness between T1 and T2. From T3 to T4, the mere exposure effect seemed to have reached a level of saturation, as no further changes were observed. This is consistent with findings that the effects of mere exposure are strongest up to 10 repetitions (Bornstein, 1989). Thus, although participants in the *Danger* condition clearly differentiated between low and highly innovative materials, they did not develop differential aesthetic appreciation due to the evaluations. Instead, they preferred low innovative materials from the beginning, and this preference persisted over time.

In the *Fascination* condition, low innovative materials were also preferred in T1. However, because the materials were evaluated in terms of fascination, novelty, and stimulation, attractiveness ratings for the two stimulus classes developed very differently, and resulted in two cross-over interactions between innovativeness and time. The appreciation of highly innovative materials increased from T1 to T2, and again from T3 to T4. In contrast, the appreciation of low innovative materials did not change. In T3, again, the highly innovative materials started from about the same level as in T1. This indicated that the increase in the attractiveness of highly innovative materials did not last a week—attractiveness actually decreased. Although we did not directly measure emotional changes due to the different kinds of evaluation, the findings are in accordance with the assumption that fear-related processing yields sustainable effects in memory (LeBar & Cabeza, 2006). On the other hand, when danger and fear are not activated or emphasized, then the positive aspects of innovation show their effects. Thus, some aesthetic experiences benefit from positive, hedonic situations (Leder et al., in press). The differences between the two conditions clearly support the assumption of a situation-sensitive and adaptive aesthetic sense. This finding is consistent with situated cognition approaches, wherein behavior is contextualized within the actual situation in which they occur (Smith & Semin, 2004).

Regarding the temporal stability of changes in aesthetic appreciation, the data also show that attitudes toward innovation endured the one-week break after the danger evaluations. This is in accordance with the assumption that danger- and fear-related processes might have a special role in memory consolidation (LeBar & Cabeza, 2006). Although this is biologically plausible, further research on emotion-based consolidation processes is needed, particularly regarding their role in more applied contexts, where positive emotional states such as joy, interest, and pride are in the fore (Desmet, 2008).

Varying situational context through the use of different evaluation dimensions had strong effects on the attractiveness evaluations over time. Being directed towards the potentially dangerous or fascinating elements of objects might result in the selective consideration of various aspects of the objects. Situational influences are presumably distinct for ambiguous objects, and therefore particularly salient for innovative objects, which could be seen as positive and fascinating, or negative, uncertain, and dangerous. This also has practical implications for the introduction of innovative products: a strong emphasis on the fascinating factors of a product might be an important ingredient for its success. This emphasis can be accomplished through placing the product into a corresponding context. Marketing strategists should consider these findings.

In the present study, significant changes according to time, level of innovation, and situational contexts were found only for the attractiveness scale, and not for any of the other scales used in the test blocks. While measures of interestingness and owning interest showed sensitivity to innovation, they did not vary with other variables. Thus attractiveness revealed some advantage due to this sensitivity. We found differential effects of repeated evaluation after one week. Future studies should consider extending the time range to those reflecting production cycles that span months or even years (Carbon, 2010; Carbon & Leder, 2007).

Moreover, future studies should investigate if the appreciation of innovativeness is also sensitive to other kinds of situational demands. Innovation is ambiguous, and involves familiarity and novelty. Therefore, its appreciation might be particularly sensitive to other context-inherent features that either favor novel or familiar features. For example, the effect of novelty might generalize and result in particularly strong preferences for innovation in situations when perceivers become tired of repetitive and highly familiar tasks.

To conclude, the present study revealed that the aesthetic appreciation of innovation, which is often seen as a driving force in product design, is sensitive to situational contexts. When the situation demanded caution (*Danger* condition), mere exposure-type effects for both stimulus classes were shown, and the changes were enduring. However, when the situation stressed fascination, challenge, and novelty (*Fascination* condition), there was a cross-over interaction between time and innovativeness for attractiveness ratings. These results explicitly show that aesthetic appreciation is adaptive and context-dependent.

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Author Note

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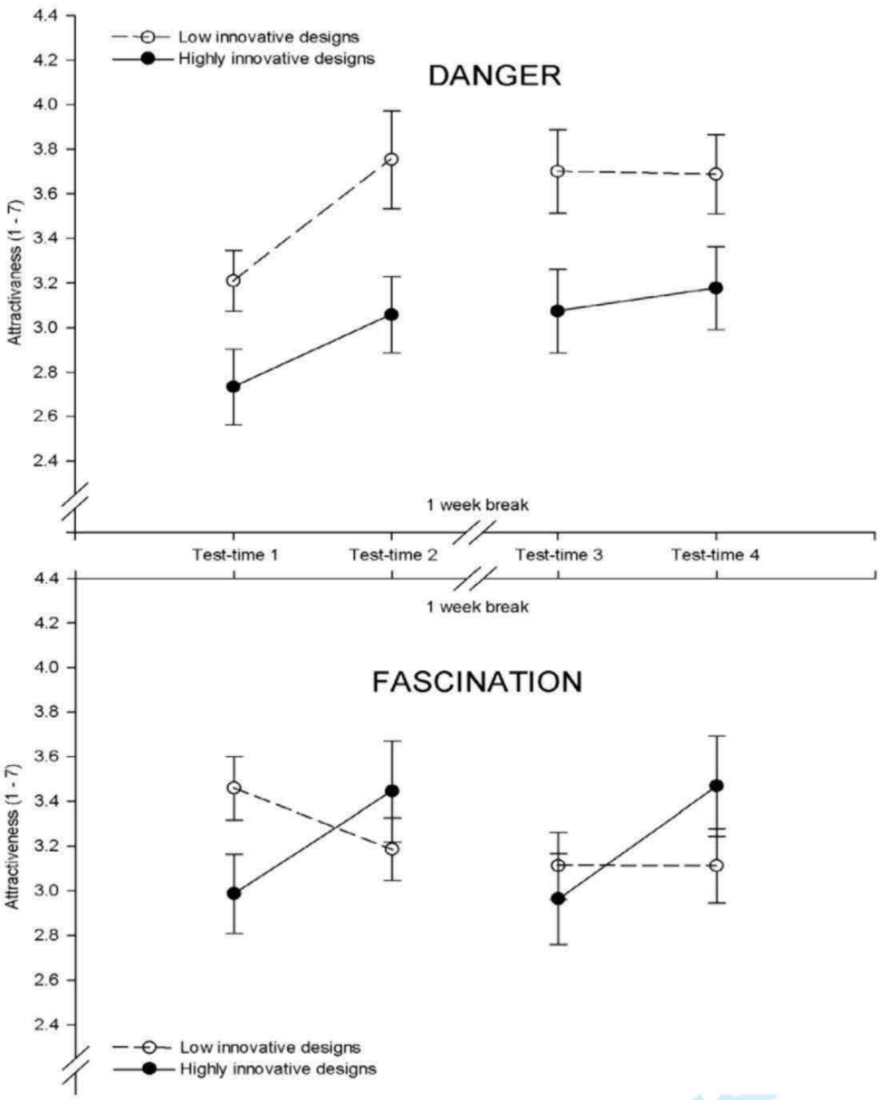
Footnotes

[1] Scales in the *Danger* condition consisted of the following attributes: dangerous, breakdown probable, error-prone, unsafe, risky, user unfriendly, difficult to get used to, exhausting, unclear, inconvenient, and inexpedient. Scales in the *Fascination* condition were exciting, arousing, thrilling, stimulating, surprising, groundbreaking, progressive, novel, fascinating, ingenious, and terrific.

Figure Caption

Figure 1. Interaction between Time and Innovativeness for attractiveness ratings at Test-time 1 (T1), at T2, T3, and T4: Averaged mean values with one standard error of the mean are indicated for low and highly innovative designs: condition *Danger* (upper) and condition *Fascination* (below).


Low innovative designs
Highly innovative designs
DANGER
Attractivaness (1 - 7)
4.4
4.2
4.0
3.8
3.6
3.4
3.2
3.0
2.8
2.6
2.4
1 week break
Test-time 1
Test-time 2
Test-time 3
Test-time 4
1 week break
FASCINATION
Attractiveness (1 - 7)
4.4
4.2
4.0
3.8
3.6
3.4
3.2
3.0
2.8
2.6
2.4
Low innovative designs
Highly innovative designs

Critical Reflection

In Project III we induced the situational contexts "danger" and "fascination" to observe their influence on the dynamics of AA for low and highly innovative car interiors. By including an experimental design with four test times containing two RET phases we found differential effects for both conditions.

The conditions implemented in the experiment of Project III were labelled "danger" and "fascination". However, this labelling could be misleading, since the attributes used in the conditions were diversified. The condition "danger" included the attributes: dangerous, breakdown probable, error-prone, unsafe, risky, user unfriendly, difficult to get used to, exhausting, unclear, inconvenient, and inexpedient. Attributes such as unclear or inconvenient might not activate any schema associated to danger. Similarly, in the fascination condition using exciting, arousing, thrilling, stimulating, surprising, ground-breaking, progressive, novel, fascinating, ingenious, and terrific, the attribute novel might at least not necessarily activate the schema fascination. To improve the research stream developed in Project III in this regard the validity and/or internal consistency of the used attributes should be reassessed.

In Project I we found the strongest effect when multiple concepts had been primed. In line with this result a multiple manipulation of "negative" or "positive" schemas could increase the situational context; importantly the quantity of schemas should be the same for both conditions to enable a comparison. The attributes of Project III might prime cognitive schemas as well as emotions, which should be experimentally checked in future studies. The model of aesthetic appreciation of arts (Leder, Belke, Oeberst, & Augustin, 2004) points out the importance of cognitive as well as emotional aspects influencing the aesthetic appreciation, thus in further studies a combination of e.g. positive cognitive and emotional aspects versus negative ones could be employed. Another interesting option could be the inducing of positive or negative emotions. Although the exact kind of manipulation in this project remains to be uncovered, it showed that changes in AA are susceptible to situational contexts, which has an important impact on consumer research and marketing.

IV. What changes in changing design appreciation? Dynamic interplay of variables regarding aesthetic appreciation over time

Motivation

In Project I we assessed the aesthetic appreciation (AA) as a construct through the variables: attractiveness, arousal, interestingness, valence, boredom and innovativeness. As mentioned in the critical reflection of Project I it is still unclear how these variables and their networks are inter-related and which variables are of specific importance for AA. Liking and/or the attractiveness of objects might have a special status, since it was used frequently in aesthetic research as the main variable for operationalising aesthetic appreciation (Faerber, et al., 2010). To better understand the construct of AA and the interplay of its variables as implemented in Project I, we observed in Project IV how those variables correlate with attractiveness and which could probably predict future attractiveness ratings—a research question being of major relevance for consumer research.

To take future perception of the stimulus material into account, we again included the RET procedure to enable the observation of these correlations over time. We further aimed to shed light on inter-individual differences in respect of the variable’s interplay and included boredom as an independent variable to check for possible effects of increased boredom (Perkins & Hill, 1985) on the relation of the mentioned variables. Arguing on a stimulus level, Berlyne (1970) discussed boredom as a limiting factor for the mere exposure effect. He proposed low complexity and the lack of novelty of stimuli leading to low arousal as key factors for boredom. Because stimuli which induce a medium arousal level are preferred the most, too low and too high arousal levels should yield low hedonic values. Bornstein et al. (1989) already extended the stimulus-related approach by integrating the additional personality factor boredom-proneness, inspiring us to further abstract from the mere stimulus level towards situational factors. In Project IV we analysed the limiting factors of boredom for low versus highly innovative stimuli in dependence of the presentation time of stimuli evoking different levels of boredom as situational variable.

Original Paper

Running head: AESTHETIC APPRECIATION

What changes in changing design appreciation? Dynamic interplay of variables regarding aesthetic appreciation over time

Gernot Gerger[1], Helmut Leder[1*], Stella J. Faerber[2] and Claus-Christian Carbon[2]

[1] *Faculty of Psychology, University of Vienna, Vienna, Austria*

[2] *Department of General Psychology and Methodology, University of Bamberg, Bamberg, Germany*

* Corresponding author: Helmut Leder, University of Vienna, Faculty of Psychology, Liebiggasse 5, 1010 Vienna, Austria, Email: helmut.leder@univie.ac.at, Phone: +431 4277 47821

Summary.— Aesthetic appreciation may change over time as seen in phenomena such as Zeitgeist or fashion trends. To understand these changes, we investigated the dynamics of aesthetic appreciation through the dynamic interplay between the variables attractiveness, arousal, interestingness, valence, boredom, and innovativeness to cover the differential aspects of aesthetic appreciation. Investigating the evaluation of design objects we also varied the level of boredom as a situational variable. All variables were measured twice, before and after a repeated evaluation phase (Carbon & Leder, 2005). High consistency of the correlations among these variables across participants would be evidence for an underlying general variable structure of aesthetic evaluation. Patterns of correlations between predictors and attractiveness were indeed similar across participants, but after the evaluation phase consistency was higher, independent of level of boredom. This increasing consistency supports the interpretation that through repeated evaluations, a comparison standard had developed.

144 words – 150 allowed

Keywords: attractiveness, aesthetic appreciation, dynamics, predictor, mere exposure, RET procedure, design evaluation.

An aesthetically appealing product design is a key element that distinguishes between winners and losers in consumer markets (Liu, 2003). This is especially the case in technically advanced industries. E.g., in the car industry the technical quality of a product is often taken for granted and consumers' decisions are increasingly based on the aesthetic appreciation of car designs (Hekkert & Leder, 2008). Also, the attractiveness of a product's design also predicts general user satisfaction (Hassenzahl, 2004). In this study we were interested in a series of research questions emerged in recent years: 1) how five variables (arousal, interestingness, valence, boredom, and innovativeness) identified as key variables for predicting aesthetic appreciation are indeed correlated with attractiveness.2) How this complex relationship between these variables changes over time and by elaborating the material. 3) how consistent the evaluations on aesthetic dimensions are across persons. 4) What impact the variable boredom state has on aesthetic appreciation, particularly when highly and low innovative material has to be evaluated in the course of a long test-retest design with intermediate elaboration of the material.

Attractiveness evaluations are not always stable, they can change over time as a result of processes such as habituation and familiarity (Zajonc, 1968) or active elaboration (Carbon & Leder, 2005) and deposit in phenomena such as Zeitgeist or fashion trends (Carbon, 2010). An example of the latter is the Renault Megane with its innovative rear end, which was introduced to the market in 2002, but then was not appreciated. However, after the car had been on the market for some time, its design was eventually found attractive. Such changes in attractiveness for car designs were also shown experimentally (Carbon, Hutzler, & Minge, 2006; Carbon, Michael, & Leder, 2008; Faerber, Leder, Gerger, & Carbon, 2010) and historically (Carbon, 2010).

However, attractiveness is only a key variable for aesthetic appreciation and cannot cover all aspects of aesthetic appreciation (Faerber, et al, 2010). Aesthetic appreciation can be understood as a complex semantic network, in which different dimensions are involved. This network is active during aesthetic perception and evaluations. Faerber et al (2010) showed the connection of six important variables for aesthetic appreciation (attractiveness, arousal, interestingness, valence, boredom, and innovativeness), which they derived from literature. Apart from attractiveness the arousal level of an object is important for the aesthetic appreciation. Arousal is one of the main variables in Berlyne's (1970a) psychobiological theory of appreciation; he claimed that stimuli with medium levels of arousal are found most attractive (see also Berlyne, 1970b; Saklofske, 1975). Arousal is influenced by variables such as novelty, uncertainty, and in particular, complexity. These results are not unambiguous, as empirical studies which examined arousal by varying complexity have shown that high complexity (and presumably high arousal) was found most attractive (Martindale, Moore, & Borkum, 1990; Tinio & Leder, 2009). Interestingness also has a great influence on attractiveness (Bornstein, Kale, & Cornell, 1990; Silvia, 2005). According to appraisal theories (see Silvia, 2005), it is related to engagement and coping (Leder, Belke, Oeberst & Augustin, 2004; Millis, 2001). Valence is besides arousal one of the basic dimensions of emotions (e.g., Osgood, 1966; Russel & Mehrabian, 1977). It has been suggested that the "what is beautiful is good (positive)" stereotype (Dion, Berscheid, & Walster, 1972; Eagly, Makhijani, Ashmore, & Longo, 1991) contributes to a positive correlation between valence and attractiveness. Furthermore, we implemented boredom as it is a limiting factor for aesthetic appreciation (Bornstein, 1989; Bornstein et al., 1990). Innovativeness is an essential variable in product design, and it is known to affect the dynamics of attractiveness. Innovativeness, defined as "originality by virtue of introducing new ideas"

(Carbon & Leder, 2005, p. 587), should not be confused with novelty , as innovativeness in contrast to novelty, retains its properties rather stable over time (Carbon & Leder, 2005). Innovative designs are often initially not liked (Lee, 2001; Moulson & Sproles, 2000; Robinson & Elias, 2005; Zajonc, 2001), but following repeated exposure and evaluation are often preferred thereafter (Carbon & Leder, 2005; Carbon, Hutzler & Minge, 2006; Faerber et al., 2010). Together these six variables cover very important aspects of aesthetic appreciation.

Until now it is unclear in which relationship these six important variables of aesthetic appreciation stand, which of them could predict the key variable attractiveness or - even more important - which one could predict future attractiveness. Uncovering these relations would give further impact on how the semantic network of aesthetic appreciation is tied. Also, as mentioned above, the attractiveness of objects underlies clear dynamics over time. Consequently, to test for the predictive power of these variables for attractiveness, the characteristic changes of the whole interactive pattern of these variables could be helpful to prevent design failures. So, we were interested in the whole pattern of the six variables of aesthetic appreciation before and after changes over time and especially the interconnection of the mentioned variables with the key variable attractiveness.

Regarding the aesthetic appreciation changes in the appreciation due to familiarization may be expected. Thus, in accordance with the mere exposure effect, correlations with valence could increase over time as a consequence of familiarization (Zajonc, 1968). If boredom reduces attractiveness, then we might find higher correlations between attractiveness and boredom after repeated evaluations. On the other hand, habituation could cause correlations between arousal and attractiveness to become weaker after repeated evaluations (Berlyne, 1970). Regarding innovativeness, Carbon and Leder (2005, see also Carbon et al., 2006) found that the appreciation of innovative car interiors increased after repeated evaluations while judgments of innovativeness remained rather stable. Therefore, we expect higher correlations between attractiveness and innovativeness after repeated evaluations. Changes in the correlations between interest and attractiveness may be explained by appraisal processes. Silvia (2005) argued that interest is determined by two sequential appraisal mechanisms: the first appraises something as new, uncertain, complex or ambiguous; the second appraises coping potential. Thus, after having appraised something as new, people try to cope with the stimulus by resolving ambiguity and assigning meaning. Such processes have been assumed to increase aesthetic appreciation (Leder et al., 2004; Millis, 2001). Because interestingness reflects the tendency to resolve the ambiguity of new and complex stimuli, the correlations between interestingness and attractiveness ratings should increase if the stimuli become familiar following several evaluations.

Beyond the interplay of the variables of aesthetic appreciation on a mean level across participants we were also interested in the within participants variations. Jacobsen and Höfel (2002) measured the attractiveness of abstracts pattern. They compared individual and group regressions models and found that only about half of the participants were adequately represented by the group model. Therefore we analyzed the consistency of the ratings within the ratings of attractiveness and the other five variables covering aesthetic appreciation. In order to determine whether the relationships among these variables are consistent, we performed analyses at both the individual and group levels. If attractiveness judgments are governed by individual and general factors that depend on individual judgment strategies, then correlations with attractiveness should be different amongst perceivers. However, if these correlations are consistent across perceivers, then it can be concluded that the variables represent a general underlying structure that determines aesthetic appreciation. Because consumer products are sold to individuals, it is important to understand the nature of individual judgment strategies. Thus, comparing individual correlations and group mean correlations should determine whether variables are related to attractiveness generally or individually.

Furthermore, as mentioned above, boredom can be a limiting factor for aesthetic appreciation, on the one side as an integral component of the stimulus itself, but also on the other side as a situational factor. In the latter case it could influence the correlations between variables. If individual differences in judgment strategies become more pronounced following repeated evaluations, then we would expect a decrease in the absolute size of correlations across all variables over time. On the other hand, if a common comparison standard for the stimuli develops following repeated evaluations, and as a consequence, judgments become clearer, then the correlations across all variables would increase. Boredom, as a situational variable, has also been discussed as a general factor that influences cognitive strategies. Little is known about how boredom influences evaluations. Perkins and Hill (1985) hypothesized that a high state of boredom would alter judgment strategies in general because bored participants use limited cognitive strategies and consequently make fewer and less differentiated distinctions among stimuli. This would mean that higher states of boredom would, in general, weaken the pattern of correlations across the variables. To test this hypothesis directly, we included boredom not only as predictor variable, but also as an independent variable implemented by two different presentation durations. We hypothesized that a prolonged exposure to a stimulus results in higher boredom, which could reduce attractiveness (Berlyne, 1970a; Leventhal, Martin, Seals, Tapia, & Rehm, 2007; Stang, 1974).

We implemented an experiment with two conditions (short and long presentation duration) and examined the key variable attractiveness together with the five predictor variables:

arousal, interestingness, valence, boredom, and innovativeness to investigate aesthetic appreciation. The manner in which these variables correlate should shed light on the complexities and underlying structure that determine the aesthetic appreciation of design. To trigger dynamics in aesthetic appreciation we implemented a test-retest design with intermediate Repeated Evaluation Technique (RET, Carbon & Leder, 2005). Within this technique the stimulus material is elaborated due to different attributes, which induces dynamics in aesthetic appreciation in a controlled way. Testing all variables twice should also reveal which variables over time gain in predictive strength in terms of attractiveness ratings. A relative gain in predictive strength would be indicated if the correlation between a single variable and attractiveness during the first evaluation block is smaller than with the attractiveness evaluation after the repeated evaluation block. Such a variable which at the beginning better predicts future attractiveness (in the future after extensive evaluations) would be particularly interesting because this would shed light on the factors that cause changes in attractiveness. Within this design we were also interested in the relationships among these variables were analyzed on both individual and group mean levels.

Methods

Participants

Forty-eight students (34 female, 14 male) from the University of Vienna participated for partial course credit. The mean age of the participants was 22.4 (range: 19 to 39 years).

Stimuli and Apparatus

Eighteen photorealistic car interiors were used in this study (as in Färber et al., 2010). According to pre-studies, the stimuli systematically varied on two levels of innovativeness. The experiment was run on Macintosh eMac computers using PsyScope 1.25 PPC (Cohen, MacWhinney, Flatt, & Provost, 1993). The stimuli were presented at a size of 500 x 321 pixels with a screen resolution of 1024 x 768 pixels.

Procedure

The experiment consisted of three blocks. In block 1 the stimuli were evaluated on attractiveness and the five predictor variables (T1), in block 2 they were evaluated on different attributes (RET block), and in block 3 stimuli were evaluated on attractiveness and the five predictors, again (T2). In order to avoid anchor effects, the experiment began with a preview phase in which the participants viewed the stimuli (without rating) by simultaneously showing one half of the items with pseudo-randomized position on the screen for six seconds followed by the other half of the items for another six seconds.

In block 1 and 3 (T1 and T2) participants evaluated all 18 car interior designs one after the other on the six variables in the following order: attractiveness, arousal, interestingness, valence, boredom, and innovativeness and were asked e.g. "How attractive is the design". Participants used a 7-point Likert scale (1= least significant, 7= most significant) to indicate their ratings.

In block 2 (RET block) the participants evaluated all car interiors on 22 different scales. The scales were chosen according to results of a pre-study in which 55 (36 female) participants rated a large number of attributes, fitted to describe product designs, for their arousal and valence. For the present study 22 attributes, which had been rated high on arousal and valence (half positive, half negative) were selected. Thus, in the RET block the participants rated the stimuli on the scales due to a 7-point Likert scale (1= least significant, 7= most significant): stress inducing (original German term used in the experiment: stressig), disgusting (ekelhaft), repulsive (abstoßend), gruesome (grausig), deterrent (abschreckend), bothersome (nervend), idiotic (idiotisch), daft (bescheuert), ugly (hässlich), damn stupid (saublöde), ridiculous (lächerlich), fantastic (fantastisch), passionate (leidenschaftlich), terrific (grandios), fascinating (faszinierend), revolutionary (revolutionär), desirable (begehrenswert), outstanding (hervorragend), impressive (beeindruckend), extraordinary (außergewöhnlich), unique (einzigartig), and dynamic (dynamisch). The presentation order of the scales was randomized across participants. After that block 3 immediately followed (see above). The presentation order of the car interior designs was randomized for each variable and all scales of the RET block.

To induce two levels of boredom states, half of the participants were assigned to a short condition where the presentation duration for each stimulus was 2.6 seconds. The other half was assigned to a long condition, in which the presentation duration was 5.0 seconds. The short presentation duration resembles the mean rating time of the same stimulus material obtained from previous undisclosed studies, thus, should on average be an adequate presentation duration for the implemented ratings in all blocks. In contrast, five seconds were chosen to induce boredom, or at least higher degrees of boredom. To validate whether this manipulation of boredom was successful, immediately after T2, participants indicated how boring the experiment was. For this rating, they also used a 7-point Likert scale (1= least significant, 7= most significant)

Results

In order to analyze the correlational patterns between attractiveness and each predictor variable as well as differences in these patterns across participants, we calculated Pearson correlations on a subject basis. Correlations were calculated for each of the predictors (arousing, interesting, valence, boredom, and innovativeness) and attractiveness per person, separately for T1 (T1 predictors x T1 attractive) and for T2 (T2 predictors x T2 attractive). To identify the predictor variables, which are able to predict the attractiveness ratings in T2 and thus, hold the ability to predict future attractiveness ratings, T1 predictors and T2 attractive ratings were correlated. All correlations were Fisher z-transformed for the statistical tests (Bortz, 1993, p. 201) and all mean correlations reported are retransformed Fisher-z values averaged across participants.

Effect of boredom state

We examined if boredom had an effect on the pattern of correlations. The post-experimental boredom ratings revealed that participants rated the long condition ($M = 5.8$) significantly more boring than the short condition ($M = 4.3$), $t(45) = 3.79$, $p<.01$, $d = 1.13$. However, this higher state of boredom in the longer condition did not have an effect on the overall correlational pattern. This was revealed by three separate repeated measurement ANOVAs for the respective test blocks (T1 predictors x T1 attractive ratings, T2 predictors x T2 attractive ratings, and T1 predictors x T2 attractive ratings) with condition (long, short) as between-subjects variable and correlations of the five predictors as within-subjects variable. The analyses revealed neither significant effects for condition nor for the interaction between condition and correlations (all p's > 0.28). Therefore, data for further analyses were collapsed over the short and long conditions.

Analyses of the correlations on individual and group levels

We analyzed the correlations based on the individual ratings for the T1 and T2 predictor variables and attractiveness ratings. For almost all participants (46 out of 48), there was a positive correlation between arousal and attractiveness in T1 and T2. The mean correlation across participants was $r(48)=.59$ in T1, and increased to $r(48)=.76$ in T2. Regarding boredom and attractiveness ratings, 36 participants showed the expected negative correlation in T1. This number increased to 39 participants in T2. This was again reflected in the mean correlations with $r(48)=-.33$ in T1 and $r(48)=-.56$ in T2. Innovativeness and attractiveness ratings correlated positively for most of the participants in T1 (32 out of 48 participants). However, the mean correlation in T1, $r(48)=.21$, was the smallest compared to the other predictors. Importantly and in accordance with our predictions, the correlations between attractiveness and innovativeness increased in T2, $r(48)=.54$. In addition, 41 of the 48 participants showed a positive correlation in T2. Interestingness and valence ratings showed the expected pattern of positive correlations with attractiveness. In T1, 40 participants showed a positive correlation between interestingness and attractiveness ratings; this number increased to 46 participants in T2. The respective mean correlations were $r(48)=.41$ in T1 and $r(48)=.66$ in T2. For valence and attractiveness ratings, 46 participants showed positive correlations in T1 and all 48 participants in T2, with $r(48)=.53$ in T1, and $r(48)=.75$ in T2.

The descriptive analyses showed a clear pattern. Correlations on both individual and group levels indicate that all predictors were related to attractiveness. Arousal had the highest predictive power (and was most consistent across participants), closely followed by valence, interestingness, and boredom. Innovativeness had the lowest predictive power. Especially in T2, after all of the stimuli had already been evaluated several times, all correlations became stronger. Thus, the high degree of coherence of the pattern of correlations regarding the individual and mean correlations suggests that the predictors are rather universally powerful for attractiveness judgments.

Changes in the pattern of correlations between T1 and T2

In order to analyze changes over time, we performed a 5 (correlations – Fishers z values - between boredom, arousal, valence, innovativeness, interestingness, x attractiveness ratings) x 2 (test blocks, T1 and T2) repeated-measurement ANOVA. In case of violations of sphericity Greenhouse Geisser corrections were applied. These can be seen in the adjusted degrees in freedom. Because we were interested in absolute changes in the correlations, the negative signs of the boredom x attractiveness correlations were reversed. This analysis revealed significant main effects for test block, $F(1, 47) = 34.8$, $p<.01$, $\eta_p^2 = 0.43$, and predictors, $F(3.1, 145.9) = 6.2$, $p<.01$, $\eta_p^2 = 0.36$. Regarding test block, the correlations generally increased from T1 to T2. The main effect of predictors was further explored by post-hoc tests. These revealed significant effects for the arousal and valence correlations; they were both significantly higher than the correlations of all other predictors (all *p*´s < 0.01; Bonferroni adjusted). Innovativeness showed the weakest correlations and was also significantly different from the interestingness correlations ($p < .01$). For exploratory reasons, we further analyzed the significant main effect of time separately for each predictor. These dependent *t*-tests (Bonferroni-adjusted) showed an increase of the correlations for each specific predictor from T1 to T2, and revealed that the absolute size of the effect depended on the predictors [arousal x attractiveness $t(47) = 4.2$, $p <.01$, $d =1.08$; innovativeness x attractiveness $t(47) = -5.2$, $p<.01$, $d=0.97$; interestingness x attractiveness $t(47)=-5.1$, $p <.01$, $d=1.09$; boredom x attractiveness $t(47)=2,7$, $p<.01$, $d= 0.69$; valence x attractiveness $t(47)=-5.6$, $p<.01$, $d= 1.29$]. The effect sizes (adjusted Cohen's *d*) of the dependent measures were calculated according to Formula 3 in Dunlap, Cortina, Vaslow and Burke (1996).

Predictive quality of the variables

To identify the predictors that were particularly sensitive to indicate changes over time, we analyzed correlations between T1 predictors and T1 attractiveness ratings versus T1 predictors and T2 attractiveness ratings. In this analysis, the T1 correlations served as the baseline for indicating changes in the predictive quality of the predictors. A 5 x 2 repeated measurement ANOVA involving predictor correlations and test blocks (T1 versus T2) revealed a main effect of predictors, $F(1.9, 91.4) = 53.5$, $p<.01$, η_p^2 0.53. The main effect of predictors was qualified by an interaction between predictors and test block, $F(2.2,105.2)=3.72$, $p=.023$, $\eta_p^2=0.07$. To explore this interaction, we conducted follow-up dependent t-tests, separately for each specific predictor (e.g., arousal T1 x attractiveness T1 vs. arousal T1 x attractiveness T2; all alpha-values were Bonferroni-adjusted). Only the innovativeness x attractiveness correlations increased significantly when T1 innovativeness ratings were used to predict T2 attractiveness ratings, $t(47)=-2.9$, $p=0.03$, $d=0.51$; see Figure 1. None of the other correlations differed significantly.

[Please insert Figure 1 about here]

Discussion

We examined the relationship between important predictor variables (arousal, boredom, innovativeness, valence, and interestingness) for aesthetic appreciation and the variable attractiveness. Further, we were interested in how this relationship changes following a phase of active elaboration to find out more about the complex pattern of aesthetic appreciation over time and its consistency across participants. We found some consistency in how the predictor variables were related to attractiveness ratings at both the individual and group levels. After repeated evaluations, the relationship became stronger and more consistent as suggested by the increase of correlations showing in the same direction across participants. This suggests that the predictors generally relate to attractiveness and these relations are rather constant across participants. However, group level analyses revealed that there were differences in the absolute strength of the correlations of the predictors. The correlations were strongest for the arousal and valence ratings, weaker for interestingness and boredom ratings, and weakest for innovativeness ratings.

The higher correlations in T2 as compared to T1 suggest the formation of a comparison standard, as a result of the repeated evaluations. In T1, the stimuli were unfamiliar and judgments presumably were therefore based on personal standards rather than on the stimulus set. Through repeated evaluations, participants became accustomed to the stimuli and developed more coherent criteria for evaluating the stimuli. If the formation of a comparison standard caused the higher correlations, then this should be reflected in the effect sizes. And indeed, changes in the correlations between arousal, interestingness, valence, and innovativeness with attractiveness of T1 compared to T2 all led to strong effects above Cohen's $d = 0.8$ (Cohen, 1992). Changes in the correlations between the boredom and attractiveness ratings still resulted in a medium effect size of Cohen's $d = 0.69$. Thus, the results support the assumption that through the evaluations a comparison standard developed. The differences in the effect sizes also serve as evidence that each of the predictors had impact on the correlational patterns.

The highest correlations were found for the arousal and attractiveness ratings. This is in accordance with Martindale et al., (1990), but not with Berlyne's (1974) arousal theory; the latter had predicted rather moderate correlations. Correlations for valence and attractiveness ratings were also high. Valence ratings correlated positively in T1, and this correlation was even higher in T2. This is in accordance with the above explanation that participants followed a "what is beautiful is good (positive)" stereotype (Dion, et al., 1972; Eagly, et al., 1991). Interestingness ratings correlated moderately positively with attractiveness ratings in T1. Silvia (2005) proposed two appraisal mechanisms for interestingness: novelty-complexity and coping potential. Accordingly, interestingness ratings in T1 were presumably triggered by the novelty of the stimuli. However, experiences through repeated evaluations presumably increased the coping potential with novelty (Scherer, 1999). Thus, in T2, much higher correlations were found. These findings thus support explanations based on changes in the appraisal structure of interest. Correlations between boredom and attractiveness were weaker. Boredom ratings correlated negatively in T1, and the correlations increased in T2. This is in line with Berlyne' (1970b) and Stang's (1974) two-factor theory and with previous findings (e.g. Bornstein, et al., 1990; Van den Bergh & Vrana, 1998). According to Stang (1974), two factors determine preference: habituation and tedium (or boredom). Repeated exposure to stimuli will eventually lead to habituation; when boredom sets in, the positive effects of habituation is reduced. Therefore, boredom becomes more important after repeated evaluations. As expected, correlations between innovativeness and attractiveness were weakest at T1, but increased after repeated evaluations. These findings replicate the results of Carbon and Leder (2005) that participants need some time and elaboration to appreciate innovative designs. Interestingly, the predictability of attractiveness through innovativeness increased over time. The T1 innovativeness ratings correlated higher with the T2 than with the T1 attractiveness ratings. Therefore, innovativeness might be a good candidate as a predictor of the development of attractiveness ratings over time. Predicting future attractiveness ratings is especially important for products with long developmental cycles such as cars. For such products, design failures could be quite costly.

The state of boredom had no effect on the pattern of correlations. It could be argued that the effects of boredom might have been present in both conditions because the mean boredom rating was above the midpoint in the short condition (4.3 on a seven-point scale). According to Perkins and Hill's (1985) hypothesis higher states of boredom affect cognitive strategies because people use limited and less differentiated strategies and thus, generally lower correlations in T2 than in T1 would have been expected. This was not supported by the data. Boredom's lack of effect is more in line with the assumption of a formation of a comparison standard.

These results have implications for other fields of psychology. Researchers often avoid extensive stimulus familiarisation because of the fear that boredom constrains the judgment capabilities of the participants; this is not supported by our data. Thus, the fear of constrained judgments due to massive stimulus exposure seems unwarranted.

The current research demonstrated that arousal, interestingness, valence, boredom, and innovativeness are strongly related to evaluations of the attractiveness of an object. The effects of these factors are consistent across and within participants; consistency even increases after repeated evaluations. This increase in correlations suggests that over time and through elaboration, participants formed more stable and reliable judgments. We assume that a comparison standard had been established. Our findings have clear implications for consumer research. If researchers want to understand how novel, innovative and rather unfamiliar consumer products are appreciated, then the RET procedure seems to be an adequate method for obtaining more reliable judgments and capturing dynamics of aesthetic appreciation.

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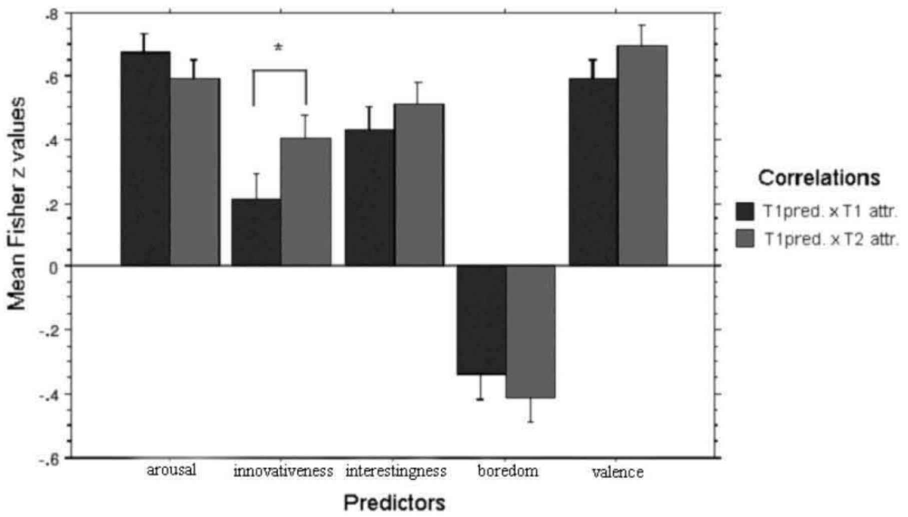
Figure Captions

Figure 1: Correlations (Fisher z-transformed values) of T1 predictors x T1 attractiveness ratings and T1 predictors x T2 attractiveness ratings; * indicates significant differences at a .05 level

Figure 1: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T1pred. x T2 attr.

Critical Reflection

Results of Project IV revealed that all variables of the implemented construct of AA are indeed correlated with attractiveness. These correlations increased over time and were rather constant across participants, which suggests that the predictor variables relate to attractiveness in a more general sense. These results provided further evidence for the inter-dependency of the variables: arousal, interestingness, valence, boredom and innovativeness with attractiveness. This indirectly demonstrates the multidimensionality of AA. The difference in the inter-correlations could be interpreted as differences in the overlap of the perceptual networks of these concepts. Following this argument, the semantic network for processing arousal as well as that for valence would have the highest overlap with the attractiveness network. As arousal and valence are highly important variables for the emotional response to a stimulus (Russell & Mehrabian, 1977), this might further indicate the specific importance of emotional processes while rating attractiveness. This interpretation could be limited by the fact that the RET phase of the experiment of Project IV in particular contained highly emotional attributes. Since the correlation of arousal and valence were the highest comparing ratings of T1 as well as for T2, the impact of the RET phase could have even enhanced this correlation.

When analyzing the predictive power of variables of T1 on attractiveness at T2, we found only Innovativeness (at T1) of such a quality that it was capable of predicting attractiveness (at T2) in a significant way. Keeping in mind the dynamics of attractiveness ratings for this kind of stimulus material, which was also used in Projects I, II and III, this effect is in full accordance with our theory: innovativeness needs elaboration and time, so it can be of relevance especially when such elaboration, for instance via RET, has taken place. Nevertheless, previous research has also found clear (negative) relationships between innovativeness and attractiveness at T1 (e.g., Carbon & Leder, 2005b). As low innovative stimulus material was often found more attractive at first sight in comparison to highly innovative stimuli, the correlation in T1 could have been proposed to be negative, however after a cross-over interaction of innovativeness and time for attractiveness could have changed to being positive. The weak correlation of attractiveness and innovativeness in T1, however, could be due to inter-individual differences. In this line Moulson and Sproles

(2000) proposed that some individuals prefer innovations immediately, while others do not (cf. Rogers, 2003). These inter-individual differences in appreciating innovativeness at first sight could have led to the relatively weak correlation between innovativeness and attractiveness in T1. Future studies further investigating inter-individual difference in more detail, for instance, in comparison with personal characteristics would be very promising.

Further work on this project could include several aspects. First of all an expanded set of variables, which relate to AA, could be included to investigate, which variables are most important for AA and how they relate to each other. These variables should be thoroughly derived from the literature and theories of aesthetic appreciation. In one study several objects including different kinds of objects, which may be aesthetically appreciated, could be rated in a between subject design relating to these different variables. Results then could be analysed within a factor analysis to identify different factors of AA and along with this propose relations between the variables. Furthermore, correlations between these variables could be calculated to find out how the variables relate to each other – and not only to attractiveness. A further step could be a multiple regression analysis, e.g. to find out, which variables strongly or rather weakly predict attractiveness.

We evidently showed that longer presentation times indeed led to higher assessments of increased boredom. Despite the successful implementation of situational boredom participants found themselves in both conditions in a rather bored situation. This might be the reason for not finding differential effects in the dynamics of AA. Future research should increase the difference between the experimental boredom levels and should asses general boredom proneness of the participants following Bornstein et al.'s (1990) advice.

V. Dynamics of aesthetic appreciation from a perspective of adaptation in a multidimensional object space

Motivation

In Projects V and VI we were especially interested in how the psychological representation of a category (e.g. the object class chairs) in terms of aesthetic appreciation (AA) would be affected by highly distinctive exemplars. We transferred the principal logic of the representation of faces by a so-called face space (Valentine, 1991) to the domain of aesthetics. We implemented a multidimensional object space for the category chairs, in which an exemplar is represented by a vector defining its location as well as its distance from the origin. Specifically, we used this framework to show how typicality and liking ratings in an implemented two-dimensional object space would change due to the processing of highly distinctive exemplars due to adaptation. We argue that due to adaptation the norm of a category will be recalibrated, which as a consequence changes the configurations of the typicality and liking dimensions of the related object space.

The variables typicality and liking are of special importance for AA. For instance, both the preference-for-prototypes hypothesis and the average hypothesis state that the more typical or average an object is the more we will like it. Recent results (Blijlevens, et al., in press), however, cast doubt on the idea of an linear relationship between typicality and liking, and instead assume a curvilinear relationship. Moreover, Hekkert, Snelders and van Wieringen (2003) transferred the MAYA design principle to the domain of empirical aesthetics, which propagates the joined influence of typicality and novelty on attractiveness. To shed more light on the relationship of typicality and liking we focused on these variables in Projects V and VI.

Furthermore, in Project V we challenged the question on how the distance of the adaptors to the test set would moderate the dynamics of the typicality and liking space by introducing three distances between the adaptor and the test set within the object space.

Original Paper

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Dynamics of aesthetic appreciation from a perspective of adaptation in a multidimensional object space

running heading: DYNAMICS OF AESTHETIC APPRECIATION

Stella J. Faerber(1)*[Present address: University of Bamberg], email: stella.faerber@uni-bamberg.de; Claus-Christian Carbon(1) email: ccc@experimental-psychology.com

1. University of Bamberg, Department of General Psychology and Methodology, D-96047 Bamberg, Germany

Due to ongoing alterations of our environment aesthetic appreciation is subject to dynamic changes. One explanation for such effects is the recalibration of the norm regarding adaptation. In three experiments we assessed liking and typicality, two major variables for aesthetic appreciation, of products (chairs) systematically by varying shape and saturation in terms of their distances from the adaptors. Based on the face space framework we created a multidimensional object space model susceptible to deformations due to adaptations. Clear adaptation effects were in line with the norm-based model showing re-formations of the whole space. Importantly, we did not find uniform effects for liking and typicality, e.g., mere exposure only had an impact on liking. The dissociate effects on the two dimensions of the object space might indicate a moderating effect of the strength of correlation between an implemented dimension and the observed variable and thus, on the dynamics of object space.

1 Introduction

Aesthetic appreciation is subject to change over the course of time. Fashion trends led people to wear flared bell bottom jeans in the 1970s, drainpipe cuts in the 1980s, baggy jeans in the 1990s as well as hipsters in the 21st century. Systematic research on trends and cycles can be found for the design of cars (Carbon, 2010) and also for natural objects like ideal body shape (Pettijohn & Jungeberg, 2004). One possible mechanism behind such dynamics in aesthetic appreciation is the cognitive phenomenon of adaptation (Carbon, 2010), since fashion trends, for example, are initiated by the introduction of innovations, which are firstly worn by innovators, later picked up by early adopters and finally accepted by late adopters (Moulson & Sproles, 2000; Sproles, 1981). This way a fashion trend overtakes a western society like a wave, until it finally disappears with the arrival of the next innovative trend.

Visual adaptation paradigms test the effect of visual exposure to stimuli with a common trait (e.g., images expanded on the y-axis) on the perception of novel stimuli (DeBruine, Jones, Unger, Little, & Feinberg, 2007; Webster, Kaping, Mizokami, & Duhamel, 2004; Webster & MacLin, 1999). It is assumed that the adaptation to stimuli with extreme values on the observed dimension (e.g., expansion on the y-axis) recalibrates the mental average on this dimension (Carbon & Ditye, in press; Carbon, et al., 2007). Since within such paradigms the subsequent perception of normality and attractiveness changes in the direction of the adaptors (Bestelmeyer, Jones, DeBruine, Little, & Welling, 2010), it is a likely mechanism underlying dynamics in aesthetic appreciation in everyday life. Effects of adaptation on liking or attractiveness were demonstrated for natural categories like faces (Anzures, Mondloch, & Lackner, 2009; Buckingham, et al., 2006; Cooper & Maurer, 2008; DeBruine, et al., 2007; Little, DeBruine, Jones, & Waitt, 2008; Rhodes, Jeffery, Watson, Clifford, & Nakayama, 2003; Rhodes, Louw, & Evangelista, 2009) or female bodies (Winkler & Rhodes, 2005), but less frequently for artificial categories such as cars (Carbon, 2010).

According to the *average hypothesis* average or typical exemplars of a category are perceived as more attractive than less average or typical ones (Langlois & Roggman, 1990; Valentine, Darling, & Donnelly, 2004). These effects of averageness on attractiveness ratings are independent of symmetry or smooth complexions often discussed in regard to morphed stimuli (Carbon, Gruter, Gruter, Weber, & Lueschow, 2010; Rhodes, Sumich, & Byatt, 1999; Valentine, et al., 2004). This correlation of typicality and attractiveness was observed for natural as well as for artificial categories (Halberstadt, 2006) and is hypothesized to be a side effect of familiarity for artificial categories (Halberstadt, 2006; Halberstadt & Rhodes, 2003). Thereby, experience can lead to higher familiarity and thus, higher attractiveness (Peskin & Newell, 2004), which according to, e.g., exemplar theories also leads to a higher typicality. During adaptation to

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extreme (atypical) exemplars of a category, these exemplars probably become more typical and thereby more attractive (see also, Carbon & Leder, 2005). This way attractiveness judgements are probably triggered by the continuously updated prototype of a category (Anzures, et al., 2009). The impact of typicality on aesthetic judgements is also outlined in the preference-for-prototypes theory described by Whitfield and Slatter (1979), which was demonstrated for several artificial categories, e.g., for consumer products (Veryzer & Hutchinson, 1998) or interior designs (Pedersen, 1986). However, a favoured object should be "most advanced, yet acceptable" (Hekkert, Snelders, & van Wieringen, 2003), which contributes to the influence of novelty as well as typicality on the aesthetic appreciation. This is in line with a suggested curvilinear correlation of typicality and liking, proposing that a medium level of typicality will be preferred to very typical or very atypical exemplars (e.g., Blijlevens, Carbon, Mugge, & Schoormans, in press). Thus, although typicality is a promising candidate for forecasting liking ratings, the most typical exemplar might not be the most favoured one.

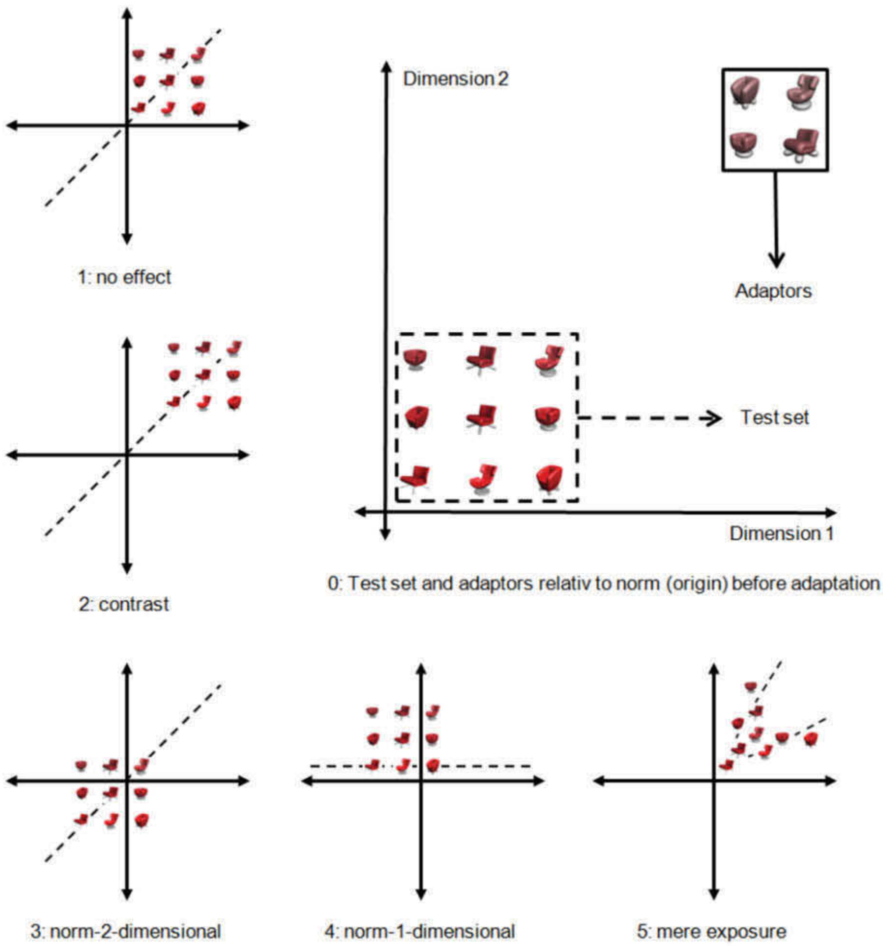

Figure 1. Distribution of the object space on the dimensions shape and saturation and possibilities of deformations after adaptation. Above: A sample test set in object space and in the periphery possible adaptors. A: Changes in line with exemplar theories. B: Changes in line with the norm-based model on both dimensions. C: Changes in line with the norm-based model on one dimension. D: Changes due to the mere exposure effect.

In the present study we focused on adaptation effects as a possible mechanism behind dynamics of aesthetic appreciation by observing the typicality and liking of objects. We hypothesized that by the recalibration of the prototype towards the adapted dimensions also the liking of the whole set of objects would be affected. But how exactly does experience shape

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aesthetic preferences? According to the multidimensional space framework introduced by Valentine (1991) exemplars of a category are assumed to be encoded as a point in a multidimensional space and thus, "a location in a Euclidean multidimensional space provides an appropriate metaphor for the mental representation" (p. 166). Thereby the dimensions represent features that are used to encode the exemplars. Within this framework exemplars of a category should be distributed around the most typical exemplars or the prototype of the category, which was shown repeatedly in experiments (e.g., Johnston, Milne, Williams, & Hosie, 1997). Around this prototype the space has a higher density than in the periphery, where more distinctive and less typical exemplars are represented (Lee, Byatt, & Rhodes, 2000). Such a density distribution was also found for faces varying in terms of attractiveness showing that attractive faces are more clustered than unattractive faces (Potter, Corneille, Ruys, & Rhodes, 2007) and that attractive faces are closer to their own-group prototype (Potter & Corneille, 2008). According to attractor field models the similarity of exemplars in such a space is perceived more within low density areas (Tanaka & Corneille, 2007; Tanaka, Giles, Kremen, & Simon, 1998). Although the face space and its distribution as well as the recalibration of the norm or prototype by adaptation has been subject of research, to our knowledge no one has yet explored how exactly such a psychological space is reformed by adaptation.

Our main research interest in this study concerned the reformation of the object space due to adaptations on two implemented dimensions: shape and saturation of colour. Figure 1 shows the implemented object space varying on two dimensions including the test set and possible adaptors as well as five possibilities of change due to an adaptation paradigm. First of all the adaptors could be too extreme and thus, would not be perceived as pertaining to the same category as the test set. This would lead to no adaptation effects and the perception of the test set would not change (Figure 1, possibility A: no effect). Another possibility of change could be seen in line with the exemplar-based model, which suggests that exemplars are encoded based on their absolute values on each dimension, whereby the centre of the object space represents the highest density, but plays no part in encoding (Valentine, 1991). In line with these assumptions Robbins, McKone and Edwards (2007) suggested that adaptation would lead the perception to repulse away from the adaptors. For changes in object space this would imply a diagonal translation of the norm away from the adaptors' position (Figure 1, possibility 2: contrast). Thereby the test set could be affected by a general shift of all stimuli away from the norm as indicated in Figure 1. Such an effect could also be explained by contrast effects. This effect of adaptation, however, is rather unlikely, since the literature on adaptation effects reported repeatedly that adaptation effects lead to a recalibration of the norm in the direction of the adaptors (e.g., Rhodes & Jeffery, 2006). This would be in congruence with the norm-based model. Thereby the exemplars are presumed to be perceived in comparison to a norm, which resembles the centre of the category and the centre of the object space. An exemplar is coded in terms of its direction and level of deviation from the average. This model predicts that adaptation would shift the norm along the dimension in the direction of the adaptors. Thus, all the stimuli of the test set would be equally affected by an equal shift of their load on this dimension. Adapting on two dimensions would implicate that all the stimuli of the test set would be affected by adaptation and a diagonal shift would occur (Figure 1, possibility 3: norm-2-dimensional). However, the effect of adaptation of one dimension could be stronger than the adaptation of the other dimension, which would again shift the whole test set, but stronger in the one dimension. With extreme differences between the dimensions this would probably lead only to effects of one dimension and thus to a shift parallel to only one of the axes (Figure 1, possibility 4: norm-1-dimensional). The object space could be further reconfigured (Figure 1, possibility 5: mere exposure), especially if the adaptors were lying within the test. In such a case the cognitive mechanism underlying the mere exposure effect could account for changes in object space. In the mere exposure paradigm the repeated perception to a stimulus leads to enhanced liking (Zajonc, 1968). In this case only a part of the test set would be affected by the adaptation procedure. Only the stimuli of the test set, which also lie within the adaptation set or are very similar to those, would be effected. These stimuli would probably increase in, for instance, liking, whereas the other stimuli might not be affected or might even decrease. In three experiments we observed whether changes of object space were in line with the norm-based model or would rather match other possible changes.

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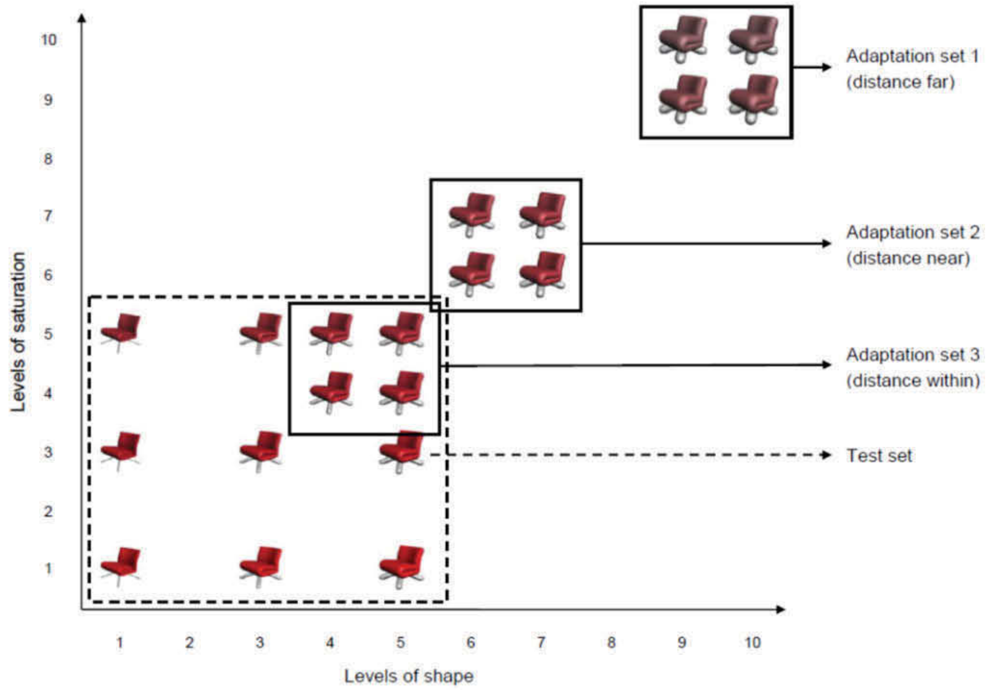

Figure 2. Test set and adaptation sets of Experiments 1, 2 and 3. The test set consisted of the stimuli with the levels 1, 3 and 5 of either shape or saturation and their combination, resulting in 9 stimuli per chair model. The distance of adaptation set (4 stimuli per chair model) to the test set varied for each experiment with a far distance for Experiment 1, a near distance for Experiment 2 and a within distance in Experiment 3.

Furthermore, we were interested how the distance of adaptors to the test set would impact the dynamics of the object space (Figure 2). In this study we observed adaptors with a big distance (Experiment 1: far adaptation set), small distance (Experiment 2: near adaptation set) as well as an adaptation set, which lay within the test set (Experiment 3: within adaptation set). Recent experimental results showed stronger adaptation affects with a larger distance of the adaptors to the test set (Jeffery, et al., 2010; Robbins, et al., 2007). This is in line with the above mentioned norm based model as well as the two-pool model. The latter proposes that a perceptual dimension has two opponents with a norm falling between these two ends of the dimension (Robbins, et al., 2007). The combination of the activation of the two pools accounts for the typicality, while an equal activation will be perceived as norm. During adaptation each pool reduces its activity in proportion to the strength of its initial response, thus the more sensitive pool becomes stronger adapted. This model predicts that the more distant the adaptors are to the test set (near the norm) the stronger the adaptation effect is. Similar predictions are made by the norm-based model (Robbins, et al., 2007). For the current study the norm-based model would predict less pronounced adaptation effects the nearer the adaptation set was to the test set (strongest effects in Experiment 1, less strong effect in Experiment 2 and the least strong effects in Experiment 3).

For Experiment 3 with the adaptors lying within the test set also processes concerning the mere exposure effect could be active (see above). Thus, although the adaptation effect might decrease with smaller distances of the adaptation set, in Experiment 3 the liking of the stimulus, which is part of the adaptation set as well as the test set, and its surrounding stimuli could be enhanced due to the mere exposure effect. To our knowledge there are hardly any published mere exposure studies that investigate the variable typicality in this context. Brentar, Neuendorf, and Armstrong (1994) observed the mere exposure effect for music collecting inter alia the variable subjective novelty and found no effect for subjective novelty on exposure. However, as mentioned above an increase in familiarity was assumed to induce an increase in perceived typicality and thus, in the case of Experiment 3 mere exposure effects could lead to similar changes in typicality as proposed for liking.

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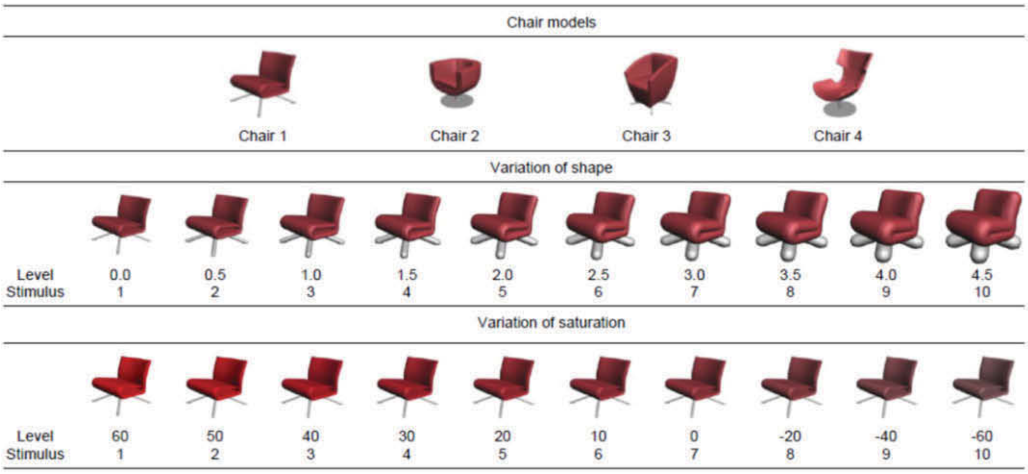

Figure 3. 3D-chair models and their variation in the dimensions shape and saturation. Each of the four chair models was systematically varied on ten levels of shape and saturation. The levels of shape relate to the parameter of inflation strength of the software 3ds Max, the ones of saturation are specifications of Adobe Photoshop. The last three levels of saturation differ with 20 of the indication of measurement, since three pre-raters suggested that with the same difference of 10 indications the measurement could not differ between the levels below indication 0.

To investigate such possible changes in object space we created an object space by systematically varying chairs on the dimensions shape and saturation of colour (Figure 3 and 4). For the implemented dimensions we derived features, which are firstly important to aesthetic appreciation and secondly could be varied systematically and independently. Shape is especially important for object categorisation and identification (e.g., Rosch, Mervis, Gray, Johnson, & Boyesbraem, 1976) and thus for the perception of typicality. For aesthetic appreciation shape plays also an equally important role. As mentioned above novel, innovative designs often come along with new languages of design (the so-called "Formensprache", Carbon, 2010), which trigger aesthetic appreciation (e.g., Carbon, 2010; Gerger, Leder, Faerber, & Carbon, in press; Leder & Carbon, 2005; Veryzer & Hutchinson, 1998). We used the possibility to inflate objects to implement the variable shape. Inflation is the degree to which extent an object was inflated or bloated like an airbed. Thereby, the shape of an object becomes more and more round and curvy, but also voluminous (see also Figure 3). We assumed that the least inflated chairs, which resembled the original shape of the chairs, would be rated as the most typical and would be liked the most. The second implemented dimension was the saturation of colour. Valdez and Mehrabian (1994) investigated amongst others the effect of saturation of colour (vividness of colour, with lower saturated colours containing more grey) on the emotional reaction, which itself is an important part of the aesthetic response to an object (Faerber, Leder, Gerger, & Carbon, 2010; Leder, Belke, Oeberst, & Augustin, 2004). They found a strong and consistent effect of saturation on emotion via arousal increasing linearly and strongly with colour saturation. These results for arousal were confirmed only recently for product designs showing increased aesthetic appraisal with induced arousal through saturation of colour (Blijlevens, et al., in press). For the typicality of an object the arousal might play a less important role as typicality is mainly linked to familiarity and thus to more geometrical/proportional properties. Famous furniture companies, especially ones often frequented by students (in the German speaking countries, for instance, Kika, XXXLutz) used red, highly saturated furniture for their advertisements at the time this study was carried out as well as in the years before. Consequently, we expected that participants had probably adapted to such a highly saturated red colour for furniture to some extent and would therefore perceive a highly saturated colour as being more typical and also, since it is more arousing, as more likable. With the adaptors being low saturated, and thus less arousing, we implemented an adaptation away from this proposed highly saturated norm. In sum, we hypothesized a stronger effect of the dimension shape on typicality ratings than of the dimension

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saturation, but an equally strong effect of both dimensions on the liking ratings. These different impacts should be reflected in the first ratings before adaptation as well as within the dynamic of object space.

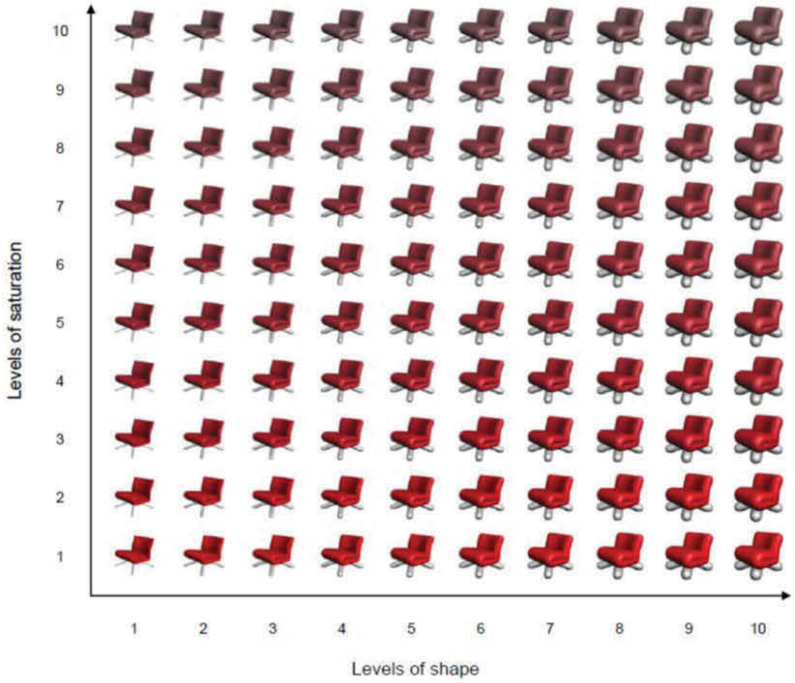

Figure 4. Implemented object space for one example chair varying on 10 levels of shape and 10 levels of saturation.

Within the implemented object space we were interested in changes of typicality and liking ratings and thus, in changes in perceived typicality and liking space. In line with the average hypothesis as well as with the preference-for-prototypes theory similar adaptation effects for typicality space and liking space could be expected. A further explanation why changes in both spaces could be similar lies within network theories. These theories would probably presume that while rating the typicality or liking of an object, similar neural networks were active. This way changes in the network for typicality, for example, would also affect the network for perceiving liking, since both networks overlap and, thus share the same neural populations (Versace, Labeye, Badard, & Rose, 2009). In this study the network representing and processing the objects (chairs) would probably be adjusted due to adaptation. As object representations are directly linked to its category, the typicality ratings should be directly affected. As the network for processing liking of these objects is supposed to overlap with the network for typicality, the network for liking should be indirectly affected and thus lead to similar, but weaker effects. However, this assumed strong impact of typicality in liking is currently much debated (see above) in respect to its strength as well as to its linear relationship. Thus, the interplay could be more complex.

To summarize, we proposed that the implemented adaptation paradigm would lead to a reformation of the whole object space in line with the norm-based model. Thereby, these changes would be moderated by the distance of the adaptors to the test set leading to less strong effects the smaller the distances and possible moderating effect of mere exposure were. Furthermore, we hypothesized moderating effects of the implemented dimensions, since a differently high correlation of the dimension and the observed variable could probably lead to differently strong adaptation effects. These different impacts of the distance of the adaptors and the implemented dimensions could account for different dynamics in typicality and liking space.

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2 Method of Experiments 1-3

2.1 Participants

A total of 102 undergraduate students participated for course credit. This sample consisted of 85 women and 17 men with a mean age of 22.0 years (*SD* = 3.7). The distribution for the Experiments 1, 2 and 3 were: n1 = 36 (*M* = 22.2 years; *SD* = 3.6; 31 female), n2 = 35 (*M* = 21.5 years; *SD* = 4.1; 29 female) and n3 = 31 (*M* = 22.5 years; *SD* = 3.5; 25 female). All of them had normal or corrected-to-normal vision assured by the *Snellen Eye test*, also none of them showed any abnormal colour processing diagnosed by a sub set of Ishihara colour cards. None of the participants took part in more than one of the reported experiments.

2.2 Apparatus and Stimuli

The stimulus material consisted of 80 photo-realistic images of chairs sized at 640 x 480 pixels and were presented on a 17-inch Apple eMac CRT monitor with a resolution of 1024 x 768 pixels. We generated the stimuli using four 3D-chair-models (Figure 3) from the collection Archmodels Vol.1 (2005) of *Evermotion*. We varied each chair on the dimensions *shape* und *saturation of colour* using *Autodesk 3ds Max 2009* and *Adobe Photoshop CS2* on ten levels each (see Figure 3 for an example of the systematic variation on each dimension and Figure 4 for the creation of the physical object space due to these two dimensions). From these stimulus sets we obtained the test set (nine stimuli per chair model) and the adaptation set (four stimuli per chair model) for each experiment (for an overview of the experiments see Figure 2).

2.3 Procedure

All experiments used the same procedure with the same test set, but different adaptation sets. The experiments consisted of two sessions separated by 3-5 days. In the first session we implemented the first test phase (T1) and first adaptation phase (A1) and the second session started with a shorter adaptation phase (A2) followed by the second test phase (T2) (Figure 5).

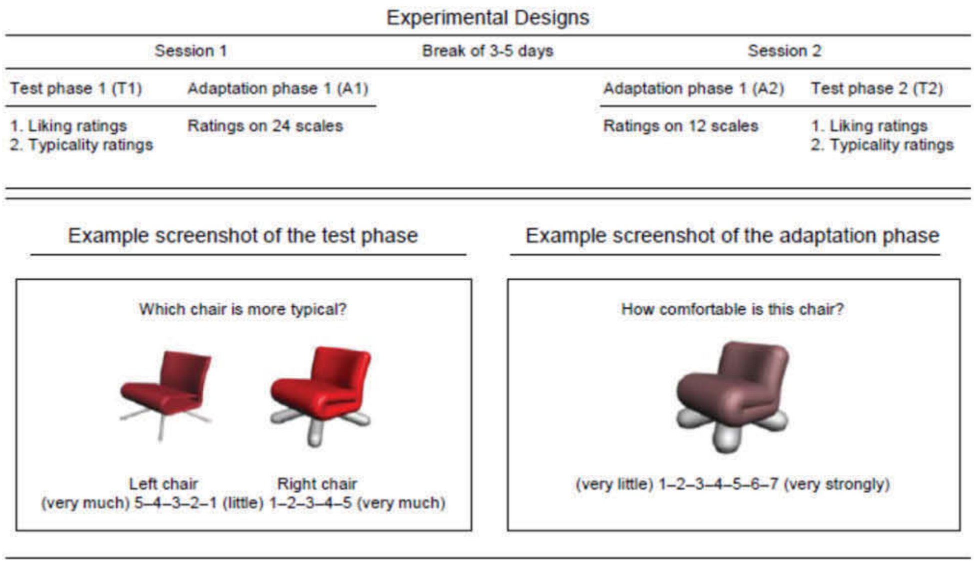

Figure 5. Experimental designs of Experiments 1, 2 and 3. The experimental design for each experiment was the same. Session 1 consisted of the test phase 1 (typicality and liking ratings) and the first adaptation phase. After a break of 3-5 days the session 2 followed containing a second shorter adaptation phase and ended with the test phase 2 (typicality and liking ratings). Examples of screen shots of the test and the adaptation phase are displayed.

In the identical test phases (T1 and T2) we first assessed the variable liking (German: Gefallen) and then typicality (German: Typikalität) for the participants by collecting relative

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judgements similarly to Buckingham, DeBruine, Little, Welling and Conway (2006). Thereby we showed two stimuli of the test set (always of the same chair model) simultaneously and asked the participants, which of the two chairs they liked more or found more typical (the scales were introduced in advance). After choosing one chair they further had to indicate on a 5-point Likert scale (1 = "little" [wenig, due to a program error "very" was not displayed at this end of the scale], 5 = "very much" [sehr viel]) how much they liked the chosen chair more (or how much they found it more typical) than the other displayed one (see Figure 5). For each variable the participants gave 144 relative ratings consisting of 36 ratings per chair model, since for every chair model each stimulus of the 9 stimuli of the test set was compared with each of the remaining ones. We balanced the display side of the paired stimuli on the screen and randomized the order of the stimulus pairs. The task was self-paced and identical for both variables.

In the adaptation phases (A1 and A2) we introduced the Repeated Evaluation Technique (RET; Carbon & Leder, 2005). With this technique participants rate the stimulus material on different scales to induce a deep elaboration of the stimulus material in a controlled way, proven to induce dynamic effects of aesthetic appreciation for a wide range of participants, from typical volunteers such as students (Carbon, Michael, & Leder, 2008) to aged persons with no academic background (Carbon & Schoormans, in press). In A1 participants rated the adaptation stimuli on the scales: appealing (ansprechend), carefully thought out (durchdacht), classic (klassisch), compact (kompakt), conventional (konventionell), durable (beständig), elegant (elegant), extravagant (extravagant), formal (förmlich), functional (funktionell), futuristic (futuristisch), inviting (einladend), neat (ordentlich), of high quality (hochwertig), embellished/playful (verspielt), overwhelming (erdrückend), pleasant (angenehm), dull (eintönig), regular (regelmäßig), restrained (dezent), rounded (abgerundet), solid (gediegen), tasteful (geschmackvoll) and conservative (bieder). Phase A2 was half as long as A1 and comprised the scales: bulky (sperrig), clear (klar), comfortable (komfortabel), conservative (konservativ), well-considered (überlegt), functional (praktisch), luxurious (luxuriös), minimalist (schlicht), modern (modern), robust (robust), stylish (stilvoll) and visionary (phantasievoll). In A1 and A2 first the question and one of the 16 (four per chair model) adaptation stimuli were displayed either for 1,000, 2,000 or 3,000 ms. After that the stimulus disappeared and was displayed again together with a 7-point Likert scale (1 = "very little" [sehr wenig], 7 = "very strongly" [sehr stark]) to show how much the participant agreed on the given attribute applied to the stimulus. At that point participants were able to rate the stimulus in a self-paced manner. Immediately after that the next stimulus was presented. The stimuli were rated consecutively in a randomized order for each scale, randomised across participants. Trials for all phases were presented by PsyScope 1.25 PPC (Cohen, Macwhinney, Flatt, & Provost, 1993) and all participants were tested individually.

Table 1. Effects of shape and saturation and their interaction on typicality and liking ratings in T1 and T2.

	Variable	Effect	Experiment 1 (far)				Experiment 2 (near)				Experiment 3 (within)			
			df	*F*	η_p^2	*p*	*df*	*F*	η_p^2	*p*	*df*	*F*	η_p^2	*p*
Ratings in T1	Typicality	Shape	2/70	178.22	0.84	.001	2/68	182.68	0.84	.001	2/60	101.46	0.77	.001
		Saturation	2/70	2.97	0.08	.058	2/68	2.95	0.08	.059	2/60	6.82	0.19	.002
		Shape x Saturation	4/140	2.53	0.07	.044	4/136	2.34	0.06	.059	4/120	<1	0.01	.861
	Liking	Shape	2/70	23.26	0.40	.001	2/68	15.75	0.32	.001	2/60	8.63	0.22	.001
		Saturation	2/70	18.53	0.35	.001	2/68	6.42	0.16	.003	2/60	7.83	0.21	.001
		Shape x Saturation	4/140	3.37	0.09	.011	4/136	2.10	0.06	.085	4/120	1.60	0.05	.179
Ratings in T2	Typicality	Shape	2/70	51.29	0.59	.001	2/68	18.20	0.35	.001	2/60	48.60	0.62	.001
		Saturation	2/70	2.84	0.08	.065	2/68	1.71	0.05	.188	2/60	6.26	0.17	.003
		Shape x Saturation	4/140	<1	0.01	.820	4/136	2.69	0.07	.034	4/120	3.68	0.11	.007
	Liking	Shape	2/70	10.97	0.24	.001	2/68	6.18	0.15	.003	2/60	18.41	0.38	.001
		Saturation	2/70	9.70	0.22	.001	2/68	3.21	0.09	.047	2/60	3.71	0.11	.030
		Shape x Saturation	4/140	1.53	0.04	.196	4/136	2.52	0.07	.044	4/120	<1	0.03	.470

Note. Significant effects as well as marginal effects, defined as $.05 < p < .08$, are indicated in bold.

2.4 Handling of the raw data of the collected relative ratings

In all experiments we collected data for typicality and liking through relative ratings. Two chairs were presented simultaneously and the participants had to rate the more typical or more liked stimulus on a five-point Likert scale. We gave the stimulus e.g. more typically rated points from 0.5 to 4.5 and the paired stimuli points from -4.5 to -0.5, thus, implementing a scale with 10 points from -4.5 to 4.5. For example, when a participant rated a stimulus with one as more typical, then this stimulus was assigned 0.5 points and the paired stimulus -0.5 points for this rating. For

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further processing of the data we averaged the recalibrated data across the different ratings for each stimulus and also across the four different chair models.

3 Results and discussion of Experiments 1-3

Our main interest in this study concerned the dynamics in object spaces moderated by the distance of the adaptation set to the test set. For a validation of the implemented stimulus variation we will first outline descriptive statistics as well as effects of the implemented dimensions shape and saturation on typicality and liking ratings in T1 and T2. Secondly, we will report the dynamics of aesthetic appreciation (typicality and liking) for each experiment due to the implemented adaptation paradigms. Thirdly, we will be investigating the changes in the object spaces on a stimulus level to find out how the psychological typicality and liking space were reformed by adaptation.

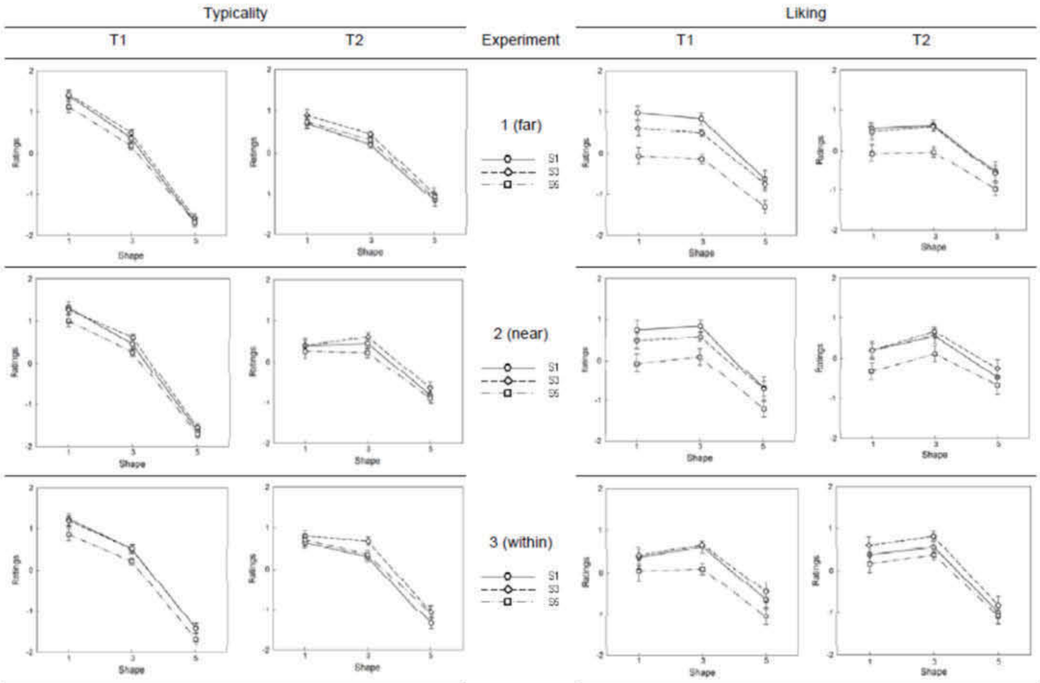

Figure 6. Typicality and liking ratings in test time 1 (T1) and 2 (T2) for Experiments 1, 2 and 3. For each dependent variable one graph with shape (x-axes) separated by the saturation levels (S1 = saturation level 1, S3 = saturation level 3 and S5 = saturation level 5) are shown. Means and standard errors of the means are indicated.

3.1 Validation of the implemented stimulus variations

Figure 6 shows the systematic variation of the ratings in regard to the implemented dimensions (shape and saturation) for both dependent variables, separately for all experiments in T1 and T2. To further explore the effects of the implemented dimensions we conducted two factorial univariate analyses of variance (ANOVAs) with shape (levels 1, 3 and 5) and saturation (levels 1, 3 and 5) as within subject factors and with either typicality or liking ratings as dependent variable for each experiment and for each test time separately (Table 1). In the following we will focus on the main effects in T1 of these analyses as we report these for validation purposes. In T1 results for typicality ratings showed highly significant effects for shape in all experiments as well as strong trends for saturation in Experiment 1 and 2 and a significant effect in Experiment 3. The effects were by far stronger for shape with $\eta_p^2 = 0.84$, $\eta_p^2 = 0.84$ and $\eta_p^2 = 0.77$ for Experiments 1, 2 and 3, respectively, than for saturation with $\eta_p^2 = 0.07$, $\eta_p^2 = 0.08$ and $\eta_p^2 = 0.19$ for Experiments 1, 2 and 3, respectively. Analyses of liking ratings in T1 resulted in significant effects for shape as well as for saturation in all experiments. Effects of shape and saturation did not differ so strongly for liking ratings: for shape we obtained $\eta_p^2 = 0.40$, $\eta_p^2 = 0.32$ and $\eta_p^2 = 0.22$ in Experiments 1, 2 and 3, respectively, for saturation we found $\eta_p^2 = 0.35$, $\eta_p^2 = 0.16$ and $\eta_p^2 = 0.21$ in Experiments 1, 2 and 3, respectively. However, these effects were less strong than of shape for typicality ratings. This is in line with our assumption that the dimension shape, thus shape of an object, is more important for typicality judgements than the saturation of colour regarding this kind of stimuli. On the other hand both dimensions seem to be equally important for liking judgements. In sum, both shape and saturation, the two experimentally varied dimensions implemented here, could be validated as being effective on altering typicality as well as liking ratings, although typicality ratings for the dimension saturation showed only marginal effects in Experiments 1 and 2; all other main effects were highly significant.

In T2 we observed slightly different effects compared to T1 (for details see Table 1), which we ascribed to adaptation effects. These we will describe in the next two results sections.

Table 2. Dynamics of typicality and liking: effects of shape, saturation and their interaction on changes of typicality and liking ratings.

	Variable	Effect	Experiment 1 (far)				Experiment 2 (near)				Experiment 3 (within)			
			df	*F*	η_p^2	*p*	*df*	*F*	η_p^2	*p*	*df*	*F*	η_p^2	*p*
Differences in ratings (T2–T1)	Typicality	Shape	**2/70**	**22.2**	**0.39**	**.001**	**2/68**	**34.22**	**0.50**	**.001**	**2/60**	**6.65**	**0.18**	**.002**
		Saturation	**2/70**	**3.6**	**0.09**	**.033**	2/68	<1	0.01	.883	**2/60**	**13.94**	**0.32**	**.001**
		Shape x Saturation	4/140	1.49	0.04	.210	4/136	1.28	0.04	.281	4/120	1.70	0.05	.155
	Liking	Shape	**2/70**	**4.01**	**0.10**	**.023**	**2/68**	**7.94**	**0.19**	**.001**	2/60	1.60	0.05	.211
		Saturation	**2/70**	**6.57**	**0.16**	**.002**	**2/68**	**4.20**	**0.11**	**.019**	2/60	2.30	0.07	.109
		Shape x Saturation	4/140	1.66	0.05	.164	4/136	<1	0.01	.803	**4/120**	**2.50**	**0.08**	**.046**

Note. Significant effects are indicated in bold.

3.2 Dynamics of aesthetic appreciation

In order to test whether dynamics in aesthetic appreciation occurred we conducted differences per stimulus of the ratings (T2 minus T1) and conducted with these differences of typicality and liking ratings as dependent variables again two repeated measurement ANOVAs with shape (levels 1, 3 and 5) and saturation (levels 1, 3 and 5) as within subject factors and the differences (T2 minus T1) of either typicality or liking ratings as dependent variable for each experiment separately (Table 2). In Experiment 1 we observed significant changes in typicality ratings for shape as well as for saturation. Also, results showed significant changes in liking ratings for shape and for saturation.

Table 3. T-tests between ratings of T2 versus T1 for each stimulus for typicality and liking.

				Experiment 1 (far)			Experiment 2 (near)			Experiment 3 (within)		
				Shape			Shape			Shape		
				1	3	5	1	3	5	1	3	5
Typicality	Saturation	5	*t*	**3.08**	-1.28	**-5.51**	**4.51**	.24	**-5.75**	1.05	-1.29	**-3.91**
			p	**.004**	.210	**.001**	**.001**	.810	**.001**	.300	.207	**.001**
			d	**-0.51**	0.21	**0.92**	**-0.76**	-0.04	**0.97**	-0.19	0.23	**0.70**
		3	*t*	**4.37**	.89	**-4.55**	**6.00**	.08	**-6.97**	**2.46**	-1.83	**-2.77**
			p	**.001**	.413	**.001**	**.001**	.934	**.001**	**.020**	.077	**.010**
			d	**-0.73**	-0.14	**0.76**	**-1.01**	-0.01	**1.18**	**-0.44**	0.33	**0.50**
		1	*t*	**5.65**	**2.14**	**-3.49**	**5.86**	.01	**-4.25**	**3.97**	**2.14**	-.48
			p	**.001**	**.040**	**.001**	**.001**	1.000	**.001**	**.001**	**.041**	.633
			d	**-0.94**	**-0.36**	**0.58**	**-0.99**	0	**0.72**	**-0.71**	**-0.38**	0.09
Liking	Saturation	5	*t*	.00	-1.01	**-3.05**	1.73	-.16	**-3.77**	-.67	**-2.76**	.202
			p	1.000	.318	**.004**	.094	.862	**.001**	.505	**.010**	.841
			d	0	0.17	**0.51**	-0.29	0.03	**0.64**	0.12	**0.50**	-0.04
		3	*t*	1.28	-1.14	-1.61	1.84	-1.13	**-2.96**	-1.15	-1.82	1.85
			p	.209	.261	.116	.074	.266	**.006**	.258	.079	.074
			d	-0.21	0.19	0.27	-0.31	0.19	**0.50**	0.21	0.33	-0.33
		1	*t*	**3.44**	**2.89**	-.90	**3.84**	**2.79**	-1.37	-.15	.36	**2.26**
			p	**.002**	**.007**	.373	**.001**	**.009**	.180	.880	.722	**.032**
			d	**-0.57**	**-0.48**	0.15	**-0.65**	**-0.47**	0.23	0.03	-0.07	**-0.41**

Note. For a better overview results for each test set are indicated in the same spatial alignment as in Figure 7. Statistics, based on *t*-tests, are given with the regarding *t*-value (*t*), *p*-value (*p*) and Cohens'*d* effect size (*d*).

In Experiment 2, we only found significant effects of typicality for shape, but not for saturation. Liking ratings showed significant effects for shape as well as for saturation. In contrast, in Experiment 3 analyses resulted in significant effects in typicality ratings for shape and saturation, but no significant main effects in liking ratings for shape or saturation. Thus, we found dynamics

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in aesthetic appreciation, which varied in regard to the distance of the implemented adaptation set. Also, changes in typicality and liking did not occur similarly. These results will be discussed in more detail in the next section, in which we further explore the whole pattern of changes within the object spaces by further analyses on a stimulus level.

3.3 Changes in the object spaces on a stimulus level

Changes over time (T2 versus T1), analyzed by dependent *t*-tests for each stimulus for both dependent variables showed systematic differences between the experiments (Table 3). These results confirmed the results of the reported ANOVAs describing the dynamics over time, however, they gave much more detailed insight into the systematic of these changes. For a better overview of the pattern of dynamics within the psychological object spaces we show the effect sizes of the associated *t*-tests in Figure 7.

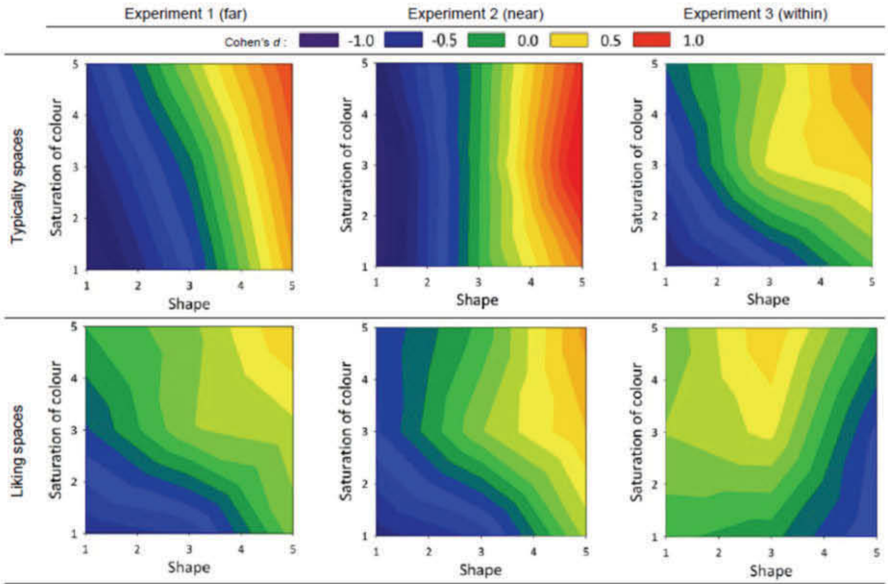

Figure 7. Dynamics of object space. Within the implemented object space the changes over time for the dependent variables are indicated through the effect sizes of the *T*-tests comparing ratings of t2 versus T1 (Table 3). Changes in typicality space and in liking space are shown for each experiment separately.

The observed dynamics in typicality and liking space of Experiment 1 are in line with the norm-based model (Figure 1, possibility 3: norm-2-dimensional). The translation of the test set on the diagonal indicates effects of changes of the space on both dimensions (shape and saturation), which were confirmed due to the results of the dynamics of typicality and liking in Table 2. For typicality ratings the changes for shape were thereby stronger than that for saturation (d = 0.39 and d = 0.09), which we assumed, since shape is probably a more important variable than saturation for typicality ratings. However, this could also indicate that the adaptation on the dimension shape is more efficient. The later interpretation could be ruled out, since the changes in liking space were equal for shape and saturation (d = 0.10 and d = 0.16), but less strong compared to the effect of shape for typicality ratings. Thus, different changes in typicality and liking space cannot be attributed to a general less strong change of the liking space hypothesized in regard to the preference-for-prototypes theory as well as to the network hypotheses, since the effect for saturation was equally weak for typicality and liking. This indicated that the liking space is at least not only influenced by the changes in perceived typicality.

In line with possibility 3 (norm-2-dimensional) of Figure 1 the translation of the test set would furthermore be indicated by an increase of the ratings between T1 and T2 for stimuli closest and most similar to the adaptors, but a decrease in ratings for stimuli furthest away from and least similar to the adaptors. This was confirmed by the results of the *t*-tests (Table 3 and Figure 7), which show a systematic variation of the effect sizes of the changes due to the adaptation effects on both dimensions. For example, for the typicality ratings all three stimuli of level 5 of shape increased in typicality (nearest level to the adaptors) with effect sizes of $d = 0.58$, $d = 0.76$ and $d = 0.92$. The increase of effect sizes indicated the moderating effect of the dimension saturation with $d = 0.58$ being the saturation level furthest away from the adaptors and $d = 0.92$ for the stimuli nearest to the adaptors. Figure 8 models the perceived typicality space before and after adaptation and gives an overview of the changes of the distances of each stimulus to the norm. For example, stimuli, which increased in typicality, were further away from the norm before adaptation than after it.

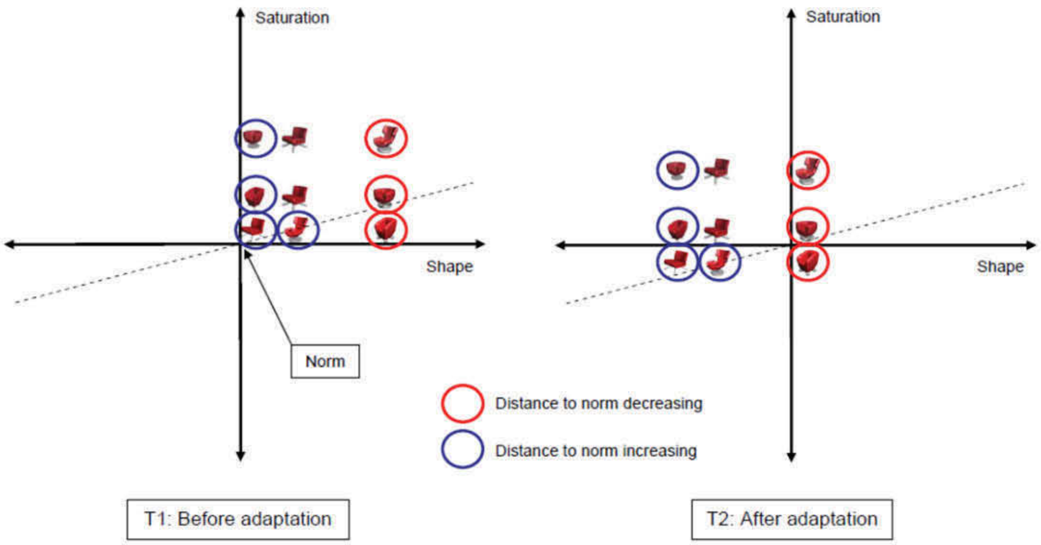

Figure 8. Model of norm-based changes for typicality in Experiment 1. This Figure shows the typicality space before (T1, left side) and after (T2, right side) adaptation. The stimuli of the test set are not semi-distant, since participants rated levels 1 and 2 as more similar than levels 2 and 3 in both dimensions in T1. The centre of the coordinates again represents the norm which shifted according to adaptation along the diagonal (dashed line). The diagonal indicates that within Experiment 1 for typicality we found stronger effects for shape than for saturation. In T1 and T2 those stimuli are marked, which either increased (red circles) or decreased (blue circles) in typicality. Note that for those stimuli which increased in typicality the distance to the norm decreases from T1 to T2 and for those decreasing in typicality it increases

Results for Experiment 2 were also in accordance with the norm-based model, although the reconfiguration of the typicality space resembled possibility 4 of Figure 1 (norm-1-dimensional), since the space changed only due to adaptation on the dimension shape. Analyses for the dynamics of typicality thereby resulted in a significant effect for shape of $d = 0.50$ and a not significant effect for saturation with $d = 0.01$ (Table 2). These missing adaptation effects could be attributed to the nearer distance of the adaptors to the test set. The liking space changed like in Experiment 1 due to adaptations on both dimensions (Figure 1, possibility 3: norm-2-dimensional). For liking space results showed a significant effect for shape with $d = 0.19$ and for saturation with $d = 0.11$ (Table 2). These effects were confirmed through the follow up t-tests (Table 3 and Figure 7). Comparing Experiments 1 and 2 we found differences in changes due to the other distance of the adaptors for typicality space, but not for liking space. These results did not account for a linear relationship of typicality and liking, since adaptation effects on saturation in Experiment 2 occurred for liking, but not for typicality. Again the preference-for-prototypes theory or the network hypothesis could not be confirmed for the dimension saturation, which again could be attributed to the different impact of the dimension saturation on typicality and liking. At least the network for processing typicality does not directly or exclusively influence the liking network as sometimes supposed. Thus, we found again differences between changes in typicality and liking space.

Observing the dynamics within the typicality space for Experiment 3 we once more found evidence for adaptation effects in line with the norm-based model. The analyses resulted in significant dynamics for shape with $d = 0.18$ and for saturation with $d = 0.32$. The pattern of change for the liking space was *not* in accordance with the norm-based model, but could rather be interpreted as effects of mere exposure. We neither found significant effects for shape ($d = 0.05$) nor saturation ($d = 0.07$). These effects alone could be interpreted due to less strong adaption effects, since the adaptors in Experiment 3 were located very close to the norm. However, regarding the results of the *t*-tests (Table 3) and the pattern of change shown in Figure 7, this interpretation alone is rather unlikely. The pattern of change for liking is more in line with possibility 5 for Figure 1 (mere exposure). If we suppose a mere exposure effect to occur, the more similar the stimuli of the test set are to the adaptation set, the stronger the effect(Zizak & Reber, 2004), with classic mere exposure effect of high strength being only visible for the same stimuli being observed in the adaptation set and being tested in the test set. We found indeed a data pattern, being partly compatible with these assumptions. The pattern of change of liking space showed an epicentre of action in the area, where the adaptation set was located, showing a significant increase in liking for a very similar stimulus while another dissimilar stimulus decreased. These results seemed to be rather a result of changes in saturation. However, the liking of the specific stimulus, which was within the adaptation and the test set, did not change. This could be interpreted due to boredom effects, since boredom is a limiting effect of the mere exposure effect (Bornstein, Kale, & Cornell, 1990). Most prominently in Experiment 3 we found different dynamics for typicality and liking space. For typicality this change resembled a diagonal shift of the norm, whereas the weak changes in liking space might rather be due to mere exposure effects. The mere exposure effect moderated at least possible adaptation effects. In this experiment we found no differences in effects for the dimensions for either typicality or liking.

In sum, these results revealed dynamics in typicality and liking spaces, which were moderated by the distance of the adaptation set to the test set or norm. Moreover, changes in liking space could not only be seen as a weaker change of the dynamics taking place in typicality space.

4. General discussion

Following the hypothesis that aesthetic appreciation changes over time we observed changes in liking and typicality ratings within an adaptation paradigm. Thereby we were especially interested in the changes in object space while varying the distance of the adaptors. We observed systematic changes of typicality and liking space due to adaptations on both implemented dimensions: shape and saturation of colour. Thereby, the adaptation in line with the norm-based model translated the norm as such that the whole object space was affected.

For typicality space we found changes in line with the norm based model in all experiments, whereas for liking we observed changes according to the norm-based model in Experiments 1 and 2, but a different pattern of change in Experiment 3, which could be interpreted according to the mere exposure effect. Thus, the very important variables for aesthetic appreciation (liking and typicality) did not always change similarly as proposed by the preference-for-prototypes theory. Although, liking and typicality surely bound to each other, this correlation might not be as strong as often supposed and might not be linear for the aesthetic appeal of product designs. One explanation could be that the above mentioned curvilinear correlation of typicality and liking (Blijlevens, et al., in press) accounted for different ratings in typicality and liking before adaptation and possibly also for different changes in the spaces. Another explanation for the different findings for typicality and liking space could be that also changes in the perceived novelty, which we did not collect in this study, triggered changes in liking space. In this sense typicality could only be seen as one among other multidimensional factors influencing liking (Whitfield, 2000). Such a disparity of typicality and liking exists, for example, for metals as iron and steel are the more typical metals, but silver and gold are more preferred.

These results could lead to a re-interpretation of the network hypothesis. Possibly, according to adaptation the representations of the exemplars of a category change, get enriched and aspects of their characterising dimensions are explained differently. This way the network of exemplar representation is constantly updated. By rating these exemplars on typicality, the network for processing and perceiving typicality accesses the network of exemplar presentation. This will of course lead to an overlapping and in part identical activation of networks. By rating typicality of

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the exemplars cognitive processes, such as attention to specific exemplar properties (e.g., shape), could influence the outcome of typicality ratings and even the changes in typicality space. While rating liking, the network for processing liking will again access the representational network. But, in contrast, the network of processing liking will probably be more sensitive to adaptations of the representational network on saturation than that for processing typicality. Thus, access on the network for exemplar representations could be triggered by e.g. processes related to attention and could lead to different outcomes for typicality and liking space. Similarly, Lin and Murphy (1997) found differences in categorization due to different background knowledge participants gained with the learning of a category. Depending on the attention participants paid to specific parts of the exemplars they categorized the very same exemplars differently and were not aware of missing components, if they were not important for the categorization process. Furthermore effects of attitude, personal standards and selective attention on the face space were discussed by Busey (1998), who argued that such influences could expand or shrink a particular dimension.

Along these lines a reason for different changes on the implemented dimensions could be the different importance of a dimension for the specific variable. As we hypothesized that shape is more important for typicality than saturation, we found stronger changes in typicality space for shape. On the other hand we showed equally strong changes in liking space due to shape and saturation as we assumed a similar importance for both dimensions for liking. Thus, changes in object space could be triggered by the strength of correlation of the specific dimension and the observed variable (e.g., liking).

We found varying results due to the varying distance of the adaptation set. However these results could not just be interpreted in regard to the norm-based model or the two-pool model, which would predict a weaker adaptation effect with smaller distance. For typicality space we found an intermixed pattern. For shape as well as for saturation, which at least for saturation could not be interpreted in this sense, which would simply lead to weaker effects the nearer the adaptors were to the norm. On the other hand we found changes in liking space in Experiments 1 and 2, but less strong changes in Experiment 3, which could be interpreted in line with the norm-based model. However, these changes in Experiment 3 could be better interpreted due to mere exposure effects at least on a stimulus basis. In sum, we found different effects on typicality and liking space due to the varying distances.

Results of this study gave further evidence for a recalibration of the norm due to adaptation, which led to changes of the whole object space in regard to the perceived typicality and liking. As discussed above such a recalibration of the norm could account for changes in aesthetic appreciation in everyday life, where people familiarize themselves with new products, which might have a new shape or colour intensity. After familiarization these products then might become more typical and are thus more liked, whereas other older products with a less novel shape or colour intensity in turn become less typical and less liked. Such changes could reflect changes in object space as we found in the present study. Importantly, our study showed systemic reconfigurations of the whole object space due to adaptation effects, which were moderated by the observed variables (typicality and liking), the implemented dimensions (shape and saturation) and the distance of the adaptors to the tested stimuli.

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Critical Reflection

Results of Project V showed reconfigurations of the whole object space due to adaptation effects, which were moderated by the observed variables, typicality and liking, the implemented dimensions, shape and saturation, as well as by the distance of the adaptors to the test set. They gave further evidence for a recalibration of the norm due to adaptation and were in line with the norm-based model. However, further research is needed to shed light on the cognitive mechanisms working within near distances of the adaptors as we also found effects in line with the mere exposure effects in Experiment 3. Is there a mere exposure effect, thus an enhancement in ratings, not only for the variable liking, but for others, too? And are the cognitive mechanisms behind adaptation and mere exposure effects the same or different? These questions could probably lead to interesting further research, but could not be answered within the limited frame of the present research.

We found a rather complex interplay of moderations through the implemented independent and dependent variables. Importantly, results indicated that different dynamics in the object space seemed to occur in dependence of the importance of the implemented dimension for the variable (typicality or liking). Further research of dynamics in object space could therefore investigate further dimensions besides shape and saturation to find out how the strength of correlation between the dimensions and the investigated variable(s) impact the dynamics. In this line the stimulus material should be very carefully manipulated and pre-experimentally matched to equate the levels of variation across different dimensions. In the context of the current project we were more interested in generally developing a framework for testing adaptation effects in a multidimensional object space, so we did not pay specific attention to equating the dimensions, here the levels of shape and saturation. Although even a strong inequity disparity would not account for the observed differences between typicality and liking, it could account for general differences in the strength of the adaptation effect between shape and saturation. Furthermore, a (pre-) study could shed light on the proposed differences in degrees of correlation between the dimensions and the dependent variable(s).

In sum, Project V to our knowledge showed for the first time adaptation effects of AA (including the variables liking and typicality) with systematically varied stimulus material of an artificial category, since most research in this field concentrates on natural categories, mostly faces. Aside from that only Carbon (2010) showed adaptation effects for liking within the artificial category of cars, however, not with highly controlled and systematically varied stimulus material as done here. Additionally, we developed the face space model further to be a helpful framework for employing aesthetic research in it, especially to visualise how the perceived typicality and liking space changes due to adaptation.

VI. Jump on the innovator's train: Cognitive principles for creating appreciation in innovative product design

Motivation

The general motivation for Project VI was similar to Project V: to investigate dynamic changes in object space due to adaptation. However, in this project we concentrated on potential transfer effects from specific objects used as adaptors to other objects in a test set. In real contexts we often find innovative features of products, which are introduced by a certain brand. If the innovation is successful it is likely to be copied by competitors after some latency. Within this project we experimentally observed whether products imitating such innovative features could gain similar appreciation and thus, whether they could link to the innovator's successful track. Specifically we varied the similarity of the products, imitating the original, while all imitating products included the innovative feature, a certain proportion and saturation.

In line with the above mentioned distributed semantic network theory (Hutchison, 2003) one could argue that each exemplar of a category represents a concept within the distributed network of a category. An exemplar (e.g. chair) would then be represented by different weighted features (e.g. a certain number of legs, a chair back, a seat). The more similar two exemplars are the more features they will have in common. Within the shared features very similar exemplars would have the very similar weights, for example they would have the same kind or thickness of legs. In Project VI we proposed that the more similar an exemplar (chair) would be to the adaptor (chair with highly distinctive features) the stronger the adaptation effect would be, since the network of similar exemplars is more overlapping and features are similarly weighted than for dissimilar ones. Thus, the adaptation to one specific feature (here elongated chair-back) would affect similar chairs more than dissimilar ones leading to comparable developments of evaluation of this exemplar to the adaptor.

We implemented this research idea through an object space with the dimensions proportion and saturation assessing the variables typicality and liking. We introduced one "adaptor" chair and three others, which varied in similarity to the adaptor chair to determine whether dynamics in typicality and liking space could be shown in a transfer condition and whether these dynamics would be moderated by the similarity of the exemplar to the adaptor.

Original Paper

Running head: Transfer effects of product appreciation

Jump on the innovator's train:

Cognitive principles for creating appreciation in innovative product design

Stella J. Faerber[1, *] and Claus-Christian Carbon[1]

University of Bamberg

[1] both authors contributed equally to this work

[*] corresponding author:

University of Bamberg

Department of General Psychology and Methodology

D-96047 Bamberg, Germany

E-Mail: stella.faerber@uni-bamberg.de

Phone: +49 951 863-1864

Fax: +49 951 601-511

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Author note

Please address all correspondence to Stella J. Faerber at the Department of General Psychology and Methodology, University of Bamberg, D-96047 Bamberg, Germany. E-mail: stella.faerber@uni-bamberg.de. We would like to thank Andrea Lyman for proofreading the text and Sabine Albrecht, Jörn Freese, Claudia Gorr, Sabine Kügel and David Winkelmann for conducting parts of the experimental data.

Abstract (135 words)

In real life we find shared preferences for specific product applications such as Apple's iPhone or iPad, which after gaining acceptance and appreciation are susceptible to being copied by competitors. Psychological research on the phenomenon of shared preferences and the probable benefit of copying innovative design features is still lacking. We tested gains of appreciation for imitators through an adaptation paradigm where typicality and liking of such innovative features were analysed in a dynamic way. We found significant changes in typicality and liking for close imitators being highly similar to the original. When innovative features become more typical and more liked through familiarization appreciation increases. This process which evidently needs time and elaboration creates the specific opportunity that imitators who jump on the innovator's bandwagon by introducing similar features are participating in the innovator's success.

Jump on the innovator's bandwagon:

Cognitive principles for creating appreciation in innovative product design

In real world contexts, we find high amounts of shared taste for consumer products demonstrated by clear market dominance of specific brands in different application areas, such as the supremacy of Apple's iPhone or the iPad (Rawsthorn 2006). Systematic research investigating the basis or the genesis of such phenomena of common-sense appreciation is rare, although the effects of taste and appreciation on the markets are of major relevance making it a fundamentally important issue of psychological research.

One major factor for generating a shared basis for aesthetic appreciation is adaptation towards frequently presented design properties inducing so-called "cycles of preferences", synchronized preferences for similar product outward appearances (Carbon 2010). In 2001 BMW presented the highly innovative 7-series (E65) with a unique design element (Kreuzbauer and Malter 2005), the mockingly termed "Bangle Butt" (named after the chief-designer Chris Bangle), leading to controversial discussion and consumers' rejections. Importantly, from a theoretical point of aesthetic research, the Bangle Butt was not only accepted after a while underlining the importance of familiarization (Zajonc 1968) and elaboration (Carbon and Leder 2005), but has even been imitated by competitors such as Mercedes-Benz S-Class (W221) and Lexus LS-series (USF-40).

To create an experimental analogy, we generated computer-aided designs of chairs, which differed in the degree of overlap between the "adaptor chair" (analogous to the innovative product, here the BMW) and "imitating chairs" (analogous to the imitating products, here the Mercedes/Lexus) to reveal transfer effects of appreciation from the "adaptor" to the "imitators". Following the idea of appreciation being a rather complex, multidimensional construct (Faerber et al 2010), we used two key variables of product appreciation, *typicality* and *liking* (Hekkert et al 2003).

Method

Participants

Forty undergraduate students (33 women; M=21.6 ys, SD=3.5; normal vision and color abilities) participated for course credit.

Stimuli

All stimuli used in the experiment were a subset of four large bidimensional sets consisting of different photo-realistic 3D chair models (Evermotion) varying on 10 (*proportion* = elongation of chair-back; 1=original, 10=most elongated) ×

10 levels (*saturation* of red; 1=most saturated, 10=least saturated). For the test-set we employed 3 × 3 levels of proportion x saturation (both times: levels 1, 3, 5) including the adaptor chair and 3 "imitating chairs" (imitator 1-3). By conducting two pre-studies we assured increasing differences of outward appearance from imitator 1 to 3 compared to the adaptor chair. In pre-study 1 (N=8) and pre-study 2 (N=6) participants rated pairwise the overall similarity between the chairs and the similarity of the chair backs, respectively, on a 7-point Likert scale (1="very dissimilar", 7="very similar") yielding the ratings in Figure 1. For the adaptation-set we used 2 x 2 levels of proportion and saturation (levels 9, 10), represented by 4 variants of the adaptor chair with different hues. Due to the usage of extreme levels of both design dimensions the adaptation-set represented highly distinctive chair features analogous to BMW's Bangle Butt.

Procedure

To test sustained adaptation effects (Carbon and Ditye in press; Rhodes et al 2009), we decided to divide the experiment into two sessions with a delay of at least two days. In the first session, we conducted a pre-adaptation evaluation followed by a first adaptation phase, while the second session started with a shorter adaptation phase followed by a post-adaptation evaluation. In both identical evaluation phases, we first collected the variable liking and then typicality through relative judgements similarly to Buckingham, DeBruine, Little, Welling and Conway (2006) by showing two stimuli of the test-set (same chair model) simultaneously and asked the participants, which of the two chairs they liked more or found more typical. In a self-paced rating procedure, participants indicated on a 5-point Likert scale how much more they liked the chosen chair (or to which extent they found it more typical) than the other model displayed (the higher the value, the stronger the difference, from "little" to "very much").

In both adaptation phases we used the Repeated Evaluation Technique (RET; Carbon and Leder 2005), in which individually tested participants rated the randomized stimuli on different attributes (24 and 12, respectively) such as elegant or functional to realize a deep elaboration of the adaptation-set.

Results and discussion

Our main interest concerned the empirical proof of transfer effects of appreciation from highly distinctive designs typically shown by so-called "innovators" (Rogers 2003) to more or less similar products imitating those features. We indeed found clear transfer effects modulated by the similarity of the imitators to the adaptor for both variables (typicality and liking) that we subsumed under aesthetic appreciation (Figure 1).

Insert Figure 1 about here

The typicality for eight out of nine stimuli changed significantly for the adaptor chair as well as for imitator 1, while we obtained seven significances for imitator 2 and only five for imitator 3. We observed far less pronounced adaptation for liking than for typicality, with only three significant changes observed for the adaptor chair, two for imitator 1 and only one for imitator 3. In sum, the more similar the imitator the stronger the changes of appreciation were after having inspected highly distinctive design features. The pronounced effects on changes of typicality indicate that the mere exposure to new, innovative and unfamiliar design properties increases the typicality of such properties, making them more familiar and common, and thus, enabling their integration into the visual habits (Carbon and Leder 2005). Such a familiarization, which also leads to higher liking (Bornstein 1989), seems to be the essential precondition of accepting and truly appreciating new and innovative design (Hekkert et al 2003).

Moral of the study: the true "innovators" (Rogers 2003) providing innovative, and consequently distinctive, designs have one major advantage: they are the first such models on the markets. Unfortunately, it can be demonstrated that humans lacking visual habits towards innovative designs dislike them (Leder and Carbon 2005), because they need time and elaboration to appreciate them (Carbon and Leder 2005). Ironically, imitators benefit from this delay, especially if they capture the unique design elements of innovators, while decreasing their own idiosyncrasy.

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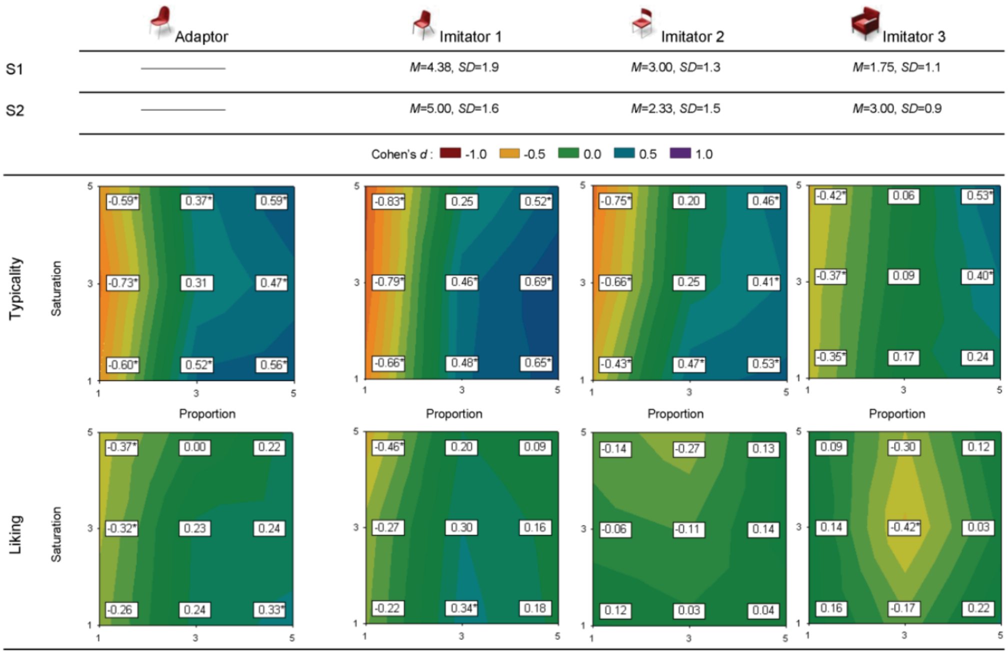
Figure captions

Figure caption 1. Adaptation and transfer effects of product appreciation. This figure shows the implemented bidimensional test-set including the levels 1, 2, and 3 for both dimensions (saturation and proportion) for all chairs. Effect sizes of changes over time for typicality and liking are indicated by Cohen's *d* of the *T*-tests (T2 vs T1). Furthermore, similarities of the whole chair (S1) and the chair backs (S2) of each "imitator" chair compared to the adaptor chair are shown through *M*s and *SD*s in the top rows.

Figure

Figure 1.



Critical Reflection

In Project VI we found clear adaptation transfer effects for typicality and liking moderated by the similarity of the "imitator" chair to the "adaptor" chair. These results provide further evidence that firstly, not only the typicality ratings, but also the liking ratings of objects are accessible for adaptation effects. Secondly, transfer effects for these adaptation effects could be shown. (Neural) representation of specific features or properties of exemplars seem to exist, which when adapted through new experiences, influence the perception of other "novel" exemplars. A next step could be to investigate transfer effects over categories, for instance the appreciation of a specific feature property from architecture (shape of the windows of a façade) to cars (shape of the side windows).

In contrast to Project V, we did not find transfer effects for the dimension saturation in Project VI. There could be several reasons for this result: firstly, effects of the dimension proportion were so strong that weak effects of saturation could not be revealed through the used rating scales any more. This is rather unlikely, since we could detect effects of both dimensions in Project V. Secondly, the adaptation paradigm was slightly different to that in Project V. In Project VI the adaptors consisted of only one chair model, which additionally varied regarding the hue. The perception of hue might interact with the perception of saturation and thus, the low saturated adaptors might not all be perceived as being saturated on the same low level. This interdependence of hue and saturation might have weakened the adaptation effect. Thirdly, the experimental procedure of Project VI compared to Project V had been carried out under different lighting conditions and on different test computers. It is likely that the saturation levels under these conditions had not been perceived very well. This could be checked by comparing the saturation ratings in test time 1 of both projects. It is likely that the variation of the adaptors regarding the hue as well as the different laboratory conditions led to the absence of adaptation effects within Project VI. Future projects should therefore check for laboratory conditions with constant and clear presentation of saturation, ensured by special measuring devices that assess the luminance, hue and saturation. Another possibility would be the inclusion of further dimensions of the adaptors, which do not interact with other implemented dimensions.

General Discussion

Aim of this thesis was to demonstrate the dynamic quality of aesthetic appreciation (AA) for artificial categories and to illustrate how such dynamics develop over time. All projects gave further evidence for the dynamic quality of AA within artificial categories. Thus, within different experimental paradigm we systematically showed that new experiences are capable of influencing our perception and AA. We demonstrated that the norm of a category is recalibrated during or after such experiences leading to changes in perception. However, the perception does not necessarily change immediately due to new experiences, e.g. design classics keep their high appreciation for a very long time, but we revealed the general capability of the cognitive apparatus to dynamically change the AA of an object leading to an increase or decrease of appreciation over time.

In **Project I** (priming semantic concepts) we challenged the idea of AA being a construct, which exhibits a combination of different variables. The value-combination of these variables would determine whether an object will be aesthetically appreciated or not. Results of this project provided evidence of the moderating effect of primed semantic networks on the dynamics of AA. We found qualitative as well as quantitative difference of the impact of the primed networks, which were not determined due to the mere length of the experimental procedure. Also, we showed that the elaboration of the material during the Repeated Evaluation Technique (RET) phase caused an additional increase in the dynamics underlining the importance of elaboration in general and the high utility of techniques addressing such cognitive processes like the RET in particular.

Project II (context dependent effects) concerned effects of the implemented stimulus set (heterogeneous versus homogenous) and showed that the used stimulus set affects the dynamics of AA. A possible interpretation is in line with Bornstein (1989) and Tversky (1977) that stimulus material is always judged in relation to each other. However, we showed that such set effects also concern dynamical changes in perception, here AA. In **Project III** we specifically addressed situational aspects (danger or fascination?) realized through the usage of implementation of different sets of attributes during the RET phase. Within this procedure we aimed to direct the awareness of the participants to dangerous and inconvenient aspects of the interior designs or to fascinating ones. We showed effects of the implemented attributes during the RET phase leading to differential dynamics especially for low and highly innovative stimuli. Further research could observe the impact of inducing positive or negative emotions on the dynamics of AA including a manipulation check. **Project IV** (variables' dynamic interplay) aimed to shed light on the relation of the implemented variables of the construct of AA of Project I (attractiveness, arousal, interestingness, valence, boredom and innovativeness). We found medium to high correlations of all variables with attractiveness, which increased after dynamics of AA were triggered by the RET procedure. Innovativeness was the only variable (assessed before the RET phase), which could predict later attractiveness ratings (after the RET phase). Thus, innovativeness had the best potential for predicting future appreciation.

Projects V and VI observed changes in the psychological space of objects (typicality and liking space) via adaptation paradigms. Importantly, both projects provided further evidence for the norm-based model of categories (e.g., Robbins, McKone, & Edwards, 2007) and showed, to our knowledge for the first time with systematically controlled stimulus material, that the liking of an object changes due to adaptation paradigms and furthermore that adaptation can lead to the recalibration of the whole object space. Results of **Project V** (dynamics of object space) pointed out that the correlation of typicality and liking is not simply linear as would be predicted of the average or preference for prototype hypothesis, but instead might be more complex, e.g. curvilinear. Strikingly, the effect of adaptation seems to be moderated by the importance of the adaptive dimensions for the observed variable as we found stronger adaptation effects for shape than for saturation for the variable typicality. This result could lead to further systematic research in this direction. We also found a moderating effect of the distance of the adaptors to the test set, however, not clearly in line with the norm based model. This model would predict stronger adaptation effects the more dissimilar the adaptors were to the test set. Results of Project V seemed to be moderated by mere exposure effects. Finally, in **Project VI** (the innovator's train) we showed adaptation transfer effects for typicality and liking, which were moderated by the similarity of the tested chair models to the adaptor chair.

Within this thesis the AA was always assessed through more than one variable, thus as a construct, from simply observing attractiveness and innovativeness or liking and typicality to the most extensive implementation through the six variables: attractiveness, arousal, interestingness, valence, boredom and innovativeness. Although the implementation of AA as a construct seems promising (see section motivation of Project I) further research is needed to find out, which concepts or variables are central parts of the construct of AA and how they relate to it and to each other.

What did these projects find out about the limits and scopes of the RET procedure? By introducing the RET Carbon and Leder (2005b) investigated dynamics of attractiveness and innovativeness of product designs (car interiors) within a test-retest design and an intermediate RET phase. In Project I-IV we found evidence that the assessment of the variables at test time 1 (before RET phase) influences the dynamics of AA through the priming of semantic concepts, which may lead to a pre-activation of the relevant neuronal networks and/or lead to further thoughts and expectations of the participants concerning the AA and related topics. Importantly, priming alone did not account for the typical “RET effect” that dynamics of AA do emerge. In this sense expectations and thoughts about the stimulus material might be influenced by the kind of attributes used in the RET phase (Project II). Furthermore, even the kind of stimulus set in use should be considered while investigating the dynamics of AA or using the RET procedure, since a set of stimuli will be judged in relation to each other (Tversky, 1977). Thus, when using the RET, for example, for market research, these aspects should be carefully considered while investigating future AAs of products.

Inspired by Valentine’s face space framework (1991) we extended this idea from observing similarities within a category to other variables and most importantly observed the reconfiguration of such a psychological space over time. Results of this work could initiate further research. Apart from e.g. investigating the importance of the observed dimensions in relation to the strength of the adaptation effect as mentioned above the relation and differences of liking and typicality ratings could further be observed. For example, there might be differences between the agreement within typicality and liking ratings over participants, which could be analysed over the analyses of variances of the ratings. More obvious, this research approach could lead to analyses of changes in typicality and liking space via multidimensional scaling techniques (MDS).

The generalization of the results of the reported projects might be limited since Projects I-IV employed the same stimulus material using photo-realistic pictures of car-interiors and Projects V and VI included the usage of photo-realistic pictures of different chair models. As adaptation effects have been shown within a variety of artificial and natural categories (for instance, faces, bodies) similar effects for other stimulus material concerning other categories are highly probable. A further critical aspect concerning the stimulus material and the results of Projects I-IV concerns the importance of the awareness of innovativeness. For examples, we found an impact of priming the semantic concept innovativeness and results for innovativeness being a predictive variable for attractiveness – concerning stimulus material, which varied on this dimension. Thus, the results of Projects I-IV should be reconsidered in this respect. However, design theory claims that appreciated objects are "Most Advanced Yet Acceptable" (the MAYA principle) (Hekkert, et al., 2003) and therefore should exhibit at least to some extent novel – innovative – aspects, which underlines the importance of novelty or innovativeness for AA.

Within this thesis we did not take into account inter-individual differences between participants, for instance, their socialisation, culture or personal characteristics. However, as mentioned in the section general motivation these subjective factors influence the AA of an object and are likely to influence the dynamics of AA. Thus, one very important step further would be to take inter-individual differences into account while investigating the dynamics of AA.

Results of the projects of this thesis have an impact on general principles of psychology (e.g. adaptive nature of perception and representation) as well as more applied ones (e.g. market research). They shed light on the underlying principles of the development of AA, namely the dynamic nature of appreciation effects. They challenged the experimental implementation of AA and suggested the investigation of AA as a construct to capture a more holistic view on the phenomenon of dynamics in aesthetics. Lastly, the work questioned the underlying neuronal structures concerning the processing of AA regarding the constitution and architecture of these neural networks to demonstrate possibilities of future research combining different methods and techniques from different fields of research such as the neurosciences.

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