New Ideas in Psychology xxx (2017) 1–9

Contents lists available at ScienceDirect

New Ideas in Psychology

journal homepage: www.elsevier.com/locate/newideapsych

Towards a unified model of aesthetic pleasure in design

Michaël Berghman [1], Paul Hekkert*

Department of Industrial Design, Delft University of Technology, Landbergstraat 15, 2628 CE Delft, The Netherlands

ARTICLE INFO

Article history:
Received 31 May 2016
Received in revised form
7 March 2017
Accepted 17 March 2017
Available online xxx

Keywords:
Product design aesthetics
Safety and accomplishment needs
Unity-in-variety
MAYA

ABSTRACT

In this study we test the Unified Model of Aesthetics (Hekkert, 2014), which posits that the aesthetic sense has evolved to identify and value prospects for safety and accomplishment. The principles of unity-in-variety, most-advanced-yet-acceptable and autonomous-yet-connected are considered manifestations of these conflicting urges at separate levels of stimulus processing. We empirically integrate these principles to gauge their unique contribution to the aesthetic experience, using two distinct surveys (study 1—300 respondents and 20 stimuli, study 2—60 respondents and 24 stimuli). Both surveys confirm the three principles constituting the Unified Model of Aesthetics. The principles are found to operate independently and jointly, although unity-in-variety has the strongest impact on aesthetic pleasure.

1. Introduction

When considering cars, phones or clothing, it does not take much effort to realize that products can evoke sensory delight. In recent years academic interest for product aesthetics has burgeoned, finding that products' perceived beauty contributes to their usability (Sonderegger & Sauer, 2010) and market success (Landwehr, Wentzel, & Herrmann, 2013). Moreover, aesthetic considerations are not restricted to certain 'aestheticized' product categories. Even objects as mundane as toothbrushes or food packaging can have an aesthetic impact on users, as they too are the result of more or less careful design.

However, *knowing that* aesthetic pleasure matters for product design does not necessarily imply *understanding why*. For that purpose, we are generally referred to the vast literature concerning aesthetics in the arts, which has identified a number of factors deemed relevant for aesthetic appreciation. Within psychology the branch of empirical aesthetics initially focused on objects' structural, perceptual features (e.g. Boselie & Leeuwenberg, 1985; Cupchik & Berlyne, 1979). When also taking into account an object's (proto-)typicality and meaning (i.a. Bornstein, 1989; Leder, Carbon, & Ripsas, 2006; Whitfield, 1983), it broadened its scope to aspects of a more cognitive nature. Additionally, research in social psychology and sociology has substantiated the social significance of aesthetic preferences (Bourdieu, 1993; Temme, 1992). Hence, although individual strands of research have identified a number of mechanisms to account for observed aesthetic preferences, paying heed to the intricately complex and multidimensional nature of the aesthetic experience, a more general theoretical foundation has so far been largely lacking. Therefore, much can be gained in the domain of object aesthetics from a more comprehensive, fundamental theoretical framework.

In this paper, we will elaborate and empirically test a framework that manages to reconcile diverse factors salient for product design aesthetics – the Unified Model of Aesthetics, originally coined by Hekkert (2014).

2. Safety and accomplishment

Aesthetic appreciation quite obviously differs a lot over time and across regions as well as individuals. It is therefore tempting to assume that it is heavily culturally mediated. The capacity in itself to unfold aesthetic appreciation, however, does appear to manifest itself universally. This has given way to the dominant view in psychology that aesthetic sensitivity must be part of the human biological make-up and, by implication, that it has developed throughout the evolution of our species (e.g., Hekkert, 2006; Pinker, 2002; Ramachandran & Hirstein, 1999). Moreover, if its underpinning is biological, this feeds the expectation that, regardless of its variegated manifestations, the aesthetic experience abides to

* Corresponding author.
E-mail address: p.p.m.hekkert@tudelft.nl (P. Hekkert).
[1] Present address: Erasmus School of History, Culture and Communication, Erasmus University Rotterdam, Burgemeester Oudlaan 50, 3000 DR Rotterdam, The Netherlands. berghman@eshcc.eur.nl

http://dx.doi.org/10.1016/j.newideapsych.2017.03.004
0732-118X/

principles that apply universally as well.

In line with such an evolutionary account, we adopt a strict notion of aesthetic appreciation or aesthetic pleasure (see also Blijlevens et al., 2017), as "… The pleasure people derive from processing 'the object' for its own sake," "as a source of immediate experiential pleasure in itself, and not essentially for its utility in producing something else that is either useful or pleasurable" (Dutton, 2009, p. 52). Aesthetic pleasure thus conceived is an affective response that guides our adaptive behaviour (Damasio & Carvalho, 2013), supports perception (Barrett & Bar, 2009), and is distinguishable from emotions (e.g., Batson, Shaw, & Oleson, 1992; Brehm, Miron, & Miller, 2009). In contrast to emotions, which allow us to evaluate the beneficial or harmful nature of a situation, aesthetic pleasure serves no immediate practical function (see Hekkert, 2014). In order to account for this anomaly, the *by-product hypothesis* has taken root (Hekkert & Leder, 2008; Johnston, 2003). The success of our species has depended on its adaptation to varying circumstances. This has entailed reconciling two conflicting urges. On the one hand, we seek safety. Partly, we survive by staying out of harm's way. On the other hand, though, we need to take some risk as well. To find food and shelter, our species had to be able to take initiative with uncertain outcome. Therefore, a need for *accomplishment* has evolved to balance out the need for *safety*.

Instrumental to fulfilling these urges are our faculties. They provide information about our environment and thereby enable us to identify possible threats and opportunities. As fluent processing of this information thus entails an evolutionary advantage (see Reber, Schwarz, & Winkielman, 2004), it is assumed that we have developed an ability to derive pleasure from this sense-making process – an *aesthetic sense*. Aesthetic pleasure can thus be defined as pleasure that emanates exclusively from perceiving, from sensory-motor understanding in itself (Hekkert & Leder, 2008; Hekkert, 2014). As the aesthetic sense is a by-product of the faculties that allow us to make sense of our surroundings, it is likely to be triggered primarily in those situations that are conducive to the functioning of these faculties. In other words, aesthetic pleasure will be a function of the extent to which a stimulus can be processed smoothly in line with evolutionary drives. Whereas uncomplicated sensory information allows for an economical, fast and therefore safe operation of our senses, discordant input enables them to identify prospects for accomplishment. After all, the primary task for any organism is the preservation of life and the furtherance of conditions for growth (Damasio, 1999). Hence, the aesthetic pleasure evoked by a stimulus is hypothesized to depend on the perceived balance it strikes between these conflicting urges (Hekkert, 2014).

By no means the aforementioned should be taken to downplay the complexity of the aesthetic experience. As indicated above, factors of a perceptual, cognitive as well as social nature come into play. At these distinct levels of stimulus processing, different issues are at stake. Still, we argue that these can effectively be traced back to evolutionary drives. Therefore, UMA accommodates for multiple dimensions that can be considered different manifestations of the fundamental balance between safety and accomplishment. In the following paragraphs we will introduce three basic principles, pertaining to either the perceptual, cognitive or social plain.

2.1. Perceptual unity-in-variety

Throughout the literature, it has been substantiated repeatedly that people value perceptual input to be orderly and coherent. By presumably allowing easy and efficient perceptual processing *unity* increases aesthetic pleasure. This is most evident in the operation of the Gestalt laws, as documented by behavioral psychology. Stimuli that display symmetry, continuity, closure, repetition, …are found to make a coherent impression, and – for that reason – they are liked more (Arnheim, 1954; Wagemans et al., 2012).

However, as our environment is made up from diverse elements, our senses have evolved to cope precisely with this variety of information. If perceptual input would be overly unified, the senses would get dulled (Berlyne, 1971; Biederman & Vessel, 2006). Therefore, we like some challenge in the form of *variety* to counterbalance unity, if only to enable us to perceive discrete entities. Thus, on the perceptual level, we derive aesthetic pleasure from stimuli that fulfill our need for both unity and variety.

Previous research has consistently provided robust support for the importance of unity-in-variety in the aesthetic appraisal of stimuli. In the domain of product design, both unity and variety, although negatively related, have been found to add to aesthetic appreciation when statistically controlling for one another. This clearly suggests that a maximization of both characteristics is liked best (Post, Blijlevens, & Hekkert, 2016).

2.2. Cognitive typicality and novelty

We need to bring structure into our experiences. Although unity and variety go some way in ordering our impressions, we need to attribute meaning to these impressions for them to be useful for further action. Therefore, cognitive processing entails recognizing and meaningfully categorizing perceptual input. To do this we rely on previous experiences. Encounters with similar stimuli provide a frame of reference, so higher similarity allows for smoother processing. In this vein, psychological research has established that appreciation rises with the sheer frequency of confronting a particular stimulus – a mechanism that has come to be known as the 'mere exposure effect' (Bornstein, 1989; Zajonc, 1968). Moreover, as we have to categorize the things we perceive, stimuli that are clear exemplars of a category can be processed more easily, which again drives appreciation (Whitfield, 1983). In other words, we value a degree of *typicality* as this increases recognisability.

On the other hand, stimuli that are novel are liked as well for enabling us to learn and enrich our experience (Bornstein, 1989). Similar to the account about the evolution of the senses on the perceptual level, Biederman and Vessel (2006) argue that this is due to our brain having adapted to cope with new, atypical information. Illustrating the balance between typicality and novelty, Biederman and Vessel (2006) find higher levels of appreciation for novel stimuli, but only on the condition that observers are able to recognize what they are seeing.

In the domain of product design, this balance has been subsumed under the acronym MAYA – aesthetic appreciation will be highest for designs that manage to be *Most Advanced, Yet Acceptable* (Hekkert, Snelders & Van Wieringen, 2003). In practice, it would seem to imply that we tend to like products that we can easily recognize (say, as a drill hammer, a television set or a car), but that offer a new take on such type of products.

The literature has provided substantiation to the MAYA principle, finding once more a negative correlation between typicality and novelty, but positive effects on aesthetic appreciation (Carbon, 2010; Thurgood, Hekkert, & Blijlevens, 2014).

2.3. Social connectedness and autonomy

Apart from the perceptual and cognitive impressions they make on us, objects, and more specifically consumer products, also function socially and evoke social meanings. In everyday usage, products (and the way they are designed) get associated with certain groups of people and assigned an affective value (Barrett & Bar, 2009). They come to symbolize a group identity and this in turn is likely to affect aesthetic appreciation of those belonging – or

Please cite this article in press as: Berghman, M., & Hekkert, P., Towards a unified model of aesthetic pleasure in design, New Ideas in Psychology (2017), http://dx.doi.org/10.1016/j.newideapsych.2017.03.004

aspiring to belong – to a group (Markus & Kitayama, 1991).

Again the reasons may be rooted in our species' evolution. Belonging to a group can be assumed to be beneficial because of increased reproductive possibilities and the pooling of resources. Group membership provides a level of security that could not be reached by individuals on their own (Axelrod & Hamilton, 1981). Herein lies the reason why we have evolved to find objects that symbolize group membership aesthetically attractive.

However, within the safe confines of the group, we benefit from standing out to some extent. From an evolutionary perspective, this can be explained in the sense that group members individually need to attract mates or make sure that they have their share of the resources. For that reason, we are likely to have incorporated a need to assert our autonomy. Thus, we aesthetically value objects that symbolize uniqueness from our reference group. This is also in line with sociological arguments on the use of cultural taste as a way to assert social status (Bourdieu, 1984). In sum, on the social level, our aesthetic experience of objects may be determined by the extent to which they signal both *connectedness* and *autonomy*.

Compared to the literature on unity-in-variety and MAYA, research on the importance of social dimensions is less extensive in the domain of design aesthetics. Yet, the studies that have been conducted so far do lend support to a positive impact of both connectedness and autonomy (Blijlevens & Hekkert, 2015).

3. Unifying the unified model

Fig. 1 provides a schematic overview of the unified model of aesthetics. It can be seen how the aesthetic appreciation of products is determined by a single set of conflicting needs for safety and accomplishment, which is instantiated through distinct principles on various levels entailed in the processing of stimuli. Individually the principles we have introduced on the preceding lines have been tried and tested previously. However, as they refer to distinct aspects of stimulus processing, they are likely to impact the aesthetic appreciation of product design in different ways. In other words, notwithstanding the fact that they have similar underpinnings, it is quite probable that they will exert their effect – at least partly – irrespective of one another. Aesthetic appreciation for a product will therefore derive from the combined effect of perceptual, cognitive as well as social factors working simultaneously. In the present study, our aim is to empirically establish the effects on aesthetic appreciation proposed by UMA. In doing so we are testing a conceptual framework that manages to integrate factors that have so far only been considered in isolation. In that sense, we offer a notably comprehensive understanding of design aesthetics. This is specified throughout a number of hypotheses.

Given the earlier work on the principles constituting the three levels of UMA (i.a. Post et al., 2016; Blijlevens & Hekkert, 2015; Thurgood et al., 2014), we will initially test whether we can replicate formerly established effects. We will do so on a larger set of products, involving greater numbers of participants. Therefore, the first hypothesis is as follows.

Hypothesis 1. *At each level conflicting qualities together increase aesthetic appreciation.*

As a step-up to a more integrated approach, we investigate the underlying conflicting needs that are held to be instantiated at various levels of the UMA model. Arguably it is not possible to directly observe the connection between particular factors affecting aesthetic appreciation and their assumed evolutionary roots using the type of quantitative data as we do. However, regardless of the different nature of the various levels of UMA, it can still be expected that the dimensions of safety and accomplishment seeking can be detected in the data across the levels.

Hypothesis 2. *Unity, typicality and connectedness refer to a single underlying dimension and so do variety, novelty and autonomy.*

As a consequence of a theoretical backdrop that traces aesthetic preferences back to evolved human biology, the principles posited by UMA are held to be universal in scope. That is to say, in principle any person should display higher aesthetic appreciation for products (and stimuli in general) that strike a balance between unity and variety, typicality and novelty and autonomy and connectedness, in line with the ingrained needs for safety and accomplishment. However, as mentioned, differences in aesthetic appreciation across time and individuals point to the fact that people tend to disagree in matters of aesthetics. As adaptations enable us to cope with our environment, different circumstances (i.e., culture, background, expertise) will lead to different responses (Hekkert, 2006). The reasons for aesthetic experience may very well be stable, its manifestation could still differ considerably. Therefore, we posit that UMA principles apply universally, but only on the level of subjective experience. By way of illustration, factors like novelty and typicality may have an effect on aesthetic appreciation that is rather stable across people, but individuals may differ concerning what they deem typical or novel and, correspondingly, their appreciation of products may diverge.

Still, the distinct levels of UMA differ in nature, as they play a different part in processing and rely on different information. Some of this information is accessible to perceivers in general, whereas some of it requires interpretation. As a consequence, we may expect interpersonal differences to vary from one level to the next. Unity and variety refer to the organization of perceptual information, which requires little interpretation on the part of the perceiver. Determinants of unity – like symmetry, continuity, and so on – can be observed fairly easily, and so can the sheer number of elements (as the main determinant of variety). Hence, intersubjective consensus is likely to be still pretty high for these factors (but not perfect, through training people may still acquire a heightened

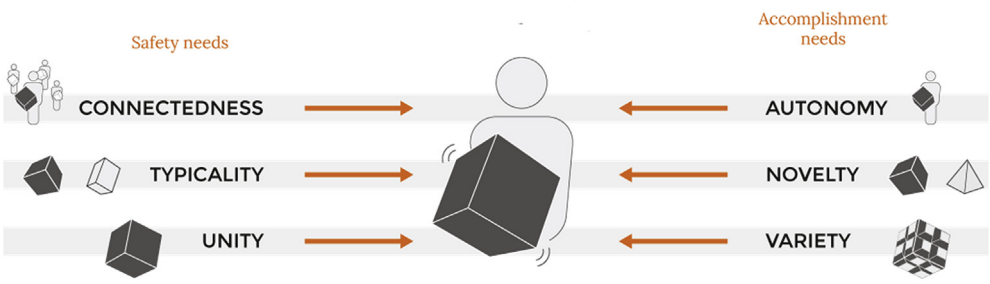

Fig. 1. Unified model of aesthetics.
Safety and accomplishment needs on the perceptual, cognitive and social level of stimulus processing.

Please cite this article in press as: Berghman, M., & Hekkert, P., Towards a unified model of aesthetic pleasure in design, New Ideas in Psychology (2017), http://dx.doi.org/10.1016/j.newideapsych.2017.03.004

sensitivity for these features – Hekkert, 2006). When concerning cognitive processing, differences may be considerably larger as the assessment of typicality or novelty presupposes comparison with earlier experiences. Obviously, some people have had more experience with particular products, which will stretch their understanding of what is typical and will therefore enhance their tolerance for novelty for that type of products. On the social level, interpersonal differences can be expected to be even larger. Connectedness and autonomy are asserted with reference to a certain group of people. Whether a product signals connectedness or autonomy therefore depends on the group one considers oneself to be part of. Formally, we hypothesize as follows.

Hypothesis 3. *Assessments of connectedness and autonomy will differ more across subjects than assessments of typicality and novelty, which in turn will differ more than assessments of unity and variety.*

The strength of UMA lies in the fact that it goes beyond a unidimensional explanation of aesthetic appreciation. The principles at its various conceptual levels exert an effect on aesthetic appreciation in combination. As they refer to different aspects of the product experience and therefore to different qualities of the product, they are expected to have a unique effect on aesthetic appreciation. This means that we do not expect any of the levels to entirely comprise any of the others. Therefore, taking into account three levels will provide a better explanation for aesthetic appreciation than only accounting for a single or two levels. As a consequence, the main goal of this study can be captured by the following set of hypotheses.

Hypothesis 4. *a. The various principles of UMA have a unique effect on the aesthetic appreciation of products.*

b. A larger amount of variance in aesthetic appreciation will be explained when adding additional principles to the model.

The preceding hypotheses are tested through two surveys in which respondents are requested to evaluate a set of products on aesthetic appreciation as well as the concepts accounted for by UMA. We will consider visual aesthetics in particular, keeping up with the dominant focus in psychology of aesthetics. However, there is no reason to assume that the principles under scrutiny would be limited to the visual domain. For example, research has established similar effects of tactile unity and variety (Post, Blijlevens, & Hekkert, 2014). This is beyond the scope of the present study, although we do realize that this implies a considerable limitation to the reach of our findings. In the following section we will address the methodological specificities of the research design.

4. Methodology

4.1. Stimuli

The data for the present analyses were collected in the course of two distinct surveys in which images of products belonging to various product categories were presented to respondents. The stimuli for both surveys were taken from prior research conducted on distinct levels of UMA (Blijlevens & Hekkert, 2015; Post et al., 2016; Thurgood et al., 2014).

For the first survey, the stimulus set consists of images of twenty products belonging to five product categories (1. bicycles, 2. sunglasses, 3. dining tables, 4. espresso makers, 5. table lamps – four products per category). The product categories were chosen to obtain a broad enough range of products – comprising electrical appliances, fashionable accessories, furniture and vehicles. Particular products were selected that had previously garnered high, moderate as well as low levels of aesthetic appreciation and varying scores on the principles under scrutiny in the studies they were taken from. This was done exclusively to ensure sufficient dispersion on the variables under scrutiny.

In the second survey, only two product categories were involved (1. espresso makers, 2. bicycles), but the number of stimuli per category was increased from four to twelve, bringing the total number of stimuli to 24. The approach with two surveys was done to obtain both breadth and detail in the data, while keeping the numbers of stimuli practically feasible for respondents. The survey with more product categories ensures that results are not limited to particular product types, thereby enhancing external validity. The survey with more stimuli per category was done to ascertain that results were not the outcome of selectivity in stimulus selection. Hypotheses are tested on both data sets separately.

4.2. Sample and data collection

Both surveys were administered online through the crowdsourcing platform Amazon's Mechanical Turk. A growing body of literature vouches for the response quality of this platform for psychologically oriented research (for more information on the operation and quality of data collection on Amazon Mechanical Turk, we kindly refer the reader to Buhrmester, Kwang, & Gosling, 2011; Paolacci, Chandler, & Ipeirotis, 2010). Respondents were instructed to rate the entire set of stimuli, so respondents participating to survey 1 individually rated 20 products, those participating to survey 2 individually rated 24 products. To further ensure data quality, we built in a number of attention checks.[2] Respondents who failed these, could not finish the survey and their response was not taken into account. Also, the survey could only be taken from a desktop or laptop computer to ensure adequate viewing conditions and it was only accessible for people located in the United States. This was done to avoid effects of varying cultural sensitivities (Hekkert & Leder, 2008). We do recognize that the United States are culturally quite diverse, but what mattered for our concerns was that people living in this country are generally aware of and have access to similar products.

In both surveys, the order of the stimuli was randomized between respondents to rule out order effects. Per stimulus, respondents saw an image of a product together with a list of items for evaluation on a single web page. Before evaluating the stimuli, the respondents had to grant their informed consent, after which they could indicate their age and sex. To get acquainted with the procedure, they had to rate a trial product. This product was a watch and therefore did not belong to any of the product categories involved in the actual study. The data obtained from this trial were left out of the analyses.

In this way, we recruited two independent samples. Only response from people who finished the entire survey was included in the analyses. Survey 1 had a sample of 300 individual participants (43.3% female – mean age 33.22, SD = 9.65), who were paid $4 for their participation. Hence, the resulting dataset consisted of 6000 data rows (300 respondents * 20 stimuli). Survey 2 had 60 individual participants (30% female – mean age 34.73, SD = 10.59), who were paid $4.5 (because of the larger number of stimuli to be evaluated), resulting in a dataset of 1440 rows (60 respondents * 24 products). The paid amounts were considered fair in view of the effort required.[3]

[2] At random places throughout the lists of items for evaluation, items were included instructing the respondent to tick a particular number. As the use of these checks was explicitly announced in the surveys' instructions, meeting these checks did not pose any challenge to a respondent carefully reading the statements.

[3] In survey 1, 147 additional people had started the survey, but were excluded from analyses for not finishing or failing attention checks. In survey 2, 26 people were excluded on these grounds.

Please cite this article in press as: Berghman, M., & Hekkert, P., Towards a unified model of aesthetic pleasure in design, New Ideas in Psychology (2017), http://dx.doi.org/10.1016/j.newideapsych.2017.03.004

4.3. Operationalization of UMA

In both surveys, participants were requested to rate the stimuli on a number of items referring to aesthetic appreciation and the various concepts comprised by UMA. These items were presented in the form of statements, to which the participants could indicate their level of agreement on a seven-point scale (1 = 'fully disagree', 7 = 'fully agree' – intermediate scores were not labelled). Per stimulus, statements were presented in a randomized order. For aesthetic appreciation, unity, variety, novelty and typicality, the statements were taken from a battery of items that has been validated to measure these concepts (Blijlevens et al., 2017). The items on autonomy and connectedness were adapted from a study establishing the effect of social considerations on aesthetic appreciation (Blijlevens & Hekkert, 2015).

The following items were used.

Aesthetic appreciation
(*survey 1—mean=4.62, SD=1.55, Cronbach's* $\alpha = 0.93$).
(*survey 2—mean=4.62, SD=1.49, Cronbach's* $\alpha = 0.94$).

- *This product is pleasing to see.*
- *The design of this product is beautiful.*
- *This product has an attractive design.*

Unity
(*survey 1—mean=5.08, SD=1.33, Cronbach's* $\alpha = 0.80$).
(*survey 2—mean=5.03, SD=1.26, Cronbach's* $\alpha = 0.80$).

- *The product is unified.*
- *The product is coherent.*

Variety
(*survey 1—mean=4.19, SD=1.69, Cronbach's* $\alpha = 0.81$).
(*survey 2—mean=4.59, SD=1.34, Cronbach's* $\alpha = 0.76$).

- *The product conveys variety.*
- *The product is rich in elements.*

Typicality
(*survey 1—mean=4.27, SD=1.98, Cronbach's* $\alpha = 0.93$).
(*survey 2—mean=3.92, SD=1.78, Cronbach's* $\alpha = 0.92$).

- *The design is typical for this kind of product.*
- *This is a standard design for this type of product.*

Novelty
(*survey 1—mean=4.14, SD=1.88, Cronbach's* $\alpha = 0.87$).
(*survey 2—mean=4.57, SD=1.58, Cronbach's* $\alpha = 0.87$).

- *This product is original.*
- *The design of this product is novel.*

Connectedness
(*survey 1—mean=3.49, SD=1.55, Cronbach's* $\alpha = 0.82$).
(*survey 2—mean=3.53, SD=1.55, Cronbach's* $\alpha = 0.87$).

- *The design of this product makes me feel connected to people like me.*
- *The design of this product shows that I am similar to people like me.*

Autonomy
(*survey 1—mean=3.89, SD=1.84, Cronbach's* $\alpha = 0.90$).
(*survey 2—mean=4.11, SD=1.74, Cronbach's* $\alpha = 0.90$).

- *This product design helps me to be unique in reference to people like me.*
- *The design of this product helps me to distinguish myself from others.*

For the purpose of analysis, variables were calculated by averaging the scores on the items referring to a particular concept. In line with the theoretical expectations of UMA, per conceptual level concepts are found to be negatively correlated (albeit moderately in some cases), indicating that they indeed refer to conflicting characteristics. Hence, in survey 1, for unity and variety: $r = -0.18$, for typicality and novelty: $r = -0.79$ and for connectedness and autonomy: $r = -0.07$. In survey 2, unity and variety: −0.03, typicality and novelty: $r = -0.74$ and for connectedness and autonomy: $r = -0.09$.

We should stress that the results from the study at hand are based on subjective evaluations from its participants. We have not systematically manipulated the stimuli to a certain effect, nor have we used information on the stimuli from the original studies they were taken from as 'objective' characteristics in our analyses. As we expect relations between aesthetic appreciation and the principles of unity-in-variety, MAYA and connected-yet-autonomous to manifest themselves subjectively in principle, it would make little sense to attempt to objectify certain product characteristics.

5. Results

5.1. Identifying UMA patterns

As a first step of the analyses, we checked whether the data were in line with the previous findings on UMA. For this purpose, we conducted a series of multivariate regressions to assess the effect on aesthetic appreciation of the distinct principles contained in the model separately. In other words, in this stage analyses were conducted taking into account only the two variables that constitute the principle working at a particular conceptual level of the model – unity and variety at the perceptual level, typicality and novelty at the cognitive level and connectedness and autonomy at the social level. These analyses may also serve as a point of reference for analyses combining multiple UMA principles in paragraph 5.3. For a proper estimation of statistical parameters, we have to account for the fact that individual respondents have rated multiple products and individual products have been rated by multiple respondents. As a consequence, ratings from individual respondents and for particular products may be clustered. It is possible that some respondents have a tendency to give higher ratings on average and, likewise, some products are rated higher regardless. Hence, there is a hierarchical structure in the data, with ratings being nested in two ways. Such variation is of no concern to our present purposes, so it should be formally accounted for to achieve proper estimations of the substantive effects (so-called fixed effects). Therefore, the regression analyses were conducted using cross-classified multilevel linear models, including random intercepts for both stimuli and respondents.

When taking into account only the variables at the perceptual level of stimulus processing, notwithstanding the fact that they are negatively correlated, both unity and variety bear a positive effect on the aesthetic score attributed to product designs – as expected. For unity effects are encountered of $\gamma_{10} = 0.46$ (s.e. = 0.01, $t = 34.337$, $p < 0.001$) in survey 1 and $\gamma_{10} = 0.59$ (s.e. = 0.03, $t = 22.803$, $p < 0.001$) in survey 2. Variety has an impact of

Please cite this article in press as: Berghman, M., & Hekkert, P., Towards a unified model of aesthetic pleasure in design, New Ideas in Psychology (2017), http://dx.doi.org/10.1016/j.newideapsych.2017.03.004

$\gamma_{20} = 0.52$ (s.e. = 0.01, t = 45.114, $p < 0.001$) in survey 1 and $\gamma_{20} = 0.47$ (s.e. = 0.02, t = 20.263, $p < 0.001$) in survey 2. In sum, in both surveys, effects on the perceptual level are quite substantial, and the relative importance of unity and variety differs across surveys. In both surveys, variance in random intercepts is significant at alpha = 0.01, meaning that average scores that were attributed differ between respondents and particular stimuli. In multilevel linear modelling, calculating R^2 as an indication of goodness-of-fit is quite uncommon as its interpretation is not straightforward. However, to obtain an idea of the proportion of variance explained by the fixed effects of the models we calculate Ω^2 as 1 minus the ratio of the residual error of a model containing both fixed and random effects and a model containing only random effects (as proposed by Xu, 2003). For survey 1, we thus find that 34% of variance is explained by the fixed effects of unity and variety. In survey 2, fixed effects account for 41% of variance in aesthetic appreciation.

On the cognitive plain, consistent with the theory of UMA, a multilevel regression of aesthetic appreciation scores renders positive effects of both typicality ($\gamma_{10} = 0.14$, s.e. = 0.01, t = 9.322, $p < 0.001$ in survey 1 – $\gamma_{10} = 0.32$, s.e. = 0.03, t = 11.404, $p < 0.001$ in survey 2) and novelty ($\gamma_{20} = 0.43$, s.e. = 0.01, t = 29.382, $p < 0.001$ in survey 1 – $\gamma_{20} = 0.50$, s.e. = 0.03, t = 16.176, $p < 0.001$ in survey 2). In survey 1 the effect of typicality turns out to be rather moderate, but still highly significant. This is notable, given the strong negative correlations between typicality and novelty in both surveys. These findings indicate clearly that although these variables are very contradictory, they are not the extremes of a single scale and they do refer to different characteristics. Hence, the MAYA principle is corroborated by these findings, as products are liked to be novel, but also sufficiently typical.

Again, variance in random intercepts for both stimuli and participants is significant ($p < 0.01$) for survey 1 as well as 2, indicating that the use of multilevel linear models is called for. Calculating Ω^2 as before tells us that in both surveys 12% of variance can be attributed to fixed effects of typicality and novelty.

At the social level, multilevel regression analyses again render significant positive effects of connectedness ($\gamma_{10} = 0.33$, s.e. = 0.01, t = 27.198, $p < 0.001$ in survey 1 – $\gamma_{10} = 0.39$, s.e. = 0.02, t = 16.148, $p < 0.001$) and autonomy ($\gamma_{20} = 0.39$, s.e. = 0.01, t = 35.661, $p < 0.001$ in survey 1 – $\gamma_{20} = 0.29$, s.e. = 0.02, t = 13.259, $p < 0.001$ in survey 2) on aesthetic appreciation. Once more, variance in random intercepts for stimuli and respondents is significant at alpha = 0.01. Explained variance amounts to 28% in survey 1 and to 25% in survey 2.

In sum, these initial explorations of the data seem to largely lend support to the individual principles contained by UMA, with positive effects on aesthetic appreciation of both conflicting qualities constituting the principles. This implies that for a product to be appreciated aesthetically, it should be taken to reconcile opposing qualities.

5.2. Testing general UMA assumptions

As a next step in the analyses, we tested whether the data conform to the general theory underlying the model. We therefore conducted a factor analysis with oblique varimax rotation on the various principles. As we did not want to impose restrictions on the analyses, we conducted exploratory analyses on the data. Again, this analysis took into account the fact that data are clustered. Hence, the presented factor solution is controlled for the clustering effect at the respondent level.[4] For both surveys, this renders a two-factor solution, accounting for 77.25% of variance in survey 1 and 72.77% in survey 2. This analysis clearly supports the underlying safety-accomplishment balance proposed by the theory – as in both analyses unity, typicality and connectedness load highly on one factor, whereas variety, novelty and autonomy load on the other. Not surprisingly, these factors are negatively correlated – $r = -0.37$ ($p < 0.05$) in survey 1 and $r = -0.34$ ($p < 0.05$) in survey 2. In Table 1 factor loadings are reported (loadings of survey 2 in italics).

As stated in hypothesis 3, we expect subjective experience of principles to differ to a varying extent between levels of UMA. In other words, it theoretically makes sense that people will be more similar in their assessment of perceptual properties than they will be in their cognitive and social assessment, as those depend on interpretation in relation to prior experiences and the groups they belong to. Such interpersonal subjective differences in assessments can be grasped on the basis of respondents' deviation from the mean score on the variables concerned, which is indicated by the variables' variance. Therefore, we test whether variance differs significantly between the conceptual levels of UMA. To this end, we calculate a variable that lists the variances for unity, variety, typicality, novelty, connectedness and autonomy by stimuli. Hence, per product there are six lines, corresponding to the six variables on which the product was rated. As a result, in the case of survey 1, this variable contains 120 cases (20 stimuli * 6 variables) and 144 cases (24 stimuli * 6 variables) in the case of survey 2. We then regress these variances on the levels they belong to (perceptual, cognitive and social), using a multilevel linear model with random intercepts for individual stimuli to account for levels of variance being higher or lower for particular products regardless of the variable that is being considered. The hypothesis finds clear support from these analyses. In survey 1, variance on the variables belonging to the cognitive level (typicality and novelty) is significantly lower ($\gamma_{10} = -0.41$, s.e. = 0.08, t = −4.959, $p < 0.001$) than that on connectedness and autonomy at the social level (reference category). As expected, variance on the perceptual variables of unity and variety turns out to be even lower ($\gamma_{20} = -0.71$, s.e. = 0.08, t = −8.524, $p < 0.001$). In survey 2, results are even more pronounced (perceptual level $\gamma_{10} = -0.94$, s.e. = 0.07, t = −12.850, $p < 0.001$, cognitive level $\gamma_{20} = -0.51$, s.e. = 0.07, t = −6.999, $p < 0.001$, as compared to the social level). These results indicate that people deviate less from the mean score when assessing cognitive and – especially – perceptual features. When compared to connectedness and autonomy, this implies indeed that the subjective experience of perceptual features is less open to individual interpretation and so is cognitive processing, albeit to a lesser degree.[5]

5.3. Combining UMA principles

To assess the combined effect of the principles constituting UMA, on the data from survey 1 a multilevel regression analysis was conducted of aesthetic appreciation on unity, variety,

[4] These analyses were conducted using the two-level exploratory factor analysis procedure of the Mplus statistical package. This procedure also renders a factor solution at the respondent level. At this level, the optimal solution in both surveys contained a single factor (merely indicating that some respondents have a tendency to rate higher, regardless of the criterion at stake). This solution is of no substantive concern to the present study, as it merely serves to obtain a proper estimation of the factor solution across respondents. For this reason, it is not reported.

[5] It could be argued that these findings are partly due to constricted variance, given the high mean scores in both surveys on especially unity, posing a ceiling effect on the variance of this variable. However, when repeating these analyses excluding unity – thus using only variety at the perceptual level – the pattern of results is highly similar in both surveys.

Please cite this article in press as: Berghman, M., & Hekkert, P., Towards a unified model of aesthetic pleasure in design, New Ideas in Psychology (2017), http://dx.doi.org/10.1016/j.newideapsych.2017.03.004

Table 1
Rotated factors on UMA principles.

	Accomplishment		Safety	
Unity	0.09	*0.11*	0.65	*0.61*
Variety	0.81	*0.73*	−0.04	*0.10*
Typicality	−0.56	*−0.44*	0.54	*0.63*
Novelty	0.77	*0.77*	−0.27	*−0.29*
Connectedness	0.22	*0.16*	0.65	*0.68*
Autonomy	0.82	*0.77*	−0.07	*−0.06*

typicality, novelty, connectedness and autonomy, again accounting for random intercepts for individual respondents and stimuli. On the basis of Ω^2 we find that fixed effects of this model account for 42% of variance in aesthetic appreciation. In line with hypothesis 4b, the combined model explains a substantially larger proportion of variance as compared to the models containing only pairs of variables from a single level (as reported in 5.1). However, even without looking at parameter estimates, the proportion of explained variance already gives an indication that the effects of UMA principles will not be additive. That is to say, the increase in explained variance is not as big as would be expected if effects of principles would not overlap. The parameter estimates are reported in Table 2.

It is notable that the effect of typicality diminishes and barely reaches significance as a result of accounting for variables at the other levels of UMA. A series of hierarchical regression analyses was run to see to the inclusion of which variables this decline is due (not reported). These indicate that both unity and connectedness account for about half of the original effect of typicality.

The other variables in UMA do maintain a more substantial positive effect on aesthetic appreciation. However, the effects decrease considerably when compared to the analyses where only variables belonging to a single conceptual level were included. Stated differently, there is a substantial overlap between the principles contained in the model, as also evidenced by the factor analysis reported before. The various principles do add to aesthetic appreciation in their own right, but their added value decreases. It is apparent, though, that the variables at the perceptual level (unity and variety) remain the strongest. It would seem that for a design to be aesthetically pleasing, the degree of unity and variety it features is a lot more decisive than its cognitive or social significance.

These analyses were replicated on the data from survey 2. This time we also tested whether effects differ depending on the type of product by including interaction terms with product category (calculated on centred variables to avoid multicollinearity between main and interaction effects).

This analysis accounts for 49% of variance in aesthetic appreciation on the basis of Ω^2. Again, a substantially larger proportion is explained by including three levels of UMA.

Parameter estimates are reported in Table 3. As concerns unity and variety, results are fairly similar to the ones obtained in survey 1, in the sense that both maintain a large positive effect on aesthetic appreciation. At the social level effects remain, but the effect of autonomy becomes markedly smaller as a result of including variables of the other conceptual levels. However, the effect of connectedness stands strong. The mildly significant positive interaction effect with product type indicates that this is especially the case for bicycles. Stated differently, although people also like espresso makers to signal connectedness to a group they feel part of, their aesthetic appreciation for bicycles depends even more on this social sensitivity.

At the cognitive level, effects are slightly more complicated. The effect of typicality now fails to reach significance. The significant main effect for novelty means that this property is deemed relevant for participants when assessing the aesthetic quality of espresso makers. When taking note of the interaction effect, though, we find that the main effect is compensated, which indicates that the novelty of bicycles is considered of less importance. These findings indicate that the impact of particular qualities depends on the product considered. In the discussion we will offer a tentative explanation for this.

6. Discussion

By and large, our findings offer clear support for the Unified Model of Aesthetics, which was the main interest of this study. Perceptual, cognitive and social factors contribute uniquely to the aesthetic experience. The fact that highly similar results were obtained from two distinct samples, surveyed on varying numbers of stimuli, lends further substantiation to these results. Some findings are of note in particular.

The effects at the perceptual level stand out. Compared to cognitive and social qualities, which depend on personal experience and circumstances, unity and variety can be deliberately

Table 2
Multilevel regression effects on aesthetic appreciation scores in survey 1.

Fixed effects				
Independent variables	Estimate	Std. Error	t	
(intercept)	−0.57	0.13	−4.694	***
unity	0.38	0.01	25.983	***
variety	0.33	0.01	22.892	***
typicality	0.03	0.01	1.533	*
novelty	0.09	0.01	7.203	***
connectedness	0.21	0.01	18.080	***
autonomy	0.17	0.01	12.362	***
Random effects				
	Variance	Std. Error	Wald Z	
residual	0.97	0.02	53.181	***
intercept (participant)	0.30	0.03	10.076	***
intercept (stimulus)	0.07	0.02	3.000	**

*p < 0.05 **p < 0.01 ***p < 0.001.

Table 3
Multilevel regression effects on aesthetic appreciation scores in survey 2.

Fixed effects				
Independent variables	Estimate	Std. Error	t	
(intercept)	−1.83	0.28	−6.607	***
unity	0.52	0.03	15.454	***
variety	0.32	0.04	8.957	***
typicality	0.06	0.03	1.824	
novelty	0.23	0.04	5.785	***
connectedness	0.19	0.03	6.427	***
autonomy	0.10	0.03	3.348	**
product type	−0.16	0.10	−1.646	
unity*product type	−0.03	0.04	−0.520	
variety*product type	−0.00	0.05	−0.068	
typicality*product type	−0.00	0.04	−0.022	
novelty*product type	−0.16	0.05	−2.909	**
connectedness*product type	0.08	0.04	2.075	*
autonomy*product type	−0.02	0.04	−0.399	
Random effects				
	Variance	Std. Error	Wald Z	
residual	0.81	0.03	26.003	***
intercept (participant)	0.21	0.05	4.536	***
intercept (stimulus)	0.04	0.02	2.566	*

*p < 0.05 **p < 0.01 ***p < 0.001.
Product type was dummy coded '0 = espresso maker' and '1 = bicycle'.

Please cite this article in press as: Berghman, M., & Hekkert, P., Towards a unified model of aesthetic pleasure in design, New Ideas in Psychology (2017), http://dx.doi.org/10.1016/j.newideapsych.2017.03.004

manipulated in a more straightforward way as they refer to the organization of the perceptible elements of a design. Our findings therefore have immediate relevance to design practice, as they indicate that for designers focusing on these qualities is worthwhile. Not only are their effects on aesthetic appreciation by far the largest, they also stand strongest when controlled for the other levels. Moreover, they turn out to be more stable among people as well. As such, unity and variety can be considered very reliable determinants of aesthetic appreciation.

On the other hand, the effects of typicality repeatedly turn out to be modest. When considered on its own, the MAYA principle is attested. However, when taking into account the degree of unity and the social significance of a design, it is clear that people prefer the advanced to the acceptable. On second inspection, this is not that surprising. We mentioned that typicality refers to a product's recognisability – of it being identifiable as belonging to a particular category. In that vein, we referred to Biederman and Vessel's (2006) observation that people only like novel stimuli *on the condition that* they are able to recognize them. Our finding concerning typicality may thus merely indicate that the products we presented could be identified adequately by the participants. For the purpose of validity we deliberately chose to present only products that are currently on the market – which tend to be acceptable to some extent. It could be expected, though, that stronger effects of typicality might have occurred had we also included more exotically looking products.

In study 2, we observed that the effect of some qualities differs depending on the product category. Although once again perceptual properties have a strong effect regardless, novelty and connectedness are of more importance for some types of products. We might interpret this finding in relation to the risk entailed by a product. Using a bicycle is not without danger. Therefore, it should look mainly safe and reliable. For espresso makers this is of less concern. Arguably, products that are somehow considered risky - whether socially or physically – drive people toward the safe side of the balance. This calls for consideration in future research.

The joint effect of UMA as scrutinized here explains up to 49% of the variance in visual aesthetic appreciation. Given the limited number of factors involved, this amount is quite considerable. Still, it also means that half is not accounted for. One reason for this may be that we have only taken into account visual information. Products, however, are not visual artworks. We should once more stress that visual inspection is but one aspect of design aesthetics and it can and should not be reduced to only this domain. We cannot rule out that people make inferences about a product's sound, feel, … and that these affect the aesthetic assessment that they contrive. Related, but more importantly, products are designed to be used. A product may look good, but this does not necessarily mean that it also works well, that using it leads to a nice experience. Visual inspection does little justice to the sensory wealth that is provided by the interaction with a product. And people are more than likely to make inferences about this as well when looking at a product. Focusing on a single sense goes some way to understand the aesthetic experience, but we are well aware that in order to grasp product aesthetics properly we should take into account the interaction as a whole (Hassenzahl et al., 2013; Locher, Overbeeke, & Wensveen, 2010).

Finally, we should also stress that products are designed to serve a particular function. In that sense they offer a solution to a problem. This solution in itself can be aesthetically pleasing no less, because an idea can be beautiful. Research on this topic has substantiated that products are found to be more beautiful if the underlying idea offers maximum effect for minimal means (Da Silva, Crilly, & Hekkert, 2016). In fact this principle captures the essence of UMA – we derive aesthetic pleasure from experiencing things that require little effort, yet allow us to push forward.

7. Conclusion

In the present study our aim was to test the Unified Model of Aesthetics empirically on the bases of data obtained in two separate surveys. The model posits that aesthetic appreciation of an object – and of a designed product in particular – is a function of it displaying perceptual unity-in-variety, of it being typical, yet novel (or MAYA) and of it symbolizing both social connectedness and autonomy. Throughout a series of multilevel regression analyses, taking into account conflicting principles at separate levels, we found out that this is the case. These findings are in line with previous research on UMA, corroborating our first hypothesis.

The principles of UMA are manifestations of a single, underlying set of conflicting drives – for safety and accomplishment – which we have incorporated throughout evolutionary history. This theoretical account, as stated in hypothesis 2, finds support from factor analyses. However, the principles effectively refer to distinct product qualities, which are processed in different ways. The analyses testing hypothesis 3 imply that this is the case. For that reason they are expected to have an independent effect on aesthetic appreciation. As proposed by the fourth hypothesis, we found that they do – the principles comprised by UMA have unique effects on aesthetic appreciation. The perceptual qualities of unity and variety maintain the largest effect. By contrast, whether a design is considered typical turns out to be less important for aesthetic appreciation when controlled for qualities at the perceptual and social level. This finding could be interpreted in the sense that product design that displays sufficient unity and signals similarity to a social reference group is often also considered typical. If these conditions are not met by a design in the eyes of a perceiver, typicality hardly adds aesthetically. We do derive added pleasure from the cognitive processing of a product, but primarily if we experience it to be somewhat unexpected.

Acknowledgments

The authors would like to thank Janneke Blijlevens, Clementine Thurgood and Ruben Post for their help in stimulus selection and Koen Beullens for his assistance with the analyses.

Paul Hekkert was supported by the MAGW VICI grant number 453-10-004 from The Netherlands Organization for Scientific Research (NWO).

References

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

Axelrod, R., & Hamilton, W. D. (1981). The evolution of cooperation. *Science, 211*(4489), 1390–1396.

Barrett, L. F., & Bar, M. (2009). See it with feeling: Affective predictions during object perception. *Philosophical Transactions of the Royal Society B: Biological Sciences, 364*(1521), 1325–1334.

Batson, C. D., Shaw, L. L., & Oleson, K. C. (1992). Differentiating affect, mood, and emotion: Toward functionally based conceptual distinctions. In M. S. Clark (Ed.), *Vol. 13. Emotion, review of personality and social psychology* (pp. 294–326). Newbury Park, CA: Sage.

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

Biederman, I., & Vessel, E. (2006). Perceptual pleasure and the brain. A novel theory explains why the brain craves information and seeks it through the senses. *American Scientist, 94*(3), 247–253.

Blijlevens, J., & Hekkert, P. (2015). Autonomous, yet connected": A social design principle explaining consumers' aesthetic appreciation of products. In *2015 academy of marketing conference-the magic in marketing* (pp. 1–8). The Academy of Marketing.

Blijlevens, J., Thurgood, C., Hekkert, P., Chen, L. L., Leder, H., & Whitfield, T. W. (2017). The Aesthetic Pleasure in Design Scale: The development of a scale to measure aesthetic pleasure for designed artifacts. *Psychology of Aesthetics, Creativity, and*

the Arts, 11(1), 86.
Bornstein, R. F. (1989). Exposure and affect: Overview and meta-analysis of research 1968–1987. *Psychological Bulletin, 106*, 265–289.
Boselie, F., & Leeuwenberg, E. (1985). Birkhoff revisited: Beauty as a function of effect and means. *The American Journal of Psychology, 98*, 1–39.
Bourdieu, P. (1984). *Distinction: A social critique of the judgement of taste*. London: Routledge.
Bourdieu, P. (1993). *The field of cultural production: Essays on art and literature*. New York: Columbia University Press.
Brehm, J. W., Miron, A. M., & Miller, K. (2009). Affect as a motivational state. *Cognition & Emotion, 23*(6), 1069–1089.
Buhrmester, M., Kwang, T., & Gosling, S. D. (2011). Amazon's Mechanical Turk a new source of inexpensive, yet high-quality, data? *Perspectives on Psychological Science, 6*(1), 3–5.
Carbon, C. C. (2010). The cycle of preference: Long-term dynamics of aesthetic appreciation. *Acta psychologica, 134*(2), 233–244.
Cupchik, G. C., & Berlyne, D. E. (1979). The perception of collative properties in visual stimuli. *Scandinavian Journal of Psychology, 20*, 93–104.
Da Silva, O., Crilly, N., & Hekkert, P. (2016). Maximum Effect for Minimum Means: The Aesthetics of Efficiency. *Design Issues, 32*(1), 41–51.
Damasio, A. R. (1999). *The feeling of what happens: Body and emotion in the making of consciousness*. New York: Harcourt Brace & Company.
Damasio, A., & Carvalho, G. B. (2013). The nature of feelings: Evolutionary and neurobiological origins. *Nature Reviews Neuroscience, 14*(2), 143–152.
Dutton, D. (2009). *The art instinct: Beauty, pleasure, & human evolution*. New York, NY: Oxford University Press.
Hassenzahl, M., Eckoldt, K., Diefenbach, S., Laschke, M., Len, E., & Kim, J. (2013). Designing moments of meaning and pleasure. Experience design and happiness. *International Journal of Design, 7*(3), 21–31.
Hekkert, P. (2006). Design aesthetics: Principles of pleasure in design. *Psychology Science, 48*(2), 157–172.
Hekkert, P. (2014). Aesthetic responses to design: A battle of impulses. In T. Smith, & P. Tinio (Eds.), *The cambridge handbook of the psychology of aesthetics and the arts* (pp. 277–299). Cambridge: Cambridge University Press.
Hekkert, P., & Leder, H. (2008). Product aesthetics. In N. J. Schiffestein, & P. Hekkert (Eds.), *Product experience* (pp. 259–285). Amsterdan: Elsevier Science Publishers.
Hekkert, P., Snelders, D., & Wieringen, P. C. (2003). 'Most advanced, yet acceptable': Typicality and novelty as joint predictors of aesthetic preference in industrial design. *British Journal of Psychology, 94*(1), 111–124.
Johnston, V. (2003). The origin and function of pleasure. *Cognition & Emotion, 17*(2), 167–179.
Landwehr, J. R., Wentzel, D., & Herrmann, A. (2013). Product design for the long run: Consumer responses to typical and atypical designs at different stages of exposure. *Journal of Marketing, 77*(5), 92–107.
Leder, H., Carbon, C. C., & Ripsas, A. L. (2006). Entitling art: Influence of title information on understanding and appreciation of paintings. *Acta Psychologica, 121*(2), 176–198.
Locher, P., Overbeeke, K., & Wensveen, S. (2010). Aesthetic interaction: A framework. *Design Issues, 26*(2), 70–79.
Markus, H. R., & Kitayama, S. (1991). Culture and the self: Implications for cognition, emotion, and motivation. *Psychological Review, 98*(2), 224.
Paolacci, G., Chandler, J., & Ipeirotis, P. G. (2010). Running experiments on amazon mechanical turk. *Judgment and Decision Making, 5*(5), 411–419.
Pinker, S. (2002). *The blank slate*. New York: Viking Penguin.
Post, R. A. G., Blijlevens, J., & Hekkert, P. P. M. (2014). Aesthetic appreciation of tactile unity-in-variety in product designs, 22-24 August 2014. In *Proceedings of the 23rd biennial congress of the international association of empirical aesthetics*. New York, USA: IAEA.
Post, R. A. G., Blijlevens, J., & Hekkert, P. (2016). 'To preserve unity while almost allowing for chaos': Testing the aesthetic principle of unity-in-variety in product design. *Acta Psychologica, 163*, 142–152.
Ramachandran, V. S., & Hirstein, W. (1999). The science of art: A neurological theory of aesthetic experience. *Journal of Consciousness Studies, 6*(6–7), 15–51.
Reber, R., Schwarz, N., & Winkielman, P. (2004). Processing fluency and aesthetic pleasure: Is beauty in the perceiver's processing experience? *Personality and Social Psychology Review, 8*(4), 364–382.
Sonderegger, A., & Sauer, J. (2010). The influence of design aesthetics in usability testing: Effects on user performance and perceived usability. *Applied Ergonomics, 41*(3), 403–410.
Temme, J. E. V. (1992). Amount and kind of information in museums: Its effects on visitor satisfaction and appreciation of art. *Visual Arts Research, 18*(2), 28–36.
Thurgood, C., Hekkert, P., & Blijlevens, J. (2014). The joint effect of typicality and novelty on aesthetic pleasure for product designs: Influences of safety and risk. In A. Kozbelt (Ed.), *Proceedings of the 23rd biennial congress of the international association of empirical aesthetics* (pp. 391–396). August 22-24, New York, USA.
Wagemans, J., Elder, J. H., Kubovy, M., Palmer, S. E., Peterson, M. A., Singh, M., et al. (2012). A century of Gestalt psychology in visual perception: I. Perceptual grouping and figure-ground organization. *Psychological Bulletin, 138*, 1172–1217.
Whitfield, T. W. A. (1983). Predicting preference for familiar, everyday objects: An experimental confrontation between two theories of aesthetic behaviour. *Journal of Environmental Psychology, 3*, 221–237.
Xu, R. H. (2003). Measuring explained variation in linear mixed effects models. *Statistics in Medicine, 22*, 3527–3541.
Zajonc, R. B. (1968). Attitudinal effects of mere exposure. *Journal of Personality and Social Psychology, 9*(2p2), 1.

Please cite this article in press as: Berghman, M., & Hekkert, P., Towards a unified model of aesthetic pleasure in design, New Ideas in Psychology (2017), http://dx.doi.org/10.1016/j.newideapsych.2017.03.004