Chapter II Aesthetic properties of real-life stimuli: An approach to stimulus construction using Multidimensional Unfolding

1) Introduction

Two important requests are repeatedly raised in experimental aesthetics research: stimuli should allow for systematic control of factors influencing aesthetic judgments and should explain real-life aesthetics. The present research presents an approach that allows creating stimuli that comprise these two claims. A multidimensional unfolding approach (MDU) was used to identify aesthetic dimensions of visual stimuli representing real-life objects (Study 4). The identified aesthetic dimensions were then used to create new stimuli that varied primarily in the relevant aesthetic dimensions (Studies 5 and 6). The new stimuli are systematically controlled in their variation and are applicable to real-life aesthetics because they represent everyday objects.

2) Theoretical Considerations

a. Traditional Stimulus Material

Historically, stimulus material in aesthetic research ranged from simple visual shapes, such as abstract polygonal figures, to complex objects, such as works of art. Abstract polygonal figures have mainly been used in early experimental research (e.g., Berlyne, 1974b; Berlyne et al., 1974; Birkhoff, 1933; Eysenck, 1941, 1965; Eysenck & Castle, 1970; Fechner, 1876) because they allow controlled variations of stimulus dimensions. However, using such simple stimuli has also been widely criticised, mainly because they are not created for aesthetic appreciation (Berlyne, 1971). Namely, it was argued that simple figures do not have artistic qualities comparable to works of art and are therefore not suitable for studying real-life aesthetics. Consequently, more recent research has used more complex visual stimuli such as works of art (e.g., Bamossy et al., 1983; Götz et al., 1979). Works of art, by nature, have the advantage that their artistic quality is much more advanced than that of simple polygons. Yet, complex stimuli have the disadvantage that they vary on other than aesthetic dimensions, e.g. the style or content of a painting. If the researcher has no control over these variations in the stimuli, their use for aesthetic research is rather limited. To control for variations in works of art Eysenck (Eysenck, 1983; Götz et al., 1979) asked a painter to create paintings for the specific purpose of his research, namely for measuring aesthetic sensitivity. This way, various aspects of the paintings were controlled and one could consider the stimuli to vary only on a specific aesthetic dimension, in this case the dimension of harmony. This approach, however, is not particularly feasible because it would require a painter to create new works of art for each research study and objective. Additionally, while reducing differences between stimuli, it is unlikely that the painter is capable to create versions which differ only in one dimension. Moreover, works of arts are not suitable for studying aesthetic evaluations of everyday objects (e.g., furniture or car designs).

b. The Absence of Relevant Criteria

To create stimuli that vary only on relevant aesthetic dimensions, criteria for aesthetic qualities need to be identified. One might think that the Gestalt Psychology already contributed such criteria in its concept of *Gute Gestalt*, "goodness of configuration." According to this concept people do not perceive their environment in terms of discrete visual elements but rather in terms of configurations (*Gestalten*). The Gestalt school formulated laws to illustrate the goodness of configuration, such as symmetry, balance, and proportion (e.g., Boring, 1942; Koffka, 1935; Metzger, 1953). However, as Berlyne (1971) pointed out these laws are rather elementary. They are so vague that they can hardly be used as criteria to decide which of two patterns is aesthetically superior.

Another approach with potential for useful criteria for identifying aesthetic dimensions comes from Berlyne's new experimental aesthetics. Berlyne compared stimulus patterns that varied on collative structural properties along dimensions like familiar-novel, simple-complex, or expected-surprising (Berlyne, 1963, 1970, 1974a). This research however was mostly done with artificial stimuli and, the collative properties could not be confirmed for everyday objects (Ritterfeld, 2002). Thus, it is unclear which aesthetic dimensions contribute to the aesthetic response when everyday objects are evaluated. The aesthetic value of cutlery, for example, might depend on its shape, on how well the different parts of a cutlery set go together, or simply on the material from which it is made.

In sum, even though aesthetic principles that might be important for evaluating the aesthetic appeal of objects, such as symmetry, balance, clarity, and novelty, have been identified, it is not yet known which (if any) of these characteristics apply to everyday objects.

3) Study 4 – Expert interviews

The purpose of Study 4 was to identify aesthetic properties of stimuli which can be used to label empirically derived aesthetic judgment dimensions (Study 5, below). Another aim of this study was a stepwise reduction of an initial stimulus pool. To attain these goals, expert interviews were conducted using a set of everyday objects and a set of works of art as stimuli.

a. Material, Experts and Procedure

i. Stimulus material

The stimuli used in the present research were pictures of everyday objects and works of art. More precisely, stimuli of four different object classes were chosen: paintings, offices, car interiors, and cutlery.

ii. Experts

The experts recruited for this study were twelve interior designers, object-oriented designers and architects and twelve students of art history. The initial stimulus pool consisted of 121 pictures of objects, representing each of the four different object classes. The designers and architects were interviewed about the everyday stimuli (cutlery, car interiors and offices). The students of art history were interviewed about the paintings. The stimuli were presented to the experts one at a time on a computer screen. For each stimulus the experts were asked which aesthetic properties they use to judge the aesthetic value of the stimulus and to identify stimuli that they considered as inapt for the research aim.

b. <u>Results</u>

The aesthetic properties the experts reported for each stimulus were summarized in categories for each object class. Similar properties were sorted into the same category resulting in eight to twelve different categories of aesthetic properties for each object class (see Table 6, Appendix A). The categories were labeled using terms that had been generated by the experts in the interviews. The identification of inappropriate stimuli by the expert's resulted in a reduction of the initial stimulus pool from 121 stimuli to 42 stimuli: ten (10) cutleries, twelve (12) offices, ten (10) car interiors and ten (10) paintings. Stimuli were excluded if the quality of the picture was low compared to other stimuli, if two objects were considered being too similar to each other or if an object was too different from the majority of the other stimuli, e.g. in style. Stimuli were excluded when at least two experts considered them as inapt.

4) Study 5 – Multidimensional Unfolding: Dimensions of Aesthetic Judgments

Using Multidimensional Unfolding (MDU), Study 5 examines whether non-experts use the aesthetic properties identified in Study 4 as common criteria for evaluating the aesthetic value of objects.

a. <u>Multidimensional Unfolding</u>

i. The model

The main advantage of MDU is that it allows the identification of underling structures in preference data (Borg & Groenen, 1997). Unfolding was first developed by Coombs (1964) as an unidimensional method and generalized to multidimensional unfolding by Bennett and Hays (1960). The model assumes that each stimulus represents the same object for each individual. Thus, each individual should perceive the same qualities when looking at a picture of an object (e.g., cutlery). Differences in preference judgments are therefore due to a different subjective *evaluation* of the cutlery by the individuals, not to different perceptual qualities of the cutlery itself. Data is analysed with the basic assumption that an ideal object exists for each person. This ideal object is depicted as hypothetical ideal point representing each person in a dimensional space and each alternative object is represented as stimulus point. Accordingly, the model represents persons and objects in the same dimensional space. The preference judgment between two stimuli is interpreted such that the preferred stimuli are closer to the ideal point (and thus to the person) than alternative, less preferred stimuli. Thus, individuals and stimuli are mapped in the space such that the relations between the points represent the observed preference orders of the different individuals on the same set of objects. Proximities of stimuli to individuals are reflected in the distances between the points in the space. Using this information as a starting point, the question is: Can a researcher identify one or more dimensions on which the preference judgments for a group of individuals are based? In other words, are there common latent attributes underlying the different preference orderings across a set of individuals? If this is the case, it is reasonable to assume that individuals use common criteria in evaluating the given stimuli (Coombs, 1964; for an overview see Eisermann, 2002; McIver & Carmines, 1981). Thus, this method seemed to be the appropriate approach in the present study to investigate whether individuals use certain aesthetic properties as common criteria in order to judge the aesthetic value of some given objects.

ii. The "pick k *out of* p*" method*

For collecting the preference data from participants a method was chosen that is less demanding for the participants than pair comparison. This method is as good as pair comparison at getting the necessary information to build a full rank order of the stimuli, and is called the "*pick k out of p*" method. In this method participants are presented with subsets of stimuli out of which they have to pick a certain number of most preferred stimuli. To get a full preference order of all stimuli, it is sufficient when at least three stimuli in a set are rated by each individual (Coombs, 1964). Preference rankings were chosen over (Likert-type) ratings because current methodological research has shown that the quality of the data is higher for rankings when a series of different objects is evaluated (Krosnick, 1999).

iii. Degeneration

A problem of the unfolding technique is degeneration. Degeneration occurs when: (a) two *different* objects are not differentiated by a solution, which is the case if there is no distance between them, or (b) when two *equivalent* objects are differentiated by a solution, which is the case if there is some distance between them. One situation in which unfolding solutions tend to degenerate is when the variance in the data is very small. Thus, to minimize the danger of degeneration in the present study, a certain amount of variance had to be assured for the preference data. This was done in presenting each stimulus several times to each participant.

iv. Interpretation of a MDU solution

MDU solutions were interpreted based on two aspects in the present research: (a) the proximity of the object stimuli to each other and (b) the aesthetic properties derived from the expert interviews. Regarding the proximity of object stimuli to each other, the smaller the distances between two stimuli, the more similarly the objects were evaluated in terms of preference by the non-experts. Looking at each dimension of a solution separately, these sequences of points correspond to a linear order of the given stimuli on each aesthetic dimension respectively. If this order for each dimension is interpretable in terms of aesthetic properties, the solution can be seen as interpretable in terms of rankings on the underlying aesthetic dimensions.

To interpret the rank orders represented by the dimensions of the MDU solutions in terms of criteria for aesthetic judgments, the aesthetic properties derived from the expert interview were used. “Stimulus by aesthetic property matrices” were build separately for each object class representing a characteristic profile for each stimulus (Table 7 shows a simplified example). For the interpretation of the aesthetic dimensions identified by MDU, the stimuli in the matrix were ordered in the preference order of a given unfolding dimension. If a dimension of an unfolding solution is interpretable in terms of one of the aesthetic properties derived from the expert interviews, the matrix shows a specific pattern for one of the aesthetic criteria (i.e., information in a column). That is, the stimuli in the upper rows of the column show the aesthetic property (indicated by “+” in the matrix) and the stimuli in the lower rows of the column do not show this property (indicated by “–“in the matrix) or vice versa. In the example in Table 7, the stimulus order would be interpreted as “harmony”-dimension. This unfolding solution, which is based on the aesthetic judgments made by non-experts, can now be interpreted as the aesthetic property which the experts had identified as “harmony”.

Table 7. Example for "Stimulus by Aesthetic Property Matrix"

	Aesthetic properties			
Stimuli	Simplicity	Proportion	Harmony	Ergonomics
k	+	+	+	+
a	+	-	+	-
c	-	-	+	+
d	-	+	+	+
e	-	+	+	-
i	+	-	+	+
b	+	-	-	-
f	+	-	-	+
g	+	-	-	-
h	-	+	-	-

Note: The order of stimuli represents a dimension of a possible unfolding solution. This dimension would be interpreted as "harmony"-dimension in the given example. + indicates that a stimulus shows the respective aesthetic quality, - indicates that the stimulus does not show the respective aesthetic quality.

b. Overview of Studies

A pilot study and the main study were designed as online studies. The aim of the pilot study was to test the feasibility of the procedure and to determine how many times each stimulus needs to be presented to assure sufficient variance in the data in order to minimize the danger of degeneration of the solutions. The main study served to identify dimensions that non-experts used to judge the aesthetics of everyday objects.

c. Pilot Study

Results of a pilot study with a convenience sample of N = 69 German participants suggested that showing each stimulus three times did not produce sufficient variance in the data to result in an interpretable solution. Therefore the number of times each stimulus was presented was doubled in the main study.

d. Main Study

i. Design, participants, and procedure

1. Design

In the main study each stimulus was presented six times. To avoid fatigue effects the number of stimuli per participant was reduced by having each participant only evaluate stimuli from one object class. Thus, each participant judged 60 (cutlery, car interior or paintings) or 74 (offices) stimuli. The "*pick k out of p*" method was chosen because it is less cognitively demanding than pair comparisons but as good as pair comparison at getting the necessary information to build a full rank order of the stimuli. Participants are presented with a random selection of stimuli out of the overall stimulus set at a time. They have to pick a certain number of most preferred stimuli out of each subset of selected stimuli. To get a full preference order of all stimuli at least three stimuli in each subset of stimuli have to be rated by each individual (Coombs, 1964). For the object classes containing ten different stimuli (i.e., car interiors, cutlery and paintings) each subset showed five of the ten stimuli. In the object class that contained twelve stimuli (offices) each subset consisted of six of the twelve different stimuli. Within each object class the stimuli building each subset were randomly selected. The random assignment of stimuli to subsets was restricted such that no stimulus appeared twice within a single subset. Participants were asked to pick the three most aesthetic stimuli out of each subset. Overall each participant had to judge twelve subsets of stimuli each showing either five or six stimuli at a time.

2. Participants

A sample of *N* = 217 German subjects participated in the main study, 131 men and 77 women (nine participants did not indicate their gender), between 18 and 61 years of age (*mean* = 30.49, *SD* = 7.42). Participants were recruited online from two sites explicitly designed for conducting online studies. The announcements asked the addressees to participate in an online study about object aesthetics and provided them with the necessary link to the web page where the study was hosted.

3. Procedure

The first page of the online study contained a short introduction; the second page explained the procedure. By clicking a button that led participants from the first to the second page, they were randomly assigned to one of the four conditions. The third page showed the first subset of stimuli. On this and each following page participants were asked to “choose the three most aesthetic stimuli out of the given set of stimuli by marking them with a mouse-click in the given field”. Once all three stimuli in a subset were marked participants continued to rank the next subset of stimuli. Participants could only proceed to the next page if they had chosen three stimuli in a subset. Once participants moved on to the next page, they could not go back to a previous page. After rating all twelve subsets, participants were asked some demographic questions. The procedure of the main study was the same as in the pilot study with the exception that participants were now randomly assigned to one of four conditions.

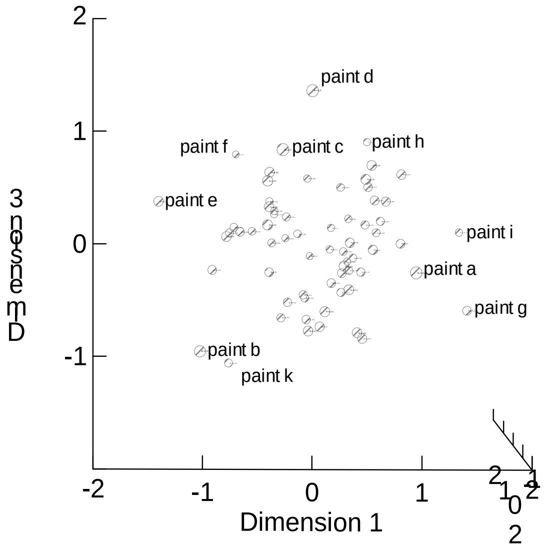
ii. Results

Because the unfolding model assumes that each individual only responded once to a set of stimuli, the data were reduced to an equivalent form. Namely, the data were aggregated by counting how often each individual picked each stimulus overall. This sum scores are used as measures of preference. The more often an object has been chosen by a person the more it seemed to be preferred by this person.

Analyses were conducted separately for each object class. For the office stimuli, a two-dimensional solution was found to be sufficient to depict the preference data. Three-dimensional solutions were found to best represent the preference data for all other object classes. Figures 1 - 4 show the preference maps for the four object classes. For an easier understanding the preference maps for the three dimensional solutions were rotated such that only two dimensions are visible in the geometric representation. The preference maps relate visually the perceived actual distances between points representing stimuli and ideal points. Thus, they also illustrate the rank order for a set of stimuli for each respective dimension. The goodness of fit measure used here is Kruskal's (1964) stress formula (form 1). It is based on the distances contained in the matrix and indicates the fit of the distances to the transformed data. In other words it indicates how closely the distances between pairs of points fit the measured dissimilarities between the corresponding objects. Thus, the smaller the stress index the better the fit of the solution. (For an interpretation of stress values see J. B. Kruskal, 1964.) Figures 1 - 4 show the stress indices for the four solutions. As can be seen, the solutions are ranging between good and fair solutions.

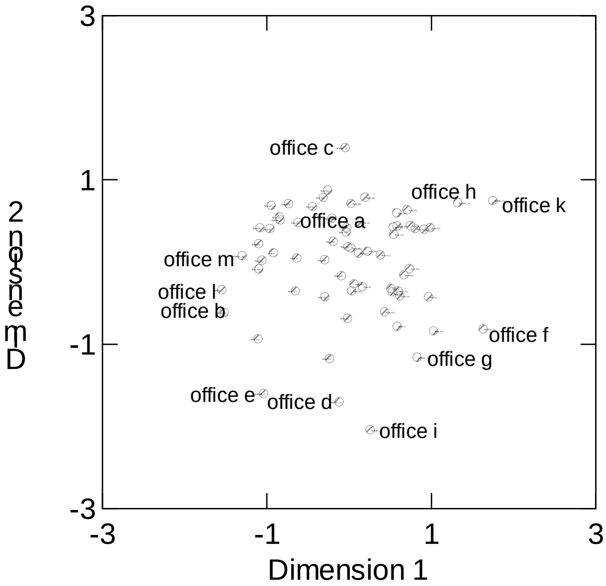
Using the interpretation technique described above, the MDU solutions found for the four object classes were interpreted as follows: For paintings, Dimension 1 represented paintings with shapes ranging from rather straight geometrical to more curved shapes. Dimension 2 represented different painting techniques and Dimension 3 referred to contrast in the paintings. Accordingly, the dimensions were labelled "shape", "painting technique," and "contrast". For the office stimuli, Dimension 1 characterized a more or less appealing way of arranging furniture. Dimension 2 signified the perceived atmosphere in the room, ranging from brighter rooms with big windows to rather dark rooms without windows. These dimensions were labelled "arrangement" and "atmosphere". For car interiors, Dimension 1 referred to the simplicity of the overall impression of the interior. Objects on this dimensions ranged from car interiors with rather simple, classical designs with few colours and only one or two different materials to car interiors with rather complex designs, different colors and different kinds of materials integrated in the interior. Dimension 2 represented the impression of clarity that results out of how instruments are set up in the car. Dimension 3 related to the technical equipment integrated in the car interior, ranging from rather technologically advanced to rather simple equipment with little technology. The dimensions were labelled "simplicity, "clarity," and "technology." Finally, for the cutlery stimuli, Dimension 1 depicted the proportion of head to handle for each instrument of a set of cutlery. Dimension 2 referred to how harmonious the different instruments (fork, knife, spoons) of a set of cutlery looked together. Dimension 3 referred to the impression of how well the instruments might lay in one's hand when using them, depending on how the handle of the cutlery was shaped.

Figure 1. 3 dimensional preference map: paintings



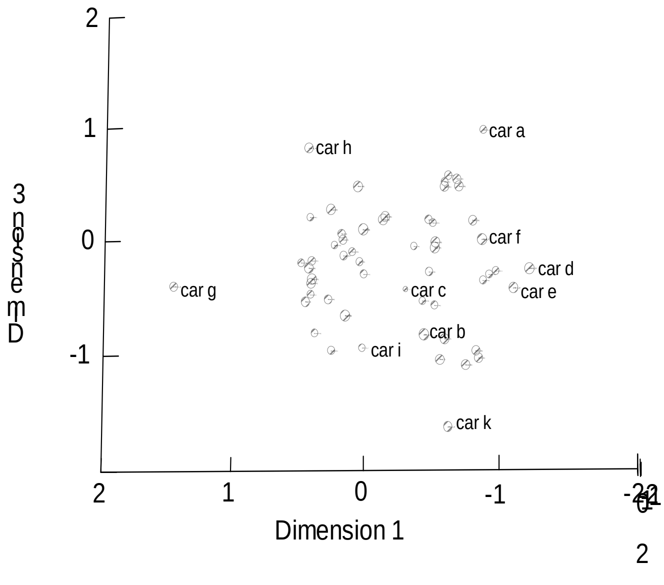
N = 56, *stress* = .075

Figure 2. 2 dimensional preference map: offices



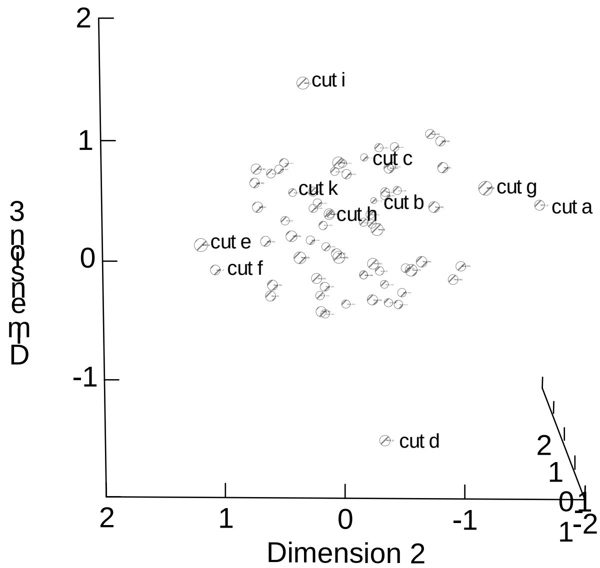
N = 55, *stress* = .11

Figure 3. 3 dimensional preference map: car interiors



N = 46, *stress* = .087

Figure 4. 3 dimensional preference map: cutlery



N = 60, *stress* = .063

Note: For an easier understanding the preference maps for three dimensional solutions are rotated such that only two dimensions are visible.

The cutlery dimensions were labelled “proportion,” “harmony,” and “perceived ergonomics.”

The results show how the knowledge derived from expert interviews can be combined with dimensions identified through MDU. Thereby a clear description of the structure of preferences of non-experts for stimuli was obtained. Thus, the unfolding solutions, which are based on aesthetic judgments by non-experts, can be interpreted in terms of aesthetic properties identified by experts. What results is the identification of dimensions of a common aesthetic space that people commonly use when making preference judgments for a given object class. With these results one important step in the development of systematically varied visual stimuli is completed.

5) Study 6 – Multidimensional Unfolding: Confirmation of Aesthetic Dimensions

In Study 6, the aesthetic dimensions identified in Studies 4 and 5 were used to create new sets of visual stimuli. By using one template stimulus that was changed on the identified aesthetic dimensions, the new stimuli were systematically controlled for factors influencing the aesthetic judgment. Again, using MDU for data analysis, Study 6 examines if the aesthetic dimensions derived from Study 5 could be successfully implemented in the new sets of stimuli. If it can be confirmed empirically that the dimensions are implemented as intended, it could be concluded that the new stimuli represent real-life objects that vary only on relevant aesthetic dimensions.

a. Creating of New Stimuli

In the present study the same object classes of real-life objects as in Study 5 were used (paintings, offices, car interiors, cutlery).

i. Construction method

A method that deals with the systematic construction of real-life stimuli is conjoint analysis (for details see Green & Srinivasan, 1978, 1990; Green & Wind, 1975; Krantz, Luce, Suppes, & Tversky, 1971b). The most popular method for stimulus construction in conjoint analysis is the full-profile method. In this approach, a stimulus is constructed by combining selected levels of each pre-selected dimension (Hair, 1998). In the present study, for example, a dimension of offices was the atmosphere of the room represented by its brightness, with the variations high, medium and low. A stimulus with a high level on the atmosphere dimension would be a bright office with a window. An office with a medium level would be a bright one without window and an office with a low level would be a dark one without window. Given that each stimulus was manipulated on two or three dimensions, each stimulus consists of a combination of one level for each dimension.

ii. Number of dimension levels

It has been found that the relative importance of a dimension increases with the number of levels that comprise it (Wittink, Krishnamurthi, & Nutter, 1982; Wittink, Krishnamurthi, & Reibstein, 1990). Thus, stimuli within each object class were designed with an equal number of levels for each dimension. In deciding the range of variation of levels it was relevant to consider how many stimuli should result. Because one person should be able to judge all new stimuli, the overall number of stimuli should not exceed 40, or ten per object class. Thus, within the object classes, the number of levels depended on the number of dimensions identified in Study 5. For object classes with two dimensions, the levels of these dimensions should not exceed three, resulting in 3 x 3 = 9 stimuli. For object classes with three dimensions, the levels of dimensions should not exceed two, resulting in 2 x 2 x 2 = 8 stimuli. However, it became clear that the “contrast”-dimension in the painting was difficult to manipulate independently from other dimensions. The contrast in the paintings could, for example, be manipulated by changing the brightness of colors or by manipulating the painting technique (oil-paintings might be perceived as showing more contrast than aquarelle paintings). However, these manipulations affected other aesthetic dimensions, namely the color or painting technique. Because for future uses of the stimuli it seemed important to construct stimuli with orthogonal dimensions (Hair, 1998), only the dimensions “shape” and “painting technique” were manipulated for paintings. Thus, two stimulus classes (office and paintings) were created using two dimensions with three different attribute levels and two stimuli classes (car interiors and cutlery) were created using three dimensions with two different attribute levels.

iii. Constructing procedure

The stimuli from Study 5 were used as templates. Within each of the four object classes the stimulus that received the highest aesthetics ratings in Study 5 was used as a template and modified along the derived dimensions using Adobe Photoshop 6.0. The painting judged as most aesthetic did not represent a stimulus that could have been realistically changed on the relevant dimensions[1]. Thus, the second most aesthetic stimulus was chosen as a template. This stimulus had been chosen as the most aesthetic stimulus by 53.6% of the participants. For the car interiors the stimulus selected as template had been chosen as the most aesthetic stimulus by 45.5% of the participants. The most aesthetic cutlery stimulus had been chosen by 63.3% and the most aesthetic office stimulus by 81.5% of the participants.

The modification of the four template stimuli along the derived dimensions is illustrated for the cutlery stimulus. Figures 5 and 6 show the original cutlery stimulus (Figure 5) and a stimulus in which all three dimensions were varied (Figure 6). The cutlery stimulus consists of a set of cutlery, namely a fork, a knife, a table spoon and a tea spoon. The "proportion"-dimension of the cutlery stimulus was manipulated by shrinking the handles of all instruments in the cutlery set to 2/3 of their original size. The "harmony"-dimension was manipulated by shrinking the fork and the two spoons of the cutlery set as a whole but keeping the knife in its original size. The "perceived ergonomics" dimension was manipulated by reducing the width of the handles of all instruments. Using the full-profile method and a full factorial design, eight stimuli were created by manipulating all three dimensions of the stimulus for each new stimulus. Thus, the final stimuli consist of a combination of one level for each of the three dimensions. The four new sets of stimuli are presented in Appendix D.

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[1] The painting judged as most aesthetic showed basically a screen on which one third was painted in one and the other two third was painted in another color. Thus it seemed difficult to significantly change the shape of this painting without changing it on other dimensions. Additionally, this painting was a relatively well known painting by Rothko.

Figure 5. Template stimulus for cutlery

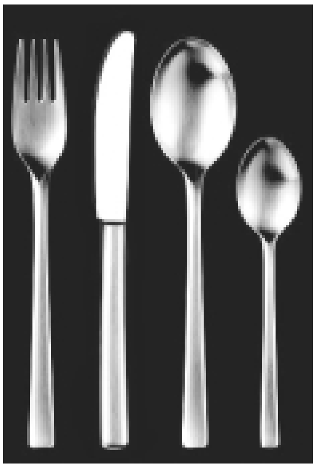

Figure 6. Variation of cutlery stimulus

b. Participants, Design and Procedure

i. Participants

The stimuli were presented to an online sample of $N = 65$ participants. Thirty-four men and 29 women (two participants did not report their gender) between 21 and 61 years of age ($M = 32.34$, $SD = 9.53$) participated in the study. Participants were recruited by the same means as in Study 5.

ii. Design

Each participant was presented with the stimuli of all four object classes (34 stimuli). All stimuli in one object class were presented at a time and each stimulus in each respective object class was shown only once.

iii. Procedure

A similar procedure as in Study 5 was used, but participants were asked to rank order the stimuli from the most to the least aesthetic, assigning the smallest number (1) to the most aesthetic stimulus.

c. Results

The full set of rankings capturing the participants' preferences was subjected to MDU analysis separately for each object class. For paintings, a three dimensional solution was found to be the best fit for the data (stress = .06). The first and the third dimension represented the expected dimensions, namely "shape" and "painting technique." Thus, the two dimensions used for constructing the new stimuli were confirmed by this solution. However, the second dimension found in the MDU solution was not implemented when constructing the stimuli. An inspection of the stimuli indicated that this dimension might represent a "contrast"-dimension. Due to the change of the painting technique stimuli seem to show more or less contrast.

For the office stimuli the expected two dimensional solution (stress = .15) was found with Dimension 1 depicting the "atmosphere" – dimension and Dimension 2 representing the "arrangement"-dimension. A three dimensional solution for the same data showed a much better fit (stress = .07). The first and second dimension again represented the "atmosphere"- and the "arrangement"-dimensions. The third dimension seemed to reflect differences in the contrast of the pictures here due to the change of the atmosphere dimension in the stimuli. A comparison of the Shepard-Diagrams of the two solutions confirmed the better fit of the three-dimensional solution. The preference maps, however, showed a good structure for the two dimensional solution whereas the three dimensional solution showed a tendency for degeneration. Both solutions nonetheless confirmed the implemented dimensions in the new office stimuli.

For the car interior stimuli, as expected, a three dimensional solution showed good fit (stress = .05) for the preference data. The first dimension found by MDU corresponded to the "technology"-dimension, the second matched the "simplicity"-dimension and the third represented the "clarity"-dimension.

Finally, the analysis of the cutlery data resulted in the expected three dimensional solution (stress = .06). Dimension 1 matched the "proportion"-dimension, dimension 2 corresponded to the "perceived ergonomics" and dimension 3 represented the "harmony"-dimension confirming the dimensions used to construct the new cutlery stimuli.

Overall, the MDU analysis for all four object classes confirmed the dimensions used to create the new stimuli. In the case of paintings and offices, an additional dimension was identified that seemed to be a result of the systematic manipulation of the other two dimensions. I will return to this point in the discussion, below.

6) Discussion

The research presented in this chapter shows how common criteria of aesthetic judgments can be identified using MDU and used to create new stimuli. The advantage of this approach is that important aesthetic judgment dimensions can be varied while all other dimensions of the objects remain constant. Thus, a long existing dilemma in which researchers had to choose between either using simple stimuli in order to have control over the variation in the stimulus material or using complex visual stimuli that represent real-life objects (and thus have higher aesthetic qualities) seems to be solved.

The present findings indicate that stimulus construction in aesthetic research not only has to be carried out with great care, but also that new stimuli should always be tested for their specific aesthetic dimensions prior to their use. The MDU solution for paintings in Study 6 showed good fit for a three dimensional solutions instead of the expected two dimensional solution. Similarly, for offices a three dimensional solution showed better fit for the preference data. In both cases the additional dimension represents an artifact of the construction process. More precisely, manipulating the different level of dimensions in the respective stimulus classes created additional unintended, though orthogonal (see below), third dimensions. Thus, especially in the field of aesthetics where small changes in stimuli apparently have an important impact on how aesthetic properties of stimuli are used for building aesthetic judgments, aesthetic dimensions of stimuli should be empirically confirmed. One way to identify these dimensions is using MDU analysis as illustrated in the present chapter.

The third dimension in the two solutions of the present study does not present any problem for using the new stimuli for future research. Even though they were not intended, once identified by MDU they can be taken into account in future research. Because the end results of the unfolding solutions represent dimensions that are approximately orthogonal to each other (Hays & Bennett, 1961), the third dimensions identified for paintings and offices in Study 6 can be considered as important judgment dimensions when the aesthetic of the given stimuli is evaluated. Even though they originate in artifacts of the stimulus construction process, they represent meaningful independent dimensions of aesthetic judgments for the given stimuli.

The results also stress the need for an empirical identification of judgment dimensions. Assuming that all relevant dimensions of a stimulus were equally important for the aesthetic judgment, stimuli with a higher number of more aesthetic attributes (e.g. low, high, high) would be expected to be preferred over stimuli with a lower number of more aesthetic attributes (e.g. high, low, low). However, this expectation was not met for all dimensions in Study 6. These findings might be explained by the importance that different dimensions of a stimulus might have for the overall aesthetic judgment. If the dimensions of a stimulus are differently important for an aesthetic judgment, the combination of different levels may lead to different preference orders depending on the importance of a certain dimension as found for some dimensions in Study 6. For example, if Dimension 1 is much more important for the aesthetic judgment than Dimension 2 or 3, then a stimulus consisting of a high level for Dimension 1 and low levels for Dimensions 2 and 3 might be preferred over a stimulus consisting of a low level for Dimension 1 and high levels for Dimensions 2 and 3. Consequently, it seems inappropriate to argue exclusively on a theoretical level or with the existence of important judgment dimensions which of different objects should be preferred or perceived as more aesthetic. Instead, empirical research must provide evidence for theoretically derived dimensions and their relative importance for the overall aesthetic judgment. In the present chapter relevant aesthetic judgment dimensions were identified. Future research must investigate the relative importance of each judgment dimension.

In concluding, aesthetics research can benefit from MDU in that it can help identify important dimensions that are used as common judgment criteria for different stimuli and can thus help creating systematically varied real-life stimuli. MDU is thus an approach that has much to offer to aesthetics research.

The research presented in Chapter 2 has shown that common criteria of aesthetic judgments can be identified using multidimensional unfolding, and that these criteria can be used to create new stimuli. The advantage of this approach is that important aesthetic judgment dimensions can be systematically varied across stimuli while all other dimensions of the objects remain constant. Four sets of eight or nine stimuli representing everyday objects were created that systematically vary on relevant aesthetic dimensions.

In the research described in Chapter 3 the stimuli developed in Chapter 2 will be used for scale development. In contrast to the stimuli used for the scale developed described in Chapter 1, the new stimuli only differ in their aesthetic values on the identified aesthetic dimensions. They are thus a very homogeneous pool of stimuli that nevertheless varies considerably and systematically in terms of the aesthetic value of the stimuli. Consequently, variation in the aesthetic judgment of the new stimuli (Chapter 2) within each object class can only be due to differences in the perception of the aesthetic dimensions varied when constructing the stimuli. As a result, problems that occurred in Study 1 and 2 (Chapter 1) resulting from the heterogeneity of the stimuli used when developing the ugly and the beauty scale - such as low goodness of fit measures in EFA and CFA - should not occur when developing a scale using the systematically varied stimuli from Chapter 2. Furthermore, for the stimuli used for scale development in the research of Chapter 1 it was unclear, which stimulus characteristics influence the aesthetic judgment. In contrast, for the new systematically varied stimuli it is quite clear which stimulus characteristics have an impact on the overall judgment, namely the aesthetic judgment dimensions identified in Study 4 and 5 and used for stimulus construction in Study 6.

The results of the first scale development also suggested that aesthetic sensitivity for ugly objects is different from sensitivity for beautiful objects. Accordingly, the stimuli chosen as templates for the construction of the new stimuli were the most aesthetic stimuli of each object class. In other words, because aesthetics - and consequently measures developed so far for measuring aesthetic sensitivity - focuses by definition on the beautiful rather than on the ugly, the most beautiful (and not the most ugly) stimuli were chosen for stimulus construction in Chapter 2. Consequently, the stimuli used for the scale development reported in Chapter 3 only assess the aesthetic sensitivity towards beautiful objects.

In sum, Chapter 3 describes the development of a new scale for measuring visual aesthetic sensitivity using stimuli that systematically vary on the relevant aesthetic dimensions identified in Chapter 2. Additionally, the scale developed focuses on measuring aesthetic sensitivity for beautiful rather than for ugly objects.