Effects of Novelty and Its Dimensions on Aesthetic Preference in Product Design

Wei-Ken Hung [1,*] and Lin-Lin Chen [2]

[1] *Department of Industrial Design, Ming-Chi University of Technology, Taipei, Taiwan*
[2] *Department of Industrial and Commercial Design, National Taiwan University of Science and Technology, Taipei, Taiwan*

Product designers seek to create novel designs that elicit aesthetic responses from consumers. In this paper, we re-visited the much investigated relationship between novelty and aesthetic preference, but also with a new focus on what constitutes novelty in product design. Based on prior research on consumer's perception of product appearance, we included three fundamental dimensions of product semantics – trendiness, complexity, and emotion – in our study, and investigated their influences on novelty and aesthetic preference. We selected 88 chairs that are highly varied in shape but correspond to a common prototype – a chair with back support and without arms – as stimuli. We then conducted a semantic differential study on the 88 chairs, where trendiness, complexity, and emotion were measured by using bipolar adjectives "traditional-modern", "simple-complex", and "rational-emotional", respectively, while novelty and aesthetic preference were evaluated by using the bipolar adjectives "typical-unique" and "beautiful-ugly", respectively. The results confirm Berlyne's hypothesis that the relationship between novelty and aesthetic preference resembles an inverted-U curve, where the chairs perceived to be most beautiful are those with a moderate level of novelty. Each of the three dimensions – trendiness, complexity, and emotion – forms a positive linear relationship with novelty. This result shows that the three fundamental dimensions of product semantic can be regarded as predictor variables for novelty; of the three dimensions, trendiness has the greatest influence, followed by complexity, and finally by emotion. The three dimensions influence aesthetic preference differently: both complexity and emotion exhibit inverted-U relationships with aesthetic preference, while trendiness has a small positive linear relationship with aesthetic preference.

Keywords **–** Product Semantics, Novelty, Aesthetic Preference, Trendiness, Complexity, Emotion.

Relevance to Design Practice **–** Using photos of chairs as stimuli, we show that chairs with a moderate level of novelty can achieve higher aesthetic preference, rather than chairs that are very typical or very novel. In addition, by linking product appearance characteristics to perception of product novelty, we hope to provide information to designers so that they can try to achieve the optimal level of novelty in product design.

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Introduction

An understanding about how to create beautiful objects which elicit aesthetic responses from "sensory pleasure and delight" (Hekkert & Leder, 2008) is fundamental to the profession of design. All design disciplines – including architecture, product design, visual communication design, interface design, and animation – are the combinations of knowledge about aesthetics and the different embodying technologies. In a more commercial context, product appearance has been recognized as an important factor in the success of a product (Bloch, 1995; Hertenstein, Platt, & Veryzer, 2005). By changing different aspects of product appearance, including forms, materials and colors, designers try to communicate messages and elicit responses from consumers (Crilly, Moultrie, & Clarkson, 2004; Creusen & Schoormans, 2005; Hsiao & Chen, 2006). As pointed out by Raymond Loewy in his famous MAYA ("Most Advanced, Yet Acceptable") principle, a successful design must be as innovative as possible, but not so much as to be considered unacceptable (Loewy, 1951). To achieve higher aesthetic preference, designers should aim for the best combination of typicality and novelty (Hekkert, Snelders, & van Wieringen, 2003; Hekkert & Leder, 2008).

Several studies in the past have investigated the relationship between novelty and aesthetic preference in product design (e.g., Whitfield, 1983; Hekkert et al., 2003; Blijlevens, Carbon, Mugge, & Schoormans, 2012). In this paper, we re-visited the relationship between novelty and aesthetic preference, but looked further into what novelty means in product design. In particular, we employed three fundamental dimensions of product semantics – trendiness, complexity, and emotion – from (Hsiao & Chen, 2006), and explored how changes in product semantics affect judgment of product novelty and, in turn, judgment of aesthetic preference. By linking product appearance characteristics to novelty, we hope to offer operational information to designers, so that they could try to achieve the optimal level of novelty in product design.

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***Corresponding Author:** hwkm@mail.mcut.edu.tw

Typicality/Novelty and Aesthetic Preference

Prototypicality or *typicality* is usually defined as the degree to which an object represents a category (Loken & Ward, 1990; Veryzer & Hutchinson, 1998; Hekkert, et al., 2003). Barsalou (1985) discussed three possible determinants of typicality: similarity to ideals of the category, similarity to the central tendency of the category, and frequency of encounters as a category member. To investigate the influences of typicality, some studies employed the "prototype distortion" approach by systematically varying a given prototypical stimulus (e.g., Veryzer & Hutchinson, 1998; Blijlevens, et al., 2012), while other studies measured the perceived typicality by goodness of example ratings (e.g., Barsalou, 1985; Hekkert, et al., 2003). The concept of novelty is related to typicality. Berlyne (1971) classified two kinds of novelty: absolute novelty – an object that has never been experienced before – and relative novelty – an object that consists of new combination of previously experienced elements.

Past studies obtained inconsistent results concerning the relationship between typicality/novelty and aesthetic preference. A preference for prototype theory was proposed by Whitfield (1983; Whitfield & Slatter, 1979). Using different styles of chairs as stimuli, Whitfield and his colleagues found positive linear relationship between typicality and preference. By systematically distorting stimuli, Veryzer and Hutchinson (1998) found negative linear relationship between prototype distortion and aesthetic response. Other studies using houses, paintings, and music performances also found positive relationships between typicality and preference (Purcell, 1984; Hekkert & van Wieringen, 1990; Repp, 1997; Hekkert & Leder, 2008).

Ward and Loken (1988) set out to determine when preference for typicality might not hold. They proposed that, when prestige, exclusiveness, or distinctiveness is important to the consumers, the relationship between typicality and preference could be negative, rather than positive. Thus, novel designs might be preferred. In a recent study, Radford and Bloch (2011) found that products with high levels of visual product "newness" elicited more affective reactions than those with lower levels of "newness." When studying aesthetic appreciation of car interiors, Leder and Carbon (2005) found that participants changed from preferring the classical version to the more innovative version, after repeated exposures to the different designs.

The classic research in experimental aesthetics by Berlyne (1974) suggests a third possible model: an inverted-U-shaped relationship between typicality/novelty and aesthetic preference. This model hypothesizes that objects with a moderate level of novelty are preferred over both extremely typical and extremely novel objects. A few studies (Meyers-Levy & Tybout, 1989; Schoormans & Robben, 1997) have confirmed this inverted-U-shaped relationship model.

Instead of treating typicality and novelty as two ends of a continuum, Hekkert and colleagues (2003) measured typicality and novelty separately and investigated their joint influences on aesthetic preference. The results showed that typicality and novelty have large negative correlations, and tend to inhibit the effect of each other. As a result, the correlations between typicality and aesthetic preference were not significant; nor were correlations between novelty and aesthetic preference. However, when the influence of one variable was taken out, the other variable showed a linear relationship to aesthetic preference, indicating partial independence of the two variables.

Why Such Divergent Results

From the above review, different theories have been proposed for the relationship between novelty and aesthetic preference, including preference for typicality, preference for novelty, and preference for a moderate level of novelty. Among these studies, we thought that the work by Hekkert and colleagues (2003) provides a possible explanation to these divergent results. By treating typicality and novelty as separate factors, they demonstrated partial independence of typicality and novelty. Their findings led us to suspect that there are two linear relations at work – preference for typicality and preference for novelty – and the multiplication effect of these two linear functions results in an inverted-U quadratic function predicted by Berlyne (1974). We therefore hypothesized that the relationship between the bipolar typicality/novelty and aesthetic preference is an inverted U-curve.

However, if the relationship is an inverted U-curve, why were there relatively few studies able to show such a relationship? Why were there such divergent results, from preference for typicality, to preference for novelty, to preference for a moderate level of novelty, and even no significant correlations? We thought that the selection of stimuli to be included in the study could be one of the key issues. It is possible that the selection of stimuli might not have sufficiently covered the range of variations in typicality and novelty. As pointed out by (Hekkert et al., 2003), the linear relationship between typicality and aesthetic preference often observed in past studies might be due to the very restrictive range of novelty covered by the set of stimuli.

Wei-Ken Hung is a PhD candidate at the Department of Industrial and Commercial Design at National Taiwan University of Science and Technology, and a lecturer at Department of Industrial Design at Ming-Chi University of Technology. Since 2006, he has been the project manager of the ideastorming initiative: concept design of future products (www.ideastorming.tw), which is funded by Taiwan's National Science Council and aims to foster cross-disciplinary collaboration between design and engineering researchers. His research interests include product semantics and cross-disciplinary collaboration between design and technology. For his doctoral research, he focuses on measurement of contradictory semantics and investigates the relationship between contradictory semantics and aesthetic preference.

Lin-Lin Chen is a professor in the Department of Industrial and Commercial Design at National Taiwan University of Science and Technology (NTUST). She received her Ph.D. from the University of Michigan at Ann Arbor, and taught briefly at Iowa State University before returning to Taiwan. Her research focuses on attractiveness of product appearance, computer-aided concept exploration and evaluation, interface design, and geometric algorithms. She was dean of the College of Design at NTUST from 2004 to 2010, president of the Chinese Institute of Design from 2007 to 2008, and convener for the arts (and design) area committee of Taiwan's National Science Council from 2009 to 2011. She is editor-in-chief of the International Journal of Design, vice president of the International Association of Societies of Design Research (IASDR), and a fellow of the Design Research Society.

On the other hand, it is also possible that the range of stimuli might have been too wide – in the sense that there exist several possible prototypes for the set of stimuli. When judging the degree of typicality/novelty of a stimulus, a participant might compare it to a "prototype" (a typical chair as the baseline for comparison) that seemed most suitable. For example, when evaluating the novelty of a chair, the prototype chosen by a participant could be a stool, an armchair, a sofa, a bench, an office chair, among many other possibilities. Because different participants could be comparing the same chair to different prototypes, the resulting degrees of "novelty" could vary so wide and contained so much noise that the signal – the relationship between typicality/novelty and aesthetics – was masked and not easily detectable.

To investigate the relationship between typicality/novelty and aesthetic preference, we therefore developed a strategy for selecting a suitable set of stimuli. Specifically, we first conducted a pilot study to define a common prototype for the selected product category, and then sought wide variations of stimuli based on the given prototype. In this way, we tried to select a set of diverse stimuli that are likely to be judged against the same prototype.

What Does Novelty Mean

How is a stimulus perceived to be more "novel"? In what aspects can a stimulus deviate from the "prototype" of a product category? Hsiao and Chen (2006) identified four fundamental factors of affective responses to product appearance – trendiness, emotion, complexity, and potency – by conducting three parallel semantic differential studies on cars, armchairs, and kettles. In an independent study, Blijlevens, Creusen, and Schoormans (2009) found three main attributes – modernity, simplicity, and playfulness – in consumer's perception of the appearance of durable products. These factors summarize how a participant might evaluate the appearance of a product, and thus are plausible candidates for dimensions of novelty. In the present study, we focused on the first three dimensions discussed in (Hsiao & Chen, 2006): trendiness, emotion and complexity, which accounted for about 80% of the variance in their three experiments. By including these three dimensions into our study, we tried to estimate their relative influence on judgments of product novelty. We next review past research relating to each of the three dimensions:

The *trendiness* dimension (Hsiao & Chen, 2006) summarizes bipolar adjectives avant garde–conservative, innovative–imitative, contemporary–traditional, dazzling–ordinary, old–young, futuristic–nostalgic, and excited–calm, while the *modernity* attribute (Blijlevens, et al., 2009) corresponds to adjectives including modern, old-fashioned, classical, oldish, sleek, futuristic, kitsch ,and retro. When studying the roles played by product appearance in consumer choice, Creusen and Schoormans (2005) found that more than a quarter of the participants mentioned "a modern or contemporary look" as being important to them when choosing products. Bloch (1995) also mentioned that "prevailing styles and fashion" can influence consumer preference for product designs. These past research findings confirm the importance of trendiness/modernity as a factor in consumer's perception of product appearance. By further analyzing the appearance characteristics, Hsiao & Chen (2006) found that products with high trendiness values tended to be less prototypical, more symbolic, more pleasurable, and had medium level of functionality, while products having low trendiness values had only one common characteristic – perceived high functionality. Both (Hsiao & Chen, 2006) and (Blijlevens et al., 2009) made similar observations about how the definition of trendiness/ modernity can change over time.

The *emotion* dimension (Hsiao & Chen, 2006) summarizes bipolar adjectives soft–hard, feminine–masculine, rational–emotional, and cute – not cute. By further analyzing the appearance characteristics, they found products with high emotion values tended to have curved lines, curved surfaces, and organic forms; whereas products with low emotion values tended to have straight lines, flat surfaces, and geometric forms. This dimension, therefore, could be closely related to the well recognized curvature factor in aesthetic preference. For example, Leder and Carbon (2005) created three levels of curvature in car interior design and investigated the relationship between curvature and attractiveness ratings. Their studies indicated a preference for curved versions of car interior. Bar and Neta (2006) demonstrated people's preference for curved objects, by using pairs of real objects, such as watch or sofa, that had the same semantic meaning and general appearance except one was angular and the other was curved in form. By using abstract patterns, Silvia and Barona (2009) examined the effect of angularity on aesthetic preference while controlling for other possible influencing factors, such as symmetry and typicality. Their results also showed preference for curved objects. On the other hand, Blijlevens et al. (2012) created a series of stimuli varying from angular shapes to rounded shapes and found that aesthetic responses to the series of "angular-curved" variations exhibited an inverted U-shaped relationship.

The *complexity* dimension corresponds to bipolar adjectives simple–complex, and mainly related to the number of design elements in a product (Hsiao & Chen, 2006). Simplicity was also identified by Blijlevens et al. (2009) as one of the main attributes in consumer's perception of product appearance. In fact, simplicity/complexity has long been recognized in experimental aesthetics research as an important factor influencing aesthetic preference. Berlyne (1970, 1974) investigated the effect of complexity on aesthetic preference, and proposed the existence of an inverted U-shaped relationship between them. He hypothesized that objects with medium level of complexity are preferred over very complex or very simple objects. Hekkert and van Wieringen (1990) tested the influences of complexity and prototypicality on aesthetic appraisal of cubist paintings. For cubist paintings with low and intermediate levels of categorizability, they found an inverted U-shaped relation between complexity and beauty. Some experiments, such as those conducted by Martindale, Moore, and Borkum (1990) and Frith and Nias (1974), however, failed to confirm Berlyne's hypothesis.

Thus, the three dimensions of product semantics – *trendiness, emotion,* and *complexity* – that influence consumer's perception of product appearance have been well recognized in research on product design, consumer research, and experimental

psychology. In several previous studies on the relationship between typicality/novelty and aesthetic preference, each of the three dimensions was sometimes treated as a separate factor alongside novelty (e.g., Berlyne, 1970; Hekkert & van Wieringen, 1990) and sometimes treated as the main constituent of novelty. For example, in Blijlevens et al. (2012) and Veryzer and Huchinson (1998), levels of typicality are manipulated by changing angularity or curvature of stimuli. We think that the different treatments really depend on how novelty is defined. In this research, we view novelty as the result of an overall appraisal of visual characteristics of a stimulus, which include how trendy, how curved, and how complex it is. The result of this appraisal is a judgment on the novelty of the stimulus: how different it is from a typical object of its category. For product designers, linking the definition of novelty to the different ways a designer can change the appearance of a product will provide useful information on how to achieve the optimal level of novelty.

Research Methodology

Product Category and Prototype

We selected chair as the product category because it is one of the most representative products in design history. Designers applied various kinds of techniques to create innovative chair designs, leading to a highly diverse pool of potential stimuli.

As discussed previously, we suspected that the inconsistent results about the relationship between novelty and aesthetic preference could be due to the selection of stimuli. We therefore began by conducting a pilot study to obtain an operational definition of the shape of a "typical chair". We asked 34 sophomore students majoring in industrial design to draw sketches in response to the question "What image comes out first in your mind, as soon as the name 'chair' is mentioned?" The results are shown in Figure 1. An examination of the 34 sketches revealed that a majority of 25 chairs were similar in their forms: all have four legs, a flat seat, a vertical back, and all but one have no arms. The other 9 chairs were diverse in their shapes. Based on this pilot study, we designated the shape most commonly illustrated (Figure 1, upper right) as the "typical chair" for collecting stimuli.

Stimuli

Using the "typical chair" (Figure 1, upper right) as the basis, 523 photos of chairs were collected by using search engines, from websites of furniture companies, and from the book *1000 Chairs* (Fiell & Fiell, 1997) to cover a wide range of chairs. During this process, chairs that seemed more easily perceived to be a stool, an armchair, a sofa, a bench, an office chair, or any prototype other than the "typical chair" were eliminated. Two experienced designers (each with more than 5 years of experience) examined the chairs and eliminated those similar in shape to reduce the total number to 213. Next, card sorting and hierarchical clustering methods were employed to produce the final set of representative chairs. We asked 5 senior students with design background to independently sort the chairs into groups according to the similarities in shape. We then analyzed the sorting results by using the hierarchical clustering function in SPSS. Finally, we arrived at 88 representative chairs, of which, 41 were from the book 1000 Chairs (produced between 1900 and 1997) and 47 from the internet (produced during the last two decades). These 88 chairs were related to a common "typical chair" but ranged from highly typical to highly novel. We used high-resolution (7cm x 7cm, 300dpi) photos of chairs as stimuli for the experiments. Due to potential copyright issues, we have shown only line drawings of these chairs in Figure 3 and Table 1.

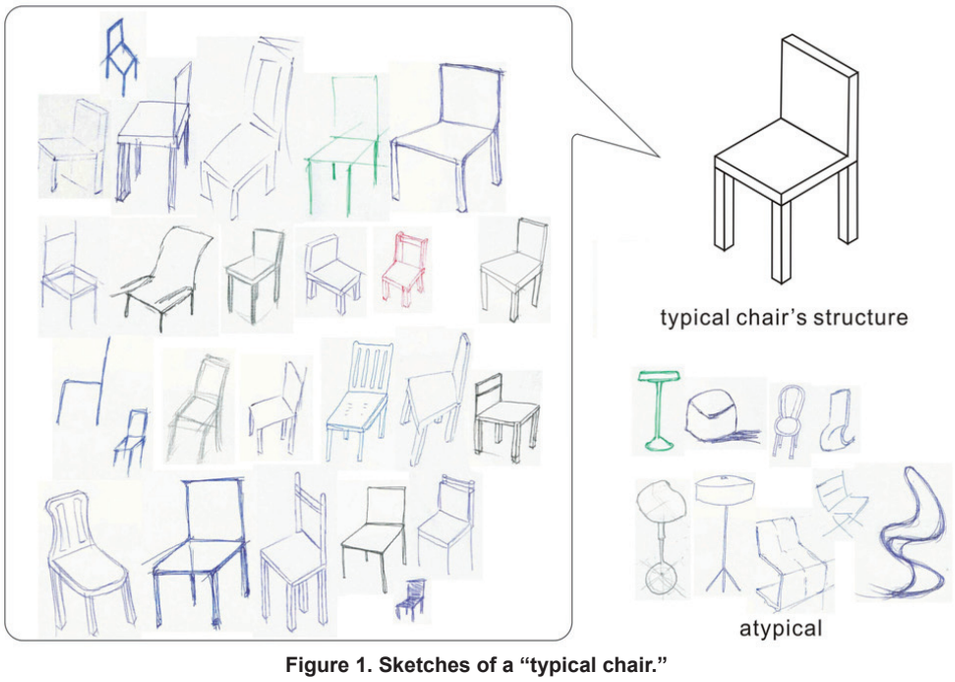

Figure 1. Sketches of a "typical chair."

Participants

The participants were recruited from the student population of Ming-Chi University of Technology in Taiwan, consisted of 60 undergraduate students (39 male and 21 female; 18 to 22 years of age). Participants were paid a small compensation to participate in the experiment.

Measures

We used semantic differential method (Osgood, Suci, & Tannenbaum, 1957) for measuring aesthetic preference, novelty, complexity, emotion, and trendiness. Two adjective-pairs were selected as the rating scales to operate on aesthetic preference and novelty.

- *Aesthetic preference*: ugly – beautiful
- *Novelty*: typical – unique

Three sets of adjective-pairs were selected to investigate the effects of the fundamental dimensions of product semantics (Hsiao & Chen, 2006) on aesthetic preference and novelty.

- *Complexity*: simple – complex
- *Emotion*: rational – emotional
- *Trendiness*: traditional – modern

Procedure

At the beginning of the task, the participant got familiarized with the range of stimuli by viewing the photos of the 88 chairs that were spread on the table. Next, the participant evaluated the chairs in five sessions. In each session, the participant divided the 88 chairs with respect to a pair of adjectives into 9 groups corresponding to a 9-point rating scale. To reduce cognitive loading, the participant was first asked to divide the chairs into three groups representing low, medium and high levels, and then further divided each group into three subgroups to arrive at a total number of 9 groups. The number of chairs was allowed to be uneven or void in each group. Participants were also asked to review the grouping and to make adjustments where necessary. The participant performed the grouping tasks at his/her own pace, and completed the five sessions of grouping tasks in about one hour. In general, the 88 chairs were perceived to cover a wide range of variations in product semantics, from simple to complex, from rational to emotional, and from traditional to modern.

Results

Effects of Novelty on Aesthetic Preference

We obtained means for each pair of adjectives operationalizing on novelty and aesthetic preference, for the 88 photos of chairs. We then tested the hypothesis that preference is an inverted-U function of novelty, by using the SPSS statistical software's curve estimation tool to perform fitting. The result showed a significant quadratic curve relationship between novelty and aesthetic preference (quadratic estimation: $R^2 = 0.183$, $F = 9.54$, $p < 0.05$; linear estimation: $R^2 = 0.010$, $F = 0.84$, $p > 0.05$), as illustrated in Figure 2. Thus, our findings confirm Berlyne's hypothesis and indicate that a moderate level of novelty achieves the highest level of aesthetic preference.

Design Characteristics of Chairs

In addition to the fitted curve relating novelty to aesthetic preference shown in Figure 2, designers might also like to see the design characteristics of chairs that were perceived to be from

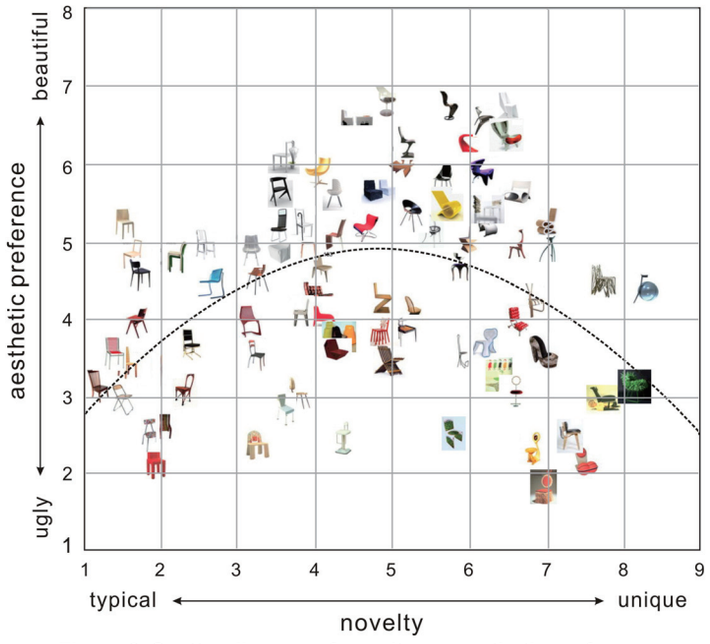

Figure 2. Scatter diagram of novelty vs. aesthetic preference.

typical to unique, and elicited responses from being beautiful to being ugly. We provide some preliminary observations on the design characteristics of 12 representative chairs.

Based on Figure 2, we first classified the stimuli into a 4x4 grid structure by k-mean clustering, with 4 levels of novelty and 4 levels of aesthetic preference, respectively. We then selected 12 representative chairs from the cells in the 4x4 grid structure, with 8 chairs on periphery (A, B, C, F, J, L, K, G) and 4 chairs in the middle region (E, D, I, H), as shown in Figure 3 (a). Slightly larger photos of the 12 representative chairs are shown in a 4x4 matrix in Figure 3 (b), roughly corresponding to their respective locations in Figure 3 (a). Reflecting the inverted U-relationship in Figure 2, there were no representative chairs for four of the cells in the 4x4 grid.

The most typical chairs (A, B, C) are located in the column to the far left. These chairs have the same structures as the typical chair in Figure 1: all have four legs, flat seats, and vertical backs. Variations in textures, colors, and form details influence the perception of the chairs to change from being ugly to being beautiful. Chairs (G-K) that were perceived to be more unique are located in the two columns on the right. These chairs significantly deviate from the typical chair in terms of overall forms and structures. The unique but ugly chairs tend to feature concrete metaphors, such as high heels (H), cultural totems (G), and grass (K), while the unique and beautiful chairs have a relatively abstract and holistic design without legs or a seat (L), or have a one-piece integrated shape with consistent material (I, J).

Chairs in the same row (e.g., C, E, I, and L) have similar aesthetic ratings. Here the perceived novelty appears to increase as the shape of the chair becomes more integrated and deviates from the typical chair. For example, the shapes change from a chair with four legs (C), to a chair with three legs (E), to a chair with integrated legs and back (I), and finally to a chair with no legs at all (L).

We note that these observations are only preliminary and restricted to this particular set of chairs. Carefully planned experiments are needed to test the influence of specific design characteristics on the novelty judgments of products.

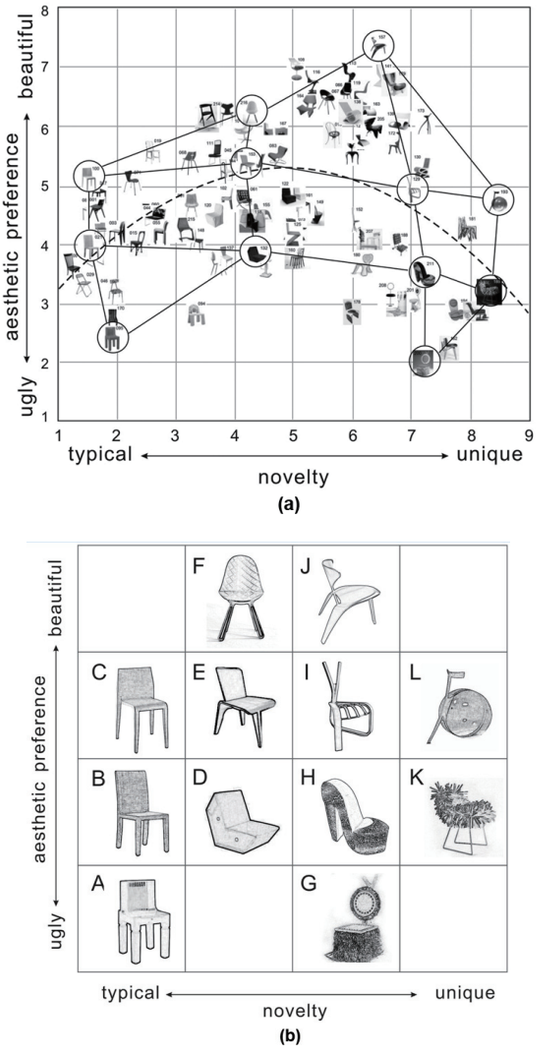

Figure 3. 4x4 grid with 12 representative chairs.

Effects of Trendiness, Emotion, and Complexity Dimensions on Novelty

To investigate what novelty means, we performed linear regression analysis on the effects of complexity, emotion, and trendiness on novelty. We found significant linear correlations in all cases (r = 0.830, r = 0.901, r = 0.910; $p < 0.05$) (Figure 4), indicating that, a typical chair is usually simple, rational, and traditional, while a novel chair is often complex, emotional, and modern.

We further performed multiple linear regression analysis, and obtained the following regression equation (R^2= 0.937; F = 417.8; $p < 0.05$):

Novelty = –1.383 + 0.586 * Trendiness + 0.412 * Complexity + 0.270 * Emotion.

The three dimensions of product semantics account for 93.7% of the variance in novelty. Thus, they can all be regarded as predictor variables for novelty, where trendiness has the greatest influence, followed by complexity, and then emotion.

Effects of Trendiness, Emotion, and Complexity Dimensions on Aesthetic Preference

Analyzing the relationship between the three semantic dimensions and aesthetic preference, we found significant inverted U-curve relationships between the complexity and aesthetic preference (quadratic estimation: R^2 = 0.184, F = 9.57, $p < 0.05$; linear estimation: R^2 = 0.019, F = 1.65, $p > 0.05$), as well as between emotion and aesthetic preference (quadratic estimation: R^2=0.088, F = 4.10, $p < 0.05$; linear estimation: R^2 = 0.022, F = 1.94, $p > 0.05$). For trendiness dimension, both quadratic and linear relations reach significance (quadratic estimation: R^2 = 0.161, F = 8.13, $p < 0.05$; linear estimation: R^2 = 0.161, F = 16.44, $p < 0.05$), but linear relation is more significant. The correlation coefficient between

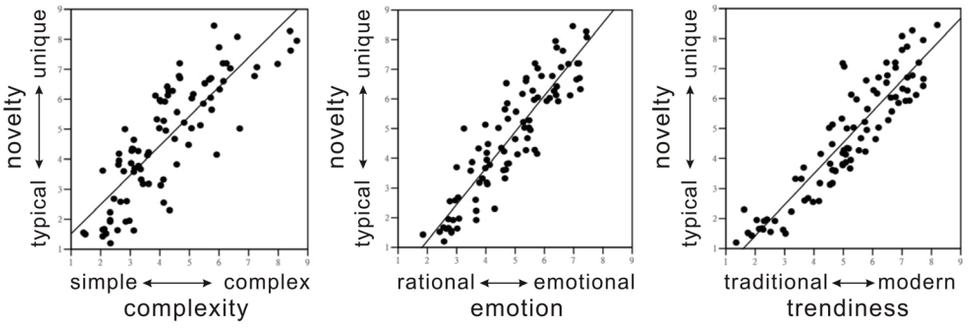

Figure 4. Scatter diagrams of complexity, emotion, and trendiness vs. novelty.

trendiness and aesthetic preference is ($r = 0.401$, $p < 0.01$). The scatter diagrams of complexity, emotion, and trendiness versus aesthetics, respectively, are shown in Figures 5 (b), 5 (c), 5 (d). In each of the scattered diagrams, both the fitted quadratic curve and the fitted line are shown. For trendiness dimension, because the fitted quadratic curve almost coincides with the fitted line, the two curves are indistinguishable in Figure 5 (d). For easy comparison, we also show the scatter diagrams of novelty versus aesthetics as Figure 5 (a).

The results indicate that the inverted U-curve relationship between novelty and aesthetic preference could be due to the influence of complexity and emotion dimensions; whereas the influence of trendiness dimension is mainly a positive linear influence.

Conclusions and Discussions

In this paper, we re-visited the much investigated relationship between novelty and aesthetic preference. Following the finding of partial independence between typicality and novelty by Hekkert et al. (2003), we conjectured the existence of an inverted-U quadratic function between the bipolar typicality/novelty and aesthetic preference, which results from the multiplication effects of the two linear functions: preference for typicality and preference for novelty. We found a significant quadratic curve relationship between novelty and aesthetic preference ($R^2 = 0.183$, $F = 9.54$, $p < 0.05$), as illustrated in Figure 2. Thus, our findings confirm Berlyne's hypothesis that the relationship between novelty and aesthetic preference resembles an inverted-U curve. Our results also offer a possible explanation for the divergent findings about the relationship between novelty and aesthetic preference. As shown in (Hekkert et al., 2003), typicality and novelty are separate factors that have high negative correlations and tend to inhibit the effect of each other. A linear relationship of preference for typicality is revealed by partialling out the influence of novelty reveals, while a linear relationship of preference for novelty is revealed by partialling out the influence of typicality. The high negative correlation between typicality and novelty means that, in many cases, typicality and novelty could be approximated as a bipolar variable. Since the product (multiplication) of two linear functions is a quadratic function, the joint influence of preference-for-typicality and preference-for-novelty produces an inverted-U quadratic function between the bipolar typicality/novelty and aesthetic preference. The inconsistent results obtained by past studies could be the consequence from the selection of stimuli, i.e., whether the set of stimuli varied along both typicality and novelty, or along only one of the factors. The former case could result in an inverted-U curve, while the latter could result in either preference for typicality or preference for novelty. Thus, our results extend the findings by Hekkert et al. (2003), and offer a potential theory explaining the relationship between novelty and aesthetic preference.

Although the quadratic curve relationship between novelty and aesthetic preference is statistically significant, the explaining power of the model is somewhat limited, because it only accounts for 18.3% of the variance. As can be observed in Figure 2, the

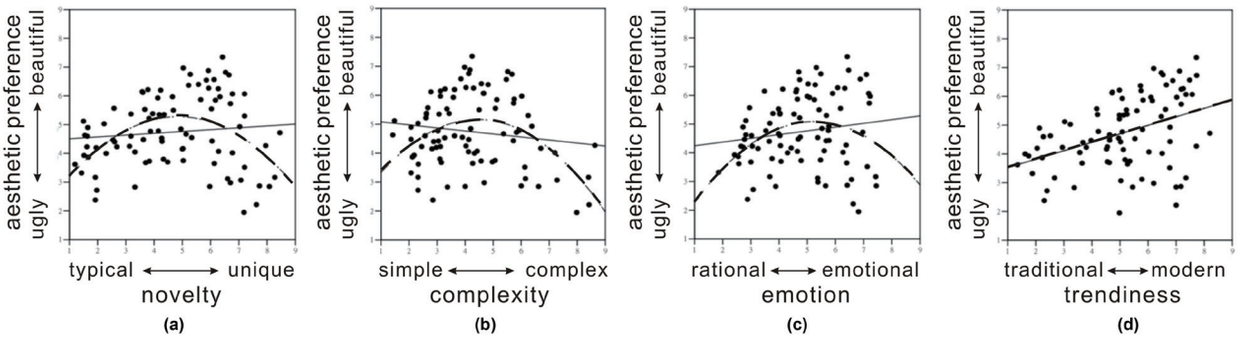

Figure 5. Scatter diagrams of novelty, complexity, emotion, and trendiness vs. aesthetic preference.

chairs perceived to be most beautiful are indeed those with a moderate level of novelty, but the converse statement is not true. Chairs with a moderate level of novelty elicited a wide range of aesthetic preference, possibly from beautiful to ugly. Why are there such wide variations? Table 1 shows the statistical analysis results for the bipolar typicality/novelty ratings for 9 chairs. The left column shows three chairs that were consistently rated as highly typical (and thus had small standard deviations), while the right column shows three chairs that were consistently rated as highly unique. The middle column shows three chairs whose typicality/novelty ratings have the largest standard deviations among the set of stimuli. These three chairs received favorable ratings in aesthetic preference and are located in the region that corresponds to medium level of novelty and high level of aesthetic preference in Figure 2. The visual characteristics of these chairs can be described as adding novel details to prototypical forms, e.g. "chair + umbrella + plant," "chair + walking cane," and "chair + cat + birds." Thus, the three chairs potentially deliver ambiguous messages in terms of typicality and novelty. Their relatively large standard deviations could be due to the ambiguity encountered by participants when trying to assign bipolar typicality/novelty ratings to these chairs.

In this research, we approximated typicality/novelty as two ends of a continuum and used bipolar adjectives for measuring novelty. There were two reasons for doing so. As discussed above, we hypothesized that the multiplication of two linear preference-for-typicality and preference-for-novelty functions results in an inverted-U quadratic function between the bipolar typicality/novelty and aesthetic preference. To test this hypothesis, we adopted bipolar typicality/novelty scale for measuring novelty. Another reason was that semantic differential method (Osgood et al., 1957), which makes use of bipolar adjectives, has been widely applied in design research. A careful examination of the relationship between aesthetic preference and the bipolar typicality/novelty could offer useful information to design researchers, who might continue to apply semantic differential methods in their research.

This approximation of typicality/novelty as two ends of a continuum works, most of the times – but not always. The bipolar scale assumes that high typicality implies low novelty, and vice versa. However, for stimuli successfully combining typicality and novelty, such as those shown in the middle column of Table 1, these assumptions do not hold. This failure of assumptions led to the relatively large standard deviations. In particular, the bipolar typicality/novelty scale might not be able to distinguish between stimuli that are indeed of medium novelty, stimuli that are both typical and novel, and stimuli that are neither typical nor novel. To resolve this ambiguity, it is necessary to treat typicality and novelty as independent factors. We suspect that the kind of partial independence between typicality and novelty demonstrated by Hekkert et al. (2003) could be present not just for typicality/novelty, but also for other bipolar adjectives, such as simple/complex. Issues relating to semantic ambiguity in product design were explored in another study (Hung & Chen, 2011).

We also looked into what constitutes novelty in product design. We included three fundamental dimensions of product semantics – trendiness, complexity, and emotion – in our study, and investigated their influences on judgment of product novelty and, in turn, judgment of aesthetic preference. We found that each of the three fundamental dimensions in product semantics – complexity, emotion, and trendiness – forms a positive linear relationship ($r = 0.830$, $r = 0.901$, $r = 0.910$; $p < 0.05$) with novelty. Furthermore, a multiple linear regression analysis showed that the three dimensions of product semantics account for most of the variance in novelty ($R^2 = 0.937$; $F = 417.8$; $p < 0.05$). Thus, complexity, emotion, and trendiness can all be regarded as predictor variables for novelty, where trendiness has the greatest influence, followed by complexity, and then emotion.

How do these dimensions account for novelty's effect on aesthetic preference? We found significant inverted U-curve relationships between the complexity and aesthetic preference ($R^2 = 0.184$, $F = 9.57$, $p < 0.05$), as well as between emotion and aesthetic preference ($R^2 = 0.088$, $F = 4.10$, $p < 0.05$). On the other hand, the relationship between trendiness and aesthetic preference follows a positive linear relationship ($R^2 = 0.161$, $F = 16.44$, $p < 0.05$). The results indicate that the inverted U-curve relationship between novelty and aesthetic preference could be due to the influence of complexity and emotion dimensions; whereas the influence of trendiness dimension is mainly linear. A possible

Table 1. Typicality/Novelty.

Highly Typical Small Standard Deviations			Both Typical and Unique Large Standard Deviation			Highly Unique Small Standard Deviations		
								
M=1.20	M=1.43	M=1.50	M=3.60	M=3.82	M=4.65	M=8.45	M=8.27	M=7.95
Std= 0.51	Std= 0.85	Std= 0.91	Std= 2.67	Std= 2.59	Std= 2.50	Std= 1.24	Std= 1.13	Std= 1.56
S= 2.60	S= 2.26	S= 2.43	S= 0.66	S= 0.63	S= 0.37	S= -3.24	S= -1.49	S= -1.67
K= 5.98	K= 5.35	K= 6.44	K= -0.82	K= -0.62	K= -0.80	K= 11.48	K= 1.21	K= 2.32

Note: M: mean; Std: standard deviation; S: skewness; K: kurtosis.

consequence of these findings is that, when studying the effects of novelty on aesthetics, if complexity and emotion dimensions are treated as separate factors – and not as aspects of novelty, the relationship between novelty and aesthetic preference will likely be linear, because novelty would then be mainly determined by trendiness.

As discussed above, our results indicate that trendiness dimension has the greatest influence on novelty, and its influence on aesthetic preference is linear with a correlation coefficient of 0.401 ($p < 0.01$). This is not surprising because trendiness/modernity often showed up as the most important factor on consumer perception of product appearance (Hsiao & Chen, 2006; Blijlevens et al., 2009). However, while complexity dimension has been shown to relate to the number of elements, and emotion dimension has been shown to relate to curves and curved surfaces (Hsiao & Chen, 2006), it is not easy to define "trendiness/modernity" in terms of specific visual characteristics of product appearance. Blijlevens et al. (2009) observed that in the 1980's angular products were modern, while now organic forms are more contemporary. Hsiao and Chen (2006) also observed that trendiness varies with what is in vogue currently. A possible factor influencing the perception of trendiness might be familiarity from repeated exposures, as discussed in (Leder & Carbon, 2005). Additional studies are needed to further understand the influence of trendiness on aesthetic preference.

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