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PRODUCT AESTHETICS

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1. INTRODUCTION

In 2003, Lidwell, Holden and Butler published a well-documented collection of 100 universal principles of design. Among these are 28 principles explaining 'How can I increase the appeal of a design?' These principles, laws, or guidelines deal with the Golden Ratio, similarity, savannah preference, symmetry and color; principles that will also appear in this chapter. Most of these principles have for centuries been applied in the arts, and have over the last century been uncovered and tested in psychological experiments. The authors claim that the application of such principles 'increases the probability that a design will be successful' (Lidwell et al., 2003, p. 11). We are tempted to adopt this claim, but want to take it a little further. Understanding why people are aesthetically attracted to some properties or patterns over others will support designers to make founded decisions on the attractiveness of their design.

Over the past ten years, the first author has given many lectures on visual aesthetics to students of industrial design. The main message of these lectures always was: People may and do differ extensively in their aesthetic reactions to objects; these reactions as well as the differences are not arbitrary, but lawful. Contrary to what the popular expression 'de gustibus non est disputandum' holds, there is accounting for taste! Does this mean we can (already) explain all varieties in aesthetic preference? Of course we cannot. There are still many unresolved issues and unpredicted (but not unpredictable) exceptions. But, after more than 100 years of theorizing and experimentation, we have come to understand quite a bit about the drivers of people's aesthetic responses to the things around us in general and designed artifacts in particular. This chapter aims to bring together these insights.

Product Experience

1.1. Aesthetics

'Aesthetics' is a very old concept, rooted in the Greek word *aisthesis* that can be translated as understanding through sensory perception. Only in the eighteenth century the concept started to be used in the way we will use it here, referring to sensory pleasure and delight (Goldman, 2001). Recently, the first author has argued that such a definition of aesthetics, i.e. the pleasure attained from sensory perception, is most appropriate in that it clearly separates aesthetic phenomena from other types of experience, such as the construction of meaning and emotional responses (Hekkert, 2006). In adopting this definition, some misunderstandings in the use of the concept aesthetics become salient, and these will now be briefly discussed.

Aesthetic is not restricted to art or artistic expressions – Many artistic expressions, like works of art, music and designs, are aesthetic in the sense that they can evoke pleasure in the observer or user. But other, non-artistic phenomena, such as people, landscapes, and sunsets can also be aesthetic in that their appearance can strike us as beautiful or attractive.

Aesthetic is not limited to the visual domain – The visual arts have clearly dominated Western art and, as a result, the concept of aesthetics has often been used as synonymous for visual beauty. If we, however, agree that aesthetics refers to sensory pleasantness in general, things can also be aesthetic or pleasant to listen to, touch, smell, or taste. In Section 4 we will discuss some aesthetic principles that apply to non-visual domains.

Aesthetic is not a matter of styling (only) – In product design we often speak of aesthetics in relation to the final surface treatment of a design or its styling. The aesthetic principles in the next sections will hopefully make clear that all product properties can contribute to the sensory pleasure that is evoked. Making a product aesthetic is clearly not something you can start to work on after most of the design is finished.

Aesthetic pleasure is not an emotion – This is probably the most controversial implication of our definition. Many scholars in the field of emotion have been theorizing about so-called aesthetic emotions, mostly referring to 'normal' emotions, like interest, fascination and surprise, that often take place in, but are not restricted to, encounters with works of art (see e.g. Silvia, 2005). Whether these emotions are a special class or no emotions at all has been subject to some debate (e.g. Frijda, 1988, 1989; Lazarus, 1991). Following our position, an emotion per se simply cannot be aesthetic.

An aesthetic response is limited to the gratification that comes from sensory perception of an object, and has no implications for any of our concerns, the class of dispositional states that is so fundamental to our emotions. In short, for an emotion to be evoked, some concern, such as a goal or an expectation, must either be violated or satisfied (e.g. Scherer, Schorr and Johnstone, 2001; see also Chapter 15 for an extensive treatment of appraisal theory). An aesthetic response, however, is 'disinterested' (Kant, 1952) or distanced (Bullough, 1912) in that no motives other than perceiving the object of perception 'as such' are at stake. The pleasure 'simply' results from the act of perception itself. This certainly does not mean that an aesthetic experience could not result in a (positive) emotion, or that responses to art cannot be emotionally moving. Most people experience strong emotional reactions when they listen to their favourite music, as was shown in studies by Blood and Zatorre (2001). How and when aesthetic responses lead to what emotions is a complex process that requires a deeper understanding of the appraisal processes underlying emotions.

Aesthetic is not an aspect, property or element of something – Following our definition, any property can elicit an aesthetic response, as long as that property is perceived as pleasant through the stimulation of one of the senses. Although we will show that some properties will more likely evoke such responses than others – and are for that reason

often coined 'aesthetic' – it is theoretically (and empirically) impossible to defend that a property or element *is* aesthetic.

1.2. Research in aesthetics

Although our definition of aesthetics is to some degree limiting, most of the research done in the area of experimental aesthetics since the pioneering work of Fechner (1876) is relevant for our overview. Much of this research focused on finding, mostly visual, properties of objects, whether simple patterns, artworks or designed objects, determining aesthetic preference. These properties are generally classified into three classes: Psychophysical, organizational, and meaningful properties (e.g. Berlyne, 1971; see Hekkert, 1995 for an overview).

The psychophysical properties are the formal qualities of objects, such as their intensity, size and color (in terms of hue, saturation, brightness), or, generally speaking, properties that can be quantified. Aesthetic effects of these properties are highly relational and contextual, as we will show in Section 2. In isolation, the most interesting findings come from color studies. It has often been demonstrated, for humans of many cultures and even for animals, that hues are preferred in the order blue, green or red, and yellow (McManus, Jones and Cottrell, 1981). Furthermore, the three color dimensions, hue, saturation, and brightness, differ with respect to their impact on aesthetic preference. Contrary to what many would suspect, variations in hue only explain a small amount of the variance in judgments of color pleasantness; brightness seems to be somewhat more important, and saturation determines by far the most variance (Smets, 1982).

The two other classes of properties, organizational and meaningful properties, have been studied more extensively and will be discussed in Sections 2 and 3. In this discussion, we will confine ourselves as much as possible to studies involving design objects as stimulus material. As will be shown, findings from these studies often suggest universal agreement in aesthetic pleasure. In Section 4 we try to explain why and under what conditions people of different times and cultures aesthetically prefer the same properties, and not only visually. Despite these universal principles, people can differ considerably in matters of taste. Section 5 is devoted to some explanations that may account for this variability. Section 6 closes with some conclusions and implications for designers and the field of design.

2. ORGANIZATIONAL PROPERTIES

Our visual system is tuned to organize information, to bring structure or order in the wealth of information that reaches our retina. Psychology of perception has achieved a good understanding of how our perceptual system makes sense of our environment by analyzing edges, contours, blobs, and basic geometrical shapes (e.g. Marr, 1982; Biederman, 1987). However, in order to represent what surrounds us we, for example, need to perceive which elements belong to the same object.

Various principles have been proposed that seem to be fundamental to how this organization unfolds (see also Chapter 1). Elements that look similar in color, size, or shape, are seen as belonging together (*principle of similarity*), a line that is interrupted and continued later on is seen as one line (*principle of good continuation*), and we tend to make the most likely or economically efficient interpretation of a pattern (*law of Prägnanz*). These are examples of so-called Gestalt principles or laws of perceptual organization and these do not only explain why we see what we see, but also why we prefer to see certain patterns over others (see e.g. Hekkert, 2006; Ramachandran and Hirstein, 1999). Simply put, we like to look at patterns that allow us to see relationships or create order. The generality of this assumption will be further investigated in Section 4. Below, we first look at some organizational properties that have been central in aesthetic research.

Although the present chapter is concerned with aesthetics in the context of product design, it needs to be mentioned that researchers often tend to investigate properties of objects in isolation. While this gives them control over the source of changes in appreciation, it also leaves the question to what extent the variation of only one property, such as 'visual contrast', contributes to our aesthetic experience derived from encounters with everyday objects such as cars, fashion designs or sculptures. In consequence, although we will discuss some properties of objects that are preferred over well-defined others, we will particularly focus on those properties that are relevant for the perception and appreciation of products.

2.1. Unifying properties

Order, balance or harmony, symmetry and 'good' proportion are omnipotent in products. Only rarely does a designer allow himself to challenge these unifying properties, to disrupt order, create misbalance or asymmetry, or design objects that are badly proportioned. If he does, he is either a bad designer or has very good reasons to do so (see Section 6). These principles are used to make a design coherent and orderly and, therefore, pleasant to look at.

Balance

Eye movement studies have shown what happens when the balance in a visual composition is distorted. Locher and his colleagues (e.g. Locher, Overbeeke and Stappers, 2005; Nodine, Locher and Krupinski, 1993; see Locher, 2006 for an overview) examined the scanpaths of people looking at original versions of paintings and versions in which the original composition was somehow altered, either by leaving out certain elements or changing the distribution of 'weight' in, for example, a typical Mondrian painting. Scanpaths of people looking at distorted versions revealed more eye movements (saccades) and less fixations, interpreted as an indication of the observer's desperate attempt to detect order and balance in the distorted composition. This interpretation is supported by findings from other studies in which pictorial compositions where systematically changed (Boselie, 1992; Hekkert and van Wieringen, 1996). Both these studies showed that changing an original, and presumably balanced, painting leads to a decrease in preference ratings, especially among untrained viewers. Together these findings reveal that people do have sensitivity for a balanced composition.

'Good' proportion

Whereas it is clear that an orderly, balanced or symmetrical design is aesthetically pleasant, it is less clear what proportion should be considered 'good' or aesthetically superior. For centuries, people believed that a ratio according to the golden section deserved this special status, but a wealth of empirical studies testing its special attractiveness yielded ambiguous results (see for an overview e.g. Berlyne, 1971; Hekkert, Peper and van Wieringen, 1994; McWhinnie, 1987).[1] At most, ratios close to the golden section seem to

[1] For those unfamiliar with the golden section ratio, this ratio is obtained when the ratio of the shortest to the longest of two lengths, such as in a rectangle or a cross, equals the ratio of the longest to the sum of the two. The numerical value of this ratio, often denoted as φ, is approximately 1.618 (or its reciprocal ϕ.618).

be preferred over other ratios, but this could easily be a range effect (Godkewitsch, 1974) or an effect of averaging (Plug, 1980), obscuring great intersubject variability (Hekkert et al., 1994; McManus, 1980). Next to the ratios in the vicinity of the golden section, the square was also often found to be a preferred ratio (McManus, 1980). As we concluded earlier, the golden section ratio probably has 'obtained this special attention mainly thanks to its unchallenged mathematical beauty' (Hekkert et al., 1994, p. 186).

As noted in the beginning of Section 2, studying properties in isolation probably tells us little about the effects of these properties in the context of design objects. Given the high interrater variability, one may therefore question whether the search for proportions of special attractivity *per se* is worthwhile. As Hekkert et al. (1994) concluded, 'instead of continuing the search for proportions of special attractivity in their own right, it is more valuable to study proportionality *of something*' (p. 200). Following this suggestion, Hekkert (1995, chapter 3) started a series of experiments on proportion preferences in context. As could be easily predicted, he found that aesthetic preference for particular rectangular proportions highly depended on the type of object the rectangle represented, such as a window, a cabinet door, or a bathroom tile (see Figure 10.1). More interestingly, preference was linearly related to the rated commonness of the proportion (Figure 10.2), a measure of familiarity (see Section 3.1). This finding was replicated in a subsequent experiment (Experiment 2, p. 73) with three (at that time) unknown and especially designed products (a portable smoke-filter, a subwoofer, and an electromagnetic radiation reducer), for which the exposure frequency was systematically varied. Other research along these lines has been done in the area of packaging, further showing that proportions of invitation cards and packages for grocery products affect consumer perception, preferences, and purchase intentions (Raghubir and Greenleaf, 2006).

Symmetry

Symmetry in simple patterns can be produced quite easily; the designer has to choose one or more axes at which the design is mirrored. Objects that are mirrored along one axis can easily be recognized as being symmetrical, and indeed are often seen as pleasant. For example, symmetrical faces are preferred over non-symmetrical ones (Grammer and Thornhill, 1994) and symmetrical abstract patterns are often seen as more beautiful (Jacobsen and Höfel, 2003). The reasons for a preference of symmetry are not fully understood. 'Reading' a symmetrical object is much easier than reading asymmetrical ones. Once you have seen one half, you know what the other half is like. Thus, an important part of symmetry preference might be due to ease of processing (Reber, Schwarz and Winkielman, 2004). Concerning beauty of faces it has been argued that

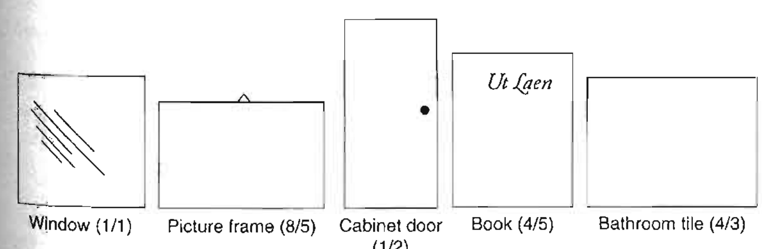

FIGURE 10.1 Examples of rectangles representing a product (from Hekkert, 1995, p. 69).

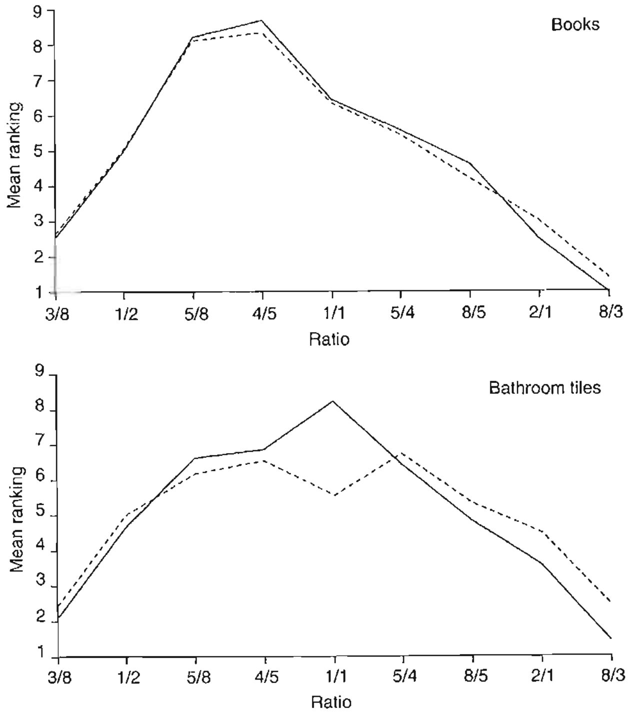

FIGURE 10.2 Mean rankings for two of the products used in Hekkert (1995, p. 72). Solid line: commonness ratings; dotted line: attractiveness ratings.

symmetry indicates a healthy development and therefore is an indicator of positive genetic make-up (Thornhill and Gangestad, 1993). Others have argued that symmetry makes faces attractive because they are more prototypical, where prototypicality is the underlying attractive feature (Rhodes, 2006). In Section 4 we will look more closely at such explanations.

2.2. Complexity and variety

If humans would just look for orderly and balanced patterns, our world and our designs would be rather simple, and presumably be experienced as boring. In some circumstances, we also seem to search for complexity and variety, a type of behavior coined diversive exploration (Berlyne, 1966).

According to Berlyne's collative-motivation model, patterns are preferred for their ability to generate arousal (Berlyne, 1971). Visual patterns with low arousal potential are not stimulating and leave the observer indifferent; patterns with very high arousal potential are too difficult to grasp and are considered unpleasant. Preferred are patterns with an arousal potential at a medium (or optimum) level, leading to the famous prediction of an inverted U-shaped function between hedonic tone (pleasantness) and arousal potential. Since collative properties, like complexity and variety, contribute most to the arousal potential of a design, they have dominated research in aesthetics.

Although ample evidence was found for an inverted U-shaped relationship between preference and complexity (e.g. Berlyne, 1970; Smets, 1973; Walker, 1980), other, mainly monotonic, functions between these two variables were observed as well (e.g. Frith and Nias, 1974; Walker, 1980). This was especially true when the stimulus material was more meaningful, such as real artworks, as opposed to the simple, artificial stimuli that were used in most studies in favour of Berlyne's model. It was concluded that Berlyne's model has limited explanatory value when ecologically valid objects, like products, are evaluated (see Hekkert, 1995; Martindale, 1984), a limitation already acknowledged by Berlyne (1971) himself. However, Berlyne's prediction reflects a more general principle of aesthetic pleasure: Unity in variety.

2.3. Unity in variety

If people are attracted to order and unity, whereas they also (occasionally) seek complexity and variety, it is easy to predict that a balance between these opposing forces would lead to maximum pleasure. This principle of unity in variety was already known to the Greeks and has been most influential in the field of aesthetics ever since (see e.g. Berlyne, 1971; Fechner, 1876). The principle holds that the greatest pleasure or beauty is arrived at by as much variety or complexity as possible with a maximum of unity or order. Attempts to formalize this principle in simple functions of order (O) and complexity (C) failed to explain preference ratings of simple polygons (see McWhinnie, 1968 for an overview of these information-theoretic approaches). In a classic study, Boselie and Leeuwenberg (1985) developed a more subtle formula, taking into account that patterns can be regular in more than one way. These additional regularities, not accounted for by the simplest interpretation of a pattern, determine a pattern's unity (R); the free parameters that are not specified by these additional regularities represent the irregularity or variety of a pattern (P). The beauty of a pattern is arrived at by subtracting P from R. This formula proved to be adequate to predict the rated beauty of simple polygonal figures. Since products, as all real-life stimuli, embody an endless number of regularities, it is hard to predict which of them will be perceived. A mathematical description of product preference on the basis of such measures therefore seems a pointless exercise. But qualitative descriptions of a design's unity and variety may help to see its formal attractiveness (see for examples, Hekkert, 2006).

Conjunctive ambiguity

Boselie and Leeuwenberg (1985) based their mathematical model on the principle of conjunctive ambiguity, which is another principle proposed to be conducive to aesthetic preference, highly related to unity in variety (e.g. Arnheim, 1974; Berlyne, 1971). When an ambiguous pattern can be visually interpreted in several ways, conjunctive ambiguity concerns the case where the separate interpretations are compatible and jointly effective. As such, it is opposed to the beauty-reducing principle of disjunctive ambiguity where alternative interpretations are mutually exclusive (as in the famous duck-rabbit drawing). Hekkert (2006) describes Jean Nouvel's building Institut du Monde Arabe in Paris as a good design example of conjunctive ambiguity (Figure 10.3): The interpretation of this building at a global level (as an Islamic weave pattern) is different from, but fully compatible with its interpretation at a local level (seeing that the holes are actually shutters that regulate the amount of sunlight entering the building).

Maximum effect for minimum means

Conjunctive ambiguity can be seen as a special case of 'maximum effect for minimum means', a general principle that explains aesthetic quality in a wide variety of domains. The principle is economy-driven: We prefer solutions, ideas, formulas and the like that

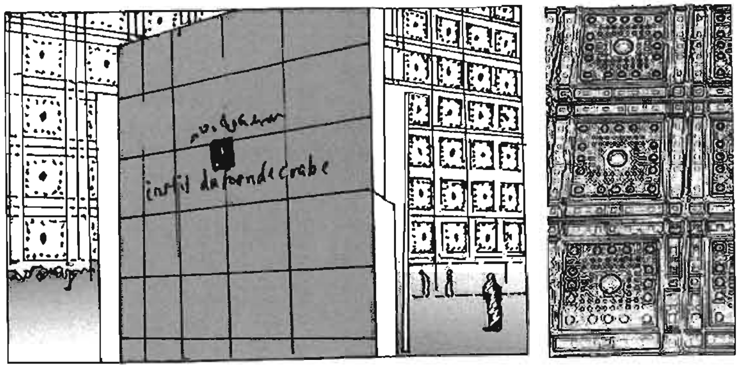

FIGURE 10.3 Institut du Monde Arabe by Jean Nouvel.

consist of as few elements or parameters as possible, while solving or explaining a range of problems or phenomena (e.g. Boselie and Leeuwenberg, 1985). For the same reason we can also say that a particular engineering solution, like a bridge, or a car suspension, is aesthetic; it only uses a limited number of constructive elements to solve all the problems the construction was meant to overcome. The general acclaim for the original Mini is, for example, based on this principle. By literally striving for minimalism in space and material – to realize a car that would be affordable to many – the designers introduced a range of innovations, such as a transversal engine, 10-inch wheel rims, and an ultra-compact wheel suspension. Analogously, an explanation or theory can be more attractive than others, and will therefore be selected, when it uses fewer parameters to explain the same phenomenon or more phenomena, a principle also known as Occam's razor (or the principle of parsimony). Since these aesthetic solutions and formulas are, by definition, also more economical or efficient – clever we could say – aesthetic sensitivity is important for scientists, engineers, and designers to create and recognize the most beautiful idea or solution. Designers often refer to this principle in preferring minimal solutions as exemplified by the iPod shuffle, an MP3 player in a tiny white box that only has a connector for an earplug, a USB connection for battery power and uploading songs, and a clickwheel for navigation, but no display at all (Figure 10.4).

3. MEANINGFUL PROPERTIES

Whereas the organizational properties in the previous section always require a beholder to perceive the extent to which they are present in a design, they can in principle be measured and formalized. The properties considered in this section are by definition subjective and are thus not properties of things, but rather properties as we perceive them. Based on our knowledge and previous experiences, we qualify something as familiar or novel, typical or strange, original or outdated. Since people in a particular culture may have considerable overlap in their backgrounds, the formal attributes on which these meanings are based may be rather consistent over people. As a result, we tend to attribute the meaning perceived to these characteristics. Logically, however, the degree to which something is perceived as novel or familiar is independent of the presence of an attribute *as such*. As we will show here, these meaningful 'properties', determining the so-called diagnosticity of a pattern, have a big impact on our aesthetic preference.

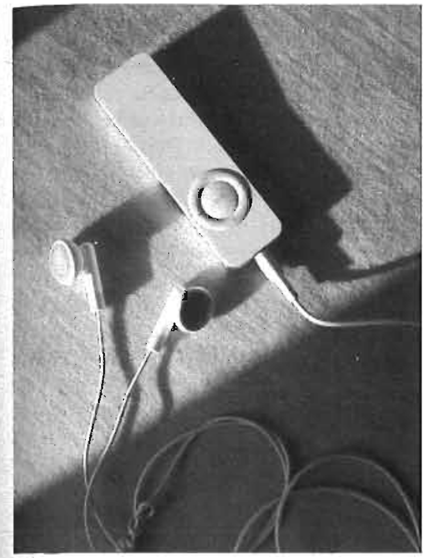

FIGURE 10.4 The Apple iPod shuffle.

3.1. Familiarity and prototypicality

Whenever we encounter an object, and this also holds for design objects, we (try to) classify it by comparing it to objects we know or have seen before. The idea that we like what we know has had an apparent appeal to psychologists for a long time. However, there are different ways in which familiarity might affect the aesthetic appeal of an object. In the next paragraphs we discuss those ways that have found empirical confirmation and were shown to be important in the appreciation of complex, real-life objects.

Familiarity

While William James and Gustav Fechner, both pioneers of psychology in the nineteenth century already assumed that 'familiarity breeds liking', it was in 1968 that Robert Zajonc provided a systematic empirical study of this phenomenon. In a seminal paper he reported evidence, from a number of sources, that mere exposure to a stimulus increases its aesthetic appreciation. Not only did he show that words with a positive connotation are far more frequent in language, he also experimentally varied the number of times that faces, Chinese characters or pseudo-Turkish words were repeated, and found that with increasing repetition the objects were liked more. He discussed his findings as a general principle of aesthetic appreciation that can explain why we often like the people we know, why we feel comfortable in our homes, and stick to the brand of a car we own. Thus, in order to create objects that people like, a straightforward recommendation could be to refer to existing, familiar solutions.

Preferring things that are familiar obviously has evolutionary advantages in that it leads to safe choices. In a world full of inherent dangers it might be sensible (or adaptive; see Section 4) to stick to the familiar and not expose oneself to strange and maybe harmful and threatening alternatives (Bornstein, 1989). Recently, an alternative has been proposed to this evolutionary explanation. Repeated exposure changes the way things are processed, the way they are perceived, classified, and recognized. Simply spoken, repetition or familiarity makes perceptual and cognitive processing easier and somehow more fluent, and this fluency is intrinsically pleasant (Reber et al., 2004). The more fluently perceivers can process an object, the more positive their aesthetic response will be. The important implication of this explanation is that fluency increases liking, not because it is a property of the stimulus, but because it is a property of the processing dynamics of the perceiver. Reber et al. (2004) thus believe that we somehow 'perceive ourselves' when we perceive and evaluate the objects around us, and attribute this ease of processing to the appreciability of the object.

However, repeated exposure has its limitations and will at a certain point (often after 20 repetitions) lead to over-exposure and saturation, and, consequently, boredom (see also Section 5.4). Furthermore, Bornstein's review (1989) showed that the effect of repeated exposure depended on the type of stimulus, being strongest for simple patterns, weak for real objects/persons, and was often not found with artworks and complex drawings. As already discussed under 'Good' proportion above, Hekkert (1995) demonstrated a strong linear relationship between attractiveness ratings and exposure frequency for three unknown products. This effect was, however, less strong when the product was presented in an 'aesthetic' (conspicuous) context as opposed to a 'neutral' (inconspicuous) one (see Figure 10.5). These results suggest that the mere exposure effect is not equally strong for all objects and in all conditions. Nevertheless, the fact that the 'mere-exposure effect' is strongest when people are not aware that the stimulus to evaluate has been shown several times (e.g. Murphy and Zajonc, 1993) indicates that the effect is automatic and difficult to suppress.

Prototypicality

In order to recognize things, we tend to classify all things into groups of objects which share some properties. For those object categories for which there are many exemplars, such as human faces, cars, toasters, or cubist paintings, it seems that through experience we build so-called prototypes. These are typical representations which allow us to trigger appropriate responses and which summarize information that all objects of that

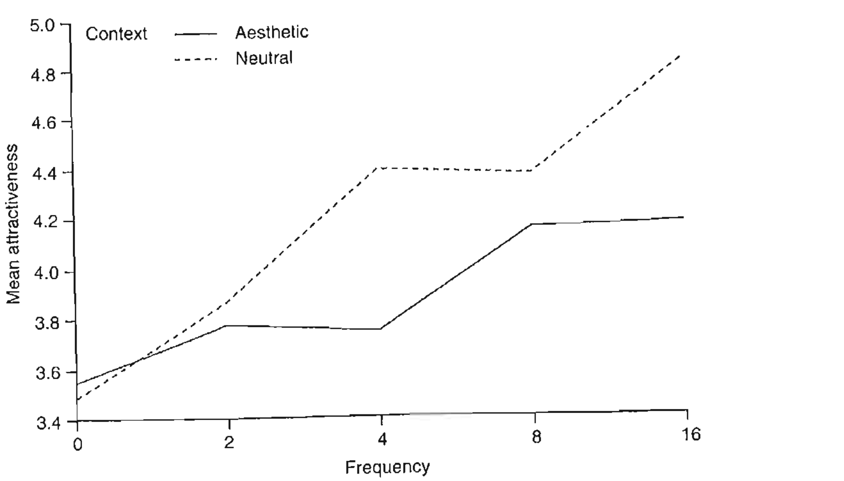

FIGURE 10.5 Mean attractiveness ratings of objects as a function of exposure frequency and context (from Hekkert, 1995, p. 77).

class have in common. This is not to say that the prototype is represented by a certain category member; a prototype is 'simply a convenient grammatical fiction; what is really referred to are judgments of degree of prototypicality' (Rosch, 1978, p. 40). Whitfield and his colleagues (1983; Whitfield and Slatter, 1979) carried out pioneering work concerning the effect of prototypicality on preference. They directly tested a preference-for-prototypes model (see also Martindale, 1984) against Berlyne's 'collative-motivation' model predicting an inverted U-shaped relationship between preference and novelty/complexity. They measured appreciation for different kinds of chairs that varied in prototypicality as a result of belonging to different styles, assuming that 'Georgian chairs' are more prototypical than 'Modern style' chairs, and these more prototypical than 'Art Nouveau' chairs. Moreover, the authors directly measured subjective impressions of typicality (as well as complexity and novelty) for all chair models investigated. As expected, more prototypical chairs were liked better, and typicality was negatively correlated with novelty, indicating that prototypicality is opposite to novelty. Contrary to what Berlyne's model would have predicted, 'complexity' did not account for differences in aesthetic appreciation. Subsequent studies in which both models were empirically tested against each other were performed for diverse categories such as houses (Purcell, 1984), cubist paintings (Hekkert and van Wieringen, 1990), and musical performances (Repp, 1997), all confirming a linear relationship between preference and prototypicality.

Although familiarity is not the only defining variable of (proto)typicality (Barsalou, 1985), the two concepts are clearly related. They both find their aesthetic attractiveness in ease of classification or processing (Reber et al., 2004). But ease of processing is not what people are always after. At various occasions people look for novel or original instances and especially children have a bias towards novelty in their early ages (e.g. Uehara, 2000).

3.2. Originality, novelty and innovativeness

Biederman and Vessel (2006) claim that as our brain has evolved in order to understand the world, it derives pleasure from processing new and unfamiliar objects. They showed that new pictures of scenes and objects were preferred over pictures shown repeatedly. Though this seems to contradict the above described mere-exposure hypothesis, this finding is very much in accordance with our everyday experience. We are often attracted by new, unusual and innovative products (Veryzer and Hutchinson, 1998). However, the visual pleasure proposed by Biederman and Vessel (2006) only emerges when we are able to identify and successfully process what we see or, in other words, when the new thing is not frighteningly unfamiliar. A related argument has also been proposed in explaining the aesthetic appeal of modern art, which allows us to experience that we master the 'new', and gain aesthetic pleasure through a subjective state of successful classification, interpretation and understanding (Leder et al., 2004).

Nonetheless, from everyday experience it is apparent that novel or innovative products are often not liked immediately. Although innovative products seem to be essential for companies in competitive markets, this initial dislike poses them with a serious problem. In a series of experiments concerning the role of innovativeness in car interior design, Leder and Carbon (2005) varied stimuli according to innovative features, such as curvature and complexity. When participants were asked to indicate how much they liked each version, they preferred the curved versions to the edged versions, a finding in accordance with a recent study by Bar and Neta (2006). Most importantly, Leder and Carbon (2005) found that their participants did not appreciate innovative versions. As we know that novelty – and innovativeness as a special case – is often initially unappreciated, the authors further aimed to understand what variables could increase liking for innovativeness. From our daily experience we know that appreciation often changes over time. Take for example the 'edgy' backside of the Megane, recently introduced by Renault. Now that the car has been on the road for a while, to most perceivers it no longer seems aversive, but gains in appreciation. This brought Carbon and Leder (2005) to think of a setting which allowed them to realistically measure not only appreciation and innovativeness in a single shot measure, but to understand the changes over time, i.e. the dynamics of innovation.

For these purposes, Carbon and Leder developed the repeated-evaluation technique (RET). In their study they used drawings of stylized car interiors, which systematically varied in innovativeness (as well as in other variables). When perceivers in a first block were asked to indicate how attractive the different versions were, they preferred the classical version. Next, participants took part in a session in which they were asked to rate all designs according to several dimensions, which made them actively deal with the designs for about half an hour (Carbon and Leder, 2005). When the participants afterwards rated all stimuli again according to liking and innovativeness, it was found that the more innovative designs were now seen as more attractive, while they still preserved their level of apparent innovativeness. From these results it can be concluded that actively evaluating the stimuli somehow reveals the possible advantage of innovativeness: The design becomes more attractive and still preserves aspects of being new, distinctive, and thus innovative.

3.3. 'Most advanced, yet acceptable'

So far we have two seemingly contradictory hypotheses, 'we like what we know' versus 'we sometimes appreciate the new'. How do these fit together? Is it possible that both are true at the same time? These two seemingly contradictory aspects are brought together in the famous MAYA principle proposed by Raymond Loewy (1951), MAYA being an acronym for Most Advanced, Yet Acceptable. Designers need to find a balance between innovation and novelty (advanced) and a certain amount of typicality (acceptable). Is such a balance possible and do objects that correspond to the principle indeed produce a high level of appreciation and pleasure?

Hekkert, Snelders and van Wieringen (2003) provided a strict empirical test of this MAYA assumption. They selected various products, such as telephones and teakettles, which differed along the dimensions of typicality and novelty. Participants rated all objects according to typicality, novelty, and aesthetic preference. As expected, novelty and typicality highly intercorrelated and each correlated poorly with preference. The trick of the study was to analyze the effect of both variables on aesthetic preference independently, by keeping the other variable (statistically) constant. In full accordance with the predictions of the MAYA principle, Hekkert et al. found independent effects on aesthetic preference of both novelty and prototypicality, and these effects were nearly equally strong. Thus indeed, attractive designs comprise a thoughtful balance between novelty and typicality.

3.4. Product expression and association

So far, the meaningful properties we discussed are rather unspecific and mainly require a generalized comparison with things we have encountered before. However, we tend to attribute many more differentiated meanings to a product, that sometimes rely on deeper levels of processing. We could, for example, see a product as feminine, easy to use, or friendly, or associate it with products from the 1950s or Italian design. Although the perception and identification of such connotative meanings are treated elsewhere in this volume (see Chapter 13) and go beyond the scope of the present chapter, identifying such meaningful properties may also have an impact on a product's perceived attractiveness. When, for example, Volkswagen introduced the New Beetle, much of its aesthetic appeal was due to the fact that the unusual shape referred to the old model by Ferdinand Porsche.

Given the narrow definition of aesthetics as adopted in this chapter, however, it remains to be seen whether such effects should be coined aesthetic. Take for instance the finding that people prefer products that express a personality that matches their own personality, also referred to as the self-congruency effect (Govers and Schoormans, 2005). The explanation for this effect is that people prefer congruent products because they are an extension of the self, and thereby contribute to one's identity. The liking in this case is based on an external motive, which renders it less aesthetic, or even non-aesthetic.

Next to such direct effects of meaning on liking, attributed meanings can also affect familiarity or originality and, thereby, have an indirect effect on a product's aesthetic appeal. In an attempt to identify the determinants of product originality, Snelders and Hekkert (1999) asked participants to indicate to what extent a set of telephones could be associated with things you encounter in other domains, such as 'in the bedroom', 'in church', 'while shopping', or 'in a fairy tale'. They showed that measures based on the relative uniqueness of these associations (i.e. a product has few associations in common with other products from the same category) were good predictors of a product's originality. Since, as we have seen, originality highly contributes to aesthetic preference, these meaningful associations have an indirect effect on a product's aesthetic appeal.

If and how product expression and association contribute to the aesthetic quality of a product remains both a theoretical and empirical question. It is nevertheless clear that a designer should consider what kinds of associations and relations to general or specific knowledge people might make, since these clearly affect the way a product is perceived and appreciated.

4. UNIVERSAL AESTHETIC PRINCIPLES

4.1. A study on cross-cultural aesthetic universals

At the end of the twentieth century a study was carried out that perfectly conforms to the law of maximum effect for minimal means. In this study, Hardonk (1999) adopted Fechner's (1876) method of production (i.e. people show their aesthetic preferences in the artifacts they produce) to find aesthetic universals: If such universals exist, they must be present in artifacts from all cultures. Hardonk found the perfect, ecologically valid, object of study – band patterns. Decorative band patterns, a motif that is repeated in one direction, are produced in all cultures and can be found on items such as vases and curtains, weapons and clothes (Figure 10.6). A further advantage of such patterns, unlike works of art, is that they are relatively simple and can therefore be objectively described and compared. But as simple and elegant as the idea of the study was, as complex was its execution.

Hardonk first started to define culture (based on independence, language and territory) and then selected a stratified sample of 20 cultures from a total of 294 in the 'Hardonk sample frame'. Next, before the selection of bands, he developed a descriptive system with properties that could, in principle, occur in bands. This system was based on people's perceptual interpretation of a band, not on its formal characteristics. This means that the system takes into account how people would describe a band in terms of objects on a background, and objects in terms of, for example, orientation and whether they are entirely visible or partly occluded (see the discussion on perceptual organization in Section 2). From each culture, 40 bands were taken randomly and put into drawings.

FIGURE 10.6 Examples of decorative band patterns in an eighth-century amphora from Attica, Greece (reprinted with permission from Biers, 1996, p. 124).

Finally, all bands were described using the descriptive system, resulting in 74 independent universal properties, properties that occur to the same degree in all cultures. These universals varied from absolute (admitting no fluctuations between cultures), to strong (minor fluctuations) to weak (somewhat more fluctuations); most were positive universals (occurring in all cultures), whereas some were negative (occurring in none of the cultures). It is of course impossible to list them all here, but let us try to summarize the most interesting findings.

Band patterns from all cultures contain one or more regularities, such as symmetry, parallelism, and equality of sides and angles. Both at the level of objects, and in the band as a whole, mirror symmetry occurred much more often than rotation symmetry, and vertical symmetry is much more prominent than horizontal symmetry. Most objects in bands consist of simple shapes, such as triangles, but in all cultures we also find patterns with more complex objects. If objects are grouped, most groups contain only two different objects (e.g. a circle and a square). Results like these support the contention that we like simplicity and order (Section 2.1), but that we (occasionally) also need some variety in this unity (Section 2.3). Furthermore, in all cultures, most bands contain no occlusions (a negative universal) and one or more ambiguities, of which object-background is the most frequent. Surprisingly, however, only disjunctive ambiguities were found and no conjunctive ambiguities (see Conjunctive ambiguity in Section 2.3).

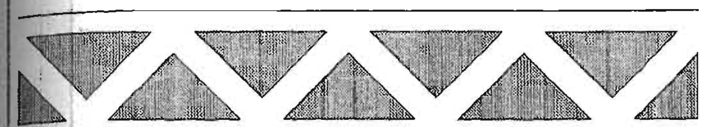

FIGURE 10.7 A universally accepted band with many universals, such as various forms of symmetry, simple shapes, parallelism, and object–background ambiguity (from Hardonk, 1999, p. 192).

Another elegant way to summarize the universals is by combining as many as possible in a single band pattern (Figure 10.7). Despite the limitations related to using band patterns as an object of study – band patterns are after all rather simple 2D patterns and often applied for other than aesthetic (e.g. symbolic, communicative) purposes – the study confirms that many of the properties discussed earlier can be regarded as universal aesthetic principles. The question then remains, where does this universality come from? How can we explain that people of all times and cultures prefer the same properties?

4.2. Evolutionary aesthetics

The most likely candidate to explain universal patterns in aesthetic preference is human evolution. Explanations along this line have been extensively proposed over the last two decades with the advancement of evolutionary psychology. The attractiveness of these theories is their ability to explain why general patterns in human behavior and their underlying psychological mechanisms are the way they are. As one of their most prominent proponents argues, 'In the study of humans, there are major spheres of human experience – *beauty* (our italics), motherhood, kinship, morality, cooperation, sexuality, violence – in which evolutionary psychology provides the only coherent theory' (Pinker, 2002, p. 135). As Darwin (1859) himself already predicted, humans have not only physically, but also mentally adapted to the challenges posed by their environments. Faced with adaptive problems, such as finding a mate, hiding from enemies, or understanding intentions, psychological mechanisms have evolved that are perfectly fit to solve such problems. As a result, we have acquired adaptations like sensory systems, a language capacity, and a trait for emotional communication, and … an aesthetic sense. One may now ask oneself, what on earth can be adaptive about finding someone attractive or something beautiful? Has it not always been argued that art and aesthetics are intrinsically useless? Art may be so, although some will certainly dispute this and argue that art is an adaptation itself (e.g. Dissanayake, 1992), but aesthetic preference certainly is not, as we will see next.

To explain the evolutionary basis of aesthetic preference, one major hypothesis can be coined the 'transfer-hypothesis' (see Rhodes, 2006), based on principles stemming from mate selection. The basic idea is that certain characteristics in attractive people, such as symmetry, are indicators of good health (e.g. an absence of parasites) and hence, may refer to reproductive fitness, the ability to produce healthy offspring (e.g. Grammer and Thornhill, 1994). The attractiveness of such features is abstracted and somehow transferred to other objects that, as such, have no biological relevance. Thus, according to this view, we have come to like symmetrical patterns, not only in humans but also in artifacts.

Others however argue that our (aesthetic) preferences are domain dependent (see Tooby and Cosmides, 2001) and related to domain-specific properties having survival value. Take for instance our preference for (properties in) landscapes. According to Wilson's biophelia-hypothesis (1984), we prefer savannah-like landscapes: Open grasslands with trees, water, animals, and plants, because these signal fertility, and thus abundance of food, as well as provide safety, in that they both offer means for hiding and spots that give an overview of the surroundings (see also Orians and Heerwagen, 1992; Pinker, 2002). It may indeed be difficult to 'translate' such specific preferences to other domains. Nevertheless, in line with other scholars such as Ramachandran (2004; Ramachandran and Hirstein, 1999), we believe there are domain-independent aesthetic universals that can be explained by looking at the evolutionary origin of our information processing system.

As argued elsewhere, this explanation is often referred to as the 'by-product' hypothesis (Pinker, 2002; Hekkert, 2006). According to this hypothesis, our aesthetic sense is a by-product of other adaptations, primarily of our sensory systems and brain.[2] Because certain patterns or features in the environment were functionally beneficial to these systems, we (have come to) derive an aesthetic pleasure from perceiving them. In other words, 'it is brains that have evolved to generate pleasant and unpleasant feelings to those aspects of the environment that were a consistent benefit or threat to gene survival in ancestral environments' (Johnston, 2003, p. 173). In order to find these patterns or aspects, we thus have to look at the functions of our sensory modalities (Hekkert, 2006). Whereas some of these functions are modality specific, possibly leading to domain-specific aesthetic preferences, there are certain functions that apply to most or all sensory domains (see Chapter 5). All sensory domains play a role in the identification of things or signals, whether it is a form, a sound, a texture, or a smell. Given the wealth of information in our surroundings and our limited capacity to process information, patterns or structures that support such identification are generally preferred over others (see also Ramachandran and Hirstein, 1999; Reber et al., 2004). From this basic 'law', we can explain many of the aesthetic principles discussed above and even predict some new ones.

Both Martindale (1990) and Ramachandran and Hirstein (1999) consider the peak shift principle a prominent principle underlying our aesthetic experience. Peak shift is a well-known phenomenon from behavioral learning and refers to the inclination of animals to respond more strongly to stimuli that go somewhat beyond the one the animal has learned to be rewarding. 'Because of peak shift, female birds that prefer to mate with males with bright rather than dull plumage will show even greater preference for males with supernormal or above-average brightness.' (Martindale, 1990; p. 47). Our liking of caricatures, for example, can be explained along similar lines in that they amplify the – already attractive – 'very essence' or prototype of a face (Ramachandran and Hirstein, 1999). Figure 10.8 is an example of peak shift in product design. In this lamp for the Italian manufacturer FLOS, the designer Achille Castiglioni in 1972 has amplified the essence or 'lampness' of a lamp by putting an enormous bulb on a pedestal. In proposing that 'all art is caricature' (p. 18), Ramachandran and Hirstein give a number of examples in which artworks show such amplifications. By isolating and amplifying the 'essence', peak shifts contribute to ease of recognition and are therefore advantageous to our brain's limited capacity.

Many of the principles proposed by Ramachandran and Hirstein are related to the unity in variety principle as discussed in Section 2.3. Since unifying or organizing mechanisms, such as grouping, symmetry, closure, and contrast, allow us to see what belongs together (or not), detecting such structures is rewarding. They all contribute to 'binding', i.e. making connections, and the creation of order and, as such, facilitate economic processing of information. This not only holds for seeing the unity, but also for the process of

[2]Our aesthetic sense is not alone in this. Many psychological phenomena that come so natural to us humans, such as religion (e.g. Dawkins, 2006), are most probably non-adaptive by-products of adaptations that do have survival value in and of themselves.

FIGURE 10.8 Lamp designed by Achille Castiglioni.

detection itself, as in solving puzzles (see also Hekkert, 2006). The rewarding effect of seeing relationships is furthermore not restricted to formal qualities, but can also result from connections made at a semantic level. This is for example the case in metaphors, where meaning is efficiently added to a product by a reference to something else (Forceville, Hekkert and Tan, 2006). Take for example Philip Starck's famous toilet brush Xcalibur, that by its name and shape refers to the sword used by King Arthur (Figure 10.9). Through this reference, a playful and adventurous meaning is added to the, for most, not so exciting task of cleaning a toilet. It is as if the product says 'let's go and attack the dirt!'. It has been argued that such metaphors can be effective even when we are not (yet) consciously aware of them (Cupchik, 2003).

FIGURE 10.9 Toilet brush Xcalibur by Phillippe Starck.

The 'by-product' hypothesis is thus capable of explaining a number of aesthetic phenomena and there is no reason why they should be restricted to the visual realm. In the next section we will briefly speculate on how this hypothesis could account for aesthetic preferences related to the other senses.

4.3. Cross-sensory aesthetic principles

When aesthetics is defined as sensory gratification – as we do – it makes sense to speak of auditory aesthetics, tactual aesthetics, and olfactory and gustatory aesthetics, next to the traditional domain of visual aesthetics. It even seems logical to regard a feeling of comfort as an aesthetic response, a sort of proprioceptive aesthetics, and it also may look plausible to use the phrase 'aesthetics of interaction', as is popular in the field of interaction design (e.g. Dunne, 1999; Overbeeke et al., 2003). However, in order to please the senses, interaction with an object is conditional, making the expression 'aesthetics of interaction' somewhat tautological.

What makes a product good to listen to, pleasant to touch or use, and nice to smell (or even taste)? Following the argument introduced in the previous section, product properties are reinforcing, and thus, aesthetically pleasing if they facilitate the adapted function of the sensory systems. Hekkert (2006) started to list these functions and proposed some first and tentative predictions as to their aesthetic consequences.

As argued, all of our senses can play a role in the identification of objects. When it comes to this primary function, aesthetic principles should therefore hold cross-sensory. Just as people like to see patterns that allow them to detect relationships, people like to detect organization in sounds, and feel structure in a surface. Moreover, people like these various sensory messages to be mutually consistent and appropriate for the product conveying them. The product may display such an 'optimal match' with respect to its utilitarian function, its intended experience, and/or the associations it evokes (Hekkert, 2006).

Next to these cross-sensory similarities of aesthetics, some functions are unique to a particular system and may lead to sensory domain-specific aesthetic principles. Take for example our sense of touch. It not only functions to provide us with information about the world, such as the shape, temperature, and weight of things, it also makes us aware of having a body and thus enables us to experience ourselves (Bermudez, Marcel and Eilan, 1995). We might therefore predict that products (or product features) contributing to this self-experience are considered pleasant. The seemingly endless and repetitive manipulations babies employ on some of their toys may be evidence for this prediction. See Chapter 2 for further examples in this domain.

As universal as these evolutionary explanations are, this is not to say that evolutionary theories are deterministic. Most evolutionary psychologists endorse the view that these psychological mechanisms can manifest themselves differently across cultures, and even across individuals, as a result of interactions with the environment. How such interactions affect the way the aesthetic principles work for each one of us will be explained next.

5. CULTURAL AND INDIVIDUAL DIFFERENCES

If aesthetic principles are universal, how come we also see many differences over cultures and individuals? The important thing to see here is that a universal principle does not automatically lead to universal agreement in people's aesthetic choices of objects. Take for instance the components that come together in the MAYA principle. Although we all (seem to) like products that are as novel as possible, while we still see them as typical of their kind, what is considered novel/typical will differ substantially over people. For example, Hekkert et al. (2003, study 2) showed that experts and non-experts weakly agreed on the typicality of the car models judged, but for both groups typicality and novelty jointly predicted aesthetic preference. People differ with respect to the things they perceive and attend to, people differ as to their previous experiences within a domain, and people differ with regard to many other background variables, and these differences may lead to a variety in aesthetic preferences, despite the universality of the underlying principles.

5.1. Sensitivity

For many of the above-described principles aspects of stimuli have been identified, but in order for these to have an effect the perceiver has to perceive them. So, you need to see (be sensitive to) order or relationships in order to appreciate it. Simply put, if you cannot detect the symmetry, closure, or any other organizational structure, you cannot like the object on these grounds. People who are not able to see the order in an abstract painting or hear the structure underlying a modern musical composition, have difficulties liking it. To them, the painting or composition is predominantly chaotic. These problems most likely play a lesser role in product design, where most designers do their best to make their designs comprehensible and easy to understand. Nevertheless, some sensitivity may be required to see all subtle ordering principles applied in, for example, a car design and to appreciate it in full. This sensitivity can of course be trained, but as in all areas of human performance, some people are (just) more receptive to or better equipped to develop such sensitivity.

5.2. Knowledge and experience

In the example of the MAYA principle described above, we have explained how differences in expertise may result in different aesthetic choices while the principle still holds.

As a result of their background or previous experience, people may perceive the degree of typicality, novelty and the like in a design differently. Similarly, because some product properties are familiar for one, but novel for another person, this may result in differential effects of fluent processing; what is easy to assimilate for one may be difficult to assimilate for another.

In the domain of art, Leder (2002) has proposed a kind of higher-level fluency that accounts for such differences. When it comes to higher-order levels of dealing with objects, when interpretation and understanding come into play, expertise and experience become more important. For example, though a Picasso portrait might elicit aesthetic responses in all of us through the use of color and shapes, the cubist style Picasso adopted leaves little doubt that the depictions of persons he used is far from easy to read. Noses might be beside both eyes, and other elements are at unnatural locations in the head, and differ from nature in coloring, shape and size. Thus, how could one explain that such strongly alienated portraits (Leder, 2002) are liked, or even aesthetically appreciated? The processing of cubist portraits presumably becomes much easier and more fluent with experience and knowledge.

This pattern holds for all domains of objects and thus also influences design appreciation. An example is the 'organic' design style by Phillippe Starck. This style is applied to numerous design objects such as cutlery, TV-sets, water-kettles, bathtubs, and even houses. For the appreciation of these products, it is essential that the 'style' is perceived and recognized, an ability that increases with experience (Cupchik and Laszlo, 1992; Augustin and Leder, 2006). Once a person can make the required stylistic discriminations, s/he will also recognize it in other objects of the same designer and like them even so. In this case, the pleasure is indirectly derived from knowledge about design, and constitutes a kind of higher-order cognitive fluency, which is quite pleasing to the perceiver.

Developing such sensitivity for style and other organizational patterns normally comes with training and experience. Experienced viewers make finer aesthetic discriminations (Winner, 1982); they attend to and perceive properties of objects, such as lines, shapes, and textures, which remain unnoticed to the untrained eye. In sum, experienced observers discover features and higher order structures to which untrained observers are insensitive, and this allows them to enjoy different features and, hence, different and more complex objects than novices. Possibly, the increasing 'aesthetization' of our designed world, where even boilers, door handles and bath-tubs become decorated design objects, will enhance the general experience and sensitivity among the audience as it contributes to people's 'aesthetic view' on everyday objects.

5.3. Culture

A variable held responsible for many of the differences in people's aesthetic choices is culture. Popular wisdom would even say that our taste is predominantly shaped by the culture to which we belong. Looking at the diversity among cultural expressions in art, fashion, and design, it seems obvious that culture has a big effect on our aesthetic preference. Other than highlighting and emphasizing these differences, it is more interesting to investigate where such differences originate. Robert Nisbett has addressed this issue in a comprehensive research program that aimed to find out whether people in Western and Asian culture perceive things differently (Nisbett, 2003). He found evidence for a more holistic style of perceiving scenes and objects by Asian people, while Americans tended to see objects in a more analytical mode of processing (see also Masuda and Nisbett, 2001). Such a fundamental difference in looking at the world reveals that cultural background affects the way a product is perceived and, subsequently, aesthetically appreciated.

Other cross-cultural studies have shown that people from different cultures may systematically differ in the values and standards they hold (e.g. Schwartz and Sagiv, 1995; Hofstede, 2001), such as the degree to which people see themselves as separate from others (individualistic) or as connected to others (collectivistic), an orientation known as self-construal (Markus and Kitayama, 1991). In a recent study, for example, it was shown that logos from predominantly individualistic cultures (e.g. United States, Germany) were more angular than those of collectivistic cultures (e.g. Hong Kong, Japan), indicating that the latter relatively prefer rounded shapes, which are considered to be more harmonious (Zhang, Feick and Price, 2006).

Instead of seeing such cross-cultural differences as unique and autonomous cultural phenomena, we suggest it is more fruitful to look for the underlying psychological mechanisms that govern these manifestations and then try to explain how these variations come across. Groups of people can share defining characteristics, such as sensitivity, standards of aesthetic quality, and perceived typicality to various degrees (Hekkert, 2006). If these defining characteristics differ at the group level (as in cultures), we find cross-group differences and within-group agreement. Sharing characteristics results from having a similar background, i.e. similar experiences in the interaction with the social, natural, and artificial environment one is raised in and has to deal with. Regarded in this way, the cultural, as well as the social, are 'nothing more' (and nothing less) than manifestations of evolved human biology (Tooby and Cosmides, 1992), where evolvement refers to the way the psychological mechanisms have developed and operate under different circumstances. As E. O. Wilson (1998) puts it, 'Thousands of genes prescribe the brain, the sensory system, and all the other physiological processes that interact with the physical and social environment to produce the holistic properties of mind and culture'. (p. 150). How this gene-culture coevolution takes place and determines our aesthetic preferences, as well as many other psychological phenomena, is currently explored (see Buss, 2005 for an overview) and will fundamentally change our future understanding of (the relationship between) culture and aesthetics.

5.4. The evolution of taste

If universal principles guide our aesthetic preferences, but are simultaneously affected by knowledge, culture, and habituation, can we predict the development of people's taste? Put differently, can designers/artists lawfully anticipate the ever-changing demands of their audiences? This is exactly what Martindale (1990) claims in his theory of artistic change that spans 20 years of research. Starting with a theory explaining changes in the development of literature, his research expanded to domains such as poetry, visual arts, music, gravestones, and careers of individual artists. The basic assumption underlying his theory is that through repeated presentation, an artistic stimulus such as a work of art, gradually loses its impact value or arousal potential (Berlyne, 1971; see Section 2.2). As a result, the capacity of an artwork to raise interest, pleasure, or attention will diminish, a process that has also been described as *Formermüdung* or 'Form fatigue' (Göller, 1888; cited in Martindale, 1990). To compensate for such habituation effects, successive artists need to increase the arousal potential of their works of art. Martindale demonstrated that this is exactly what artists do: Measures of arousal potential, like complexity, ambiguity, or novelty, increase monotonically over time.[3]

[3]Martindale warns that these increments in arousal potential should not be too large. This shift in preferences is a gradual process due to effects of peak shift and the minimal effort recipients want to spend (see also Section 4.2).

These mechanisms may explain why art changes; they do not explain the direction in which art changes. To account for this, Martindale proposed a second process contributing to an increase of arousal potential. This process entails a regression from 'secondary-process' or *conceptual* cognition, characterized by abstract, logical and reality-oriented thought processes, to 'primary-process' or *primordial* thinking, a free-associative, concrete, and irrational mode of thought. The latter type of thinking leads to new combinations of existing elements (within a style) and results in novel ideas, hence an increase in arousal potential. 'Across the time a given style is in effect, we should expect works of art to have content that becomes increasingly more and more dreamlike, unrealistic, and bizarre' (Martindale, 1990; p. 61).

At a certain point however, the style becomes saturated and further regression will lead to an arousal decrease, the 'evolutionary trap'. Artists are then required to introduce a stylistic change by allowing new elements to enter the artistic lexicon or by loosening the rules governing the old style. For this to happen, artists will rely more on conceptual, secondary-process thinking. The result of this process is a cyclical change in primordial content and coinciding changes in artistic styles. These related fluctuations could also be observed in most of the domains/artists Martindale examined.

Although Martindale's theory has proven to describe historical changes in many art forms, the question is whether it can also be applied to design products. Martindale himself was not optimistic about this and thought that a product's usefulness might put non-aesthetic pressures on the design. 'If something has a use, people want it to work. That gets in the way of its aesthetic aspects. If something has a use, people can stop using it and destroy its aesthetic aspects altogether' (Martindale, 1990, p. 55). However, in an age in which aesthetics plays a dominant role in design (Postrel, 2003), and since many products have reached maturity when it comes to their performance and functionality, Martindale's theory may very well explain the changes governing the development of many present-day products.

6. CONCLUSIONS

In the present chapter we have reviewed research on aesthetic appreciation and demonstrated that preferences or taste judgments obey certain rules or principles. More importantly, we have argued that many of these principles are rooted in human nature and can somehow be explained on the basis of adaptations of our sensory systems and brains to our environment. Since these adaptations are, by definition, functional, allowing us to deal with the demands put forward by the surroundings, we can conclude that having an aesthetic sense is extremely useful! It stimulates and reinforces us to look for patterns and unifying properties that support the tasks of our sensory systems. If we perceive them, we can perform optimally and are aesthetically gratified, thus explaining why beauty and perceived usability are so strongly correlated (Tractinsky, Katz and Ikar, 2000; see also Chapter 11). How are designers to deal with these principles of aesthetics?

6.1. Implications for design and designers

The best recommendation one could give designers is to follow the rules and obey these aesthetic principles (Hekkert, 2006). Evaluating all the products on the market, it seems clear that they do so. All cars are symmetric,[4] most mobile phones have their buttons

[4]The story goes that the first Citroen BX that was put on the market had its logo not placed in the middle-front of the bonnet, as all cars used to have and still have, but just off center. The car did not sell well and only when the logo was repositioned in the middle did sales increase drastically.

orderly organized, and many successful designs follow the MAYA-principle. Designers do not need to *know* the principles to apply them; they intuitively design accordingly, since the principles are as much part of their creative nature as they are of the observer's aesthetic perception. As Ramachandran and Hirstein (1999) claim for artists, these rules or principles are 'a set of heuristics that artists either consciously or unconsciously deploy to optimally titillate the visual areas of the brain' (p. 15). Thus, designers will and should follow the rules when there is no reason not to. Lidwell et al. (2003) propose a similar strategy in their book of 100 design principles, but they also end their introduction with an additional statement: 'The best designers sometimes disregard the principles of design. When they do so, however, there is usually some compensating merit attained at the cost of the violation. Unless you are certain of doing as well, it is best to abide by the principles' (Lidwell et al., 2003, p. 11).

What reasons could these 'best designers' have to disregard the rules? Why make something ugly, surprising, over-the-top, incomprehensible, etc? Products are not always and only designed to be visually pleasing. At times, designers break the rules for other, non-aesthetic reasons. Let us briefly explore three such reasons. First, designers could decide to make a product stand out, to make it visually very different from competing products, if needed at the cost of aesthetics. The reason is obvious: The product will draw attention and attract interest and this can be a valuable asset in saturated markets. Moreover, when an unusual appearance is due to technical progress the resulting product might need some time to be liked for its aesthetic appeal (Carbon and Leder, 2005).

Secondly, products convey meanings and deciding to express certain symbolic, cultural or personal values through a product may contribute highly to its attractiveness. It may stimulate certain people to buy a BMW that looks strong and like a predator, even if its aesthetic proportions are inappropriate.

Finally, more and more designers are becoming aware of the emotive powers of designed objects. Products can raise fascination or desire, evoke surprise, and be fun to use. Since emotions are valenced reactions, the pleasure attained from the emotional response could easily outdo any limitations as to its aesthetic quality. In the case of surprise, for example, the non-aesthetic effect of incongruity between our visual impression and our tactual experience will evoke a surprise reaction that may result in interest, amusement or other positive emotions (Ludden, Hekkert and Schifferstein, 2006).

These are some of the reasons to disregard aesthetic principles, and future designers will certainly come up with more. Nevertheless, carefully applying aesthetic rules is a safe way to ascertain product acceptance and appreciation. Especially in areas where production costs are high, such as the car industry, and given the high probability that other, non-aesthetic effects may fade out quickly in time, most designers are best off to stick to the rules.

6.2. Future of design aesthetics

We can explain (parts of) people's aesthetic preferences, but a lot of unresolved issues remain. Before drawing this chapter to a close, we want to look into some new developments that already have or will have an effect on research in aesthetics in the near future. So far, the history of empirical research in product aesthetics often relied on well-established methods from experimental psychology. Key in this type of research is the design of stimulus material. Traditionally, 'poor', simple stimuli, such as polygons and random dot patterns, were used because they allowed for systematic variation of the dimensions studied. Findings from such studies can, however, not be easily generalized to real-life artifacts such as artworks or products. Since the early 1970s, researchers in aesthetics moved to these ecologically valid, but complex artifacts as stimulus materials.

These real objects, however, vary on so many dimensions that it is often difficult to ascribe effects to the relevant stimulus dimension. As has often been argued (see e.g. Hekkert and van Wieringen, 1996; Whitfield, 2000), the 'middle' way to proceed in aesthetic research is through a systematic manipulation of relevant stimulus dimensions in real artifacts. Such techniques have been occasionally employed in the area of product design (e.g. Carbon and Leder, 2005; Van Rompay et al., 2005; Veryzer and Hutchinson, 1998), but these were still two-dimensional representations of real products. With the advancements in computer software connected to rapid prototyping, it will become much easier to make systematic variations of three-dimensional, physical objects.

Further developments in research methods might also bring new insights. The increasing interest in neuropsychological measures will broaden the scope of methods to investigate aesthetic appreciation. Up to now, neuroimaging studies in the area of aesthetics mainly were concerned with determining neuroanatomical correlates of aesthetic preference. Most of these studies have investigated the perception and appreciation of paintings using functional Magnetic Resonance Imaging (fMRI). For instance, Hansen, Brammer and Calvert (2000) demonstrated that activation of primary and association visual cortices varied depending on preference judgments. Their findings suggested that quantitative changes in activation, as well as qualitatively distinct networks of brain areas in frontal and limbic areas, are associated with positive, negative, and neutral judgments to images of artworks. Vartanian and Goel (2003) compared representational and abstract paintings in different formats (original, altered, filtered) and reported neural correlates of lower and higher preference. Kawabata and Zeki (2004) also searched for neural correlates of the perception of paintings considered to be beautiful. The perception of beautiful and ugly paintings led to a different involvement of the orbitofrontal and the motor cortex. Finally, Jacobson, Schubotz, Höfel and von Cramon (2006) applied the same technique to identify neural correlates of aesthetic judgments of abstract graphic patterns. Interestingly, the most active regions they located (e.g. medial wall and prefrontal cortex) partly overlap with the ones involved in social and moral judgments.

Looking at product aesthetics with such neuropsychological methods in the future presumably will reveal a deeper insight into the complex interplay between emotion and cognition which interact in aesthetic experiences (Leder et al., 2004) and might also reveal the underlying mechanisms, which differ from person to person and might be specific for classes of objects (Whitfield, 2000).

Both of the above developments are related to increasing technological sophistication allowing for new ways of experimentation. When it comes to theoretical progress, we strongly believe that the emerging field of evolutionary aesthetics will bring most progress as it provides a theoretical foundation against which all the variation through culture and individual history can be tested. Along with Wilson (1998) and others (e.g. Ramachandran and Hirstein, 1999; Pinker, 2002) we predict that crossing borders between psychology, evolutionary biology, and neurology will permanently change our understanding of human behavior and culture, of which our sense for beauty is just one, albeit a very prominent, representative.

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