Processing Fluency and Aesthetic Pleasure: Is Beauty in the Perceiver's Processing Experience?

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Abstract
We propose that aesthetic pleasure is a function of the perceiver's processing dynamics: The more fluently perceivers can process an object, the more positive their aesthetic response. We review variables known to influence aesthetic judgments, such as figural goodness, figure–ground contrast, stimulus repetition, symmetry, and prototypicality, and trace their effects to changes in processing fluency. Other variables that influence processing fluency, like visual or semantic priming, similarly increase judgments of aesthetic pleasure. Our proposal provides an integrative framework for the study of aesthetic pleasure and sheds light on the interplay between early preferences versus cultural influences on taste, preferences for both prototypical and abstracted forms, and the relation between beauty and truth. In contrast to theories that trace aesthetic pleasure to objective stimulus features per se, we propose that beauty is grounded in the processing experiences of the perceiver, which are in part a function of stimulus properties.

What is beauty? What makes for a beautiful face, appealing painting, pleasing design, or charming scenery? This question has been debated for at least 2,500 years and has been given a wide variety of answers (Feagin, 1995; Tatarkiewicz, 1970). However, one can broadly distinguish three main positions. Many theorists, dating back at least to Plato, saw beauty as a property of an object that produces a pleasurable experience in any suitable perceiver (Tatarkiewicz, 1970). This *objectivist view* inspired many psychological attempts to identify the critical contributors to beauty. Among the identified features were balance and proportion (Arnheim, 1974; Birkhoff, 1933; Fechner, 1876; Gombrich, 1995), symmetry (Arnheim, 1974; Birkhoff, 1933; Gombrich, 1984; Humphrey, 1997),

informational content and complexity (Berlyne, 1971, 1974; Eysenck, 1941; Garner, 1974), as well as contrast and clarity (Gombrich, 1984, 1995; St. Thomas of Aquinas, see Maritain, 1966; Solso, 1997). The objectivist view of beauty was so dominant in the 16th century that artists introduced pattern books, offering pictorial elements that artists could copy and combine with each other to create beauty (see Gombrich, 1995).

Other theorists, dating back at least to the Sophists, proposed that anything could be beautiful if it pleases the senses (Tatarkiewicz, 1970). From this perspective, beauty is a function of idiosyncratic qualities of the perceiver and all efforts to identify the laws of beauty are futile. This *subjectivist view*, reflected in expressions like "beauty is in the eye of the beholder" or "de gustibus non est disputandum" (taste cannot be debated), underlies the social constructivist emphasis on the historically changing and culturally relative nature of beauty (see Kubovy, 2000).

Most modern philosophical analyses, however, reject the objective versus subjective distinction. Instead, they suggest that a sense of beauty emerges from patterns in the way people and objects relate (e.g., Ingarden, 1985; Merleau-Ponty, 1964). In this article, we adopt this *interactionist* perspective and seek to identify those patterns. As detailed later, we propose that beauty is grounded in the processing experiences of the perceiver that emerge from the interaction of stimulus properties and perceivers' cognitive and affective processes.

Beauty, Experience, and Judgment

Before we present our proposal, a few clarifications are in order. We first introduce our use of the concept of beauty and relate it to the concept of aesthetic pleasure. Subsequently, we discuss the relation between beauty and various aesthetic judgments, such as judgments of preference and judgments of aesthetic value.

Beauty and Aesthetic Pleasure

The philosopher George Santayana described three defining features of beauty: "beauty … is value positive, intrinsic, and objectified" (Santayana, 1896/1955, p. 31). By *value positive and intrinsic*, Santayana meant that beauty provides pleasure without any reasoning about expected utility. This is similar to Thomas of Aquinas' definition of beauty as what gives pleasure at sight ("id quod visum placet"), suggesting immediate joy without intermediate reasoning (see Maritain, 1966). Similarly, the art historian Read (1972) did "not believe that a person with real sensibility ever stands before a picture and, after a long process of analysis, pronounces himself pleased. We either like at first sight, or not at all" (p. 38). Finally, beauty is objectified. For example, the experience of having a cold drink on a hot day is both value positive and intrinsic, but this immediate pleasure lies exclusively in a positive sensation of the body and has little to do with aesthetic appreciation of the object. In contrast, perceivers look at a painting not to please their body, but to enjoy the painting's beauty. Hence, people experience beauty as something that lies in the object. Therefore, beauty is not an "objective," but an "objectified" property (see also Feagin, 1995).

In our analyses we follow this philosophical tradition and define beauty as a pleasurable subjective experience that is directed toward an object and not mediated by intervening reasoning. This definition closely resembles the definition of aesthetic experience used in empirical aesthetics (e.g., Kubovy, 2000; Martindale & Moore, 1988). Accordingly, we use the words "beauty" and "aesthetic pleasure" interchangeably.

Beauty and Judgment

Research participants in experimental aesthetics and psychology studies are rarely asked to judge "beauty" per se. Instead, most studies have focused on judgments like figural goodness, pleasantness, liking, and preference. One may wonder whether these more modest judgments capture the grand realm of beauty. Most researchers, including us, believe that by studying such simple judgments, one can identify basic processes underlying the aesthetic

experience. Further, several lines of research, for example on the mere exposure effect (addressed later in this article), demonstrate that different kinds of evaluative judgments operate via similar processes (see Bornstein, 1989). Thus, there are reasons to believe that judgments of preference, liking, and beauty are closely related.

Another issue raised by the focus on basic processes and the requirements of experimental control is that most psychological studies explore fairly mild aesthetic experiences, such as those likely to accompany the perception of a vase, a simple melody, an abstract shape, or a human face. Clearly, much of what most humans call "beautiful" on a daily basis falls into the category of such mild experiences. However, we hope that future research will also explore stronger subjective experiences and examine to what extent our analysis can inform such research.

Finally, we note that beauty as explored in this article is unrelated to aesthetic value (see, e.g., Beardsley, 1981). Since the emergence of modern art, a piece of art can have aesthetic value without being beautiful (i.e., without producing an experience of aesthetic pleasure). Conversely, a painting that "pleases the eyes" may be without any artistic merit. The judgment of aesthetic value, in contrast to beauty or aesthetic pleasure as defined here, often involves substantial reasoning about the piece of art under consideration. We return to these issues in the discussion.

Overview

Our core proposal is straightforward. We suggest that aesthetic experience is a function of the perceiver's processing dynamics: The more fluently the perceiver can process an object, the more positive is his or her aesthetic response. This proposal entails four specific assumptions. First, objects differ in the fluency with which they can be processed. Features that facilitate fluent processing include all the core features identified in the objectivist tradition, like goodness of form, symmetry, figure–ground contrast, as well as variables that have not received attention in traditional theories of aesthetic pleasure, like perceptual and conceptual priming procedures. Second, processing fluency is itself hedonically marked and high fluency is subjectively experienced as positive, as indicated by psychophysiological findings. Third, processing fluency feeds into judgments of aesthetic appreciation because people draw on their subjective experience in making evaluative judgments, unless the informational value of the experience is called into question. Finally, the impact of fluency is moderated by expectations and attribution. On one hand, fluency has a particularly strong impact on affective experience if its source is unknown and fluent processing comes as a surprise. On the other hand, the fluency-based affective experience is discounted as a source of relevant information when the perceiver attributes the experience to an irrelevant source.

In the remainder of this article, we elaborate on this proposal and discuss supporting evidence from research in social and cognitive psychology as well as empirical aesthetics. We first introduce the concept of processing fluency, discuss its relation to evaluative processes, and review relevant experimental findings. Next, we provide a selective review of research that attempted to identify key contributors to beauty, drawn from different research traditions. We propose that all of the previously identified variables share a common underlying characteristic, namely the ability to facilitate stimulus processing. Following this review, we highlight how attributional processes and processing expectations moderate fluency effects on perceived beauty, and discuss challenges to our proposal. We finally show that a perceptual fluency theory of beauty can account for phenomena that are difficult to conceptualize in the context of other theories. Specifically, a perceptual fluency theory helps explain the interplay between developmentally early preferences and socialization, the apparent contradiction between preferences for average versus exaggerated forms, and why artists and scientists have often considered truth and beauty as two sides of the same coin.

The Concept of Processing Fluency

The processing of any stimulus can be characterized by a variety of parameters that are nonspecific to its content, such as speed and accuracy of stimulus processing (see R. Reber, Wurtz, & Zimmermann, 2004). These parameters tend to lead to a common experience of processing ease or "fluency" (for reviews see Clore, 1992; Jacoby, Kelley, & Dywan, 1989; Whittlesea, Jacoby, & Girard, 1990). A large number of studies show that people draw on fluency to make a variety of nonaesthetic judgments, including judgments of loudness (e.g., Jacoby, Allan, Collins, & Larwill, 1988), clarity (e.g., Whittlesea et al., 1990), duration (e.g., Witherspoon & Allen, 1985), familiarity (e.g., Whittlesea, 1993), and even truth (e.g., Begg, Anas, & Farinacci, 1992; R. Reber & Schwarz, 1999).

Although fluency may characterize mental processes occurring at various levels, our discussion is primarily concerned with *perceptual fluency* (i.e., the ease of identifying the physical identity of the stimulus). Perceptual fluency is influenced by variables such as perceptual priming, clarification, presentation duration, repetition, or figure–ground contrast, as discussed shortly. However, our arguments apply as well to *conceptual fluency,* or the ease of mental operations concerned with stimulus meaning and its relation to semantic knowledge structures (e.g., Whittlesea, 1993; Winkielman, Schwarz, Fazendeiro, & Reber, 2003). We use the more general term *processing fluency* to capture these commonalities.

Hedonic Marking of Fluency

Multiple theoretical notions converge on the assumption that high fluency is positively marked. The basic idea in all these notions is that high fluency says something about a positive state of affairs, either within the cognitive system or in the world (see Winkielman et al., 2003, for a more comprehensive treatment). Specifically, high fluency may elicit positive affect because it is associated with progress toward successful recognition of the stimulus, error-free processing, or the availability of appropriate knowledge structures to interpret the stimulus (Carver & Scheier, 1990; Derryberry & Tucker, 1994; Fernandez-Duque, Baird, & Posner, 2000; Schwarz, 1990; Simon, 1967; Ramachandran & Hirstein, 1999; Vallacher & Nowak, 1999). High fluency may also feel good because it signals that an external stimulus is familiar, and thus unlikely to be harmful (Zajonc, 1968, 1998).

Fluency and Evaluations: Empirical Evidence

As our review of the empirical literature will indicate, high fluency is reliably associated with more positive evaluations. Historically, this possibility has received most attention in the context of debates on the nature of the mere-exposure effect (i.e., the observation that repetition enhances liking for an initially neutral stimulus; for reviews, see Bornstein, 1989; Zajonc, 2000). Several authors proposed that the mere-exposure effect might reflect increases in perceptual fluency (e.g., Bornstein & D'Agostino, 1994; Jacoby, Kelley, et al., 1989; Seamon, Brody, & Kauff, 1983, Whittlesea, 1993). If so, we may expect that any variable that facilitates fluent processing similarly results in increased liking, even under conditions of a single exposure. Studies from our lab support this possibility. Some of these studies relied on variables that have a long tradition in theories of aesthetics, like figure–ground contrast, and will be reviewed in a later section. Other studies relied on manipulations that are uniquely suggested by a fluency account of aesthetic pleasure, namely visual and conceptual priming procedures.

Priming Procedures

R. Reber, Winkielman, and Schwarz (1998, Study 1) presented participants with pictures of everyday objects, such as a desk, bird, or plane (taken from Snodgrass & Vanderwart, 1980). The quality of the pictures was slightly degraded and processing fluency was manipulated through a visual priming procedure. Depending on conditions, the

target picture was preceded by a subliminally presented, highly degraded contour of either the target picture or a different picture. We expected that a matching contour would facilitate processing (high fluency), consistent with research showing that subliminal visual primes enhance the accuracy with which a stimulus can be identified (Bar & Biederman, 1998). Some participants were asked to indicate how much they liked the target pictures. Other participants were asked to press a key as soon as they could recognize the object in the picture, thus providing a measure of recognition speed, an indicator of fluency. The data were consistent with predictions: Pictures primed by matched contours were recognized faster, indicating higher fluency, and were liked more than pictures preceded by mismatched contours. Moreover, participants were unaware of the fluency manipulation, thus eliminating the possibility of strategic responding to pictures preceded by various primes.

Extending this work with a cross-modal priming task, Winkielman and Fazendeiro (2003) showed participants a series of unambiguous pictures of common objects and animals. Each picture was preceded by a letter string consisting either of a word or a nonword. Participants first indicated, as fast as possible, if the letter string was an actual English word. Subsequently, they reported their liking for the picture. The letter strings served as the fluency manipulation. Some pictures were preceded by matching words (e.g., word "dog"—picture of a dog), introducing the highest level of fluency. Other pictures were preceded by associatively related words (e.g., word "key"—picture of a lock), introducing a medium level of fluency. Yet other pictures were preceded by an unrelated word (e.g., word "snow"—picture of a desk), introducing the lowest level of fluency. The results showed a robust effect of concept priming on participants' evaluation of the target pictures. As expected, pictures preceded by matching words were liked significantly more than pictures preceded by related words, which, in turn, were liked significantly more than pictures preceded by unrelated words. Follow-up studies indicated that these fluency effects do not require that the concept primes immediately precede the target pictures. Instead, the same pattern of effects was obtained when participants studied a list of concept primes before they were exposed to the pictures.

Affective Response

Importantly, the influence of processing fluency is not limited to explicit judgments of preference and beauty, but can also be captured with psychophysiological measures. This was demonstrated by Winkielman and Cacioppo (2001), who assessed participants' affective responses to fluent stimuli with facial electromyography (EMG). EMG relies on the observation that positive affective responses increase activity over the region of the zygomaticus major ("smiling muscle"), whereas negative affective responses increase activity over the region of the corrugator supercilli ("frowning muscle;" e.g., Cacioppo, Petty, Losch, & Kim, 1986; Lang, Greenwald, Bradley, & Hamm, 1993). As expected, high fluency was associated with stronger activity over the zygomaticus region (indicative of positive affect), but was not associated with the activity of the corrugator region (indicative of negative affect). Moreover, the observed differences occurred in the first 3 sec after stimulus presentation and several seconds before participants made overt judgments, indicating a spontaneous affective response to processing fluency. A subsequent study replicated this effect, using presentation duration as a manipulation of fluency.

The Mediating Role of Affect

Theoretically, we assume that the spontaneous affective response observed in the Winkielman and Cacioppo (2001) studies mediates the impact of fluency on evaluative judgments. Presumably, perceivers interpret the positive affect elicited by processing fluency as their response to the target, resulting in more positive evaluations. This assumption is consistent with the feelings-as-information model, which holds that feelings serve as a source of information in their own right, unless their perceived informational value for the judgment at hand is undermined through (mis)attribution manipulations (e.g., Schwarz & Clore, 1983; for a review see Schwarz & Clore, 1996).

Winkielman and Fazendeiro (2003) tested this prediction by replicating the conceptual priming study described earlier with a misattribution manipulation. Before they made their liking judgments, they specifically told participants that their reactions to the stimuli might be influenced by background music played to them. The music was an ambiguous new-age piece recorded at half-speed (see Schwarz et al., 1991, for details on this manipulation). Some participants were told that the music might bias how easily stimuli come to mind (i.e., their fluency experience), whereas other participants were told the music might influence how they feel about the various stimuli (i.e., their affective experience). The results were highly informative. Specifically, attributing subjective fluency to music did not eliminate the effect of processing facilitation on liking. That is, participants who were informed that the music might influence how easily things come to mind still judged pictures as more likeable when they were preceded by related rather than unrelated words, replicating the previous findings. In contrast, attributing the affective response to the music did eliminate the effect of processing facilitation on liking. That is, participants who were informed that the music might influence their feelings toward various stimuli no longer judged new pictures as more likeable when they were preceded by related rather than by unrelated words.

This pattern of results suggests that it is the fluency- based affective reaction, and not the fluency experience itself, that serves as a basis of judgment, resulting in enhanced liking. This interpretation is consistent with research into the use of moods (e.g., Schwarz & Clore, 1983) and other phenomenal experiences (e.g., ease of recall; Schwarz, 1998) as experiential sources of information. It suggests that the affective reactions to fluency, captured in EMG studies (Harmon-Jones & Allen, 2001; Winkielman & Cacioppo, 2001) as well as self-reports of mood (Monahan, Murphy, & Zajonc, 2000), serve a crucial mediating role.

Summary

In combination, the reviewed studies demonstrate that variables that facilitate the processing of a stimulus result in more positive affective reactions, as captured by psychophysiological measures (Winkielman & Cacioppo, 2001), as well as more favorable judgments of preference (R. Reber et al., 1998). The impact of fluency on evaluative judgments is apparently mediated by the elicited affective reactions and hence eliminated when the informational value of the affective reaction is called into question through misattribution manipulations (Winkielman & Fazendeiro, 2003).

Not surprisingly, the key variables used in these experiments— visual and conceptual priming—have not received attention in traditional theories of aesthetic judgment. Yet, they share with the variables commonly considered in these theories—like goodness of form, symmetry, figure–ground contrast or prototypicality— that they facilitate fluent processing of the target stimulus. We propose that this shared characteristic is at the heart of aesthetic pleasure.

Determinants of Beauty: A Review

Next, we review research from social psychology, cognitive psychology, and experimental aesthetics bearing on two classes of factors that influence perceived beauty. We first discuss "objective" features of stimuli, such as amount of information, symmetry, figure– ground contrast, and clarity. Subsequently, we address the role of perceivers' previous experience with stimuli, such as repeated exposure to the stimulus, implicit learning of rules that underlie stimuli, and the prototypicality of the stimulus. We propose that the influence of all of these variables derives from their ability to facilitate fluent stimulus processing.

Objective Features of Stimuli

Amount of Information

The idea that the amount of information is an important determinant of beauty has a long history in aesthetics (e.g., Arnheim, 1974; Gombrich, 1984). In psychology, relevant research has mostly been conducted in the Gestalt tradition. Early researchers focused on stimulus organization and proposed that perceived "goodness" of the stimulus depends on the relation between stimulus organization and psychological mechanisms (e.g., Koffka, 1935). In their view, stimuli isomorphic to physiological mechanisms are easy to process and are rated as "good figures." This work's emphasis on processing ease anticipated later interest in perceptual fluency by several decades.[1]

Subsequent research in the Gestalt tradition has primarily focused on the amount of information represented in a stimulus, consistent with the traditional assumption that beauty resides in the object (e.g., Attneave, 1954; Hochberg & McAlister, 1953). Garner (1974) expressed the amount of information extracted from a stimulus in terms of inferred R × R subsets, which represent the number of different shapes after Reflecting and Rotating a shape. He found that judgments of figural goodness were higher the less information people had to extract from a stimulus to perceive it (i.e., when the stimulus had high redundancy). This finding is consistent with people's preference for symmetric shapes, because they contain less information than asymmetric, but otherwise identical shapes (Garner, 1974). Further research has demonstrated that this principle extends beyond judgments of figural goodness to evaluative judgments. For example, Nicki, Lee, and Moss (1981) found that ambiguity in cubist paintings, defined in informational terms, was negatively related to pleasantness judgments.

Important for our proposal, stimuli with less information are not only more pleasing, but also easier to process, as measured, for example, by recognition speed (Checkosky & Whitlock, 1973). Hence, our proposal suggests that controlling for the amount of information should reveal a preference for easy-to-process stimuli. Several studies bear on this issue. Some of these studies explored processing ease of different forms of symmetry, such as symmetry involving reflection around a vertical axis (as in capital "A" or "V"), symmetry involving reflection around a horizontal axis (as in capital "E" or "D"), or symmetry involving reflection around a diagonal axis (as in the Nordic character "Ø"). Palmer and Hemenway (1978), as well as Royer (1981), used reaction times to show that vertical symmetry is easier to detect than horizontal symmetry, which in turn is easier to detect than diagonal symmetry. Building on this work, Palmer (1991) presented dot patterns in vertically, horizontally, or diagonally symmetrical arrangements, manipulating the ease of processing while controlling for the amount of information presented (in terms of R × R subsets, as discussed earlier). Consistent with our perceptual fluency analysis, the same stimuli received the highest ratings of figural goodness when presented in a vertical arrangement and the lowest ratings when presented in a diagonal arrangement, with horizontal arrangements falling in between. Given that the amount of presented information was identical in all conditions, these findings strongly support the hypothesis that figural goodness is a function of perceptual fluency rather than amount of information per se.

Symmetry

The aforementioned findings also bear on proposals that try to locate beauty in objective symmetry. Symmetry has been found to influence the perceived attractiveness of human faces (Gangestad, Thornhill, & Yeo, 1994; Rhodes, Proffitt, Grady, & Sumich, 1998; Rhodes, Sumich, & Byatt, 1999). Moreover, symmetric patterns are preferred even if they do not serve any biologically relevant function, both in humans (e.g., Humphrey, 1997; R. Reber & Schwarz, in press) and in animals (Rensch, 1957, 1958). These observations are often explained by postulating an innate preference for symmetry (e.g., Etcoff, 1999; Pinker, 1997). Given that symmetry is indicative of mate value in several species (e.g., Thornhill & Gangstead, 1993, 1999), this is a plausible hypothesis, although the evidence for humans is mixed (see Kalick, Zebrowitz, Langlois, & Johnson, 1998, for a discussion). More important for our purposes, symmetrical patterns also have less information and are hence easier to process (Garner,

1974). In addition, computer-modeling work suggests that a perceptual system designed to recognize objects from different viewpoints will process symmetrical patterns more efficiently than any other pattern (Enquist & Arak, 1994; Johnstone, 1994). Based on these findings, we propose that symmetrical patterns may be preferred because symmetry facilitates fluent processing (see Reber, 2002).

Contrast and Clarity

Theorists of aesthetics have long considered contrast and clarity as "objective" determinants of beauty (Gombrich, 1984, 1995; Maritain, 1966; Solso, 1997). Again, empirical research suggests that the influence of these features may be mediated by their effect on processing fluency.

Studies show that recognition speed, a standard measure of fluency, is faster for stimuli high in figure– ground contrast (e.g., Checkosky & Whitlock, 1973). Similarly, Whittlesea et al. (1990) showed that a related variable, visual clarity, influences perceptual fluency as measured by memory misattribution. In their study, participants saw short and rapidly presented lists of words. After each list, a target word was presented within a visual noise mask, resulting in higher or lower visual clarity of the target word. As expected, higher clarity increased the likelihood that an item was erroneously recognized as having been presented earlier. This finding indicates a misattribution of high perceptual fluency, induced by visual clarity, to previous exposure. Consistent with this interpretation, the effect disappeared when participants knew that visual clarity was manipulated.

Building on this work, we explored the influence of figure–ground contrast on liking (R. Reber et al., 1998). In one study we manipulated perceptual fluency by varying the figure–ground contrast of circles presented for 1 sec. As expected, circles with high figure– ground contrast were judged as prettier (or less ugly, depending on the framing of the judgment task) than circles with low figure–ground contrast. Moreover, the impact of processing fluency did not depend on the framing of the judgment task. Specifically, we asked some participants to report how "pretty" the stimuli were and others how "ugly" the stimuli were. Increased fluency resulted in judgments of higher "prettiness" as well as judgments of lower "ugliness," indicating that fluency did not simply facilitate extreme judgments per se.[2]

Of course, one may argue that in the R. Reber et al. (1998) study, it is the high figure–ground contrast per se (i.e., the objective feature), not perceptual fluency, that contributes to more positive evaluations. If so, high-contrast stimuli should be judged more favorably than low-contrast stimuli, regardless of stimulus presentation time. Conversely, if perceptual fluency is the key to preference, figure–ground contrast should be most influential during short presentation times, when high contrast can facilitate processing, and least influential during long presentation times, when stimuli can be easily processed regardless of their contrast level. R. Reber and Schwarz (2001) tested this reasoning in a study where figure–ground contrast was manipulated for circles presented for 0.3, 1, 3, and 10 sec. As predicted by the fluency hypothesis, figure–ground contrast influenced aesthetic judgments only at short exposure durations, but not at the duration of 10 sec. Note that a theory that assumes that some objective feature of the stimulus per se, such as figure–ground contrast, determines preference cannot account for this finding. After all, different exposure times do not change the objective features of the stimulus. If anything, the objective features of the stimulus are most clearly perceptible at long exposure times—yet, they fail to influence judgments under this condition.

Summary

In sum, a diverse body of research shows that objective features of stimuli—like amount of information, symmetry, or figure–ground contrast[3]—influence perceptual fluency as well as preference judgments. More important, knowledge of the objective features per se is not sufficient to predict an object's evaluation. Instead, the crucial variable appears to be processing fluency. Although fluency typically covaries with objective features, fluency is the predictive variable when both are juxtaposed. Thus, identical patterns are rated more favorably when

presented with vertical rather than horizontal symmetry (Palmer, 1991), consistent with the observation that vertical symmetry facilitates processing (e.g., Royer, 1981). Similarly, high contrast enhances liking for patterns shown briefly, but not for identical patterns shown longer (R. Reber & Schwarz, 2001). Moreover, objectively identical stimuli are evaluated more favorably when their processing is facilitated through priming procedures (R. Reber et al., 1998; Winkielman & Fazendeiro, 2003). In light of these results, we propose that the influence of objective features is mediated by their influence on processing fluency.

Perceiver's History With the Stimulus

Psychological research on factors underlying beauty has also investigated the history of a perceiver's experience with the stimulus. This research points to the role of repeated exposure, implicit learning of stimulus structure, and prototypicality. Again, the influence of these variables can be traced to their influence on processing fluency.

Repeated Exposure

Repeated exposure to a stimulus results in more favorable evaluations, a phenomenon known as the mere exposure effect (Zajonc, 1968, 1998). Mere exposure effects have been obtained with a variety of stimuli (faces, ideographs, words, melodies) and a variety of measures (judgments of preference, behavioral choices, physiological responses), indicating the robustness of the phenomenon (for a meta-analysis see Bornstein, 1989; for mere-exposure effects with works of art, see Leder, 2001).

Previously seen stimuli differ from novel stimuli with regard to at least three fluency-related parameters. First, familiar stimuli are processed faster than novel stimuli (e.g., Haber & Hershenson, 1965; Jacoby & Dallas, 1981). Second, familiar stimuli elicit less attentional orienting than novel stimuli (Desimone, Miller, Chelazzi,&Lueschow, 1995). Third, familiar stimuli have more organized processing dynamics than novel stimuli (Lewenstein & Nowak, 1989; Norman & O'Reilly, 2001; E. R. Smith, 2000). Based on such findings, several researchers suggested that perceptual fluency is central to the mere exposure effect and provided evidence consistent with this account (e.g., Bornstein & D'Agostino, 1994; Jacoby, Kelley, & Dywan, 1989; Seamon, Brody, & Kauff, 1983; Whittlesea, 1993; Whittlesea & Price, 2001).

In our reading, a perceptual fluency account of mere exposure effects is compatible with Zajonc's (1968, 1998) original account. Specifically, Zajonc proposed that the mere exposure effect reflects a precognitive mechanism that ensures caution in encounters with novel, and potentially harmful, stimuli and the gradual extinction of this caution over repeated encounters, consistent with the observation of a "fear of the unknown" in a variety of species (for a review see Hill, 1978). Given that processing fluency can often be assessed before a stimulus is identified with certainty, fluency may indeed serve as a very early indicator of stimulus novelty (see Curran, 2000, and Rugg & Yonelinas, 2003, for a discussion of specific mechanisms). Moreover, the spontaneous affective responses that accompany fluency may serve as a biologically functional signal (see Winkielman et al., 2003, for a discussion).We therefore consider both accounts compatible, but note that a fluency account provides a more general conceptualization that can accommodate the influence of priming procedures as well as the influence of repeated exposure. In addition, a fluency account predicts under which conditions mere exposure effects should not be observed, namely when participants are aware of the source of fluency (cf. Bornstein, 1989). We return to this issue in a later section, when we discuss the moderating role of attributions and expectations.

Implicit Learning of Stimulus Structure

Research into the effects of repeated exposure is closely related to research into the relation between preferences and the implicit learning of stimulus structure. In one experiment, Gordon and Holyoak (1983) used letter strings constructed in accordance with an artificial finite state grammar (see A. S. Reber, 1967, 1993). In a learning phase, participants were exposed to grammatical letter strings. In a subsequent test phase, participants received novel

grammatical and ungrammatical strings and indicated their liking for these strings. As predicted, grammatical letter strings were liked more than ungrammatical ones (see also Manza, Zizak, & Reber, 1998). In a second experiment, Gordon and Holyoak (1983) were able to show that participants' liking of complex visual patterns was negatively related to pattern distortion from an acquired standard; the less distorted the pattern was in comparison to the standard, the more it was liked.

In a series of experiments, Newell and Bright (2001) presented grammatical letter strings in an encoding phase and then assessed grammaticality and liking ratings for both grammatical and ungrammatical items at test. In all three experiments, there was a consistent effect of grammaticality on liking, but only if encoding and test conditions stayed the same, ensuring fluent processing. In contrast, grammaticality judgments were not influenced by inconsistencies between encoding and test. Newell and Bright concluded that grammaticality judgments reflected attempts to explicitly recall information about training items, whereas the effect on liking was based on an (mis)attribution of fluency.

Sollberger and Reber (2004) demonstrated effects of implicit learning on liking in the domain of music. They constructed tonal music sequences in accordance with a finite state grammar. During a learning phase, participants were exposed to grammatical tone sequences. During the test phase, they were given old grammatical, novel grammatical, and novel ungrammatical sequences. Participants liked old and novel grammatical sequences more than ungrammatical sequences, supporting the notion that grammatical stimuli are pleasant.

Importantly, research shows that grammatical stimuli are processed with higher fluency. For example, Buchner (1994) first exposed participants to grammatical letter strings and subsequently presented strings with a perceptual clarification procedure, asking participants to identify the strings. Specifically, the test strings were presented in a black mask, from which pixels were gradually removed at random until the participant could identify the letter string. Participants reacted faster to grammatical rather than ungrammatical letter strings, indicating that grammatical letter strings are easier to process.

In combination, the available findings again indicate that increased preference is associated with increased fluency: "Regular" or "grammatical" stimuli are not only preferred over "irregular" or "ungrammatical" ones, but also easier to process.

Prototypicality

Martindale (1984) proposed that prototypical forms are preferred over nonprototypical forms—a proposal that is closely related to the idea that people prefer "average" stimuli (Rhodes & Tremewan, 1996).4 Numerous studies confirm that prototypical and "average" forms are preferred over nonprototypical ones. For example, several studies found a positive relation between prototypicality and aesthetic evaluations in color patches (e.g., Martindale & Moore, 1988), paintings (e.g., Hekkert & vanWieringen, 1990), and furniture (e.g., Whitfield & Slatter, 1979). Preference for prototypicality has also been found in music. For example, J. D. Smith and Melara (1990) showed that prototypical chord progressions were preferred by novices (though not by experts, as we discuss later). Similarly, Repp (1997) mixed music performances of different performers into an averaged performance, and found that such performance was highly rated.

A number of studies show that prototypical faces are preferred over nonprototypical faces (e.g., Langlois & Roggman, 1990; Rhodes & Tremewan, 1996). Theoretical explanations for this robust effect have typically focused on the idea that organisms are biologically predisposed to interpret prototypicality as a cue to mate value (Symons, 1979). For example, Thornhill and Gangestad (1993, 1999) suggested that facial prototypicality signals health, lending individuals with a preference for facial prototypicality in mate selection a selective advantage in the evolutionary past. However, recent research casts doubt on this assumption. Some studies failed to document a relation between facial prototypicality and health (Kalick et al., 1998). More important, innate preferences for

prototypical faces should not necessarily lead to preference for other prototypical objects. Yet, several studies using different methodologies show that people also prefer prototypical dogs, watches, and birds (Halberstadt & Rhodes, 2000, 2003). Thus, there are reasons to look for another explanation of the prototypicality preference. Again, perceptual fluency is a promising candidate.

A large body of literature in cognitive psychology indicates that prototypical stimuli are processed more easily than nonprototypical ones (see Posner & Keele, 1968; Rumelhart, McClelland, & the PDP Research Group, 1986; E. E. Smith, Shoben, & Rips, 1974). Following up on this literature, we conducted a study in which participants first studied several visual dot patterns. The patterns were random, but were constructed to converge on a prototype. In a later test phase, participants (a) preferred the prototype over other previously unseen patterns; (b) showed stronger EMG responses from the zygomaticus region, indicating more positive affect; and (c) falsely recognized the prototype as having been shown previously, indicating high fluency (Fazendeiro & Winkielman, 2003). Moreover, P. J. Reber, Stark, and Squire (1998) showed that exposure to several exemplars of dot patterns from the same category resulted in more fluent visual processing of the prototype, as reflected in decreased activity in the posterior occipital cortex (see Aizenstein et al., 2000, for a related finding).

In sum, we propose that the robust relation between prototypicality and attractiveness may be traced to processing fluency: Prototypical stimuli are easier to process and hence evaluated more positively, consistent with the observation that any other variable that increases processing fluency also increases liking.

Moderating Variables: Expectations and Attributions

Next, we turn to variables that may moderate this relation and address a number of potential complications. To date, moderating variables have received most attention in research on the mere exposure effect (Zajonc, 1968). As reviewed earlier, this research showed that repetition elicits a positive mood (Monahan et al., 2000) and increases preference for stimuli (Bornstein, 1989). However, this research has also identified important qualifications. Some studies found that liking initially increased with the number of presentations, followed by a decline in liking (e.g., Kail & Freeman, 1973). For example, Van den Bergh and Vrana (1998) observed that repeated exposure increased liking up to nine exposures. After 27 exposures, liking increased if the salience of the repetition scheme was low, but decreased if repetition salience was high. Other studies found that mere-exposure effects were more easily obtained for complex than for simple visual stimuli (Bornstein, Kale, & Cornell, 1990), although the latter are easier to process.

To account for such findings within a perceptual fluency account, it is useful to consider factors that determine (a) the elicitation of fluency-related subjective experiences and (b) the use of these experiences in judgment.

Processing Expectations

According to the discrepancy–attribution hypothesis (Whittlesea &Williams, 1998, 2000), fluency associated with processing a certain event is more likely to elicit a subjective experience (pleasure, familiarity, etc.) if the fluency is unexpected in light of the person's processing expectations, which constitute a "norm" for the event (Kahneman & Miller, 1986). For example, seeing your dentist (a fluent stimulus) at the dental office does not generate a strong feeling of familiarity, whereas unexpectedly seeing the same dentist at the airport does.[5] According to the discrepancy–attribution hypothesis, salient causes of fluency (e.g., an obvious repetition scheme, a very simple pattern, predictive context) allow participants to formulate accurate expectations regarding the processing fluency of the target stimuli and thus reduce the likelihood that fluency will elicit a subjective experience (Whittlesea & Williams, 2000). Nevertheless, many fluent stimuli may continue to elicit a pleasant experience even when fluency of processing is expected. For example, we suspect that people continue to enjoy prototypical faces, symmetrical

patterns, harmonious chords, and high clarity drawings even after they formed fairly accurate processing expectations for these stimuli.

Schwarz (2004a, 2004b) suggested that these diverging intuitions reflect that expectations have a dual influence: On the one hand, unexpected fluency is more likely to capture attention, resulting in a conscious experience as suggested by the discrepancy-attribution hypothesis. On the other hand, expectations entail an attribution to the variable that gave rise to the expectation in the first place. When this variable is irrelevant to the evaluation of the stimulus (as is the case for repetition schemes or predictive contexts), the experience is considered uninformative and not used informing a judgment, as discussed later. When the variable is relevant to the evaluation (as is the case for symmetry, prototypicality, and so on, which are characteristics of the stimulus itself), the experience is considered informative and used as a basis of judgment. This conjecture, derived from the feelings-as-information model (Schwarz & Clore, 1996), awaits empirical testing.

Attributional Processes

Once an affective experience is elicited by a fluent stimulus, its impact on preference judgments is moderated by attributional processes (e.g., Bornstein & D'Agostino, 1994; Van den Bergh & Vrana, 1998). In general, individuals only rely on experiential information when it seems to bear on the target of judgment, but not when they are aware that it may reflect the influence of an unrelated variable (Schwarz & Clore, 1996). Thus, people should only rely on fluency-based experiences when their informational value is not called into question. When it becomes apparent that their experience may merely reflect the influence of high repetition or a preceding prime, the experience is discounted and perceivers switch to alternative inputs to form a judgment (e.g., Bornstein & D'Agostino, 1994; Van den Bergh & Vrana, 1998). This assumption is consistent with (mis)attribution effects observed in the exploration of other sources of experiential information, like moods (e.g., Schwarz & Clore, 1983; for a review see Schwarz & Clore, 1996), ease of recall (e.g., Schwarz et al., 1991; Winkielman, Schwarz, & Belli, 1998; for a review see Schwarz, 1998), or familiarity (Fazendeiro, Winkielman, Luo, & Lorah, in press). Consistent with these earlier findings, we observed that the impact of processing fluency on judgment is eliminated when participants attribute their affective reactions to an irrelevant source, such as a background music (e.g., Winkielman & Fazendeiro, 2003), as reviewed earlier.

Challenges and Conjectures

In this section, we address various challenges that a fluency account of aesthetic pleasure needs to handle. We first discuss why people sometimes prefer complex rather than simple stimuli, including preference for complex stimuli by experts. We then turn to the question of how stimulus valence may moderate fluency effects on preference. The empirical evidence bearing on these challenges is often sparse and sometimes contradictory. We review what is known and offer some conjectures and recommendations for future research.

Stimulus Complexity

An important challenge for our fluency account is why people sometimes prefer complex over simple stimuli. After all, a simple stimulus (e.g., a single line or one musical note) should be easier to process than a complex stimulus (e.g., a pattern of lines or a chord), but the latter are commonly preferred. We propose that several processes may contribute to a relative preference for complexity.

Expectations and Attributions

As discussed in the preceding section, the ability of fluency to elicit an experience, and the perceiver's willingness to use that experience in forming a judgment, depends on expectations and attributions. Simple stimuli allow the perceiver to form more accurate processing expectations, reducing the strength of the fluency-based experience. Further, simple stimuli provide the perceiver with an obvious attribution for the experience. Consistent with these ideas, a common view in aesthetics holds that highest beauty is attained by "uniformity in variety," or "simplicity in complexity," as when a complex theme is presented in an accessible way (see Dickie, 1997). This phenomenon can be understood by conceptualizing uniformity or simplicity as a source of fluency, and variety or complexity as a source of processing expectations. That is, when processing is expected to be difficult, yet turns out to be easy, it creates a particularly strong experience of aesthetic pleasure (see Gombrich, 1984, for a related discussion).[6]

A similar logic may explain why stimulus complexity is often related to preference by an inverted U-shaped function (e.g., Berlyne, 1971; Vitz, 1966).With low levels of complexity, the source of fluency is very salient. As complexity increases, the salience of the source of perceptual fluency decreases, enhancing the misattribution of fluency to beauty. However, further increases in complexity will eventually reduce processing fluency, leading to a decrease in perceived beauty. These mechanisms would combine to form a U-shaped relation between complexity and beauty, as predicted and found by Berlyne (1971).

Different Sources of Processing Facilitation

Perceptual versus conceptual fluency. Complexity may sometimes be preferred because it facilitates access to the meaning of the stimulus. That is, a decrease in perceptual fluency due to complexity may be outweighed by an increase in conceptual fluency due to meaningfulness. Consistent with this idea, Martindale, Moore, and Borkum (1990) found that meaningfulness was a better predictor of aesthetic preference than complexity per se.

Future research may fruitfully address the relative contribution of fluency to the subjective experiences of the perceiver at various stages of processing. In a first step toward this question, R. Reber et al. (2004) examined how processing speed contributes to the subjective experience of "ease" at various perceptual stages. Participants were presented with words in high and low figure–ground contrast, printed in more and less readable fonts. The participants' task was to either detect the appearance of these words, or to identify them as quickly as possible. As expected, high contrast sped up performance on a detection task, reflecting early processing stages, but not on the identification task, reflecting later processing stages. On the other hand, high font readability sped up performance on the identification task, but not on the detection task. Interestingly, both high figure–ground contrast and high font readability enhanced judgments of the subjective ease of perception. This finding suggests that facilitation of the early stimulus detection stage and the later stimulus identification stage of processing can jointly contribute to the experience of ease. Future studies should address how facilitation at various processing stages contributes to liking.

Objective simplicity versus cognitive ease. Finally, objectively simpler stimuli are not always easier on the cognitive system. In the visual domain, complex shapes often have higher redundancy and thus are recognized faster than simple shapes (Biederman, Hilton, &Hummel, 1991). In the auditory domain, recognition of a melody is facilitated through multiple embedding of redundant patterns (Gentner & Hulse, 1998). Empirical studies and connectionist models suggest that recognition is often easier when a pattern is embedded in a larger context (e.g., the letter "r" by itself or in the context of a word), with different levels of analysis simultaneously supporting each other (Rumelhart & McClelland, 1982). In short, simplicity per se does not necessarily imply ease of processing. Hence, it is always necessary to empirically examine the actual ease of processing for simple and complex stimuli.

Experts and Novices

Numerous studies demonstrated profound differences in the aesthetic preferences of novices and experts. In general, people without art training prefer simple and symmetric visual elements, whereas people with art training prefer complex and asymmetric visual elements (e.g., McWhinnie, 1968). Similarly, music novices prefer prototypical chord progressions, whereas experts do not show this preference (e.g., Smith & Melara, 1990). Do these observations imply that only novices' preferences are influenced by processing fluency?

In our reading, two different processes are likely to contribute to these differential preferences. First, training in the arts presumably increases the fluency with which complex art stimuli can be processed. Repeated exposure to complex stimuli results in higher perceptual fluency, and training in arts gives meaning to complex structures in paintings, poems, or music, which results in an additional increase in processing ease. Accordingly, the observation that experts have higher preference for complex stimuli than novices may itself reflect fluency effects. Second, experts are more likely than novices to consider aesthetic value, the ideas behind the work, and the norms of "good" and "bad" taste (Bourdieu, 1979/1987; Gombrich, 1995). As a result, they may evaluate simple stimuli more negatively than novices, despite the pleasure they receive from easy processing.

As Wilson et al. (1993) demonstrated, such an analytic approach to aesthetic preference bears the risk of making poor choices. In their studies, participants who had to explain why they liked a poster subsequently selected posters from which they derived less pleasure once they had it at home than participants who could rely on their gut preference. Similarly, experts may run the risk of acquiring art that they find less enjoyable than expected, once they no longer interact with it in the thoughtful manner that led to their choice. However, our processing fluency account provides some hope for these experts: Extended exposure to their new treasure may eventually result in a preference that is driven by processing fluency instead of aesthetic value. In a similar vein, in the history of western music, more complex musical intervals were gradually introduced and then accepted by an initially reluctant audience, potentially reflecting increased fluency through repeated exposure. In fact, Roederer (1973) suggested that more complex musical intervals require more complex information processing, a skill that the audience acquires with increasing familiarity.

Stimulus Valence

Central to our proposal is that processing fluency is experienced as positive and that this experience, in turn, results in more favorable judgments. As our review indicates, this effect has been observed for stimuli that are largely content-free (abstract designs, novel melodies, nonwords, etc.), as well as for stimuli that are highly meaningful (everyday objects, faces, dogs, birds, watches, guns, words, sentences, etc.). This observation, however, does not imply that stimulus content is irrelevant, and we would certainly expect that stimuli with positive content are evaluated more favorably than stimuli with negative content. But how does stimulus content interact with fluency? Does fluency enhance the evaluation of positive as well as negative stimuli?

To date, the role of stimulus valence has mostly received attention in mere-exposure research. As reviewed earlier, most studies indicate that repetition of initially neutral or positive stimuli enhances preference for these stimuli (see Bornstein, 1989, for a review). However, studies with initially negative stimuli produced mixed findings. Some authors found that repeated exposure enhanced preference for initially negative stimuli (Zajonc, Markus, & Wilson, 1974), whereas others observed that repeated exposure to initially negative stimuli decreased preference for these stimuli (Brickman, Redfield, Harrison, & Crandall, 1972; Grush, 1976; Klinger & Greenwald, 1994; Swap, 1977). In our reading, mixed findings are to be expected for several reasons.

First, fluency manipulations like repetition or high figure–ground contrast are likely to have multiple effects. On one hand, they facilitate fluent processing, which elicits a positive affective response (Winkielman & Cacioppo, 2001). On the other hand, they enhance the mental representation of the stimulus and facilitate the extraction of

stimulus meaning. Suppose, for example, that you are repeatedly exposed to a negative item, like a somewhat blurred picture of a rotting carcass. With each repetition, the picture is easier to perceive, which by itself is experienced as positive. But each repetition also increases access to the item's negativity, resembling a shift from viewing the rotten carcass through a fogged window to viewing it through a clear window. This increased access to the stimulus' negativity, and the resulting affective response may eclipse any initial positive reactions due to higher fluency. Similarly, when a sinner views a perceptually fluent image of hell, the fear from the prospect of eternal damnation may well override the pleasure from ease of perception.

Second, fluent processing of initially negative stimuli may also elicit negative evaluations via meta-cognitive inferences (Skurnik, Schwarz, & Winkielman, 2000). For example, multiple repetitions of the name of a notorious murderer may increase perceivers' feeling of name familiarity, as observed in Jacoby, Kelley, Brown, and Jasechko's (1989) "false fame" effect. This "false fame" may then lead the participant to infer that the criminal must be particularly vicious, or why else would the name seem so familiar (Klinger & Greenwald, 1994)? Again, this inference may override any positive reaction due to the higher fluency of the stimulus. One paradoxical, and not yet tested, implication of this conjecture is that names and pictures of highly negative individuals (e.g., Stalin or Hitler) may initially elicit brief fluency-based positive responses, which are quickly overridden by responses based on meaning.

Finally, some studies investigated the effects of repetition on stimuli presented in differentially valenced contexts. In a positive context, mere exposure generally increases preference for old compared to new stimuli (Burgess & Sales, 1971; Saegert, Swap, & Zajonc, 1973). In a negative context, however, the picture is mixed. Saegert et al. (1973) found that personal attraction increased, but Burgess and Sales (1971) observed that increased exposure to nonsense words in a negative context resulted in a decrease in preference. These findings presumably reflect that the previous pairings of the stimulus with a negative context resulted in more negative associations, which were sufficient to override the positive influence of fluency per se. Unfortunately, the procedures used do not permit the separation of these effects.

As the reviewed examples illustrate, it is difficult to separate the relative contributions of fluency-based affective reactions and fluency-related changes in perceived stimulus meaning and associations. Developing methodologies that can shed some light on this issue is therefore an important next step. One promising strategy was used by Halberstadt (personal communication, March 2004), based on relative attractiveness judgments. Specifically, Halberstadt showed participants a variety of negative objects and assessed judgments of the relative attractiveness of a given object. His results showed that highly prototypical negative objects, such as guns, were rated as more "attractive" than nonprototypical negative objects, paralleling the prototypicality effect observed for neutral and positive objects (Halberstadt & Rhodes, 2000). Thus, it appears that fluency due to prototypicality increases attractiveness irrespective of stimulus valence.

Implications of a Processing Fluency Theory of Beauty

We now turn to a discussion of the implications of our theoretical framework and show how it can accommodate preference phenomena that are problematic for other theoretical approaches.

Nature Versus Nurture in Aesthetic Preferences

Our theoretical proposal allows for a conceptual integration of findings bearing on the aesthetic preferences of young children and the influence of socialization. This issue has received some attention in the psychology of music.

Medieval music theorists described tone combinations with simple frequency ratios as naturally pleasing rather than displeasing (see Schellenberg & Trehub, 1996). In line with this assumption, Zentner and Kagan (1996) observed that 4-month-old infants looked lon- ger at the source of music, and showed less motor activity, when the

music involved consonant sounds (i.e., those with simple numerical frequency ratios, like 1:2 or 2:3) rather than dissonant sounds, presumably indicating an early preference (see Trainor & Heinmiller, 1998, for related findings). However, the emergence of very different musical tastes in adults indicates a powerful role of socialization and experience. For example, people without musical training prefer consonant to dissonant sequences, whereas people with musical training, who had more exposure to dissonant sequences, do not show this preference (Francès, 1987).

A processing fluency account can accommodate both sets of findings. From this perspective, one source of fluency is found in biologically given perceptual mechanisms that are more attuned to certain stimulus organizations. In a study by Schellenberg and Trehub (1996), infants showed better detection of subtle changes to harmonic intervals if the combinations of tones were related by simple rather than complex frequency ratios. This finding is in line with the assumption that simple frequency ratios are easier to process than complex frequency ratios (Roederer, 1973). A second source of fluency is stimulus repetition and the implicit learning of stimulus regularities (e.g., Buchner, 1994; Haber & Hershenson, 1965; Jacoby & Dallas, 1981; A. S. Reber, 1993; Whittlesea et al., 1990).

Given these two sources of fluency, one can understand why there are few interindividual differences in music appreciation by infants (Schellenberg &Trehub, 1996; Zentner & Kagan, 1996), yet quite remarkable interindividual differences in music appreciation by adults (Francès, 1987). Specifically, infants come equipped with similar perceptual mechanisms that result in higher processing fluency for specific classes of stimuli. As they mature, repeated exposure to various examples of music of their culture and social class results in more fluent processing for familiar and regular musical elements. In fact, Tillmann, Bharucha, and Bigand (2000) presented a model showing how people may implicitly learn musical structures of their own culture, facilitating the perception of music that obeys the rules of harmony within this culture. In sum, the debate about nature versus nurture in music appreciation is mistaken from the perspective of a perceptual fluency account. Instead, this account suggests that aesthetic preferences always depend on fluency, which, in turn, is determined by both biological equipment and socialization.

A similar discussion emerged in research on facial preferences in infants. It has been shown that newborns prefer attractive faces (Slater et al., 1998). As discussed earlier, attractive faces are close to the mathematical average of the population (Langlois & Roggman, 1990). But how can infants prefer a population average if they have seen only very fewexemplars of the category? This finding can be explained by assuming the existence of innate processing biases that facilitate recognition of rudimentary face-like features (Turati, 2004). Because average faces best match the innate processing biases, they are processed most fluently and as a result are preferred by newborns (see Bednar & Miikukulainen, 2000, for a comprehensive discussion and a computational model). However, as infants mature, they are exposed to many different exemplars of a category and form new prototypes, often very quickly (Walton & Bower, 1993). This acquisition of new prototypes results in preferences for new types of "average" faces (Rubenstein, Langlois, & Kalakanis, 1999). What will eventually end up being "prototypical" for an adult will depend on the person's culture and social class, resulting in individual differences and beauty standards that vary somewhat across cultures. Hence, from the perspective of a perceptual fluency account, the nature versus nurture debate in facial preferences (as in music) can be resolved by assuming that aesthetic preference is a function of fluency, which, in turn, is determined by both biological equipment and socialization.

In sum, a perceptual fluency account can provide a conceptual integration of the apparent contradiction between early and acquired preferences by tracing both to fluency of processing. It therefore has an advantage over theories that emphasize objective features of beauty, which cannot account for effects of socialization and suggest fixed preferences across the life span. Fluency theory also has an advantage over socialization theories, which cannot account for the systematic nature of early preferences.

Prototypical Versus Exaggerated and Abstracted Forms

In apparent contradiction to a common preference for prototypicality, two popular techniques in art are exaggeration and abstraction (Ramachandran & Hirstein, 1999).A perceptual fluency theory may again shed light on this paradox. On the one hand, prototypical stimuli are easier to process than nonprototypical ones, resulting in higher preference. On the other hand, under some conditions, exaggeration and abstraction may facilitate processing even more by emphasizing central features and discarding others. This is suggested, for example, by the initially paradoxical finding that caricatures of faces are sometimes better recognized than undistorted images (e.g., Mauro & Kubovy, 1992; Rhodes, Brennan, & Carey, 1987). Future research may address this hypothesis directly and may fruitfully relate it to the discussion of preferences for prototypical versus exaggerated facial stimuli (see Perrett, May, & Yoshikawa, 1994; Rhodes & Tremewan, 1996).[7]

Beauty and Truth

Finally, our processing fluency proposal sheds new light on why artists and scientists alike have long considered beauty and truth as two sides of the same coin. In Greek and medieval art, it was considered impossible that something untruthful could be beautiful (see Eco, 1988;Tatarkiewicz, 1970). Even in 19th century poetry, beauty and truth were seen as two sides of the same coin, as expressed by Keats' famous assertion "beauty is truth, truth is beauty" (McGlone & Tofighbakhsh, 1999, p. 240). It was only later that beauty and truth were viewed as separate attributes in art.

A similar identification of beauty and truth can be seen in the philosophy of science. For a long time, an important aspect of the acceptability (i.e., truth) of a scientific hypothesis has been its simplicity (cf. Hempel, 1966). This view has a long tradition and some theorists suggested that the aesthetic value of simplicity motivated ancient cultures to begin to classify their flora and fauna, regardless of the survival needs of the tribe (see Lévi-Strauss, 1962/1966). Hence, aesthetic criteria seemingly stood at the very beginnings of scientific inquiry. Recently, philosophers of science, particularly those concerned with the complexities of evolutionary theory, began to cast doubt on the value of universally applying the simplicity principle because it may preclude the acceptance of more accurate, but less "elegant" theories (Sober, 1994).

Despite these concerns, it appears that at least some scientists use the beauty of a theory as a guide to its truth. The Nobel price-winning physicist Chandrasekhar has exemplified this thinking by quoting the mathematicianWeyl: "My work always tried to unite the true with the beautiful; but when I had to choose one or the other, I usually chose the beautiful" (Chandrasekhar, 1987, p. 65). Chandrasekhar continued:

> "the example which Weyl gave was his gauge theory of gravitation, which he had worked out in his *Raum- Zeit-Materie*. Apparently, Weyl became convinced that this theory was not true as a theory of gravitation; but still itwas so beautiful that he did not wish to abandon it and so he kept it alive for the sake of its beauty. But much later, it did turn out that Weyl's instinct was right after all, when the formalism of gauge invariance was incorporated into quantum electrodynamics." (Chandrasekhar, 1987, p. 65f)

Of course, this anecdote does not imply that beautiful theories are true—there may have been as many beautiful theories that turned out to be wrong after all. Yet, it does illustrate that some scientists believe that when a scientific proposition cannot be decomposed analytically, its truth can be revealed nonanalytically or "intuitively," by assessing its beauty.

Given this parallelism of beauty and truth in art and science, one may ask if both judgments involve similar psychological processes. In fact, there is growing empirical evidence that people use a common source for evaluations of both beauty and truth—processing fluency. For example, stimulus repetition increases judgments of liking (e.g., Bornstein, 1989; Zajonc, 1968) as well as judgments of truth (e.g., Arkes, Hackett, & Boehm, 1989; Begg et al., 1992; Brown & Nix, 1996; Hasher, Goldstein, & Toppino, 1977). Similarly, figure– ground contrast

increases judgments of liking (e.g., R. Reber et al., 1998) as well as judgments of truth. For example, R. Reber and Schwarz (1999) observed that the same statements were more likely to be judged true when presented with high rather than with low figure–ground contrast. Similarly, McGlone and Tofighbakhsh (2000) demonstrated that the same propositions are more likely to be perceived as true when presented in a rhyming rather than a nonrhyming form. Interestingly, a rhyming form also enhances the fluency with which statements are understood (e.g., Meyer, Schvaneveldt, & Ruddy, 1975, Rubin, 1995) and is used in poetry to increase the reader's pleasure (McGlone & Tofighbakhsh, 1999; Vendler, 1997). In combination, these findings suggest that judgments of beauty and intuitive judgments of truth may share a common underlying mechanism. Although human reason conceptually separates beauty and truth, the very same experience of processing fluency may serve as a nonanalytic basis for both judgments.

Summary and Conclusions

In sum, we propose that aesthetic pleasure is a function of the perceiver's processing dynamics: The more fluently the perceiver can process an object, the more positive is his or her aesthetic response. This proposal entails four specific assumptions. First, objects differ in the fluency with which they can be processed. Features that facilitate fluent processing include all the core features identified in objectivist theories of beauty, like goodness of form, symmetry, and figure– ground contrast, as well as variables that have not received attention in traditional theories of aesthetic pleasure, like perceptual and conceptual priming procedures. Second, processing fluency is itself hedonically marked and high fluency is subjectively experienced as positive, as indicated by psychophysiological findings. Third, the affective response elicited by processing fluency feeds into judgments of aesthetic appreciation, unless the informational value of the experience is called into question. Finally, the impact of fluency is moderated by expectations and attribution. On the one hand, fluency has a particularly strong impact when its source is unknown and fluent processing comes as a surprise. On the other hand, the fluency-based affective experience is discounted as a source of relevant information when the perceiver attributes the experience to an irrelevant source. One of the strengths of our proposal is its ability to integrate distinct phenomena under a common theoretical framework.

Whereas the basic fluency–liking relation is robust and reliably replicable, several complications may emerge that deserve further investigation. First, variables that influence fluency of processing can also influence the accessibility of the pre-existing semantic and affective content of the stimulus. This may increase the impact of stimulus content, potentially overriding the influence of the fluency-based affective response. Second, we conjecture that "pure" fluency effects are most likely observed at an early stage of processing and that stimulus content exerts a subsequent influence. Third, the extent to which people rely on their initial fluency-based gut response or on stimulus content is a function of their processing motivation, as observed with other sources of experiential information (for a review, see Schwarz & Clore, 1996). In general, experiential information is more influential under the heuristic processing style adopted under low motivation conditions than under the systematic processing style adopted under high motivation conditions. Differences in the preferences of experts and novices may be plausibly traced to this variable. These conjectures await systematic testing.

Let us turn to a final question. We have seen that beauty does not rest in the objective features of an object, but derives instead from the processing experiences of the perceiver. Is beauty therefore in the eye of the beholder? In a sense it is, if folk wisdom thinks of the eye as the perceptual processes of the beholder. However, beauty "in the eye of the beholder" has often been contrasted to "objective beauty." The fluency hypothesis resolves this apparent contradiction: Beauty is in the processing experiences of the beholder, but these processing experiences are themselves, in part, a function of objective stimulus properties and the history of the perceiver's encounters with the stimulus. Hence, beauty appears to be "in the interaction" between the stimulus and the beholder's cognitive and affective processes.

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Footnotes

1 Another historical precursor is Eysenck's observation that "the pleasure derived from a percept as such is directly proportional to the decrease of energy capable of doing work in the total nervous system, as compared with the original state of the whole system" (Eysenck, 1942, p. 358).

2 This result, related findings by Seamon, McKenna, and Binder (1998), as well as studies using psychophysiological measures (Harmon- Jones & Allen, 2001; Winkielman & Cacioppo, 2001) speak against the possibility that the influence of fluency on preferences is reducible to misattribution of nonspecific activation to a salient judgment dimension (Mandler, Nakamura, & Van Zandt, 1987). Instead, they suggest that the affective reaction induced by fluency is hedonically positive.

3 One well-known objective feature that we did not address is the golden section. The possibility that people have a preference for the golden section is one of the oldest and most studied phenomena in empirical aesthetics (e.g., Fechner, 1876; for a review, see Green, 1995). For example, rectangles are assumed to be most pleasing if the ratio of the short side to the long side of the rectangle equals the ratio of the long side to the sum of short and long side, which is about 1:1.618. However, evidence for preference of the golden section is mixed (Green, 1995; Kubovy, 2000). Further, we are not aware of any work testing how golden section influences processing fluency. Accordingly, we do not address the phenomenon.

4 Although the concept of "averageness" can refer to an objective feature (i.e., the stimulus represents the arithmetical mean of all exemplars in the population), in most studies averageness is closely related to prototypicality (i.e., perceiver's mental representation of the best or most typical instance of a category). That is, when participants are given stimuli that are average (e.g., they were created by morphing multiple exemplars together), usually those stimuli are prototypical (e.g., participants also see the contributing exemplars and form a mental representation of the category). Though it is theoretically possible to distinguish the "objective" population average from a more idiosyncratic psychological prototype, few studies examine distinct contributions of these two factors.

5 This possibility is elegantly illustrated by experiments showing that pseudohomophones (letter strings that sound like real words, such as "phraug") and orthographically regular nonwords (e.g., "hension") elicit illusions of familiarity and are rated as pleasant (Whittlesea & Shimizu, 2001). Presumably, these stimuli elicit cognitive and affective reactions because they are processed faster than participants expect.

6 Similar processes may underlie Eysenck's (1941, 1942) observations that order (source of fluency) and complexity (source of expectations) interact in determining aesthetic pleasure.

7 Some effects of exaggeration on attractiveness may reflect the operation of other processes, such as appeal of indicators of sexual dimorphism and sex-typical traits (Perrett et al., 1998). For example, heterosexual men tend to preferwomen with fuller than average lips.