The Visual Aesthetics of Snowflakes

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Abstract
In two experiments, participants evaluated the perceived beauty of snowflakes and solid objects. The snowflake silhouettes used as experimental stimuli were created from photographs of natural snowflakes. Both the snowflake silhouettes and computer-generated solid objects varied in complexity. In Experiment 1, 204 participants selected the single snowflake and single solid object that was the most beautiful. In Experiment 2, 33 participants rated the perceived complexity and beauty of the entire set of 100 snowflakes and solid objects. When considered as a group, the participants’ results for the solid objects replicated previous findings: The most and least complex objects were perceived as being the most beautiful. This pattern did not necessarily occur, however, for individual participants. Some participants in Experiment 2, for example, found only complex solid objects to be most beautiful \(N = 10\); other participants found only the simple solid objects to be most beautiful \(N = 11\). Additional participants perceived both the most and least complex solid objects to be beautiful \(N = 10\), while one participant only found moderately complex solid objects to be most beautiful. The results for the snowflakes were more uniform: 91% of participants perceived only the complex snowflakes as being most beautiful.

Keywords
Aesthetics, Visual Beauty, Complexity

Over the years, the topic and perception of beauty has engaged the strong attention of philosophers, psychologists, and other scientists. Some have generally maintained that beauty is “in the eye of the beholder.” According to Louis Thurstone (1954), for example, if esthetics were to be regarded as a purely normative science, then we should expect the esthetic value of an object to be determined by its physical properties. Such an interpretation seems well-nigh hopeless. It seems much more fruitful to recognize that the esthetic value of an object is determined entirely by what goes on in the mind of the percipient. (pp. 56–57)
Similarly, Santayana (1896) believed that “beauty...is a value; it cannot be conceived as an independent existence which affects our senses and which we consequently perceive. It exists in perception, and cannot exist otherwise” (p. 45). Other scholars have disagreed with this view. Thomas Reid (1785) believed that beautiful objects, while generating pleasant emotions, nevertheless produce a “judgment of some perfection or excellence in the object” (p. 739, emphasis added). Immanuel Kant (1790/1892, pp. 55–58) believed that while the pleasure that accompanies sensory experience is unique to an individual (e.g., a particular wine, such as Merlot, may be pleasant to some people, but is unpleasant to others), perceived beauty is fundamentally different. According to Kant, when someone indicates that something is beautiful, “he supposes in others the same satisfaction” (p. 57). This is because people speak “of the beautiful, as if beauty were a characteristic of the object” (p. 56).

Despite the presence of significant individual differences, previous investigators have indeed found that there are commonalities across people in terms of what they find to be beautiful (e.g., Palmer & Griscom, 2013). One factor that is known to systematically affect perceived beauty is complexity. Day (1967) conducted a series of experiments using randomly shaped polygonal figures (black on a white background) generated using methods developed by Attneave and Arnoult (1956); Day’s polygonal figures varied in complexity (i.e., number of sides, from 10 to 160). In Day’s Experiment 4, 182 participants judged 190 pairs of polygons. On any given trial, the participants were instructed to choose which of the two polygons was more pleasing. Day found that as the objective complexity of the 2D figures increased to 28 sides, the aesthetic pleasingness also increased, but then decreased as the stimulus complexity was further increased. This empirical finding by Day is consistent with a hypothesis developed by Berlyne (1970). According to Berlyne, aesthetic pleasingness increases with complexity until a point at which maximum arousal is achieved; with additional increases in complexity, aesthetic pleasure then decreases, creating an inverted-U-shaped pattern. In addition to Day, several researchers have now found that moderately complex or composite (i.e., average) stimuli tend to be the most beautiful (Halberstadt & Rhodes, 2003; Rhodes, Summich, & Byatt, 1999; Rhodes & Tremewan, 1996; Saklofske, 1975). More recently, a different effect of complexity has been demonstrated. Phillips, Norman, and Beers (2010) conducted an experiment to evaluate the perceived beauty of solid objects. Their participants perceived the most complex solid objects to be the most beautiful followed by the least complex objects—objects of medium complexity were generally not preferred. The exact relationship between perceived beauty and complexity is unclear at present given these discrepant findings, and because there is no single, agreed-upon, measure of stimulus complexity (i.e., different authors have used different measures).

A multitude of different stimuli have been used in visual experimental aesthetics: polygonal figures (Day, 1967), abstract paintings (Forsythe, Nadal, Sheehy, Cela-Conde, & Sawey, 2011), figurative or representative paintings (Saklofske, 1975), fractal patterns (Taylor, Spehar, Donkelaar, & Hagerhall, 2011), line drawings of animals and cars (Halberstadt & Rhodes, 2003), silhouettes of buildings (Heath, Smith, & Lim, 2000), faces (Rhodes & Tremewan, 1996), solid, randomly shaped objects (Phillips et al., 2010), and chairs (Faerber & Carbon, 2012). Most of the objects depicted in these stimuli have been manmade. Images or artworks depicting natural objects have not been frequently used in aesthetic experiments. This is surprising given that the human visual system evolved in natural environments. The purpose of the current study was to examine the effect of complexity on perceived beauty using snowflakes. Snowflakes represent an excellent stimulus set for a variety of reasons: (a) snowflakes have natural shapes, (b) they have a high degree of symmetry (symmetrical stimuli are often perceived to be more attractive than non-symmetrical stimuli; Cárdenas, & Harris, 2006; Jacobsen, Schubotz, Höfel, & Cramon, 2012).
2006; Rhodes, Proffitt, Grady, & Sumich, 1998; Tinio & Leder, 2009), and (c) they have a wide range of objective complexity. The solid object shapes used by Phillips et al. (2010) were also used in the current study to determine whether the relationship observed between complexity and perceived beauty is general (i.e., holds for both the 2D snowflakes and 3D solid objects) or is stimulus dependent.

**Experiment 1**

In an early aesthetics experiment by Fechner (1876), a method was employed that he called the method of choice. Fechner presented each of 347 participants with a set of 10 differently proportioned rectangles (the shapes ranged from square to a ratio of 5:2); he asked each participant to select the single rectangle that was the most aesthetically pleasing. The participants’ most common preference was for the rectangle with a ratio of $\varphi = \frac{1 + \sqrt{5}}{2} \approx 1.61$, the golden section. In the following experiment, we utilized Fechner’s method of choice in assessing our participants’ aesthetic preferences for snowflakes.

**Method**

**Experimental stimuli.** Photographs of actual snowflakes were taken by Bentley (1903, 2006). Bentley dedicated his life to studying snowflakes and found them to be very beautiful (Bentley & Humphreys, 1931/1962). He carefully captured and photographed thousands of snowflakes (Bentley & Perkins, 1898). For our experiment, silhouettes of 50 of Bentley’s snowflakes were created using Adobe Photoshop. For each of the 50 snowflakes, its outer boundary was extracted from Bentley’s original gray-level photograph; this boundary was then filled with white and placed against a black background. As is evident from the sample of snowflake stimuli presented in Figure 1, this process resulted in the elimination of all interior details. Our measure of snowflake complexity was perimeter of the outer boundaries relative to the overall area: the higher the perimeter, the more complex the snowflake. Perimeter measurements were obtained using the NIH (National Institutes of Health) program ImageJ (version 1.48 v). The snowflakes were divided into 10 groups based on complexity (Group 1 of snowflakes being the least complex to Group 10 being the most complex). These groups were equally spaced in complexity so that the difference between the perimeters of Groups 1 and 2 was the same as the difference between those of Groups 2 and 3, 3 and 4, and so forth. (see Figure 1). There were five different sets of snowflakes; each set contained snowflakes that spanned the full range of complexity (1–10). It is important to note that

![Figure 1](image.png)

**Figure 1.** One set of snowflake images used as experimental stimuli—the snowflakes vary in complexity from simplest (top left) to most complex (bottom right).
for a given level of complexity (e.g., 1, 10, etc.) significant variations in specific shape exist (see Figure 2) within our stimuli. If we find, therefore, that participants possess a clear aesthetic preference for a given level of complexity, those preferences will not be due to any particular snowflake shape. Four random spatial arrangements of the five different stimulus sets created the configuration of stimuli used in the experiment. There were thus 20 different sheets of snowflake images and each participant was given a different sheet (a configuration of 10 snowflake stimuli printed on paper by a laser printer has much higher spatial resolution, e.g., 300 dots per inch, dpi, than if the same stimuli were displayed on a computer monitor). The solid objects used in the experiment were the same as those developed by Phillips et al. (2010); they also possessed 10 levels of complexity. The individual object shapes were defined by the positions of 4,098 vertices; their complexities were measured using the variability (e.g., SD) in vertex distance from the objects’ centers (note that for a sphere, there is zero variability in vertex distance from its center). As can be seen in Figure 3, these computer-generated objects were created by iteratively modulating a sphere sinusoidally in depth (the more iterations, the more complex the resulting 3D shape and the larger the variability in vertex distance). These solid objects were treated the same way as the snowflakes: 5 distinct sets of 10 objects (with complexities 1–10) were randomly arranged four times, creating a total of 20 different sheets.

Figure 2. A depiction of the variety of specific snowflake shapes that exist within complexity Levels 1 (top row) and 10 (bottom row).

Figure 3. One set of solid objects used as experimental stimuli. These objects vary in complexity from simplest (top left) to most complex (bottom right). These objects were originally developed and used in an investigation conducted by Phillips et al. (2010).
Procedure. Participants were given a sheet of 10 snowflake images, a sheet of 10 solid object images and finally, a second sheet of 10 snowflake images. We used Fechner’s method of choice (1876/1997): For each sheet, participants were instructed to select the single snowflake or solid object they found to be the most beautiful. The first sheet of snowflakes and the sheet of solid objects were presented in a counterbalanced order (i.e., half of the participants evaluated the snowflakes first, while the remaining half evaluated the solid objects first). The second sheet of snowflakes (which portrayed a different set of snowflakes than the first sheet) was given at the end of the experiment to assess the reliability of participants’ snowflake selections.

Participants. A total of 204 Western Kentucky University students, faculty, and staff with normal or corrected-to-normal vision (average visual acuity measured at 40 cm was –0.08 LogMAR; a value of zero indicates normal visual acuity, while negative values indicate better than normal acuity) participated in the study. Written consent was given by all prior to participation in the experiment. The experiment was approved by the Western Kentucky University institutional review board. Our research was carried out in accordance with the Code of Ethics of the World Medical Association (Declaration of Helsinki).

Results and Discussion
The results for the snowflake (left panel) and solid object (right panel) stimuli are shown in Figure 4. The frequencies of the snowflakes and solid objects chosen as the most beautiful are plotted as a function of stimulus complexity. As can be seen in the left panel of Figure 4, the more complex the snowflake was, the more frequently it was chosen as the most beautiful. The simpler snowflakes (the three lowest complexity levels) were almost never selected. The solid objects with the highest complexity (see right panel of Figure 4) were most frequently chosen as the most beautiful followed by the least complex solid objects (a bimodal
distribution), as was previously observed by Phillips et al. (2010). Chi-square analyses demonstrated that the solid object ($X^2(9) = 167.67, p < .000001$) and snowflake frequency distributions ($X^2(9) = 181.59, p < .000001$) were not uniform; the effect of complexity was, therefore, significant. The patterns of results obtained for the snowflakes and solid objects possess both similarities and differences. As can be seen by comparing the left and right panels of Figure 4, participants frequently perceived both the highly complex snowflakes and the highly complex solid objects to be the most beautiful; thus it is no surprise that a contingency correlation (a nonparametric measure of correlation, see Siegel, 1956, p. 196) revealed that there was a significant relationship between the perceived beauty of snowflakes and the perceived beauty of solid objects ($C = 0.614, p < .002$). Figure 5 plots a 2D histogram of the participants’ first snowflake selections and their solid object selections. An inspection of this plot (Figure 5) clearly shows “islands” where participants preferred snowflakes and solid objects of different complexities (e.g., four participants chose a snowflake with complexity Level 4 and a solid object with complexity Level 8 as the most beautiful). The most extreme difference occurred for those participants ($N = 12$, the island at the bottom-right in Figure 5) who found the most complex snowflakes to be most beautiful, but who simultaneously found the simplest solid objects (the most spherical) to be most beautiful. A chi-square analysis demonstrated that there was a significant overall difference between the snowflake and solid object distributions ($X^2(9) = 83.1, p < .000001$).

The reliability of the participants’ snowflake selections is shown in Figure 6. The participants’ second snowflake selections were subtracted from their first snowflake selections; the absolute value of this difference was plotted as their reliability (i.e., consistency of choice across different sets of snowflake images). As can be seen in Figure 6, the majority of the participants (104 out of 204) selected two snowflakes that either had the same level of complexity or differed by one level (e.g., a participant first selected a snowflake of Level 5

![Figure 5](image)

**Figure 5.** Each cell in this two-dimensional histogram indicates the number of participants in Experiment 1 who found that combination of experimental stimuli to be the most beautiful (e.g., consider the cell at the bottom right: 12 participants found the most complex snowflakes to be most beautiful, but simultaneously found the simplest solid objects to be most beautiful).
complexity and then selected another snowflake with Level 6 complexity). On average, the participants selected snowflakes that differed in complexity by 1.9 levels, so they were reliable in their judgments across different stimulus sets.

Experiment 2

The results of Experiment 1 revealed that aesthetic perceptions of beauty are influenced by objective measures of complexity (perimeter relative to area for snowflakes and variability in vertex distance from center for the solid objects). A primary purpose of Experiment 2 was to evaluate the perceptual validity of these objective measures. A further purpose was to ask participants to rate the perceived beauty of each of the 100 individual snowflakes and solid objects.

Method

Experimental stimuli. The visual images used as the experimental stimuli were the same as those used in Experiment 1.

Figure 6. The consistency of participants' snowflake selections across repeated assessments in Experiment 1. Reliability is defined as the absolute value of the difference in complexity of the two snowflakes that were selected as being most beautiful. The most reliable participants (reliability value of zero) initially selected a snowflake with a particular complexity level from one set of stimuli and selected another snowflake from a different set that possessed that same level of complexity. The least reliable participants (N = 2) selected as most beautiful a Level 1 snowflake from one stimulus set and a Level 10 snowflake from a different stimulus set.
Procedure. Participants rated the perceived complexity and beauty of each snowflake and solid object. Five binders were each filled with 50 printouts of the solid objects, with a separate object depicted on each page. Five similar binders were created for the 50 snowflakes. Each of the binders contained different random orders of the individual solid objects or snowflakes. Participants made four different types of judgments; they evaluated the following: (a) perceived complexity of snowflakes, (b) perceived complexity of solid objects, (c) perceived beauty of snowflakes, and (d) perceived beauty of solid objects. The type of judgment was randomly ordered and the order of stimulus images (i.e., binder) that was used for each evaluation was randomly determined as well.

Before beginning each type of judgment, the participants viewed the entire set of stimuli that were to be evaluated; either all 50 solid objects or all 50 snowflakes were simultaneously presented on a poster (in a random spatial arrangement). The participants were instructed to examine the stimuli for 1 minute while considering how they varied in either complexity or beauty. The participants were also informed at this time that they would be rating each individual solid object or snowflake on a scale of 1 (least beautiful or least complex) to 10 (most beautiful or most complex). To anchor the scale, they were told that they should give a rating of 10 to whichever stimulus they thought was the most beautiful (or most complex) and should give a rating of 1 to whichever stimulus they thought was the least beautiful (or complex). The participants were then seated in front of an Apple iMac computer and given the appropriate binder. They made their ratings of each stimulus by moving a red slider (with the computer’s mouse) along a scale from 1 to 10 (the number 1 was accompanied by a label of least beautiful or least complex, while the number 10 was accompanied by the label most beautiful or most complex). The initial position of the slider was randomly determined for each stimulus. Each participant rated the perceived beauty and complexity of each snowflake and solid object; each participant thus made a total of 200 judgments.

Participants. A total of 33 Western Kentucky University students with normal or corrected-to-normal vision (average visual acuity measured at 1 m was −0.11 LogMAR) participated in the study. Written consent was given by all prior to participation in the experiment. The experiment was approved by the Western Kentucky University institutional review board. Our research was carried out in accordance with the Code of Ethics of the World Medical Association (Declaration of Helsinki).

Results and Discussion

Representative results relating perceived and objective complexity for four participants are plotted in Figures 7 and 8 for the snowflakes and solid objects, respectively. As is readily evident, a strong linear relationship between objective and perceived complexity exists for both object types; the average Pearson $r$ correlation coefficient magnitudes for all participants were 0.846 and 0.921 for snowflakes and solid objects, respectively. This result indicates that 71.6% and 84.8% of the variance in the participants’ perceptions of complexity can be accounted for by variations in objective complexity. Despite the fact that both measures of objective complexity were perceptually valid (explained more than two thirds of the variance), the relationship between actual and perceived complexity was statistically higher for solid objects ($t(32) = 5.6, p < .00001$).

Results showing how perceived beauty varied as a function of perceived complexity for the snowflake stimuli are plotted in Figures 9 and 10, while those for the solid objects are plotted in Figures 11 and 12. The average relationship obtained for the snowflakes is plotted in the left panel of Figure 9, while a histogram of different relationships exhibited by individual
participants is presented in the right panel. As is evident from an inspection of the left panel, the current overall results replicated those obtained in Experiment 1—the more complex the snowflake, the more beautiful it was generally perceived to be. The Pearson $r$ correlation coefficient ($r$) relating perceived complexity and perceived beauty was 0.995; therefore, 99% of the variance ($r^2 = 0.99$) in perceived beauty could be accounted for by variations in perceived complexity. The right panel of Figure 9 demonstrates that while most individual participants (90.9%) exhibited a linear relationship between perceived complexity and perceived beauty, some individual participants (9.1%) exhibited either a curvilinear relationship (an inverted-U) or no relationship. Examples of these individual differences are illustrated in Figure 10. Analogous results relating the perceived complexity and perceived beauty of the solid objects are shown in Figures 11 and 12. It is clear for these stimuli that the individual participant results (right panel of Figure 11 and Figure 12) generally portray a different relationship than the overall average (left panel of Figure 11). While a strong relationship between perceived complexity and perceived beauty existed for all participants except one, the type of relationship varied widely across the individual participants. For some participants, the relationship was linear with a positive slope; for

Figure 7. Results of Experiment 2. Representative participants' judgments of complexity are plotted as a function of the snowflakes' objective complexity.
The results obtained for some individual participants (those with a U-shaped function) resembled the collective results obtained across participants in Experiment 1 (see Figure 4, right panel). The average correlation coefficient (linear or nonlinear) for all participants relating perceived complexity and perceived beauty for the solid objects was 0.735; the majority of the variance (54%, $r^2 = 0.54$) in perceived beauty could be accounted for by variations in perceived complexity. There was no statistically significant difference between snowflakes and solid objects in the strength of their perceived complexity-perceived beauty relationships (average $r_s$ of 0.783 vs. 0.735, $t(32) = 1.3, p = .19$).

**General Discussion**

In the current experiments, we employed a variety of methods to investigate human participants’ perceptions of beauty—in Experiment 1, we used Fechner’s method of choice, whereas in Experiment 2, we asked participants to rate the perceived beauty (and complexity)
of all of the 100 individual snowflake and solid object stimuli. In both experiments, the great majority of our participants perceived the complex snowflakes to be most beautiful (see left panel of Figures 4 and 9). The results for the solid objects were interesting. In Experiment 1, we found that the most complex and least complex solid objects were perceived as being most beautiful (some participants chose the least complex objects as the most beautiful, while other participants chose the most complex objects as the most beautiful, see Figure 4, right panel). For some participants in Experiment 2 (Figure 11, right panel; also see participant P22 in Figure 12), their individual results replicate the same collective pattern observed in Experiment 1: they found both simple and highly complex objects to be beautiful but did not find moderately complex objects to be as attractive. For other participants (Positive linear group in Figure 11; also see participant 24 in Figure 12), only the most complex solid objects were perceived to be most beautiful. A third group of participants (Negative linear group in Figure 11; also see participant P14 in Figure 12) only found the simplest solid objects to be most beautiful.

In 2013, Palmer and Griscom pointed out that while much is known about average aesthetic preference, little is known about individual differences. In their study, participants rated their aesthetic preference for 22 different dot patterns; they also rated the patterns' perceived simplicity/complexity. When considered as a group, the participants preferred the simple (and more symmetrical) dot patterns. Many individual participants, however, exhibited a strong aesthetic preference for more complex and asymmetrical patterns. An important contribution of this study was to highlight the fact that individual participant aesthetic preferences can often differ substantially from the group average. The solid object results of our current Experiment 2 were similar to those of Palmer and Griscom in that our individual participants' aesthetic preferences often deviated from the group average (compare the left and right panels of Figure 11). While the relationship between perceived complexity and perceived beauty for the entire group (results collapsed across

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**Figure 9.** Average and individual participants’ results for the snowflake stimuli judged in Experiment 2. The left panel illustrates the average relationship between perceived complexity and perceived beauty, collapsed across individual participants, and individual snowflake stimulus sets. The right panel depicts a histogram showing the numbers of individual participants who exhibited different relationships between perceived complexity and perceived beauty.
Participants’ preferences were U-shaped, with most individual participants (more than two thirds, 69.7%) exhibiting a different pattern of aesthetic preference. As discussed previously, Berlyne (1970) hypothesized that stimuli with moderate complexities are more aesthetically pleasing than those with either lower or higher complexities. Three of our participants’ judgments in Experiment 2 (e.g., participant P23 for snowflakes and participant P12 for solid objects; see Figures 10 and 12) were consistent with Berlyne’s hypothesis. It is important to note, however, that this pattern of results was rare in the current study. While most of our participants’ results (and those of Phillips et al., 2010) were inconsistent with Berlyne’s hypothesis, Day’s (1967) results, obtained with Attneave’s polygonal figures, do agree with Berlyne (e.g., see Day’s Figures 7 and 8). At this point, it is obvious that the effects of complexity upon aesthetic preference are stimulus dependent (e.g., compare the left and right panels of Figure 4, compare Figures 9 and 11, and compare the current results with those of Day). When choosing the most beautiful, it makes a

Figure 10. Results for snowflake stimuli in Experiment 2. Individual participant examples of the different relationships found between perceived complexity and perceived beauty. Most individual participants exhibited a positive linear relationship (N = 30) like that of participant P24 (bottom left). Other participants exhibited either a curvilinear relationship (N = 2) or no significant relationship (N = 1) as illustrated by participants P23 (top) and P26 (bottom right), respectively.
difference, for example, whether one is considering polygons, 3D solid objects, snowflakes, or Jackson Pollack paintings (Taylor et al., 2011).

With regard to snowflakes, why are only the most complex snowflakes regularly chosen as most beautiful? To answer this question, it may be helpful to consider the work of William Hogarth (1753). According to Hogarth, simple figures, like circles, are *insipid*. Webster’s dictionary (1983) defines insipid as “lacking in the power of exciting emotion; flat; dull... uninteresting” (p. 949). In contrast, ovals or ellipses are more aesthetically pleasing than circles because their outer contours have more variety (e.g., possess variations in curvature magnitude, unlike circles). According to Hogarth, a pineapple is even more pleasing, because while it has an elliptical overall shape, its contour possesses yet further variety. In addition to variety, Hogarth believes intricacy also enhances perceived beauty—in his book, *The Analysis of Beauty*, he states that “the beauty of intricacy lies in contriving winding shapes.” Indeed, consider Figure 13; for Hogarth, beauty increases as one proceeds from straight lines to curved lines to “wavy” lines to “serpentine” lines. In his book, Hogarth thus considers the natural parsley leaf as having a beautiful shape (left panel of Figure 14). He also noted that attractive Corinthian capitals (right panel, Figure 14), used in ancient Greek architecture, were modeled after naturally shaped dock leaves. In addition, he points out that Gothic buildings, whose decorations are quite complex (e.g., see the window frame of the Beverley Minster Cathedral depicted in the center panel of Figure 14), are usually perceived to be very beautiful. As a further example, consider drawings by Pablo Picasso—they are frequently perceived as beautiful. A recent analysis by Koenderink, van Doorn, and Wagemans (2012) revealed that Picasso used Hogarth’s wavy “lines of beauty” in creating his drawings.

When one considers our simple snowflakes (Figure 2, top row) in light of Hogarth’s principles, one can understand why they are not chosen as most beautiful: their sides are relatively simple and thus possess minimal variety. As our snowflake stimuli increase in

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**Figure 11.** Average and individual participants’ results for the solid object stimuli judged in Experiment 2. The left panel illustrates the average relationship between perceived complexity and perceived beauty, collapsed across individual participants and individual solid object stimulus sets. The right panel depicts a histogram showing the numbers of individual participants who exhibited different relationships between perceived complexity and perceived beauty.
Figure 12. Results for solid object stimuli in Experiment 2. Individual participant examples of the different relationships found between perceived complexity and perceived beauty. Many individual participants exhibited either a positive or negative linear relationship ($N = 10$ and $N = 11$, respectively) like those of participants P14 and P24. Other participants, such as P12 and P22, exhibited either curvilinear relationships (U and inverted U: $N = 10$ and $N = 1$, respectively) or no significant relationship ($N = 1$, participant P13).

Figure 13. According to Hogarth (1753), aesthetic pleasure increases as contours progress from straight to curved to “wavy” to “serpentine.” In his view, simple figures such as straight lines and circles are boring, and additional variety (e.g., in curvature) increases perceived beauty. The serpentine example here was adapted from a figure in Rosengarten (1896).
complexity (from Level 1 to Level 10, see Figure 1), the outer contours become more and more “serpentine” and thus should become more and more beautiful according to Hogarth. Our current results (compare left and right panels of Figure 4) demonstrate that the effects of complexity upon perceived beauty can differ for different classes of stimuli. Nevertheless, the results of the current experiments demonstrate that Hogarth’s (1753) principles, such as variety and intricacy, may be helpful in understanding the perception of beauty. It is important to keep in mind, however, that our other results (for the solid objects, see Figures 4, 11, and 12) demonstrate that objects with very simple shapes can also be perceived as highly beautiful. The overall pattern of our results can also be observed in architecture: Gothic buildings can indeed be awe-inspiring and majestic, but the clean lines of buildings built in the Bauhaus style can also be highly attractive and elegant (Bayer, Gropius, & Gropius, 1938; Herzogenrath, 1968).

**Conclusion**

Complexity systematically affects the perception of beauty, but its effects are stimulus dependent and subject to individual differences.

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