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THE ASSESSMENT OF PREFERENCE FOR BALANCE: INTRODUCING A NEW TEST

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ABSTRACT

Balance is a central feature that contributes to the organizational structure of aesthetic visual images. Balance gives unity to an otherwise diverse display. Dynamic balance refers to the way in which disparate elements of an image produce visual forces that compensate for each other. Despite the importance of balance on aesthetic perception and production, few tests are designed to assess sensitivity or preference for this important attribute of images. Here, we introduce the assessment of preference for balance (APB) and report a method to derive an objective balance score. In selecting items for this test, we eliminated images that produce local grouping effects and confound assessment of the effects of dynamic balance per se. Our final test constitutes 130 images comprised of circles or hexagon elements. The objective balance scores accounted for 73% and 78% of the variance, respectively, in subjective preferences for these images.

The organizational structure of a visual image affects the way it is perceived. Specific structures are more likely to evoke an aesthetic experience. This claim does not preclude the possibility that cultural factors might influence aesthetic preferences. However, as we have argued elsewhere (Chatterjee, 2002a, 2004), preference for content is likely to be determined by cultural differences, whereas, preference for form is likely to be influenced by structural features such as dynamic balance.

Three structural features of images are known to influence preferences. First, people in Western cultures tend to prefer images in which implied movement proceeds from left to right rather than right to left. This observation was first made by Wolfflin (1941) and Gaffron (1950) and repeatedly since then (Christman, 1995; McLaughlin & Cramer, 1998; Mead & McLaughlin, 1979). Such directional cues can have subtle effects, even in relatively static images such as the orientation of faces in portraits (Benjafield & Segalowitz, 1993; Chatterjee, 2002b; Gordon, 1974; Humphrey & McManus, 1973; McLaughlin & Murphy, 1994). Second, the location of the object of greatest salience in an image influences people's preferences. In general, images with salient objects located on the right are preferred (Beaumont, 1985; Christman & Pinger, 1997; Freimuth & Wapner, 1979; Mead & McLaughlin, 1979). Finally, and the focus of this report, balance of elements within an image can have a profound influence on aesthetic preferences.

The simplest form of balance is symmetry. Preference for symmetry is postulated to be a by-product of object recognition systems (Enquist & Arak, 1994). "Dynamic balance," perhaps more interesting, is an organizational structure in which individual elements are not arranged symmetrically but balance is achieved because the visual forces of these elements compensate for each other. Dynamic balance gives coherence to an otherwise chaotic image and is one way in which unity can be rendered in diversity. In this article, we outline the ways in which balance has been studied in empirical aesthetics. Our goal is to contribute to this line of research by proposing a method to create stimuli in which balance can be quantified objectively, and to introduce a new test, the assessment of preference for balance (APB).

Theoreticians of art have long considered balance or notions of visual harmony as a central feature of aesthetic images (Arnheim, 1988; Bouleau, 1980). The apprehension of balance is likely to be related to pre-attentive visual processing. People are sensitive to balance "at a glance" within 100 ms of presentations (Locher & Nagy, 1996; Ognjenovic, 1991). Museum professionals and those not trained in the arts agree on the structural framework underlying balance in twentieth century paintings. Disruption of balance among elements produces reliable perturbations in the perception of balance (Locher, Gray, & Nodine, 1996). Balance also guides the viewer's gaze over an image and shapes the information selected for perceptual processing (see review in Locher, 1996). Gaze patterns may vary depending on artistic training. In one study, Nodine, Locher and Krupinski (1993) used the length of gaze at a location to distinguish between diversive (short) and specific (long) gazes. Diversive gaze patterns were postulated to represent sensitivity to the structure of a composition, whereas specific gaze patterns were postulated to represent scrutiny of elements of a composition. The investigators found that people trained in art, compared to untrained viewers, had a smaller ratio of diversive to specific gazes for balanced compositions and a larger ratio for unbalanced compositions. The authors interpreted these gaze patterns as an indication of the efficiency of apprehension of an image. Individuals trained in art make better use of balance when present in an image and consequently spend more time scrutinizing details of images.

Balance also plays a role in the production of images. Before the age of 9, children place elements arbitrarily on a page. After that, children incorporate organizational structure in their productions and align elements along a vertical or horizontal grid. At this time, the center of the display takes on salience (Golomb, 1987). A similar sensitivity to structure is evident in how adults create designs. Locher and colleagues (Locher, Stappers, & Overbeeke, 1998) found that adults create designs in which the geometric center and the center of balance are closely aligned. They also found that viewers familiar with the arts are able to perceptually discriminate subtle differences in the degree of balance.

These studies underscore the importance of balance in how people perceive and produce aesthetic images. Most of these studies use paintings as their stimuli (McManus & Kitson, 1995; Nodine & McGinnis, 1983). Such stimuli have obvious ecological validity. However, they offer limited experimental control. Goetz and Eysenck (Goetz, Borisy, Lynn, & Eysenck, 1979) designed a test of sensitivity to balance, the visual aesthetic sensitivity test (VAST). The VAST consists of 50 pairs of non-representational black and white images. One of the pair is slightly altered to produce a similar image, but in which the internal balance is disrupted. Seven artists decided which of the pairs of images was better balanced. The level of agreement among subjects established the difficulty of individual items in the VAST. Thus, if almost everybody agreed that one of the pairs was more balanced then this is considered an easy item. By contrast, items with relatively poor agreement (despite complete agreement among the "expert artists") are considered difficult items. The VAST test was designed to try to assess aesthetic sensitivity as a personality construct, in which normal individuals might vary along a "T" (for taste) factor, much as intelligence is postulated to vary along a "G" (for general intelligence) factor. Consistent with the investigators' postulate of a "T" factor, populations of subjects from different cultures responded similarly to the test items (Iwawaki, Eysenck, & Gotz, 1979).

The VAST has several strengths as an assessment of sensitivity to balance. Items vary in difficulty, allowing for a range of performances. The stimuli themselves resemble abstract art, providing ecological validity for this test, and minimizing the influence of content on preference. However, the VAST also has a few weaknesses. Norms of the test are established by "expert" rating and not by any objective criteria. The parametric variation within test items relates to the difficulty of discriminating between pairs, rather than to parametric variations in the degree of balance for any individual item.

Our goal here is to introduce a new test, the assessment of preference for balance (APB), which makes use of the strengths of the VAST and capitalizes on the findings of Locher and colleagues (1998), particularly from their observations of the way adults produce images. Our method can be adapted easily for those who wish to create their own stimuli for such studies. We used non-representational images in which balance can be quantified objectively. After creating such images, we tested the hypothesis that balanced images created in this manner do influence aesthetic preferences.

METHOD

Stimuli Creation

The images used in this study were created on a computer using Adobe Photoshop 7.0. Every image consisted of a white square with dimensions of 750 by 750 pixels. Each image contained seven black elements of varying sizes. These elements were circles, squares, or hexagons. The elements within each image were the same shape. A total of 216 images was used initially, with equal numbers of circle, square, and hexagon images.

Balance scores for each stimulus were calculated as the average of eight different measures referred to in this article as measures of symmetry. The measures of symmetry were derived by first dividing the area of the square into two equal parts along the principal axes: around the vertical axis, the horizontal axis, and around the two diagonal axes, bottom left to top right, and bottom right to top left axis (see Figure 1a). We derived four additional measures of symmetry by dividing the area into equal inner and outer areas. To clarify what we mean by the "inner-outer" divisions of the area, we use the vertical axis as an example (see Figure 1b). The square was segmented into four columns of equal size. The two inner columns comprise the inner area and the two outer columns the outer area. Similarly, inner and outer areas were derived around the horizontal and the two diagonal axes.

The following method was used for each of the eight measures of symmetry. For symmetry around the vertical axis, the total area (pixel count) occupied by the elements in each half was identified and the measure of symmetry was calculated as follows: $(|\text{area } 1 - \text{area } 2|)/(\text{area } 1 + \text{area } 2) \times 100$. For example, if there were 300 pixels on the left and 100 on the right, the measure of symmetry around the vertical axis would be $((|300 - 100|)/(300 + 100)) \times 100 = 50\%$. Thus, a measure of 0% reflects perfect balance around a particular axis, with equal areas occupied by the elements in both halves, and 100% reflects total imbalance with all of the elements either in the left or the right half of the square. Measures of symmetry for the other seven ways of dividing the square into equal areas were also calculated.

The average of the eight measures of symmetry gave the overall balance score for each image. For example, the image depicted in Figure 2 has a balance score of 8.58%. Also shown are the various axes used to calculate the individual measures of symmetry. For this particular image, the following measures of symmetry were obtained. The numbers represent pixel counts.

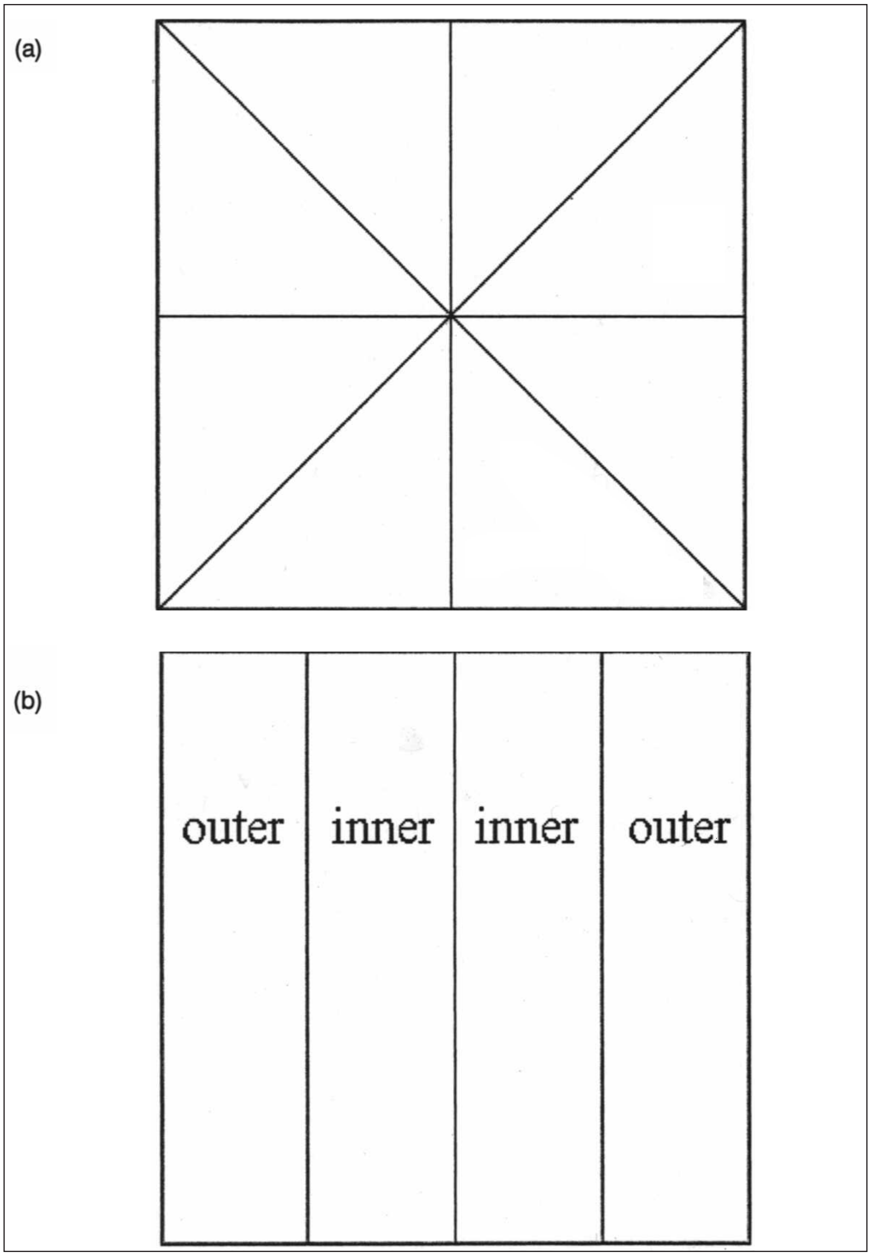

Figure 1. (a) The four principal axes around which measures of symmetry were obtained. (b) The "inner" and "outer" columns used to measure distribution of elements in the inner and outer parts of the display using vertical axes.

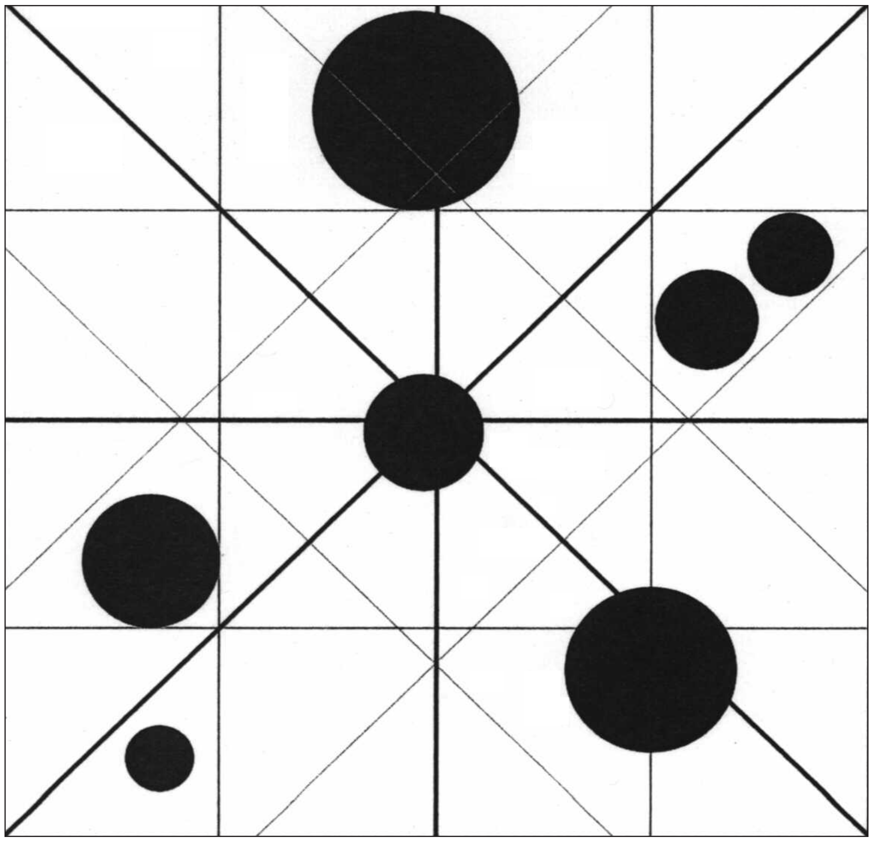

Figure 2. Example of an image using circles with a balance score of 8.58, and the relevant axes used to establish balance score.

horizontal—$((|35546 - 41120|)/(76666)) \times 100 = 7.27\%$
vertical—$((|39357 - 37309|)/(76666)) \times 100 = 2.67\%$
diagonal, bottom left top right—$((|41029 - 35637|)/(76666)) \times 100 = 7.03\%$
diagonal, bottom right top left—$((|32796 - 43870|)/(76666)) \times 100 = 14.44\%$
inner/outer divisions, horizontal—$((|34114 - 42552|)/(76666)) \times 100 = 11.01\%$
inner/outer divisions, vertical—$((|42938 - 33728|)/(76666)) \times 100 = 12.01\%$
inner/outer divisions diagonal, bottom left top right—$((|37260 - 39406|)/(76666)) \times 100 = 2.80\%$
inner/outer divisions diagonal, bottom right top left—$((|33976 - 42690|)/(76666)) \times 100 = 11.37\%$
The balance score is the average of these symmetry measures:
$(7.27 + 2.67 + 7.03 + 14.44 + 11.01 + 12.01 + 2.80 + 11.37)/8 = 8.58\%$.

We produced stimuli to cover a range of balance scores (range 3.6% to 65.9%). Figure 3 shows examples of several circle images at different points in this range of balance scores.

EXPERIMENT 1. STIMULI SELECTION

This experiment was conducted to determine if participants untrained in the arts could apprehend degrees of balance and to select stimuli that would be appropriate for the final configuration of the APB.

Participants

Four male and six female right-handed subjects participated in this experiment. They were 29.3 (±6.9) years old. None of the subjects had formal art training. They all gave informed consent, and the procedures were approved by the Institutional Review Board.

Procedures

The subjects made two kinds of judgments. First, they were asked to rate each of 216 images, for balance on a 1 to 5 scale, 5 representing the most balanced image. The instructions were adapted from the instructions for the VAST. Subjects were asked to rate the images in terms of the degree to which they were in harmony, in balance, and in which the elements appeared well ordered. They were told not to rate these images in terms of whether they liked them. Subjects were encouraged to ask questions if they did not understand what was being asked of them. The stimuli were presented in a random order.

After the balance ratings, the same subjects rated the same 216 images for their preferences on a 1–5 scale, 5 being the most preferred. Subjects were asked to rate their preference for the stimuli based on how much they liked them

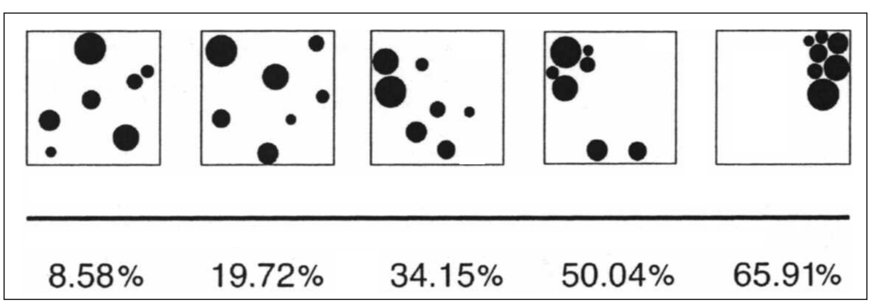

Figure 3. Examples of different circle images with a range of balance scores, each listed under the individual image.

or how much they found them interesting. In pilot studies, we found that a few subjects found it difficult to operationalize the term "like" in this context and others found it difficult to operationalize the term "interest." Consequently, we used both terms and did not define them with further specificity. Subjects were encouraged to ask questions if they did not understand what was being asked of them. The stimuli were presented in a different random order.

All stimuli were presented in the center of a computer monitor in a quiet testing room. Subjects sat approximately 60 cm from the screen. They made their judgments by pressing the number keys, 1 to 5. After they made their response, a new image appeared. There were no time limitations imposed on how long they looked at the images. Subjects took a short break (10 minutes) between the two kinds of judgments.

Results

Linear regression analyses were used to determine whether the objective balance score correlated with subjective ratings of balance. The objective balance score for each stimulus (the average score of the eight measures of symmetry) was considered the independent variable. The dependent variable was the average subjective balance score for each stimulus. Regression results are shown in Table 1a. Objective balance accounted for 71% of the variance in subjective judgments of balance. The stimuli appear to be sensitive to untrained participants' abilities to detect degrees of balance. Individual regressions confirmed that this was true for each kind of image (circles, hexagons and squares), with objective parameters of balance accounting for between 68 and 74% of the variance in subjective ratings of these images.

Linear regression analyses were used to determine whether the objective balance score correlated with preference ratings. Regression results are shown in Table 1b. Objective balance scores accounted for only 27% of the variance in subjective preferences for the images. Individual regression analyses revealed that objective balance scores correlated least with preference for square images.

Removing Outlier Images

Outlier images were selected from the results of the regression analyses. Individual stimuli that represented data points greater than 2 standard deviations of the residual errors from the overall regressions for either the balance or the preference correlations were considered outliers. Eight outliers based on the balance regressions, and 7 outliers based on the preference regressions were removed. An additional 6 images were removed to produce an equal number of circle, hexagon and square images (n = 65, each). These 6 images were selected based on those with the largest remaining residual errors in the regression analyses.

Table 1a. Regressions of Subjective Balance Measures on Objective Balance Scores for Experiment 1

	Intercept	Coefficient	Std. error	R^2
Overall	4.2	–0.049	0.002	0.71
Circles	4.3	–0.049	0.004	0.72
Hexagons	4.0	–0.049	0.003	0.74
Squares	4.2	–0.050	0.004	0.68

Table 1b. Regressions of Subjective Preference on Objective Balance Scores for Experiment 1

	Intercept	Coefficient	Std. error	R^2
Overall	3.3	–0.022	0.003	0.27
Circles	4.0	–0.024	0.003	0.49
Hexagons	2.8	–0.021	0.003	0.47
Squares	3.1	–0.021	0.003	0.39

The outliers removed reduced the total number of stimuli from 216 to 195. Although these stimuli were chosen empirically, rather than on a priori principles, visual inspection of the outlier images suggested that the spatial configuration of individual elements seemed to produce local grouping effects. For example, those stimuli rated more highly than expected on subjective balance or preference measures seemed to group into single objects, or were symmetric around a principal axis. Those rated lower than expected on balance or preference seemed to group into separate clusters and these clusters seemed to lack balance in relation to each other. Examples of outlier images are shown in Figure 4.

EXPERIMENT 2. BALANCE AND PREFERENCE

The goal of this experiment was to test the hypothesis directly that dynamic balance correlates with subjective preference. In the previous experiment subjects first made balance judgments on the same stimuli. We could not be sure that the previous cognitive set of judging the same images for balance might not have influenced their preference ratings.

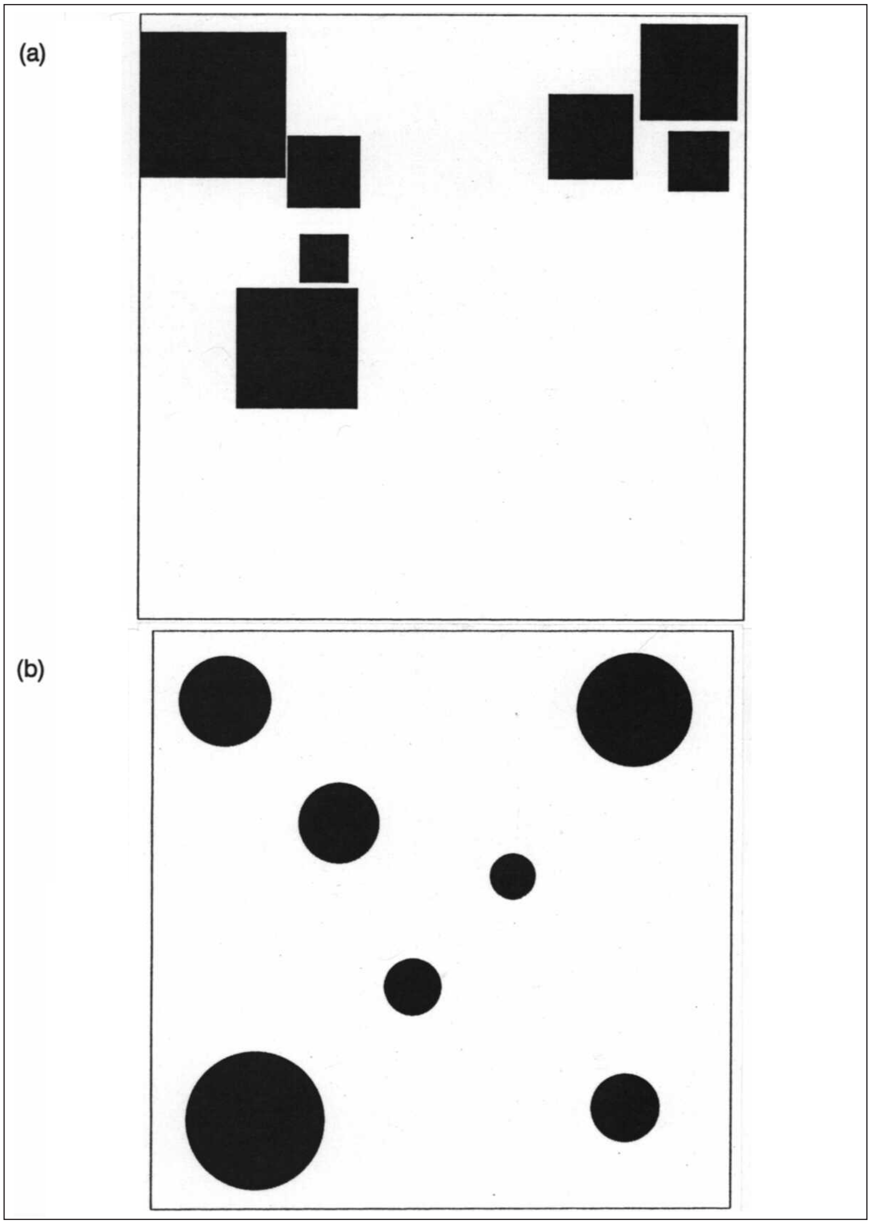

Figure 4. (a) Example of an image in which local grouping based on proximity and colinearity is likely to have interfered with assessment of dynamic balance. (b) Example of an image in which symmetry around the diagonal axes is likely to have interfered with assessment of dynamic balance.

Participants

Thirty right-handed subjects without formal art training participated in this experiment. Fourteen were men and 16 were women. They had an average age of 29.2 (+10.2). They all gave informed consent and the procedures were approved by the Institutional Review Board.

Procedures

Subjects were asked to rate the images based on preference on a 1–5 scale. Each subject was shown a sample set of 6 images with circles, squares and hexagons, to familiarize them with the kinds of stimuli that they would be rating and encouraged to ask questions if they were unsure of the task. These 6 stimuli were not used in the test itself. The 195 stimuli selected from the previous experiment were presented randomly on a computer monitor. Again, subjects sat in a quiet testing room, about 60 cm from the monitor. The stimuli were present until the subjects made their judgment by pressing the computer key 1, 2, 3, 4, or 5. After the key press a new stimulus appeared. No time limits were imposed.

Results

Linear regression analyses were used to determine whether the objective balance score correlated with preference ratings. The regression results are shown in Table 2. Overall objective balance scores accounted for 54% of the variance in subjective preferences for the images. More importantly dynamic balance accounted for 73% and 78% of the variance in preference ratings for images with circles and hexagons (see Figures 5a and 5b). By contrast, objective parameters of balance accounted for 44% of the variance in preference for squares (see Figure 5c). Visual inspection of the regression lines between balance and preference for square images revealed a non-linear relationship. For circles and hexagons preferences also seemed to plateau at the objective balance score of around 20%. Subjects' preferences seemed relatively insensitive to further degrees of objective balance.

Table 2. Regressions of Subjective Preference on Objective Balance Scores for Experiment 2

	Intercept	Coefficient	Std. error	R^2
Overall	3.3	–0.022	0.002	0.54
Circles	3.6	–0.022	0.002	0.73
Hexagons	3.1	–0.025	0.002	0.78
Squares	3.2	–0.018	0.003	0.44

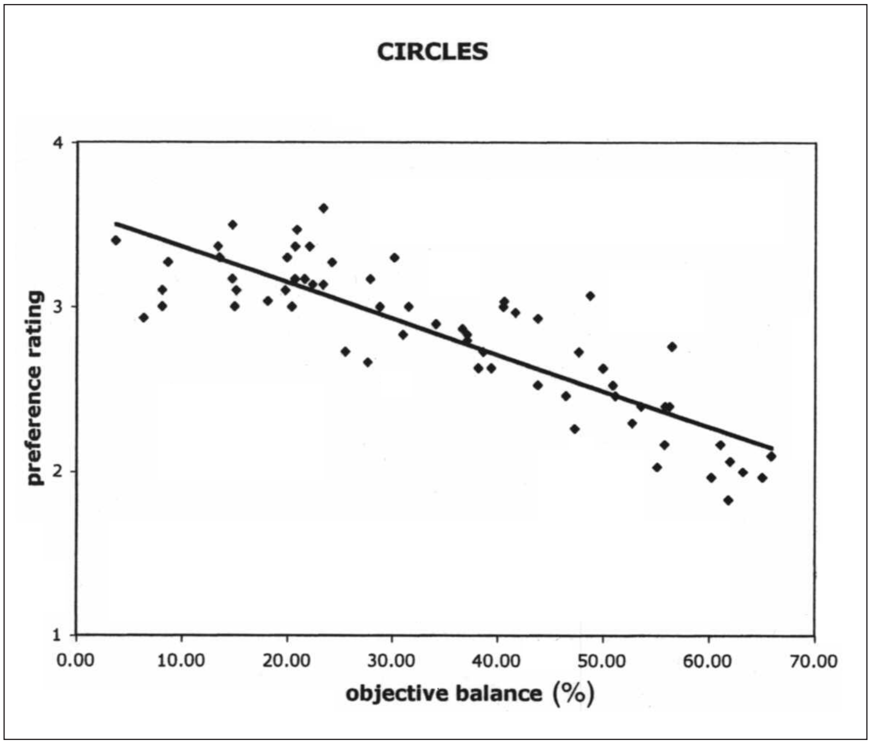

Figure 5a. Relationship of objective balance scores and preference ratings with circle images.

DISCUSSION

Our goal in this report is to introduce the APB, a test designed to assess preference for dynamic balance. The APB incorporates several characteristics in its design. We used non-representational images to avoid confounding preference for content and form. Individual elements within each design had different sizes, so that balance had to be established dynamically. In settling on our final stimuli, we eliminated images in which grouping of local subsets of the elements produced anomalous judgments.

Dynamic balance has long been considered an important aspect of aesthetic perception (Arnheim, 1988; Locher, 1996). The construction of the VAST (Goetz et al., 1979) assumed that balance is a critical feature of aesthetic perception. However, the VAST does not lend itself to quantification of balance of each individual stimulus. Our results with the APB confirm that objective parameters of balance correlate highly with subjective preferences.

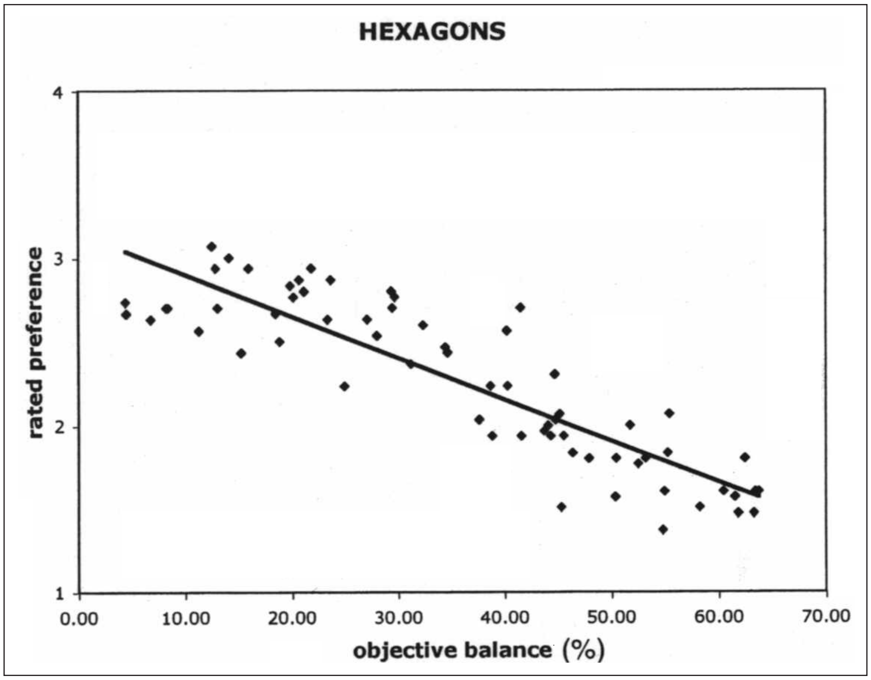

Figure 5b. Relationship of objective balance scores and preference ratings with hexagon images.

Locher and colleagues (1998) reported that subjects untrained in the visual arts produce abstract compositions in which the weighted center of individual elements is closely aligned with the geometric center of the display. Our findings show that a similar sensitivity to the geometric center evident in these production studies is also present in the perception of such stimuli. Furthermore, similar to previous observations, we show that subjects not trained in the arts are still sensitive to formal properties of dynamic balance. However, for the circle and hexagon images, subjects' preferences seemed to plateau at balance scores of about 20%. People trained in the arts make greater use of formal compositional structure when looking at artworks (Nodine et al., 1993). Such subjects' preferences may turn out to be sensitive to finer degrees of balance scores than we found in this study of subjects without formal art training.

In our study, designs with circles were preferred the most, followed by hexagons. Squares were preferred least. The influence of objective parameters of balance on preference was similar for both circles and hexagons as evidenced by similar regression slopes. By contrast, the relationship between balance and preferences for images with squares was more complicated. For these images,

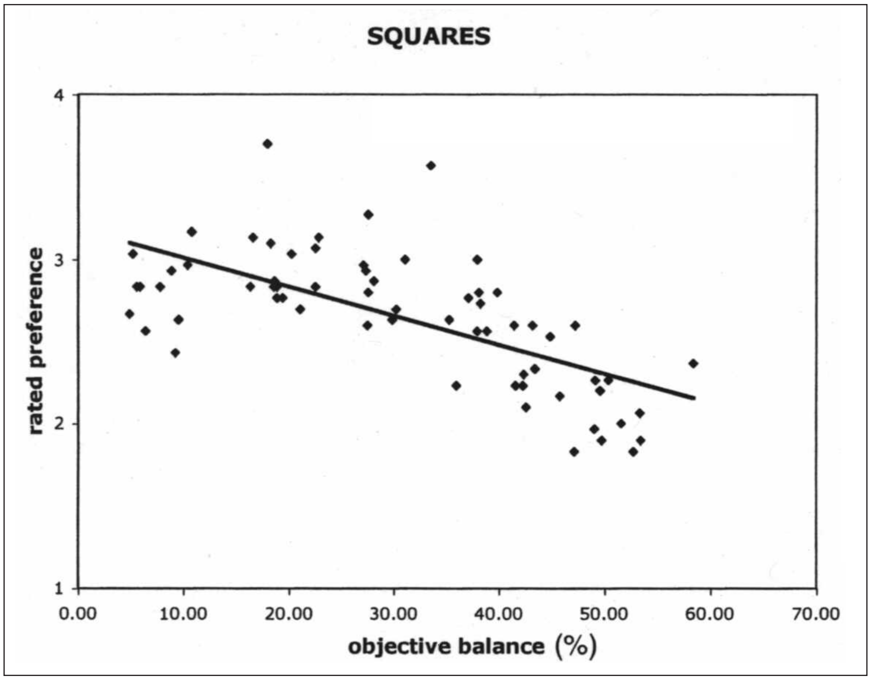

Figure 5c. Relationship of objective balance scores and preference ratings with square images.

in addition to being preferred less than the circles and squares, the relationship appeared non-linear. We suspect that the vertical and horizontal edges of square shapes produce unpredictable local grouping tensions based on the colinearity of edges, complicating assessment of dynamic balance per se. This speculation is supported by recent observations made by Locher and Stappers (2002). In an investigation of the dynamic quality of abstract designs, they found that designs with quadrilateral elements had high degrees of edge alignments and that degree of alignment as a variable significantly affected subjects' judgments of such designs.

In summary, we propose that the APB, which consists of 65 circle and hexagon stimuli each, is appropriate to probe preference for dynamic balance. These stimuli are characterized by objective scores for balance. Subjects without formal art training do prefer better balanced stimuli in this set. Our methods are easily adapted for other stimuli, such as those using different elements, or numbers of elements. For those who wish to use the APB, the specific stimuli can be obtained from
http://wernicke.ccn.upenn.edu/~chatterjee/neuroaesthetics.htm

REFERENCES

Arnheim, R. (1988). *The power of the center: A study of composition in the visual arts.* Berkeley, CA: University of California Press.

Beaumont, J. (1985). Lateral organization and aesthetic preferences: The importance of peripheral visual asymmetries. *Neuropsychologia, 23,* 103-113.

Benjafield, J., & Segalowitz, S. (1993). Left and right in Leonardo's drawings of faces. *Empirical Studies of the Arts, 11,* 25-32.

Bouleau, C. (1980). *The painter's secret geometry.* New York: Hacker Books.

Chatterjee, A. (2002a). *Universal and relative aesthetics: A framework from cognitive neuroscience.* Paper presented at the International Association of Empirical Aesthetics, Takarazuka, Japan.

Chatterjee, A. (2002b). Portrait profiles and the notion of agency. *Empirical Studies of the Arts, 20,* 33-41.

Chatterjee, A. (2004). Prospects for a cognitive neuroscience of visual aesthetics. *Bulletin of Psychology and the Arts, 4,* 56-60.

Christman, S. (1995). The role of weight versus interest versus directionality in aesthetic preferences. *Journal of the International Neuropsychological Society, 1,* 177.

Christman, S., & Pinger, K. (1997). Lateral biases in aesthetic preferences: Pictorial dimensions and neural mechanisms. *Laterality, 2,* 155-175.

Enquist, M., & Arak, A. (1994). Symmetry, beauty and evolution. *Nature, 372*(6502), 169-172.

Freimuth, M., & Wapner, S. (1979). The influence of lateral organization on the evaluation of paintings. *British Journal of Psychology, 70,* 211-218.

Gaffron, M. (1950). Left and right in pictures. *Art Quarterly, 13,* 312-331.

Goetz, K. O., Borisy, A. R., Lynn, R., & Eysenck, H. J. (1979). A new visual aesthetic sensitivity test: I. Construction and psychometric properties. *Perceptual & Motor Skills, 49*(3), 795-802.

Golomb, C. (1987). The development of compositional strategies in children's drawings. *Visual Arts Research, 13,* 42-52.

Gordon, I. (1974). Left and right in Goya's portraits. *Nature, 249,* 197-198.

Humphrey, N., & McManus, C. (1973). Status and the left cheek. *New Scientist, 59,* 437-439.

Iwawaki, S., Eysenck, H. J., & Gotz, K. O. (1979). A new Visual Aesthetic Sensitivity Test (VAST): II. Cross-cultural comparison between England and Japan. *Perceptual & Motor Skills, 49*(3), 859-862.

Locher, P. J. (1996). The contribution of eye-movement research to an understanding of the nature of pictorial balance perception: A review of the literature. *Empirical Studies of the Arts, 14*(2), 143-163.

Locher, P., Gray, S., & Nodine, C. (1996). The structural framework of pictorial balance. *Perception, 25*(12), 1419-1436.

Locher, P., & Nagy, Y. (1996). Vision spontaneously establishes the percept of pictorial balance. *Empirical Studies of the Arts, 14*(1), 17-31.

Locher, P. J., & Stappers, P. J. (2002). Factors contributing to the implicit dynamic quality of static abstract designs. *Perception, 31,* 1093-1107.

Locher, P. J., Stappers, P. J., & Overbeeke, K. (1998). The role of balance as an organizing design principle underlying adults' compositional strategies for creating visual displays. *Acta Psychologica, 99*(2), 141-161.

McLaughlin, J., & Murphy, K. (1994). Preference for profile orientation in portraits. *Empirical Studies in the Arts, 12,* 1-7.

McLaughlin, J. P., & Cramer, J. (1998). Memory for aesthetic qualities. *Empirical Studies of the Arts, 16,* 25-32.

McManus, I. C., & Kitson, C. M. (1995). Compositional geometry in pictures. *Empirical Studies of the Arts, 13*(1), 73-94.

Mead, A., & McLaughlin, J. (1979). The role of handedness and stimulus asymmetry in aesthetic preference. *Brain and Cognition, 20,* 300-307.

Nodine, C. F., Locher, P. J., & Krupinski, E. A. (1993). The role of formal art training on perception and aesthetic judgement of art compositions. *Leonardo, 26*(3), 219-227.

Nodine, C. F., & McGinnis, J. H. (1983). Artistic style, compositional design and visual scanning. *Visual Arts Research, 12,* 1-9.

Ognjenovic, P. (1991). Processing of aesthetic information. *Empirical Studies of the Arts, 9*(1), 1-9.

Wolfflin, H. (1941). *Uber das rechts und links im bilde.* Basel.

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