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ARTISTS' USE OF COMPOSITIONAL BALANCE FOR CREATING VISUAL DISPLAYS

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ABSTRACT

This study sought empirical evidence that balance influences the way adults trained in the visual arts create visual displays. Thirty-two volunteers made four designs each using two different types of shapes (rectangles or quadrilaterals) within two types of pictorial fields (a circular or rectangular format). A videotape recording of the development of each design from start to completion was used to create a digitized record of its image at 20 percent intervals of the time taken for completion. It was found that, regardless of element type, format, or phase of construction, the center of a design was closely aligned with the geometric center of the pictorial field. Furthermore, the structural or physical weight of the compositional elements measured quantitatively was evenly distributed (balanced) about the principal axes of the designs throughout their construction. These findings demonstrate the power of the center of a circular and rectangular field to function as an "anchor" or balancing point about which a design's structural skeleton is organized by artists.

In the view of many writers on Western art (e.g., Arnheim, 1974, 1988; Bouleau, 1980; Kandinsky, 1926/1979), balance is the most important design principle in the visual arts because it unifies the structural elements of a pictorial display into a cohesive organization or framework that helps determine the role of each element within a composition. A pictorial composition is said to be balanced when its elements and their qualities (e.g., size, shape, color, orientation) are poised about a balancing center so that their visual forces or tensions compensate one another and they appear anchored and stable. Together, structural components and the direction of their visual forces within a composition establish the structural skeleton or framework of any pictorial display; when they are in equilibrium about a balancing center, pictorial balance exists.

Although much has been written for centuries concerning the importance of balance as a design principle in the visual arts, almost no direct empirical evidence can be found in the literature demonstrating that balance serves as a dominant compositional strategy when artists create visual displays. Previous attempts to document the role of balance in composition have determined its presence in paintings and other artworks qualitatively by examination of their structural organization or "geometry" (see, e.g., Bouleau, 1980). We (Locher, Stappers, & Overbeeke, 1998) developed a technique, described below, which enabled us to evaluate *quantitatively* three structural characteristics of compositions that contribute to balance, namely, the location of the balancing center of a design, the distribution of physical (structural) weight about its axes, and the alignment and directional qualities of its compositional elements. Using this technique Locher et al. demonstrated that adults untrained in the arts did, in fact, employ balance as the chief organizing design principle as they created designs composed of either circles, squares, triangles, or leaves.

The present study is an extension of Locher et al.'s (1998) earlier investigation. Specifically, this study was the first attempt to evaluate quantitatively the extent to which designs were balanced as they were constructed by individuals with training in the visual arts. Videotape recordings of the development from start to completion of the designs were made and used to assess the distribution of physical weight about the principal axes of each design and the location of its balancing center. The artists created their designs from different types of triangles or quadrilaterals which varied in degree of orientation potential, as explained below. The set of shapes employed, which were structurally more complex than those used in our previous study, enabled participants to create the types of complex and dynamic designs necessary for a comprehensive examination of how balance is attained structurally.

Additionally, because it is frequently asserted in treatises on pictorial composition that the shape of a pictorial field (its format) is "the foundation on which a painting's composition is built" (Arnheim, 1988, p. 66), and is, therefore, "a condition of all appearances that fall within it" (Taylor, 1964, p. 13), participants created designs within a circular and a rectangular format so that the effects of this factor on the artists' use of balance could be assessed.

In sum, the purpose of the present study was to provide a quantitative account of the influence of balance upon artists' compositional strategies as they created designs and to examine the contribution of a design's elements and its format to the way in which balance comes about structurally.

METHOD

Participants

Eight males and 22 females enrolled in the Academy of Fine Arts of the city of Leuven and one male and one female instructor at that institution volunteered as participants. Fifteen individuals identified themselves as painters, while the other 17 participants said they specialized in either sculpture, ceramics, or graphics. The artists, whose mean age was 42.6 years, had completed an average of 3.2 years of their six-year program of studies. For eight of them, it was their first year at the academy.

Stimulus Materials and Apparatus

The elements used by participants to construct designs consisted of planar shapes cut from sheets of high-luster black polystyrene 2.0 mm in thickness. They included four triangular shapes (equilateral, isosceles, right-angle, and irregular triangles) and four types of quadrilaterals (rectangle, parallelogram, trapezoid, and irregular quadrilaterals). This collection of shapes was selected because they vary in rotational potential and because there is ample empirical evidence (e.g., Davi & Profitt, 1993; Palmer, 1980) that their perceived shape, center, and direction of pointing or orientation within a visual display are influenced by local distinctive figural characteristics (i.e., the specific type of triangle or quadrilateral) and also by global orientational properties such as line-like configurations resulting from axis-aligned or base-aligned elements within the whole configuration. Thus, as mentioned above, it was anticipated that use of the present set of compositional elements would facilitate the creation of structurally complex and dynamic designs by the artist participants.

For each of the eight shapes, a set of 12 elements was created; three each of four sizes. The dimensions for the largest shape of each of the eight element types were such that the areas of the eight shapes were the same, namely, 32 cm^2. Dimensions of the smaller shapes produced comparable areas for the medium, small, and smallest triangles and quadrilaterals, namely, 16 cm^2, 8 cm^2, and 4 cm^2, respectively.

Participants sat at a table into which an opening had been cut and then fitted with a piece of clear glass. Either a circular or rectangular display field was positioned over the opening according to the format condition for a given trial. The circular field, with a diameter of 38 cm, had approximately the same area as the rectangular field which measured 30 × 38 cm. Both fields were enclosed by a black frame 3 cm in width. The surface of the display field, frame, and white table top was covered with a large sheet of transparent technical drawing paper. This material gave the display field a light grey appearance and it reduced somewhat the contrast of the black frames. (A detailed description of the apparatus, procedure, and data preparation techniques used in the present study can be found in Locher et al., 1998.)

The contents of the display field, reflected on a mirror positioned at a 45 degree angle directly below it, were continuously recorded on tape by a videocamera suspended below the table and aligned with the mirrored image of a design. This set-up provided a high-contrast image of all shapes constituting a design unobstructed by a participant's hands as he or she arranged the elements on the display field during the construction process.

Procedure

Each participant was given unlimited time to compose four designs. One design was created within the circular frame with one type of triangle and another with one type of quadrilateral. These designs were interspersed with two others composed of a different triangle or quadrilateral shape within the rectangular frame. The order of element and format types used for the four designs was assigned to participants in such a way that the two factors were counterbalanced twice across the full set of 128 designs created by the 32 participants. At the start of each trial, the 12 shapes were arranged randomly to the left side of the display field, outside of the frame. The only restrictions placed on the structure of the designs were that no shape could overlap another and that shapes could not be joined to create a single larger shape. The experimental session lasted approximately 30 minutes

Data Preparation from the Videotape Records

For each of the four designs created by a given participant, a digitized version of it was produced from its videotape record at 20 percent intervals of the total time taken for its completion (i.e., 20 percent, 40 percent, 60 percent, 80 percent, and 100 percent—the completed design). This was accomplished in the following manner. First, the videotape image of a design at 20 percent of its completion was displayed on the screen of an Acorn Archimedes computer. Next, coordinates of the location of each shape in the field were determined interactively from the image by indicating the corners (three for the triangles or four for the quadrilaterals) of each shape displayed on the monitor. The set of coordinates for all shapes in a given display was then stored in memory.

Figure 1 presents the sequence of computer images at each of the five completion time intervals for four designs, one composed of triangles in a circular format and another in a rectangular format and designs composed of quadrilaterals in the two format types.

RESULTS

A Descriptive Account of Participants' Compositional Strategies

Inspection of the videotape records for all 128 designs revealed that participants began construction of a small number (12 percent) of designs by immediately placing the 12 elements into the display field and then rearranging them until the design was deemed finished. Most (88 percent) designs, however, were started with a few shapes and developed by additions of one or two elements which typically resulted in adjustments to the overall compositional organization before other shapes were included. Approximately the first 50 percent of total construction time, which averaged 204 s across all designs, was spent in this process of "building" a design and this duration was similar across format and element shape or shape type. Once all elements were placed in the field, participants typically used both hands to continuously slide elements from one display location to another; relatively few periods of inactivity of the hands were observed.

Distribution of Physical Weight Within the Designs

One of the most important structural properties contributing to the balance of a visual display is the distribution of physical weight within that display. Balance can be achieved by a one-to-one correspondence of components about a central axis, as with mirror-symmetric designs, or more dynamically, by an equality of structural weight about the axes of a design. This section reports the distribution of physical weight about the four principal axes of participants' designs as they were constructed. For the rectangular format, these included the vertical and horizontal axes and the two diagonals connecting the corners. Within the circular format, the principal axes were those coinciding with the four compass directions.

To determine whether participants' designs displayed balance, we computed a "balance index" about each of the four principal axes of each design. The index is the percentage of a design's area (pixels) covered by the shapes on one side of a central axis. Distributions of the physical weight for the 32 designs completed for a given element/format conditions were plotted in the form of Tukey box plots. The box plots in Figure 2 present the percentage of weight (the ordinate) to one side of each principal axis (the abscissa) for the set of 32 triangle designs constructed

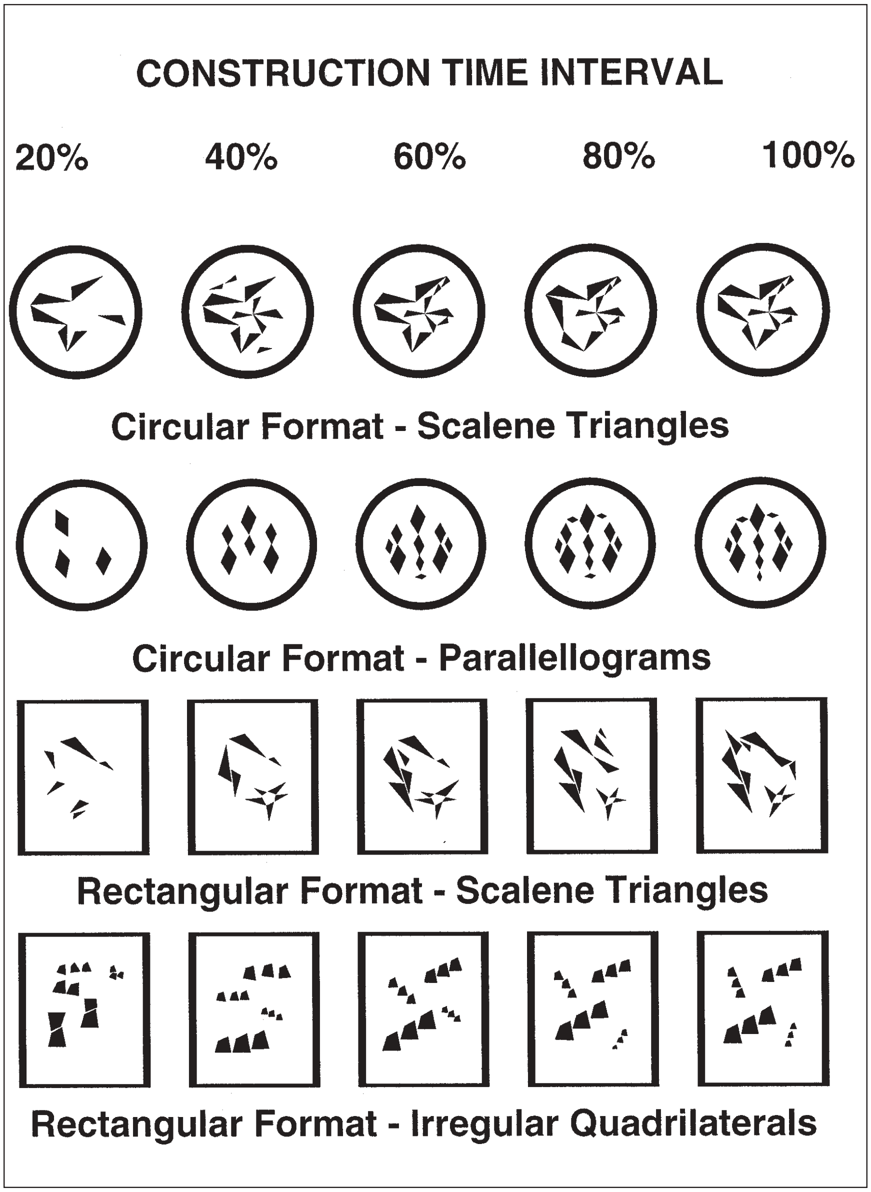


Figure 1. The sequence of computer images at each of the five completion time intervals for four designs, one composed of triangles in a circular format and another in a rectangular format and designs composed of quadrilaterals in the two format types.

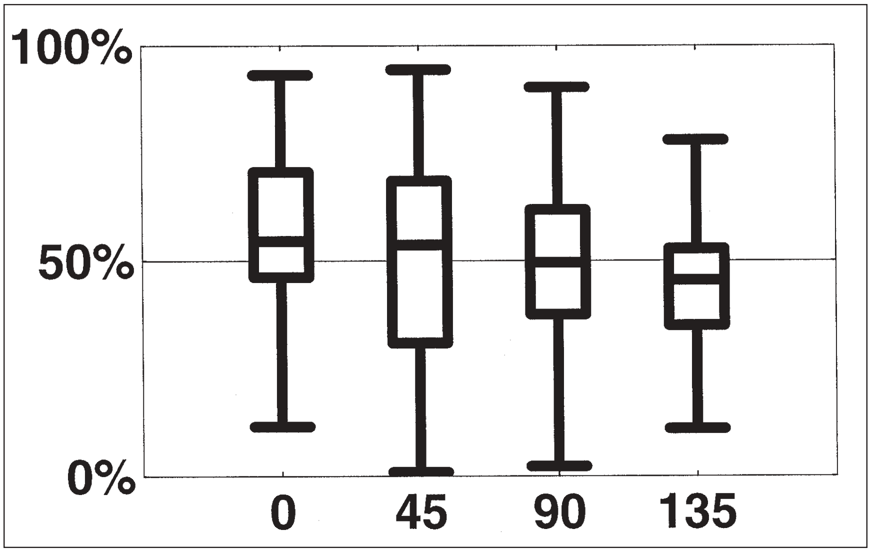


Figure 2. This figure presents box plots showing the percentage of weight (the ordinate) to one side of the vertical (0), horizontal (90) and diagonal (45 and 135) axes (the abscissa) for the set of 32 triangle designs constructed within the circular format. The explanation of how to read the figure is contained in the text.

within the circular format. Each plot depicts the quartile values of the weight distribution about an axis. The box ranges from the first to the third quartile (25 percent and 75 percent percentiles); the line in its center indicates the second quartile or median; the lines extending from the box indicate the minimum and maximum values for the distribution. Distributions are shown for the areas to the right of the vertical (0°) axis; above and right of the diagonal (45°) from top-left to bottom-right; above the horizontal (90°) axis, and above and left of the diagonal (135°) from bottom-left to top-right of the pictorial field.

As an example of how to read Figure 2, consider the bottom line in the first plot of the figure. This data point indicates that there was one participant who, in his completed triangle composition within the circular format, positioned 18 percent of the mass associated with the 12 structural elements to the right of the vertical axis of the pictorial field and the remaining 82 percent in the left side of the field. The opposite situation is reflected by the uppermost line in the same column. This participant's final composition contained 95 percent versus 5 percent of its structural weight to the right and left of the vertical axis, respectively. The box indicates that 50 percent of the designs had between 47 percent and 68 percent of their structural weight to the right of the vertical axis.

Weight distributions about the four principal axes across construction time intervals for each of four individual designs shown in Figure 1 can be found in Table 1. Figure 3 depicts the distributions of weight about the four axes of the 32 designs completed for each of the four format/shape conditions at each of the five construction time intervals. (Each plot in Figure 3 is to be read like the one in Figure 2.) What is apparent when one examines Table 1 and Figure 3 is that there was a bit more variability in weight distributions about all axes as participants added elements to their designs at the initial stage of construction (viz., completion time intervals 20 percent and 40 percent). This variability decreased once all 12 shapes were in the pictorial field and participants began to rearrange the full set of shapes into their completed designs. As seen in Figure 3, once completed, the compositions' structural weight distributions about the four axes, regardless of format or element type, were fairly evenly distributed about 50 percent the value for a perfectly balanced design.

To determine if there were any differences in weight distribution in the completed designs as a function of component type and pictorial field format, a 2 (format) × 2 (element shape) × 4 (shape type) × 4 (axis orientation) analysis of variance (ANOVA) with factors format, element shape, and axis orientation treated as within-subjects variables and shape type nested within element shape, was performed on the weight distribution data. The analysis produced only one significant effect, namely, that for the four-way interaction, $F(9,434) = 2.36$, $p < .05$. Examination of the data set revealed that this highest-order interaction reflects individual subject variability, especially for the circle format-triangle shape condition, as can be seen in Figure 3.

Location of the Balancing Centers Within the Pictorial Field

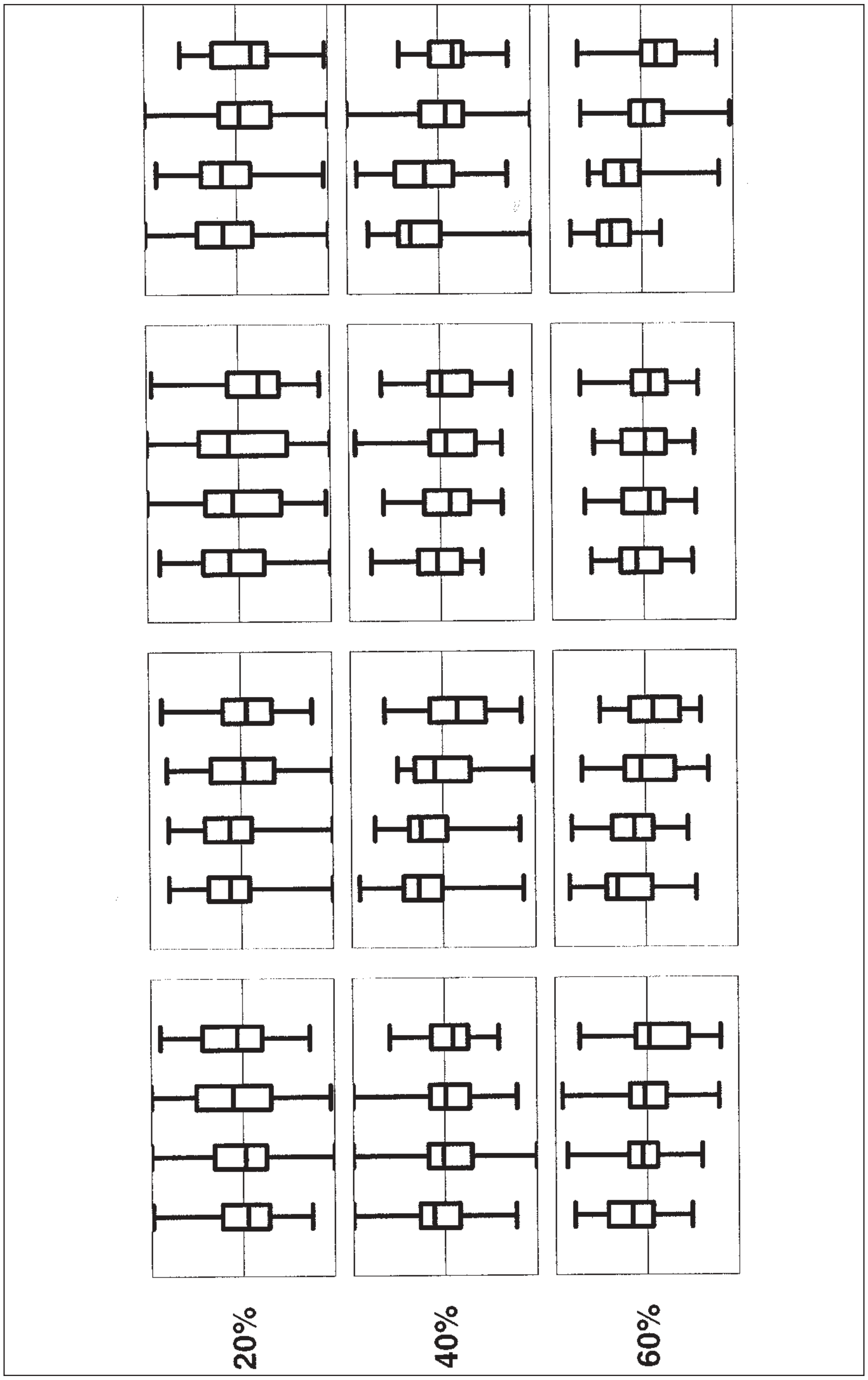
The structural balancing center of a pictorial field is located at that point within a display about which there is an equal distribution of the physical weight associated with its components. We calculated the coordinates within the pictorial field of the structural balancing centers of the four designs created by each participant at each of the five consecutive construction intervals mentioned earlier. The balancing center of a design was defined as the point within the design about which there is an equal distribution of weight associated with its 12 elements. Stated another way, it is the "center of gravity" of black space created by the elements.

Figure 4 presents the shift in the structural balancing center of each design within the pictorial field as it was completed by its artist; separate illustrations are included in the figure for triangular and quadrilateral shapes created within the circular and rectangular formats. The five data points used to generate each line are the balancing centers of one design at each of the five construction time intervals. What is apparent when one examines Figure 4 is that the balancing centers of the designs appear to be closely aligned with the geometric centers of the pictorial

Table 1. Balance Center Locations and Weight Distributions about the Pictorial Field Axes at Five Construction Time Intervals for the Four Designs Shown in Figure 1

	Construction time intervals				
	20%	40%	60%	80%	100%
	Circular format — scalene triangles				
BC	2.26–+	2.08– –	1.54–+	2.01–+	1.91–+
W-V	34%	41%	45%	44%	45%
W-H	47%	46%	48%	57%	55%
W-RD	66%	63%	64%	65%	65%
W-LD	34%	35%	41%	41%	41%
	Circular format — parallelograms				
BC	1.89– –	0.62–+	0.60– –	0.56–+	0.57–+
W-V	32%	40%	41%	41%	40%
W-H	34%	49%	44%	46%	47%
W-RD	52%	59%	54%	56%	56%
W-LD	45%	52%	48%	50%	51%
	Rectangular format — scalene triangles				
BC	3.65–+	2.11–+	2.39–+	2.78–+	2.81–+
W-V	21%	37%	29%	34%	33%
W-H	67%	59%	51%	61%	61%
W-RD	72%	67%	67%	71%	69%
W-LD	53%	42%	36%	44%	46%
	Rectangular format — irregular quadrilaterals				
BC	2.96–+	1.63– –	0.97–+	1.73–+	1.39–+
W-V	36%	42%	47%	49%	47%
W-H	48%	43%	42%	47%	42%
W-RD	66%	44%	50%	65%	59%
W-LD	48%	40%	39%	46%	41%

Note: BC = Distance (cm) of the balancing center from the physical center, the plus and minus signs following each value indicate the design quadrant in which the balancing center is located (upper-right, + +; lower right, + –; upper-left, – +; lower left, – –); W-V, W-H, W-RD, W-LD = percent of structural weight to the right of the vertical axis, above the horizontal axis, to the right of the diagonal axis clockwise from vertical, and above the diagonal axis counterclockwise from vertical, respectively.


20%
40%
60%

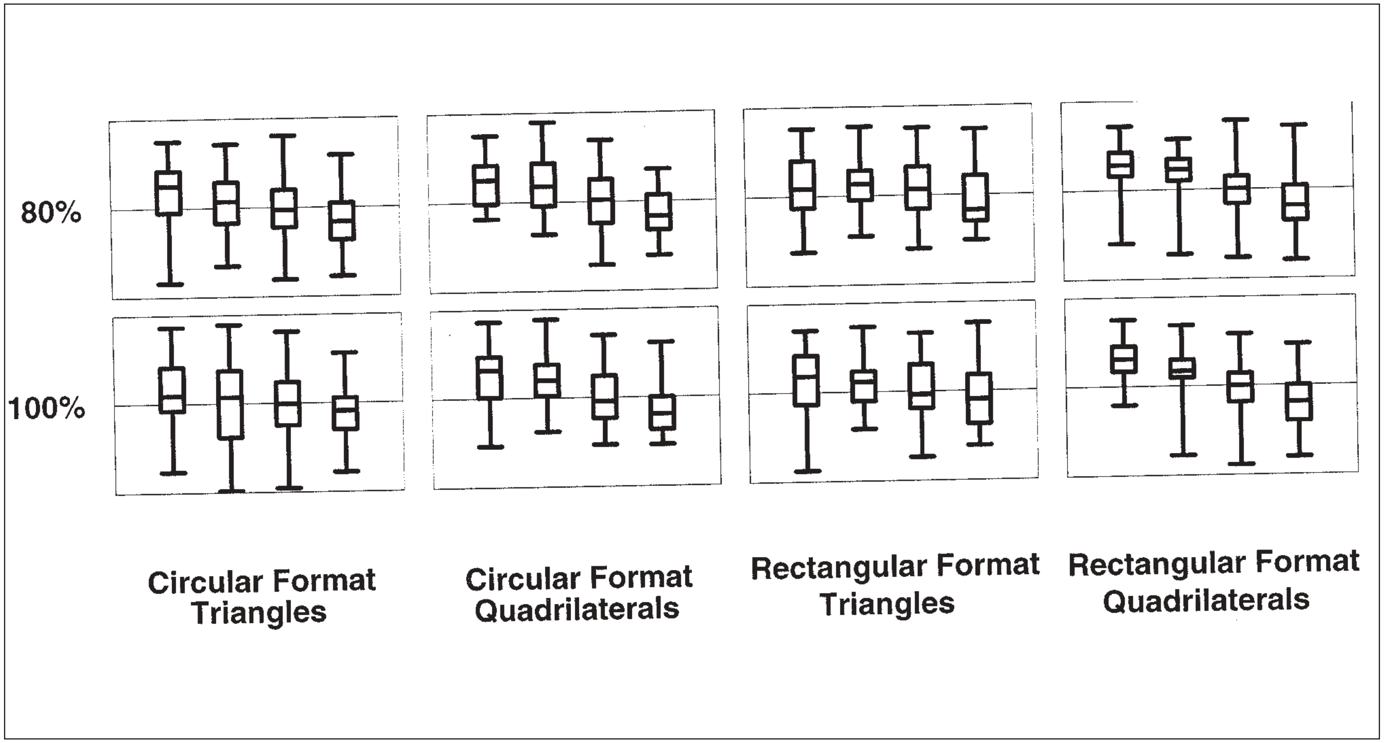
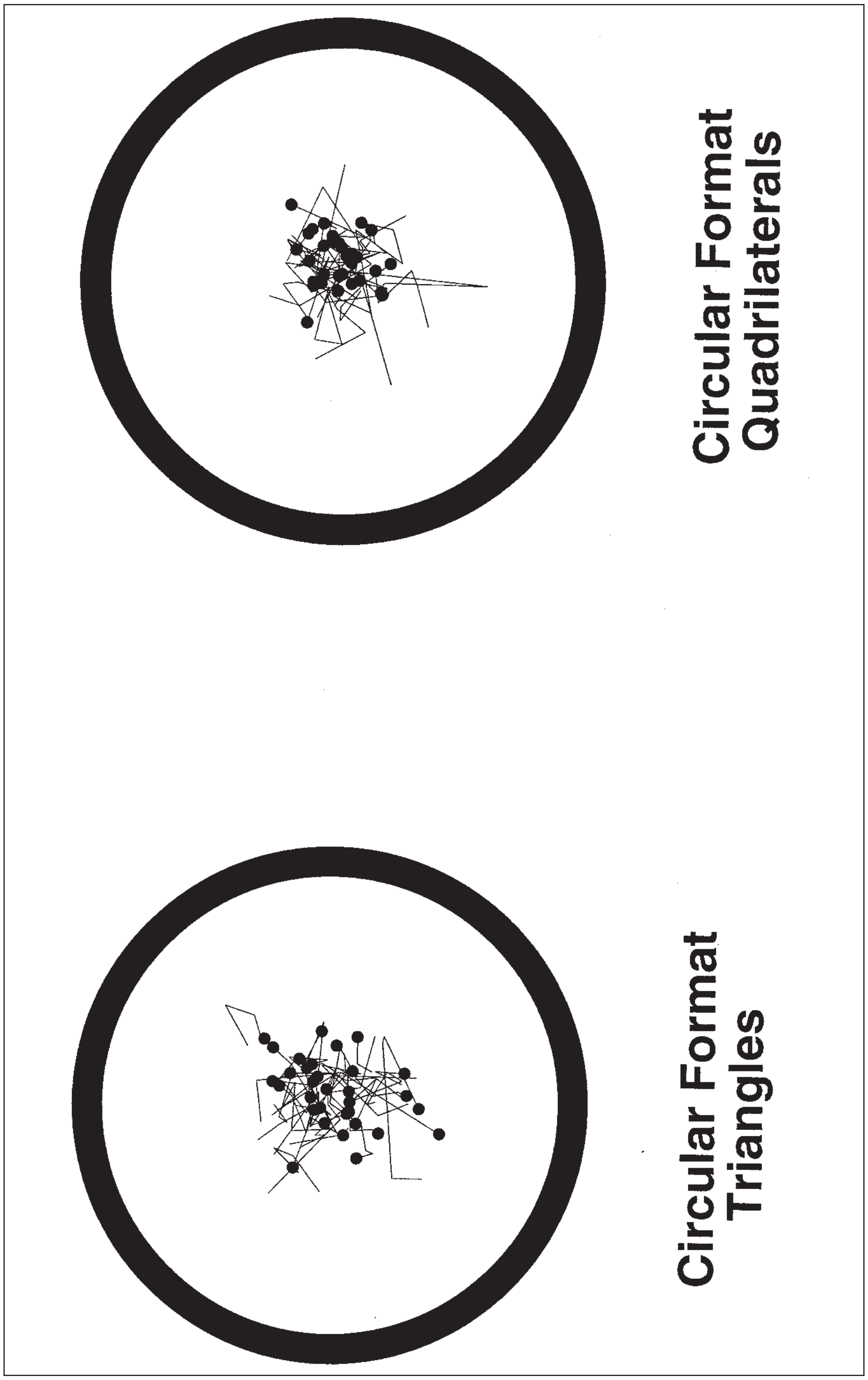


Figure 3. The figure depicts the distributions of weight about the four axes of the 32 designs completed for each of the four format/shape conditions (the abscissa) at each of five construction time intervals (the ordinate). Each plot in Figure 3 is to be read like the one in Figure 2.


Circular Format
Quadrilaterals
Circular Format
Triangles

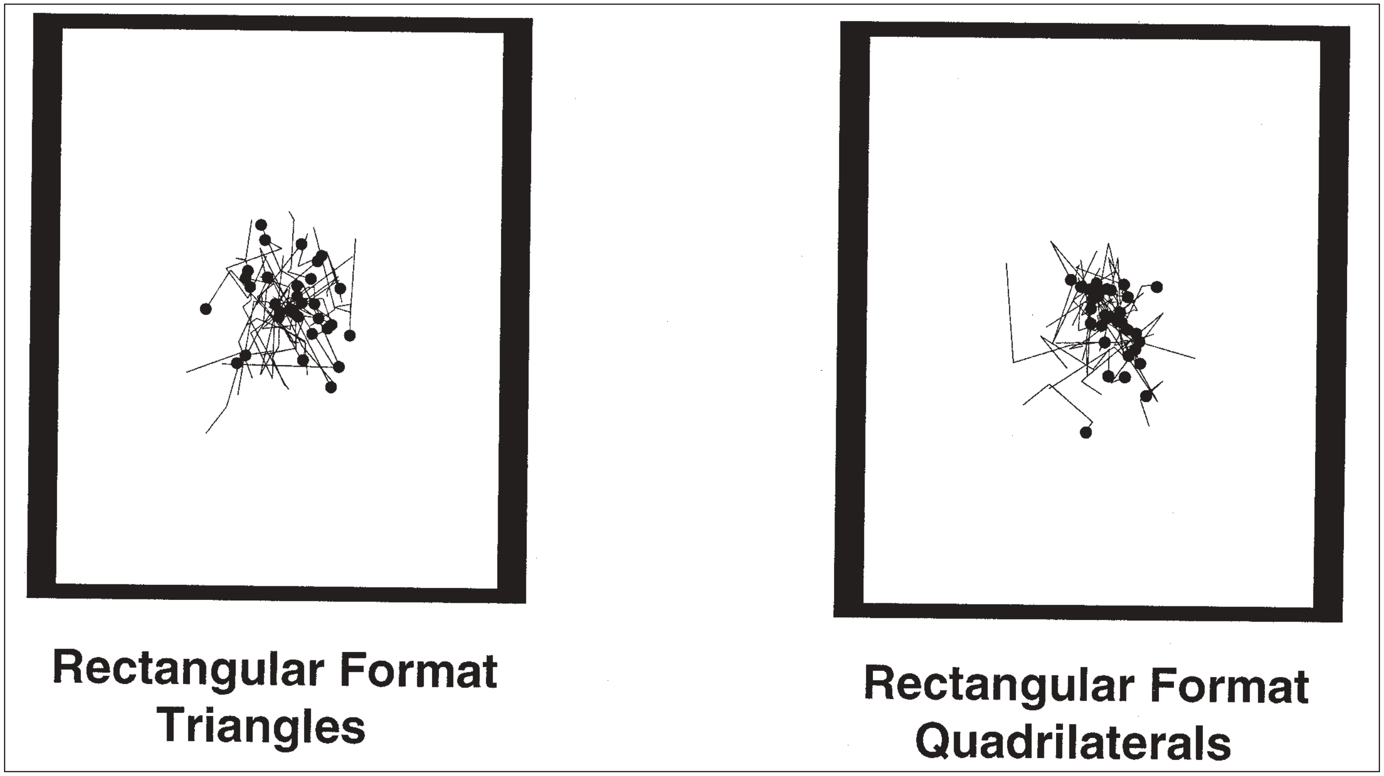


Figure 4. This figure presents the shift in the structural balancing center of the quadrilateral and triangle designs within the circular and rectangular formats as they were completed. The five data points used to generate each line are the balancing centers of one design calculated at each of the five construction time intervals. The black dots represent the balancing centers of the 32 completed designs.

fields regardless of format, component type, or phase of construction (see also the balance center data presented in Table 1). To assess quantitatively the apparent "compactness" of the balancing centers seen in Figure 4, we measured the distance (ignoring direction) between the balancing and physical centers of each design. On average, the distances (in centimeters) between the physical and balance centers for the circular format quadrilateral and triangular designs and the rectangular format quadrilateral and rectangular designs were 1.55, 2.09, 1.96, and 1.94 (*SE*s = .29, .50, .34, and .33), respectively. Given that the diameter of the circular field is 38 cm and the rectangular field measured 30 cm × 38 cm, we do not consider the relatively small differences in distance between the balancing centers and the physical centers of the designs in each of the four distributions shown in Figure 4 to be meaningful. Furthermore, a 2 (format) × 2 (element type) × 4 (shape type) × 2 (completion time; 60 percent—the time at which all elements were incorporated into the designs—and 100 percent) nested ANOVA similar to the one performed on the weight distribution data applied to the distance data produced no significant main or interaction effects. Thus, balancing centers were located very near the middle of the perceptual field for all compositional elements studied and within both formats, as can be seen in Figure 4. This finding was not unexpected given that the structural weight of the set of designs was fairly evenly distributed on either side of the principal axes of both circular and rectangular fields (see Figure 3). Clearly the physical center of both formats functioned as a powerful anchor point about which participants organized a design's structural skeleton.

DISCUSSION

It was found that, regardless of element type, format, or phase of construction, the center of a design was closely aligned with the geometric center of the pictorial field and that the structural weight of the compositional elements was evenly distributed (balanced) about the principal axes of the designs. These findings are similar to those of our earlier study (Locher et al., 1998) in which non-artists created designs within a square format using circles, squares, rectangles, or leaves. As was the case for artists in the present study, Locher et al. observed that the balance centers of the non-artists' designs were closely aligned with the geometric centers of the pictorial field and the designs' structural weight was evenly distributed about their axes.

Taken together, results of the two studies provide strong empirical support for the assertion made by Arnheim (1988), and many other art theorists (e.g., Bouleau, 1980: Taylor, 1964,) that the physical center of a pictorial field "is also the center of the composition, in the sense that all the weight of shapes and colors arranged by the painter balance around the middle" (p. 66). According to this view, the geometric center of a pictorial field functions as an "anchor" or balancing point about which an artist should organize a composition's structural skeleton in a balanced manner if he/she wishes the work to convey its meaning or statement definitively. As Arnheim notes, a circular format provides strong support for the centricity of a composition and accentuates what is going on in the middle. With respect to square and rectangular formats, he asserts that such a format "establishes its own center simply through the dynamic interaction of its four sides—a center based on visual equilibrium but roughly coinciding with the geometric center" (p. 66).

REFERENCES

Arnheim, R. (1974). *Art and visual perception.* Berkeley, CA: University of California Press.

Arnheim, R. (1988). *The power of the center.* Berkeley, CA: University of California Press.

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

Davi, M., & Profitt, D. (1993). Frames of reference and distinctive figural characteristics affect shape perception. *Journal of Experimental Psychology: Human Perception and Performance, 19,* 867-877.

Kandinsky, V. (1979). *Point and line to plane.* (Dearstyne, H. Rebay, Trans.), New York: Dover (original work published 1926).

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

Palmer, S. E. (1980). What makes triangles point: Local and global effects in configurations of ambiguous triangles. *Cognitive Psychology, 12,* 285-305.

Taylor, J. (1964). *Design and expression in the visual arts.* New York: Dover.

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