Spatial Vision, Vol. 21, No. 3–5, pp. 421–449 (2008)

Also available online - www.brill.nl/sv

Aesthetic issues in spatial composition: effects of position and direction on framing single objects

STEPHEN E. PALMER *, JONATHAN S. GARDNER
and THOMAS D. WICKENS

University of California, Berkeley, CA 94720-1650, USA

Received 23 June 2006; accepted 15 March 2007

Abstract—Artists who work in two-dimensional visual media regularly face the problem of how to compose their subjects in aesthetically pleasing ways within a surrounding rectangular frame. We performed psychophysical investigations of viewers' aesthetic preferences for the position and facing direction of single, directed objects (e.g. people, cars, teapots and flowers) within such rectangular frames. Preferences were measured using two-alternative forced-choice preference judgments, the method of adjustment, and free choice in taking photographs. In front-facing conditions, preference was greatest for pictures whose subject was located at or near the center of the frame and decreased monotonically and symmetrically with distance from the center (the center bias). In the left- or right-facing conditions, there was an additional preference for objects to face into rather than out of the frame (the inward bias). Similar biases were evident using a method of adjustment, in which participants positioned objects along a horizontal axis, and in free choice photographs, in which participants were asked to take 'the most aesthetically pleasing picture' they could of everyday objects. The results are discussed as affirming the power of the center and facing direction in the aesthetic biases viewers bring to their appreciation of framed works of visual art (e.g. Alexander, 2002; Arnheim, 1988).

Keywords: Aesthetic preference; spatial composition; rectangular frame; center bias; inward bias.

INTRODUCTION

Painters, photographers, graphic designers, and other visual artists who work in two-dimensional media continually face the problem of how to frame the subjects of their creations in aesthetically pleasing ways. The general issue is one of spatial composition: How should the to-be-depicted object(s) be situated within a rectangular frame so that the average viewer has the most aesthetically pleasing experience on viewing the result? (see Note 1). Although there is no

*To whom correspondence should be addressed. E-mail: palmer@cogsci.berkeley.edu

shortage of opinions about such matters — searching *amazon.com* for books on artistic composition yields literally dozens of contemporary treatments — there is surprisingly little empirical evidence about what factors matter and what effects they have. The present article reports an initial scientific exploration into two fundamental aspects of spatial composition: the position and facing direction of a single object within a rectangular frame.

Although the aesthetic principles we describe here are clearly related to some of those advocated by various scholars and teachers of art, they are also different in an important respect: Our proposals are purely descriptive, empirical generalizations based on measured preferences of an educated subset of the general population (namely, young college students). Most other sources of aesthetic principles are decidedly more ambitious, either attempting to formulate what viewers *should* prefer (a normative or prescriptive approach) or attempting to reveal hidden principles that underlie aesthetic success in a body of acknowledged work. There are many treatises of both sorts, a review of which is beyond the scope of this article.

Of the many factors discussed as relevant to the aesthetics of spatial composition, perhaps the most important is the concept of 'center'. Rudolf Arnheim's classic 1988 book on spatial composition is even entitled, *The Power of the Center*, and other authoritative treatments of aesthetic structure likewise emphasize its importance (e.g. Alexander, 2002). Many 'centers' are relevant to the spatial composition of an aesthetic object, the most important of which, of course, is the center of the frame itself. Also important are the centers of each object within that frame, the centers of various groups of related objects within the frame, and even the center of the viewer. Arnheim (1988), Alexander (2002), and others discuss the relationships among these centers in considerable detail, and generally note that whatever is placed at the center of the frame receives greatest visual importance, be it a single object or a group of two or more related objects. Crucially, the center holds the stability and balance of a composition and "reaches as far as the condition of balanced stability holds" (Arnheim, 1988). That is, the *perceptual* center need not occupy the precise *geometric* center of the frame, but can vary in shape and size as the objects and spatial composition of the scene vary. We note that the same can be said of the center of a given object or group of objects, which may not be at the precise geometric or gravitational center of that object.

Interestingly, this emphasis on the aesthetic importance of the center is somewhat at odds with much of the empirical work on aesthetic preferences due to spatial composition, which tends to emphasize asymmetries in off-center compositions. The genesis of this line of research appears to be an early claim by Wölfflin (1928), as reported in Gaffron (1950), that aesthetically pleasing paintings generally have their principle figure or major area of interest located distinctly to the *right* of the physical center of the picture. Wölfflin and Gaffron suggest that this effect arises because people tend to scan pictures in an arc from lower left to upper right, so that content right of center is perceptually emphasized and therefore more salient. Although their claims were purely phenomenological, subsequent empirical work lends some credence to the hypothesis that participants tend to prefer major content to be toward the right side of complex pictures. These experiments typically investigate which of two complex photographs, paintings, or drawings people prefer between exact mirror-reflections of each other (e.g. Levy, 1976; McLaughlin, 1986; McLaughlin *et al.*, 1983; Nachson *et al.*, 1999). The results show that there is a relatively small but consistent preference for the version of the picture whose more significant content is on the right side, as Wölfflin (1928) suggested. The effect is not universal, however, being more pronounced for right-handed participants and even reversing somewhat for left-handers (Levy, 1976; McLaughlin, 1986). This finding has been interpreted as reflecting asymmetries in visual processing by the left *versus* right cerebral hemispheres (Levy, 1976), but more recent research has examined cultural influences due to reading directions, reminiscent of Wölfflin (1928) and Graffon's (1950) scanning direction hypothesis. A cross-cultural study of the asymmetry effect in picture preference found that viewers who read left-to-right (Russian) showed a right-side bias, whereas those who read right-to-left (Hebrew and Arabic) showed a left-side bias (Nachson *et al.*, 1999).

Despite such findings emphasizing the importance of asymmetries in positional effects, there is also some empirical work that relates to the importance of the center of a rectangular frame. Tyler (1998a, 1998b), for example, discovered a strong, sharply peaked bias along the vertical midline of the frame in the placement of one of the two eyes in non-profile portraits of human faces. He found this central bias to be much more pronounced for the eye than for the face as a whole, the mouth, or even the single eye in profile portraits. This finding, although surprising, does not itself lend strong support to the aesthetic relevance of the center so much as it *presupposes* the importance of the center and uses it to support the special relevance of the eye (as opposed to the mouth or the whole face) to an aesthetically successful portrait.

A less obviously relevant finding that nevertheless provides clear support for the salience of the center of a rectangular frame was reported by Palmer (1991) in a series of studies on symmetry. Participants were asked to rate the 'goodness of fit' between a single small circular probe figure and a surrounding rectangular frame when the circle was located at one of 35 equally spaced positions inside a 5×7 rectangle. Participants' average fit ratings are represented in Fig. 1 by the diameter of the circles located at the corresponding position within the frame. By far the highest ratings occurred when the circle was located at the center of the rectangle, where the rectangular frame is globally symmetric by reflection about both its vertical and horizontal axes. Indeed, the pattern of goodness ratings seems to be driven almost exclusively by symmetry structure. The next-highest ratings occurred when the probe circle lay on a single global axis of symmetry, with locations on the vertical axis being rated higher than those on the horizontal axis, consistent with the greater salience of vertical than horizontal symmetry (e.g. Palmer and Hemenway, 1978). Next highest were goodness ratings of locations along extended local axes of symmetry (the angle bisectors), with the lowest ratings

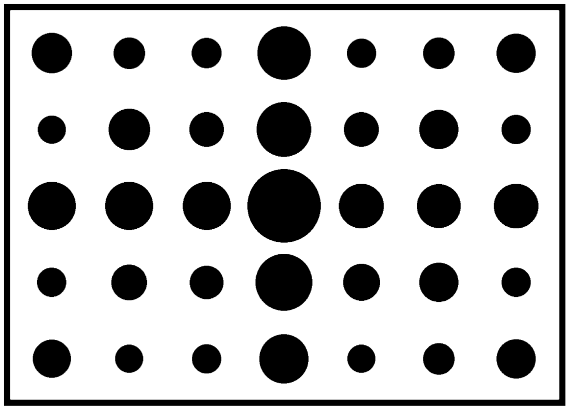

Figure 1. Goodness ratings of positions within a rectangular frame. Participants rated images of a single small circle at each of these 35 locations within a rectangle. The diameters of the circles depicted are proportional to the average 'goodness' rating on a 1–7 scale. The central, most symmetrical location was by far the 'best' position for the circle, with ratings diminishing for lesser degrees of symmetry. (The size of the presented circles was about the same as the smallest circles shown here.)

of all occurring when the circle lay on essentially no axis of symmetry at all. Similar results were obtained when a small circle was located at analogous positions within a trapezoidal shape, including the fact that the highest ratings occurred at the center. Although the relationship between these ratings of 'goodness of fit' and explicit judgments of aesthetic preference is not entirely obvious *a priori*, it is at least reasonable to suppose that 'better' fit relations between an object and its surrounding frame would tend to produce a more positive aesthetic responses than 'poorer' fit relations.

The research we report below is a series of four studies designed to understand some of the principles that underlie aesthetic response to two important variables in spatial composition: the horizontal *position* and *facing direction* of a single meaningful object relative to a surrounding rectangular frame (see Note 2). Experiments 1 and 2 illustrate the primary method we use to investigate such compositional issues: two-alternative forced choices (2AFC) of aesthetic preference. Participants are shown two pictures that differ only in the spatial framing variable(s) of interest and are asked to indicate which picture they prefer aesthetically. In this way all other differences are neutralized — particularly aesthetic response to the object(s) depicted — isolating the effects of compositional variables. We augmented these precise 2AFC measures with other tasks allowing greater freedom of choice, such as the method of constrained adjustment in Experiment 3 and free-choice in framing photographs in Experiment 4. The latter tasks are important in determining whether the effects obtained in the 2AFC paradigm generalize to more realistic, open-ended situations. Because all of our measures are specifically designed to eliminate the effects of content, our research strategy differs radically from, but is complimentary to, research aimed at determining what perceptual content participants find pleasing (e.g. Biederman and Vessel, 2006). Both kinds of research are clearly necessary to understand why people prefer the pictures they do.

EXPERIMENT 1: POSITION AND DIRECTION OF MOVING *VERSUS* FACING OBJECTS

The first experiment was an exploratory study aimed at finding out whether a psychophysical approach to studying the aesthetics of spatial framing was even viable. Jaded by the old adage 'there's no accounting for taste', we were initially concerned that huge individual differences might swamp any systematic effects. This did not turn out to be a problem, because the results were both orderly and robust.

Starting from first principles rather than tried-and-true heuristics, such as the *rule-of-thirds* (see Note 3), we examined two variables of obvious interest: the location of a single object and the direction in which it faces (if it has a perceptual front) relative to a surrounding rectangular frame. We studied the effects of these variables on preferences for the composition of pictures depicting directed objects of two kinds: objects that move in a particular direction and those that merely face in a particular direction (see Fig. 2). The 'moving' objects were chosen to be representative of objects that typically move horizontally toward their front: a man, woman, car, boat and cat. The 'merely facing' objects were typically stationary, but nevertheless have a well-defined, canonical front and back: a chair, teapot, flower, windmill and telescope. We thought that moving objects might exhibit a stronger directional bias because participants might expect the corresponding real object's motion to take it to or toward the center of the frame, whereas the merely-facing objects would not. We operationally defined the 'location' of an object as the location of its central point (midway between its left and right extremities) relative to the center of the frame, and we defined 'facing into the frame' to mean that the direction the object faces (i.e. the direction from the object's center to its front) is the same as the direction from the object's center to the frame's center (see Note 4).

We used a rectangular frame with a 4:3 aspect ratio — the same as a standard television screen — and placed objects at three locations along the horizontal midline: in the geometric center of the frame and at its quarter points, as illustrated by the dashed lines in Fig. 2. We studied front views of the same objects, which were roughly symmetrical and thus not laterally directed, to get a measurement of positional preferences unaffected by directional preferences. We expected the results to show a *center bias*: i.e. that participants' preferences would be strongly peaked at the center and approximately symmetrical, although in light of the previous research reviewed above, they might be somewhat skewed toward the right side. We also studied left- and right-facing views, which we expected to show both an approximately symmetrical center bias and a strongly asymmetrical *inward bias*: i.e. that participants would prefer pictures in which the object faces into, rather than out of, the frame. To avoid complications arising from possible preferences for

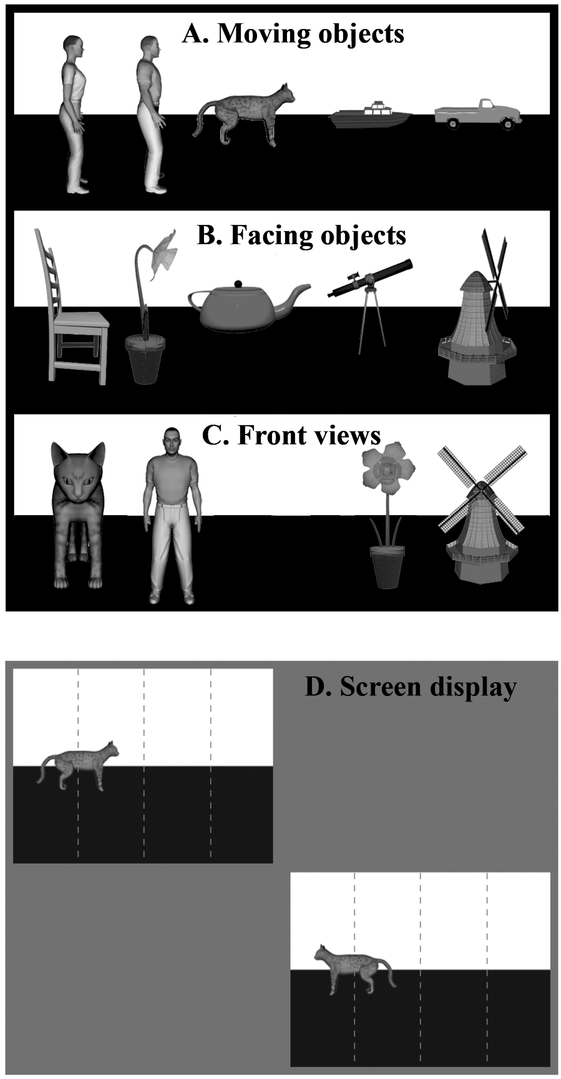

Figure 2. Display construction in Experiment 1. Ten objects — five moving objects (A) and five stationary, facing objects (B) — were rendered in right-facing (C), left-facing (not shown), and front-facing poses (C) relative to the viewer. They were presented in framed pictures at each of the three positions shown by the dashed lines in panel D (not present in the actual displays) against a black floor and a white wall. Two such displays of the same object were presented on each trial in the diagonal arrangement shown in panel D, and participants were asked to indicate which one they preferred aesthetically.

front- *versus* side-facing views, the 2AFC pairs always contained the same view of the same object, with front views paired only with other front views and side views paired only with other side views.

Method

Participants. All nine participants were students at the University of California, Berkeley, who received partial course credit in their undergraduate psychology course. Their mean age was approximately 19 years. All were naïve to the purpose and nature of the experiment and gave informed consent in accord with the policies of the University of California, Berkeley, Committee for the Protection of Human Subjects, which approved the experimental protocol.

Design. There were 60 paired comparisons of front-view images, resulting from the orthogonal combination of 10 objects (5 moving and 5 facing objects) and 6 image pairs defined by the permutations of 3 frame positions taken 2 at a time. There were also 300 paired comparisons of side-view images, resulting from the orthogonal combination of the same 10 objects and 30 image pairs defined by the permutations of 6 frame positions and directions taken 2 at a time. The screen locations of the two images in each trial were always upper-left and lower-right to reduce possible alignment effects and were counterbalanced by the just-described design of image pairs. The order of the trials was randomized by Presentation software (see http://www.neurobs.com) that controlled the experiment.

Displays. The three frame locations were defined by the geometry of the frame: the points at which the left quarter-line, the vertical midline and the right quarter-line intersected the horizontal midline of the rectangle. The centers of the objects were defined as the central point horizontally between the most extreme points at the left and right sides of the object.

Each screen consisted of two grayscale images of an object on a black ground plane against a white background, with the horizon placed along the horizontal midline of the frame. One image was located in the upper-left corner of the computer screen and the other was in the lower-right corner so that the images were not aligned on either the horizontal or vertical dimension (see Fig. 2). Each image was separated from the edges of the screen by approximately 0.75 cm, and placed on a neutral gray background, as shown in Fig. 2. Objects were modeled and rendered using Poser 6 software, and the resulting images and screens were constructed using Adobe Photoshop CS2. The display was 18″ diagonally and the resolution was 640×480 at a refresh rate of 85 Hz.

Procedure. Participants viewed the computer screen from approximately 60 cm. They were instructed to look at each screen and to press a button (left or right) indicating which image they preferred. They proceeded at their own pace and were given the opportunity to take a short break after every 60 trials.

Results and discussion

We scored participants' responses for the probability with which they chose each picture in each of the 36 2AFC pairs of pictures for each object (i.e. the 6

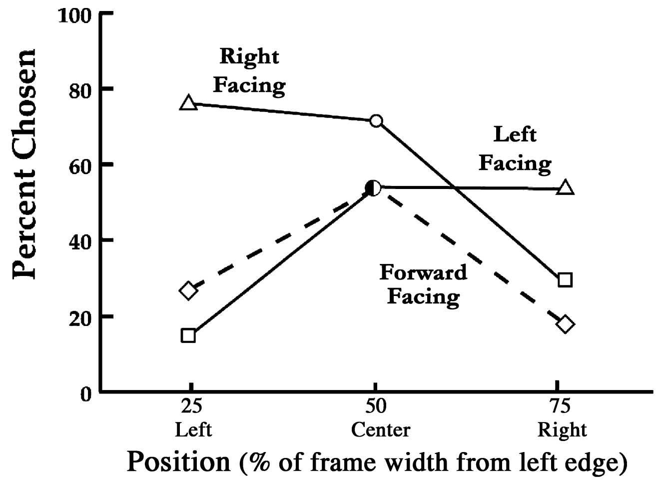

Figure 3. Results of Experiment 1. The average percentage of times that the given image was preferred over all possible comparisons is plotted as a function of the position of the object's center for left-, right- and center-facing views.

pairs of center-facing views and the 30 pairs of side-facing views). To create a composite measure of the aesthetic response to each picture, we then computed the average probability of choosing that picture across all of its pair-wise comparisons. The resulting probabilities, averaged over participants and objects, are plotted in Fig. 3 as a function of object location for the center-, right- and left-facing objects. Because of concern about statistical assumptions for probabilities, we also analysed the choice by computing Bradley–Terry–Luce (BTL) scale values from the 2AFC data for each participant (Bradley and Terry, 1952; Luce, 1959) (see Note 5). Unsurprisingly, these values were very highly correlated with the probability data ($r = 0.96$), but they allowed us to use a somewhat more cautious statistical analysis. The results of analyses of variance based on the BTL scaled data are reported below in square brackets following those based on the probability data.

The overall within-participants analyses of variance showed main effects of position ($F(2, 16) = 10.36$ [4.35], $p < 0.01$ [0.03]), facing condition ($F(2, 16) = 33.62$ [5.94], $p < 0.001$ [0.01]), and their interaction ($F(4, 32) = 25.16$ [3.98], $p < 0.001$ [0.01]). The center-facing views, which were only compared with other center-facing views of the same object, show a strong, symmetrical preference for the center position, which was chosen more frequently than either the left-side or right-side positions ($F(1, 8) = 11.99$, $p < 0.01$), which did not differ reliably from each other ($F(1, 8) = 2.33$, $p > 0.10$). Notice that this finding for symmetrical, forward-facing objects is unlikely to be consistent with the predictions of the *rule of thirds*, which implies that the optimal position should not be at the center. (A stronger test of this conclusion is presented in Experiment 3, where participants are allowed to place the object wherever they want along the horizontally-oriented midline.)

The left-facing and right-facing conditions produced a dramatically different and highly asymmetrical pattern of results, however. The central position (plotted as circles in Fig. 3) was strongly preferred to the side position for which the object faced out of the frame (plotted as squares in Fig. 3) for both the left- and right-facing views ($F(1, 8) = 56.87, 71.33$, respectively, $p < 0.001$). However, the center did not differ from the side position at which the object faced into the frame (plotted as triangles in Fig. 3) ($F < 1$, in both cases). The two lateral positions differed significantly as well, with the view facing into the frame (triangles) being strongly preferred over the view facing out of the frame (squares) for both the left- and the right-facing objects ($F(1, 8) = 37.86, 22.72$, respectively, $p < 0.001$). This pattern appears to be somewhat consistent with the *rule of thirds* in that positioning the subject at one of the off-center positions produces a positive aesthetic response that is at least equal to that in the center. Closer consideration reveals, however, that the data provide an important further constraint on the rule: off-center positions produce a good aesthetic effect only when the object faces *into* the frame, a caveat that is seldom, if ever, mentioned in connection with the rule of thirds. The pattern of results is thus consistent with both of the initially hypothesized preferences — a strong center bias and a strong inward bias — but is generally inconsistent with the rule of thirds. Experiment 2 provides more definitive data concerning the rule of thirds by examining more positions between the quarter-line and mid-line positions studied in the present experiment, including ones that are precisely at the one-third and two-third lines.

The results also show a fairly clear preference for right-facing objects over left-facing ones. The rightward bias can be seen by comparing the corresponding conditions in Fig. 3 for the side-facing conditions: The right-facing probability is greater than the left-facing probability at all three positions: the center position (circles), the inward facing position (triangles), and the outward facing position (squares) ($F(1, 8) = 11.46, 62.53, 7.10$, $p < 0.001, 0.001, 0.02$ respectively). We note that this rightward bias suggests a preference for the object facing in a direction consistent with the left-to-right reading direction in English (*cf.* Nachson *et al.*, 1999) and/or the bottom-left-to-top-right scan path hypothesized by Wölfflin (1928) and Gaffron (1950). It may also be related to hemispheric processing and handedness (*cf.* Levy, 1976; McLaughlin, 1985), but we do not yet have enough data from left-handers to examine this possibility.

There was, by definition, no main effect due to moving objects *versus* facing objects, because all comparisons were within-object. There was a marginal interaction between object type and facing condition ($F(2, 16) = 3.83$, $p < 0.05$), but it has no obvious interpretation: People slightly preferred the moving objects to face leftward and the merely-facing objects to face rightward in the side-view conditions. It is unclear why this might occur. The three-way interaction that would have indicated stronger facing effects for moving than facing objects was not present ($F < 1$). It therefore seems unlikely that either of the facing effects is related to participants' expectations that the object is about to or could move in the direction it faces. The pattern of results shown in Fig. 3 thus appears to be robust with respect to moving *versus* merely-facing objects.

There are at least two plausible explanations of the inward bias we found in this experiment, which we will discuss as the 'directional consistency' and 'front position' hypotheses. The directional consistency hypothesis is that people prefer the intrinsic directedness of the object (i.e. from its center to its front) to be consistent with the direction from the object to the center of the frame (i.e. from the object's center to the frame's center). By this account, people prefer facing objects to be directed so that their front is in the same direction relative to the object-center as the frame-center is. An alternative hypothesis can be formulated in terms of the position of the object's front: People may simply prefer the front of the object to be located as near the center of the frame as possible (i.e. there may simply be a center bias for the object's front rather than its center). This possibility is consistent with the inward bias we obtained because, for any non-centered position, the front of the object will be closer to the frame-center when it faces into the frame than when it faces out of the frame (see Note 6). The present data cannot discriminate between these two possibilities, but Experiment 2 provides a test that does.

EXPERIMENT 2: POSITION AND DIRECTION OF OBJECTS WITH DIFFERENT ASPECT RATIOS

In the second experiment, we examined more closely people's aesthetic preferences due to the interaction between position and direction. We increased the spatial resolution by using seven equally spaced locations within the range covered in Experiment 1, such that the centers of the objects were located 25, 33.3, 41.6, 50, 58.3, 66.7 and 75 percent of the frame width from the left edge of the frame, and looked at possible shape-based directional effects by varying the aspect ratios of the objects depicted. We were particularly interested in whether the preference functions for left- and right-facing objects would continue to have their maxima at the center, or whether they might actually peak off-center on the side at which the object faces into the frame. The rule of thirds predicts that the maxima should occur precisely at the one-third and two-thirds lines. The quantitative nature of these functions also bears directly on the front position account of the inward bias because it predicts that people should prefer an off-center position when it places the object's front at the frame's center. (The directional consistency explanation does not necessarily make this prediction, although it is not incompatible with it.) Increasing the number of positions also allowed us to examine the precise shape of the preference functions in terms of the center bias, which should be a symmetrical, inverted U-shaped function that peaks at the central position, and the inward bias, which should appear as a monotonic function of position that increases toward the left side for right-facing objects and toward the right side for left-facing objects.

In addition, we varied the aspect ratio of the objects to see how this global shape parameter would affect the frame-relative facing effect. As illustrated in Fig. 4,

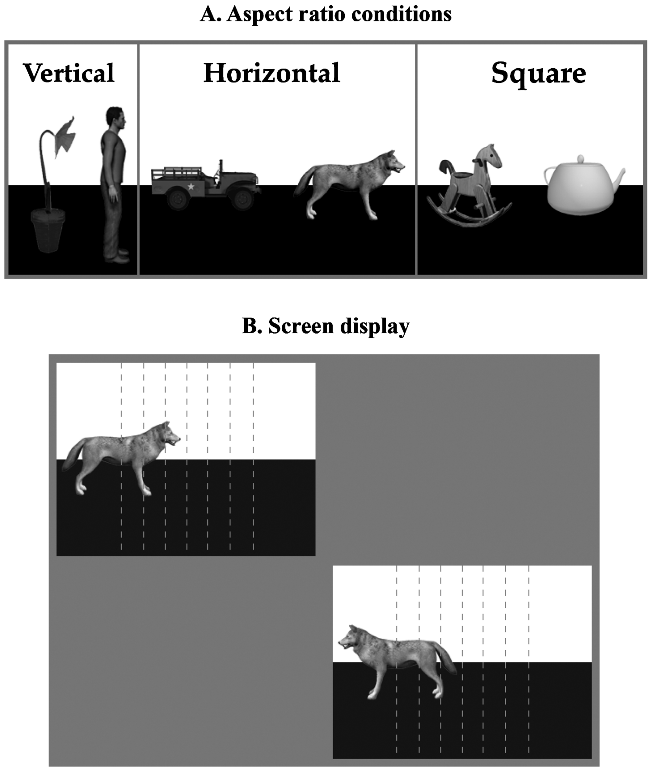

Figure 4. Display construction in Experiment 2. Six colored objects — two tall, thin, vertical objects, two short, wide, horizontal objects, and two approximately square objects (panel A) — were rendered in right-facing (shown) and left-facing (not shown) poses relative to the viewer. They were presented in framed pictures at each of the seven, equally spaced positions shown by the dashed lines in panel B (not present in the actual displays). Two such images of the same object were presented on each trial in the diagonal arrangement shown in panel B, and participants were asked to indicate which one they preferred aesthetically.

we included two tall, thin objects that were vertically oriented (a man and a flower), two objects that were about equal in height and width (a teapot and a rocking horse), and two short, wide objects that were horizontally oriented (a wolf and a jeep). The front position hypothesis predicts that the inward bias effect should be weakest for the tall, thin vertical objects (because the distance from frame center to the front of the object changes little when its facing direction is reversed), and strongest for the short, wide, horizontal ones (because the distance from frame center to the front of the object changes greatly when its facing direction is reversed).

In order to reduce the pairwise comparisons to a manageable number in the face of the four additional positions, we eliminated the forward-facing views and only compared each side-facing view at each position with (a) all other views that showed the same object facing in the same direction (the 'same-facing' comparisons) and

(b) the single view of the same object at the same position that faced in the opposite direction (the 'opposite-facing' comparisons), as indicated in Fig. 4.

Method

Participants. All but one of the 18 participants were students at the University of California, Berkeley, who received partial course credit in their undergraduate psychology course, and the remaining participant was a laboratory manager in the Psychology Department. Their mean age was 19.6 years. All participants were naïve to the purpose and nature of the experiment and gave informed consent in accord with the policies of the University of California, Berkeley, Committee for the Protection of Human Subjects, which approved the experimental protocol. The data from one participant were eliminated due to their failure to follow the instructions.

Design. The experiment consisted of 588 trials, defined by the 98 pairwise comparisons for each of the 6 objects. The 98 pairwise comparisons for each object consisted of the 14 pairs of opposite-facing comparisons at the same position, the 42 pairs of left-facing comparisons at different positions (the permutations of 7 positions taken 2 at a time), and the 42 pairs of right-facing comparisons at different positions. These pairs are counterbalanced for screen position because the permutations necessarily contain both spatial arrangements (i.e. with each picture appearing once in the upper left and once in the lower right positions).

Displays. The objects in the pictures of Experiment 2 were rendered in color using Poser 6 and Adobe Photoshop software, but were still placed in front of a black ground plane and white wall plane. The monitor measured 19″ diagonally, but the resolution and viewing distance were unchanged from Experiment 1.

Procedure. The procedure for Experiment 2 was identical to that in Experiment 1, except that participants were given a chance to take a break every 98 trials, resulting in 5 possible breaks during the experiment, rather than 6 as in Experiment 1.

Results and discussion

The results were computed, as in Experiment 1, using both average probabilities of aesthetic preference and Bradley–Terry–Luce scale values (see Note 5). Once again, the two measures were so strongly correlated ($r = 0.97$) that we used the BTL values only in the overall analyses of variance and the tests of linear and quadratic trends, for which the quantitative structure of the data is particularly important.

The data for the opposite-facing conditions, averaged over participants and objects, are plotted in Fig. 5 as a function of position for the left-facing and right-facing views. Because these data come from comparisons in which the global position of the object was the same in both pictures, if should reveal any

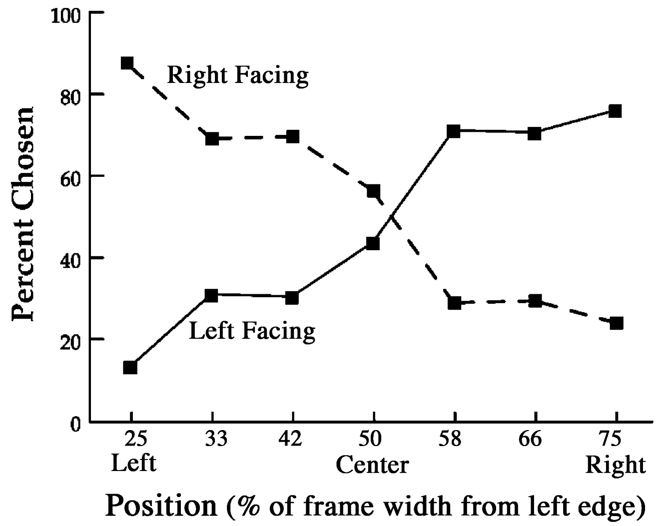

Figure 5. Results of Experiment 2 for opposite-facing conditions. The average percentage of times the given image was preferred over the same object at the same position but reflected about its geometric center is plotted as a function of the position of the object's center for left-facing and right-facing views. (Note that for each position, the two curves plotted here must sum to 1.0, because the participant was forced to choose one of the two views in each comparison. This fact explains the vertical symmetry of the two functions and dictates that only one function be analyzed statistically.)

directional component in relatively pure form. Indeed, there is a strong main effect of position ($F(6, 96) = 38.11$, $p < 0.001$) that increases dramatically and monotonically from left to right for the left-facing objects and from right to left for right-facing objects. Further analyses show that this function has a significant linear component ($F(1, 16) = 67.68$, $p < 0.001$) and no reliable quadratic component ($F(1, 16) = 1.39$, $p > 0.10$) (see Note 7). These results are thus entirely consistent with the hypothesized inward bias for objects to face into the frame. There is also a slight bias toward preferring right-facing objects, as can be seen at the central and outermost positions, but it is not statistically reliable ($F < 1$).

The data for the same-facing conditions were treated in the same way as the data in Experiment 1: they were averaged over all pairwise comparisons containing the given position and facing condition to arrive at a single measure of aesthetic preference for each condition and were subjected to BTL scaling. These data, averaged over participants and objects, are plotted in Fig. 6 as a function of position. Overall within-participants analyses of variance indicated a large interaction between left/right facing condition and the seven positions ($F(6, 96) =$ 19.05 [32.81], $p > 0.001$ [0.001]), which is evident in the dramatic cross-over of the two functions in Fig. 6. No rightward facing bias could possibly be reflected in these data because they do not include any opposite facing comparisons. For both the left- and right-facing conditions, both the linear component ($F(1, 16) = 42.61$ [29.08], 34.35 [32.47], $p < 0.001$ [0.001]) and the quadratic component ($F(1, 16) = 43.34$

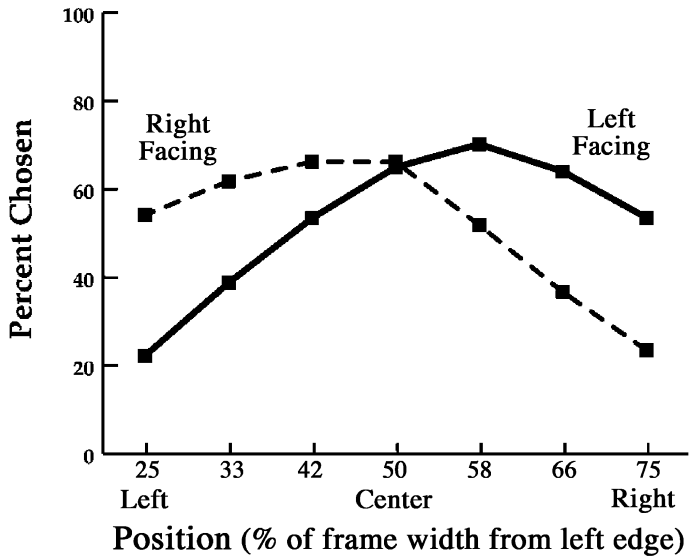

Figure 6. Results of Experiment 2 for same-facing comparisons. The average percentage of times the given image was preferred over all comparisons in which the same object faced in the same direction is plotted as a function of the position of the object's center for left-facing and right-facing views.

[30.76], 24.16 [19.73], $p < 0.001$ [0.001]) were statistically reliable (see Note 7). We understand this outcome as indicating that the data contain, as expected, both an approximately linear inward facing bias and an inverted U-shaped center bias.

The functions for left- and right-facing objects do, in fact, appear to have their maxima somewhat off-center, at around 42 and 58 percent of the way from the right and left edges, respectively, but the curves are so broad that no statistical differences are evident between these points and their immediate neighbors. Note, however, that there is no evidence favoring strong peaks at the 33 and 67 percent positions, as predicted by the *rule of thirds*, both of which were explicitly present in this experiment. Moreover, the data clearly reinforce the conclusion from Experiment 1 that the rule of thirds is properly applied only when a single focal object is directed inward. Indeed, if it were applied such that the object faced outward, the aesthetic effect would be decidedly negative for most viewers (see Note 8).

No main effects due to the aspect ratio of objects are possible in this experiment because different objects were never compared to each other. Interactions between aspect ratio and other variables are possible, however. To simplify these analyses, we first recoded the left/right facing factor to reflect whether objects face into or out of the frame, analogous to reflecting either the left-facing or the right-facing curve (but not both) in Fig. 5 about a vertical axis. This recoding effectively eliminated any main effects and interactions due to the facing factor and revealed a small but significant interaction between aspect ratio and position ($F(12, 192) = 3.02$, $p < 0.001$). The nature of this interaction can be seen in Fig. 7: there

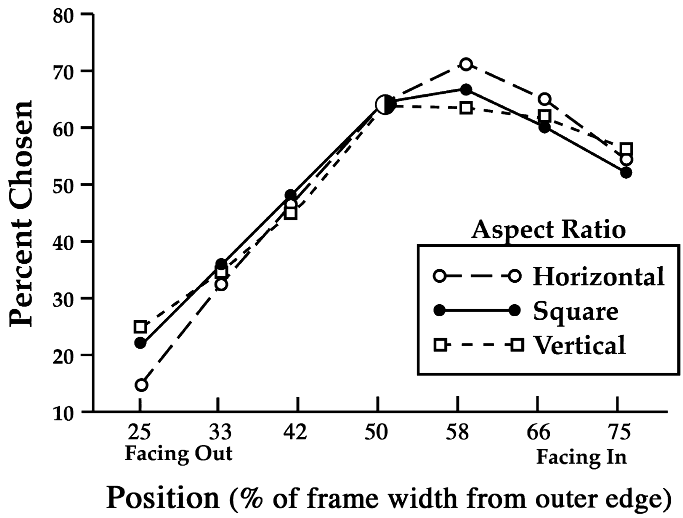

Figure 7. Results of Experiment 2 for different object aspect ratios. The average percentage of times the given image type was preferred is plotted separately for the three object aspect ratio conditions — horizontal, vertical and square — for the seven frame positions defined in terms of the object facing into *versus* out of the frame.

are more extreme positional variations for the short, wide objects (the wolf and jeep) than for the tall, thin objects (the man and flower) ($F(6, 96) = 6.57$, $p < 0.001$), with intermediate effects for the objects of intermediate aspect ratio (the teapot and rocking horse), being larger than the effects for the tall, thin objects ($F(6, 96) = 2.12$, $p < 0.05$) and slightly, but not significantly, smaller than the effects for the short, wide objects ($F(6, 96) = 1.34$, $p > 0.10$). Importantly, the peak position for the short, wide objects falls off-center toward the side at which it faces into the frame and received reliably higher ratings than the central position ($F(1, 16) = 9.50$, $p < 0.01$). A similar trend is evident for the squarish objects, but it does not reach statistical significance ($F(1, 16) = 2.50$, $p > 0.10$). This pattern of results is thus consistent with the predictions of the front position hypothesis, which postulates that the preference for a given object in a given position will be determined by the distance of its front from the center of the frame. Oddly, no corresponding differences due to aspect ratio were evident in the opposite-facing conditions, perhaps due to the smaller number of observations per data point.

To explore the extent to which the same-facing data can be predicted by variables relevant to the directional consistency and front position hypotheses, we performed a linear regression analysis of the positional effects for each of the six individual objects. The predictor variables we used were the distance of the object's center from the frame's center (the object center variable), the distance of the object's front from the frame's center (the front center variable) and the object's directional consistency with respect to the frame (the directional consistency variable). We defined the distance of an object's front from the frame's center by subjectively determining the rectangle that bounded the apparent front portion of the object and then measuring the distance from the frame's center to the center of this rectangle. Directional consistency was coded as $+1$ if the direction from the object's center to its front was the same as that from the object's center to the frame's center (i.e. at the three positions plotted as 'into the frame' in Fig. 7), -1 if these directions were inconsistent (i.e. at the three positions plotted as 'facing out' in Fig. 7) and 0 if they were neutral (at the center of the frame). The raw correlations of these three variables with the preference data for the 7 positions for each of the 6 objects (i.e. 42 observations) were: object center -0.64, front center -0.89 and directional consistency $+0.71$. (The object center and frame center correlations are negative because the preference data increase near the center, whereas these distance measures decrease near the center.) A stepwise regression in which the program determined the order of entering the predictor variables showed that front center was entered first (accounting for 79% of the variance; $F(1, 40) = 155.7$, $p < 0.001$), object center was entered next (accounting for an additional 4% of the variance; $F(1, 40) = 155.7$, $p < 0.001$) and directional consistency was entered last (accounting for an additional 9% of the variance; $F(1, 38) = 43.9$, $p < 0.001$). The final regression equation with these three independent variables had a multiple correlation of 0.96 and accounted for 92% of the variance for 42 data points. That front center was the best predictor and was entered first in the equation lends support to the front position hypothesis. However, to determine its importance beyond object center and directional consistency, we also performed a regression analysis in which object center and directional consistency were entered before front position. In this case, front center accounted for only an additional 1% of the variance, which did not quite reach statistical significance ($F(1, 38) = 3.94$, $p = 0.054$). The results are therefore ambiguous in the following sense: The single best predictor is front position, but the combination of the other two predictors (object center and directional consistency) fits the data well enough that adding front position does not significantly improve the fit.

We note that the method we used to determine the front position was entirely subjective. Moreover, because the regression program computed linear weighted combinations of the predictor variables, the object center and front center variables can actually be viewed as reflecting the influence of a single location whose distance from the frame's center provides the best fit to the data. We therefore conclude that some modified estimate of the front's center accounts for 83% of the variance, with directional consistency accounting for an additional 9%, as reflected in the original stepwise analysis. It would be interesting to estimate this modified front location separately for each object to see how much the fit could be improved and to see how closely it might correspond to the 'perceptual center' of each object as determined by other methods. We leave this project to future research specifically designed to answer it, including manipulations of frame size and shape as well as object size and shape.

EXPERIMENT 3: POSITION AND DIRECTION IN A CONSTRAINED ADJUSTMENT TASK

Forced-choice methods provide exceptional precision in determining people's preferences among the discrete alternatives chosen by the experimenter. Unfortunately, the combinatorial realities of fine-grained sampling are daunting, because the number of trials increases proportionally to the square of the number of sample values along the dimension(s) of interest. We therefore explored the more open-ended task of constrained adjustment in Experiment 3, in which participants used a computer mouse to drag the object along the horizontal midline until they found the most aesthetically pleasing position, at which point they clicked the mouse to record their preference. In other blocks of trials, we asked them to find the position that they found least aesthetically pleasing to provide data anchoring the other end of the aesthetic scale.

Method

Participants. All 9 of the participants were students at the University of California, Berkeley, who received partial course credit in their undergraduate psychology course. All were naïve to the purpose and nature of the experiment and gave informed consent in accord with the policies of the University of California, Berkeley, Committee for the Protection of Human Subjects, which approved the experimental protocol. Two participants were eliminated because they either did not understand or did not follow the instructions, as indicated by the fact that, unlike all other participants, their settings for the best positions were nearly identical to those for the worst positions.

Design. The experiment consisted of two blocks of 126 trials: one block in which participants placed the object in the *most* pleasing position, and one block in which they placed it in the *least* pleasing position. Within each block, each of 42 objects (the ten objects in each of three facings from Experiment 1, and the six objects in each of two facings from Experiment 2) were presented three times: once with the object's starting position at the left edge, once in the center, and once at the right edge of the frame.

Displays. The objects in Experiments 1 and 2 were unchanged in Experiment 3 and were presented in the same frame with the same black ground plane and white background. The only differences were that there was only one frame in the center of each screen and that the participant could control the horizontal position of the object by moving the mouse laterally. The monitor and display settings were unchanged from Experiment 2.

Procedure. In one block of trials, participants were instructed to look at each frame as it was presented and to move the object horizontally (using the mouse) to the position where the object made the overall image *most* aesthetically pleasing. In the other block, they were asked to position the object where it made the overall image *least* aesthetically pleasing. Vertical displacements of the mouse were not considered, so the object's center slid smoothly along the horizontal midline. The order of the blocks was counterbalanced so that half of the participants were instructed to place the object in the best position in the first block and half to place it in the worst position in the first block.

Results and discussion

The position of the geometric center of the object was recorded for each trial as its distance in pixels relative to the center of the frame, with positions to the left coded as negative and those to the right as positive. To enable rough comparison of the present data with those of previous experiments, the frame was divided into seven equal bins along the horizontal dimension, and the image from each trial was categorized according to the positional bin into which its center fell. The average percentage of trials on which the object center fell into each bin is plotted in Fig. 8 for the 'best position' instructions and in Fig. 9 for the 'worst position' instructions. In each case the data are shown for the leftward, rightward, and forward facing conditions.

Separate analyses were conducted on the data from the ten objects in Experiment 1 (Object Set 1, five of which implied motion and five of which were merely facing) and the six objects in Experiment 2 (Object Set 2, including two each at three aspect ratios), primarily because only the former were shown in forward (center) facing positions. The data from the left- and right-facing conditions for both object sets

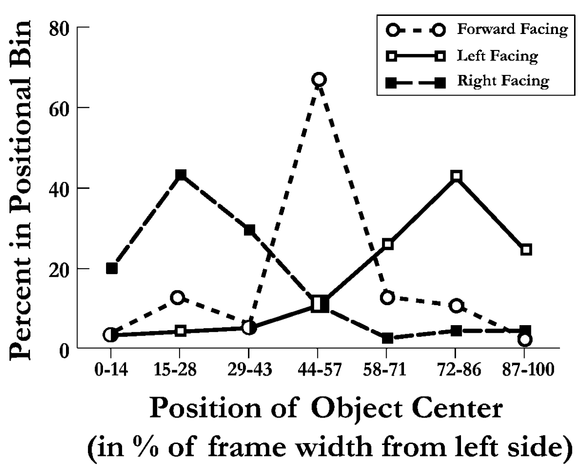

Figure 8. Results of Experiment 3 for the 'best' position. The percentage of trials in which the center of the object fell into each of seven positional bins when participants were asked to place it in the most aesthetically pleasing position for the center-facing, left-facing and right-facing images of the 16 objects used in Experiments 1 and 2.

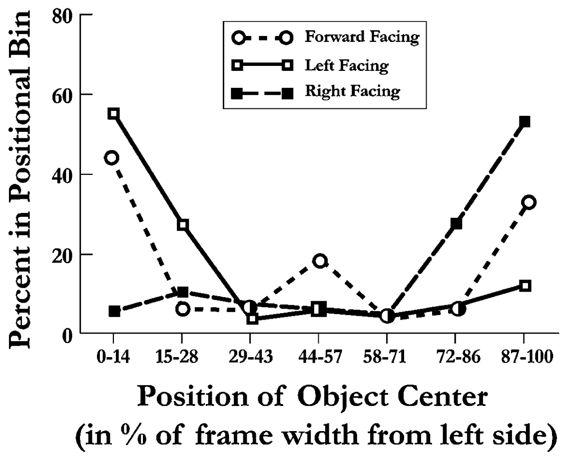

Figure 9. Results of Experiment 3 for the 'worst' position. The percentage of trials in which the center of the object fell into each of seven positional bins when participants were asked to place it in the least aesthetically pleasing position for the center-facing, left-facing and right-facing images of the 16 objects used in Experiments 1 and 2.

are combined in Figs 8 and 9 because there were no reliable differences between them, $F(1, 9) < 1$.

The analysis of the best positions with Object Set 1 showed a strong main effect of facing conditions (left, center and right), $F(2, 18) = 136.90$, $p < 0.001$, but no difference between objects that implied motion and those that were merely facing, $F(1, 9) < 1$. The centers of the objects facing right were placed further to the left than the front-facing objects, $F(1, 9) = 90.86$, $p < 0.001$, and those facing left were placed further to the right than the front-facing objects, $F(1, 9) = 85.90$, $p < 0.001$. These results are in complete accord with those from 2AFC judgments in Experiments 1 except that the inward facing bias appears to be stronger in the present data, with more strongly lateralized maxima. Indeed, the positional bin into which the objects' centers fell most frequently was even more extreme than implied by the rule of thirds, but only when the object faced inward. The centers of the forward facing objects, however, showed no such lateral biases, being very sharply peaked in the center positional bin and thus strongly inconsistent with the rule of thirds.

The best position results for Object Set 2 were similar to those for the left- and right-facing conditions of Object Set 1, with the centers of left-facing objects much farther to the right than those of right-facing objects, $F(1, 9) = 81.80$, $p < 0.001$. These results are also in accord with those from Experiment 2, except that the inward facing bias was again stronger in the present data. Unlike Experiment 2, however, the results for objects with different aspect ratios did not reach significance in the present data ($F(2, 18) = 2.78$, $p = 0.088$). Indeed, they were not even ordered in the predicted direction, with the tall, thin objects producing the largest displacement (132 pixels) and the square objects and the short, wide objects producing smaller displacements (64 and 76 pixels, respectively). Given the lack of evidence for systematic effects of aspect ratio here and in the opposite-facing comparisons of Experiment 2, we have very limited confidence in the aspect ratio effects observed in the same-facing conditions of Experiment 2.

The data from the worst positions are equally clear and compelling. The worst positions are clearly at or near the edges of the frame. This is the result of the center bias for the best positions to be at or near the center. The only exception is a small increment for the forward facing objects at the central position, which may reflect a few participants' belief in an explicit 'rule' that objects should not be placed at the exact center of a picture. For the forward-facing objects, the two edges are about equally bad, but for the left- and right-facing objects, there is a huge asymmetry: left-facing objects are least pleasing when they are on the left side of the frame and right-facing objects are least pleasing when they are on the right side of the frame. This fact is reflected in the average worst-positions of the objects in that participants located the right-facing objects farther to the right than the left-facing objects, $F(1, 9) = 121.28$, $p < 0.001$. This pattern of results presumably arises from the joint operation of the inward and center biases, which together dictate that the worst compositional choice is for the object to face outward at the most extreme position.

The present data thus converge with the primary results of Experiments 1 and 2 in affirming the existence of powerful preferences for objects to be positioned toward the center of the frame and to face into the frame. It is unclear, however, why the constrained adjustment data for the best composition gave stronger evidence of the inward bias than the 2AFC data in the previous experiments. One possibility is that adjustment strategies in the present paradigm tended to magnify the inward bias effect. For example, if participants tended to move the object outward from the center in trying to find the best location and if hysteresis effects are present, they might move it farther outward than they would judge optimal in a 2AFC paradigm. Because we have no data on the trajectories of object positions, however, we cannot evaluate such hypotheses in the present data.

EXPERIMENT 4: POSITION AND DIRECTION IN FREE-CHOICE PHOTOGRAPHY

The results of the first three experiments clearly demonstrate the existence of the center and inward biases, but we wanted to see whether they would also be revealed under the more open-ended conditions of people taking actual photographs. Participants in the previous experiments might well have discerned the purpose of the studies from the nature of the displays they were shown or the nature of the adjustments they were allowed to make, and this might have influenced their choices, either consciously or unconsciously. In the present experiment participants were given a digital camera and simply asked to take the most aesthetically pleasing picture they could of a series of everyday objects. Under these conditions it seems unlikely that the participants would discern our underlying hypotheses.

Each participant was given a digital SLR camera and asked to take the most aesthetically pleasing pictures they could of three everyday objects — a teapot, a tape dispenser, and a steam iron — in each of seven instructional conditions. The target object was positioned on a turntable so that participants could change its orientation, if they wished. The first instructional condition imposed no constraints at all: participants were free to take whichever picture they found most aesthetically pleasing. After doing this for each of the three objects, they were given the following series of six tasks that imposed specific constraints: the object must be located off-center and facing rightward (condition OCR) or facing leftward (OCL), the object must be partially out of the frame and facing rightward (OFR) or facing leftward (OFL), and the object must be entirely inside the frame and facing rightward (IFR) or facing leftward (IFL). Participants were told that 'facing rightward' and 'facing leftward' did not mean that the object necessarily had to be in full profile, but only that its front had to face right or left of directly toward (or away from) the camera. The image participants saw in the viewer was exactly the image that was recorded and analyzed.

The initial, unconstrained photographs were scored for both the central position and the direction of the object in the picture. We expected that there would be a bias toward placing the object at or near the center of the frame and that, if it were off-center, there would be a bias for the object to face into the frame. Because the rest of the conditions dictated the direction of the object, the sole dependent variable of interest was the location of the object's center. If there is indeed a preference for objects to face into the frame, then right-facing objects should tend to be framed left of center and left-facing objects should tend to be framed right of center.

Methods

Participants. All ten participants were students at the University of California, Berkeley, who received partial course credit in their undergraduate psychology course. Their mean age was 19.9 years. All were naïve to the purpose and nature of the experiment and gave informed consent in accord with the policies of the University of California, Berkeley, Committee for the Protection of Human Subjects, which approved the experimental protocol.

Design. The unconstrained ('best picture') condition was completed first for all three objects, and the remaining six conditions were randomized. Object order, which remained consistent within participants for every condition, was also randomized across participants.

Materials. The three objects (a teapot, a tape dispenser and a steam iron with its cord removed) were positioned on a white turntable 12″ in diameter. The ground plane was a white, foam-core matboard and a second white matboard, perpendicular to the ground plane, stood behind the turntable against a wall.

Procedure. Each participant received a brief tutorial in using the Nikon D100 digital single-lens reflex camera. The camera was set for automatic exposure, so that participants only needed to position the camera and zoom the lens, which had an effective adjustable focal length of 42 mm to 135 mm. The participants could stand wherever they wanted to take the photographs, but were constrained by the size of the area in which the apparatus was located (approximately $5' \times 4'$). The aspect ratio of the digital images taken by the camera was 3:2, and their size was 3008×2000 pixels.

For the three initial pictures, the experimenter placed the object on the turntable facing directly forward, and participants were then free to turn the object however they wanted. For subsequent pictures, participants were allowed to place the object on the turntable themselves, in accord with the facing instructions for that condition. The order of the left- and right-facing constraints was counterbalanced across participants.

Results and discussion

The image location of the center of the object and the object's direction of facing were determined by eye for each digital photograph. In cases where the center of the object was outside the frame, the position was coded as at the edge of the frame closest to its center (± 1504 pixels) rather than at its actual center, which was not visible in the photograph. Because this occurred frequently in the instructional condition in which participants were required to take a picture in which the object was partly out of the frame (i.e. the OFR and OFL conditions), we do not include the data from these conditions below.

The initial three 'best' photographs for each participant were the only ones in which they had free choice about how the object should face as well as where it was positioned. These images showed a strong rightward facing bias, with 80% of the objects facing right and 20% facing left ($p < 0.001$ by a binomial test). It is noteworthy that this bias occurs despite the fact that a right-handed person would normally use both the iron and the teapot (but not the tape dispenser) in a left-facing position. This fact is inconsistent with any hypothesis that a rightward bias results from standard conditions of use or even the frequency with which the objects are seen in a right-facing orientation. There was also a strong inward bias with respect to the frame, with 77% of the images showing the object facing into the frame *versus* 23% showing it facing out of the frame ($p < 0.001$ by a binomial test). The position of the object in the 'best' photo condition was strongly biased toward the center, with a mean position approximately 35 pixels offset to the left of center, probably as a result of the right-facing bias, which was relatively strong in these data.

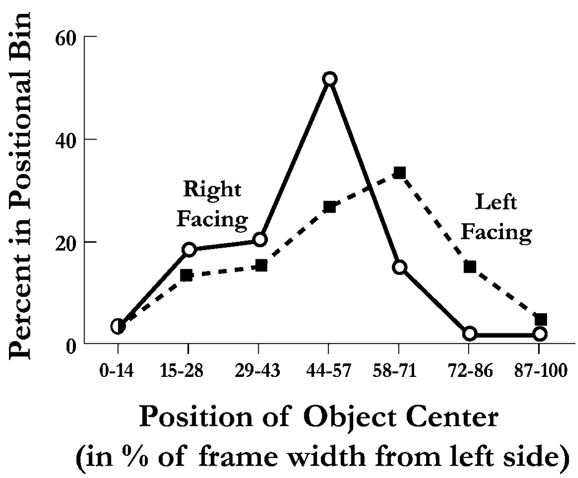

Figure 10. Results of Experiment 4. The percentage of photographs taken in which the center of the object fell into seven positional bins for the partly constrained left-facing and right-facing instructional conditions in a free-choice photography task.

The rest of the photographs, which were constrained to be facing either rightward or leftward according to explicit experimental instructions, were only analyzed for the position of the object's center. The resulting percentages of photographs in which the objects' centers fell within each of the seven equally spaced positional bins are plotted in Fig. 10, with separate functions for right-facing and left-facing instructional conditions. The results of a two-way analysis of variance on the positions of the centers of the objects indicate a main effect of facing direction ($F(1,9) = 6.99$, $p < 0.03$), but not of instructional condition, $F(1,9) < 1$, or their interaction ($F(1,9) = 1.92$, $p > 0.20$). Although these data are not as orderly as those from the 2AFC and constrained adjustment tasks, the asymmetric signature of the inward facing bias was still clearly evident: People placed the right-facing objects toward the left side of the frame and the left-facing objects toward the right side of the frame.

GENERAL DISCUSSION

Four experiments were conducted that investigated people's aesthetic preferences for the framing of simple, single-object pictures in rectangular frames. The results were consistent in revealing two powerful biases in aesthetic preference, one for objects to be positioned toward the center of the frame (the center bias) and the other for objects to face into the frame (the inward bias). Both produced consistent, statistically robust effects in every relevant comparison. A weaker third bias was sometimes evident for participants to prefer objects facing to the right (the rightward bias), but it was not as consistently observed as the other two principles, being present in Experiments 1 and 4, but not in Experiment 2.

Experiment 2 provided further evidence about why people prefer objects to face into the frame. By sampling object positions densely and by varying the aspect ratio of the objects, we found evidence for both the directional consistency hypothesis (that people prefer the object to face in the same direction as the direction from the object's center to the frame's center) and the centered front hypothesis (that people prefer the object's salient front region to be as close to the center as possible). The lack of corresponding aspect ratio effects in Experiment 3 casts doubt on the generality of the centered front hypothesis, however. Even so, the overall results strongly support the paramount importance of the frame's center in aesthetic considerations for these simple compositional issues (*cf.* Alexander, 2002; Arnheim, 1988): The most important variables can be specified in terms of the frame's center, the object's center, and the relation between the two.

The relation between the rule of thirds and our results is complex enough to merit a final summary. First, the rule of thirds appears to conflict rather dramatically with people's aesthetic preferences for the position of single symmetrical, forward facing objects, which people strongly favored to be located at or very close to the center of the frame. For left and right facing objects, it is clear that a more lateralized position is preferred, but only on the side for which the object faces into the frame. Even here the precise location of the preference peak corresponds only roughly to the $1/3$ or $2/3$ lines, being closer to the center in Experiment 2 and more peripheral in Experiment 3. Composing the frame so that the center of the object conforms to the rule of thirds was aesthetically displeasing to most of our observers when the object faced outward. If we give equal weight to these three cases — forward-, inward- and outward-facing objects — then we can summarize our results as being consistent with the rule of thirds, at best, one-third of the time (see Note 9). However, we note that our displays, unlike real photographs, contain no other objects or background structure, either of which would presumably influence people's aesthetic responses to the placement of a focal object.

Before closing, a few remarks are in order about how the present results are (or might be) relevant to the scientific study of art. First, we have quite consciously avoided claims about the relevance of our findings for deciding how 'artistic' various images are, focusing instead on simpler (and, we believe, more basic) claims about people's preferences based on aesthetic aspects of experience. There are many reasons for this, not the least of which is the thorny question of how 'art' should be defined in the first place. We particularly intend to exclude, insofar as possible, the role of cultural/institutional factors in adjudicating issues of artistic merit, such as the opinions of art critics, museum curators, and other art experts (e.g. see Cutting, 2005). The participants in our studies have well-defined and surprisingly consistent aesthetic biases, even though none of them would be counted as an expert. We are indeed interested in how people's aesthetic preferences might differ as a function of expertise and formal artistic training, but we do not address that topic in the present study. Nevertheless, we do believe that aesthetic response plays an important role in the understanding and assessment of art (particularly pre-20th century art), and to that extent, our findings are at least relevant to a scientific understanding of art.

Second, we readily acknowledge that the pictures we asked participants to judge aesthetically are not 'beautiful' or 'artistic' in any standard sense. Indeed, most people would probably describe them as relatively 'ugly'. Nevertheless, no participant ever indicated any difficulty in making the aesthetic judgments they were asked to make, and their preferences exhibited quite striking commonalities. We believe that people's aesthetic preferences for art rest on aesthetic biases that include, but are by no means limited to, the few we have identified here. If the objects and backgrounds we used had been more aesthetically pleasing, the pictures would certainly be judged as more 'artistic' overall, but we expect that the results of 2AFC judgments corresponding to those studied here, but with more pleasing content, would be quite similar to what we reported. We are currently addressing this question in further research, and will soon be able to provide an empirical answer.

Third, we realize that people's aesthetic responses to spatial composition cannot be based solely on the kinds of biases we have reported here. Indeed, images that deliberately violate standard expectations, such as the center and inward biases we have documented here, can produce quite positive aesthetic responses, particularly if the violation is integral to conveying an intended message or mood. A picture of a solitary person on a deserted beach, for example, might be judged more aesthetically pleasing if the subject were positioned decidedly off center and facing out of the frame, violating these conventions to convey feelings of isolation, loneliness, and/or longing. Although such considerations are beyond the scope of the experiments we report in this article, it is also a topic that we plan to address in future research.

Our current view about the role of aesthetic biases in understanding art from a scientific point of view is roughly as follows: When strong enough preferences for content, spatial composition, color composition, and their myriad interactions combine in a viewer's aesthetic response to a given work, the cumulative effect will sometimes pass a threshold at which that viewer would describe it as 'beautiful'. When these preferences are strongly held by a large proportion of viewers, it could accurately be described as 'beautiful' in some more general, consensual sense. We hope eventually to be able to assess such claims rigorously, but much work to be done before it can be addressed with any hope of success.

Nevertheless, even consensual, highly positive aesthetic response is not sufficient for a work to count as art — much less good art or great art — because much depends on cultural and historical factors that are largely independent of aesthetic considerations. Whether something is accepted as art is strongly influenced, for instance, by what is currently fashionable in the art world and whether the given work is sufficiently new and creative relative to the cumulative body of similar art. To take a particularly clear case, a well-executed copy of Van Gogh's *Starry Night* or Rembrandt's *The Night Watch* would presumably be judged as aesthetically pleasing to a great many viewers, but neither would count as legitimate art for reasons that have nothing to do with the nature of the experiences people might have on viewing them.

We are engaged in studying the perceptual principles that contribute to aesthetic experience rather than artistic merit. This choice rests primarily on our belief that aesthetic experience can be separated to a large extent from the institutional and historical factors that weigh so heavily in evaluations of artistic merit. The extent to which aesthetic experience is relevant to judgments of artistic merit is thus an open question for future research.

Acknowledgements

This research was supported in part by a research grant from the Committee on Research to SP at the University of California, Berkeley. The experiments were conceived and designed by SP and JG and carried out and analyzed by JG with the help of Michael Vattuone and Emily Zuckerman. The statistical analyses using Bradley–Terry–Luce scaling procedures were conducted in collaboration with TDW. We wish to thank two anonymous reviewers for their comments on an earlier draft of this article.

NOTES

1. This is not to say that all or even most artists aim to please the general public. Many direct their efforts at pleasing an artistic elite and/or their own clientele, and some at pleasing only themselves. For such artists, the results of the present studies will be at best irrelevant and at worst systematically misleading. We leave to future research the questions of whether and how the preferences of more artistically sophisticated viewers differ from those of the untrained viewers we studied here.
2. Related work in progress addresses further variables, including the vertical location of single objects, the size of a single object within the frame, the relative location (i.e. configuration) of multiple objects in a single frame, as well as the extensions of these variables to aesthetic preferences for abstract geometrical forms.
3. The rule of thirds is a well-known heuristic for spatial composition that is frequently discussed in photography. It states that when composing an image, the photographer should divide the frame into thirds horizontally and vertically and place the subject (i.e. focal object) at one of the four points of intersection of the divisions (Field, 1845). The rule of thirds clearly implies that the subject should *not* be placed at or even very near the center of the frame either horizontally or vertically to produce the most pleasing aesthetic effect.
4. The other way of characterizing the facing bias is to say that the direction the object faces is *opposite* the direction from the frame's center to the object's

center. This alternative characterization of the facing bias thus can be viewed as emphasizing directional opposition and balance: i.e. the object's unbalanced position to one side is balanced by its facing in the opposite direction. We cannot distinguish between these formulations in the present research, and choose to discuss the hypothesis in terms of directional consistency because of its more natural mapping to the usual characterization in terms of the object 'facing into the frame'.

5. In statistical analyses of binary choice data, such as those plotted in Fig. 3, caution must be exercised because the variances of probability distributions do not conform to standard variability assumptions of the analysis of variance, being necessarily lower at extreme values (i.e. near 0.0 and 1.0) than at moderate values. We therefore analyzed our results using both the probability data plotted in Figs 3, 5, 6 and 7 and Bradley–Terry–Luce (BTL) scale values derived for each individual participant from their 2AFC choice data. The scaling algorithm was written in the statistical programming language R (R Development Core Team, 2006) using the Bradley–Terry package of Firth (2005). These values were then analyzed with a repeated-measures analysis of variance. The BTL scaling procedure derives scale values from binary choice data such that the scaled values have more equal variances across the scale, thus overcoming potential problems due to unequal variances in probability data. In fact, the original probabilities and the BTL scaled values were essentially the same ($r = 0.96$ in Experiment 1 and $r = 0.97$ in Experiment 2), because the data include relatively few points in the extreme ranges. We chose to report the data in the figures as untransformed probabilities — i.e. percentages of trials on which a given image was chosen over all others — because they are more intuitively meaningful than BTL scaled values. We report statistical analyses for both the untransformed average probabilities and the transformed BTL values (the latter in square brackets) for the overall analyses of variance. Given the close correspondence between the probability data and the BTL scale values, the middle range of most of the probabilities, the magnitude of the effects, and the similarity of the outcomes, we did not repeat the statistical tests with BTL values for subsequent specific comparisons, but simply report the analyses based on mean probability measures.
6. This hypothesis is similar in certain respects to Tyler's (1998a, 1998b) finding that an eye of the subject typically falls on the centerline of a portrait, in that it defines the preference in terms of a specified part of the object being located in the center.
7. The Bradley–Terry–Luce model, as implemented, requires that the table of comparisons be complete. As a result, the BTL values reported are not broken down into separate same-facing and reverse-facing components, thus taking all of the data into account.
8. This is not to say that having a single focal object face out of the picture *always* produces a poor aesthetic effect. In some contexts, violating expectations

in this way may work quite well. A picture on the cover of *Time* magazine (November 6, 2006) illustrates this clearly, because it shows President George W. Bush on a plain white background, striding, almost half-cropped, out of the frame on the right side. The caption reads "The Lone Ranger" and was published just after the Republican party lost control of both the Senate and the House of Representatives. The otherwise aesthetically poor positioning of Bush within the frame was clearly intended to reinforce the semantic interpretation of him as isolated and out of step with the electorate. In this context, it worked very well.

9. We note for completeness that the rule of thirds, as usually stated, does not include the points we studied along the horizontally oriented midline of the frame. We have supposed that it would apply to such cases as well. Further tests of the rule would therefore be desirable using the four points it explicitly prescribes.

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