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THE VASE ON THE MANTELPIECE: THE GOLDEN SECTION IN CONTEXT

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ABSTRACT

The golden section (GS) was investigated in three experiments ($N = 91$, 87, and 73 psychology students, respectively), using both traditional methods (line bi-section, production of rectangles), and novel stimuli (contours and cutouts of vases constructed by the GS and non-GS principles) and tasks (the placement of "vases" on an imaginary and a laboratory, purpose-built, mantelpiece). In five different tasks, which varied considerably in technical details, there was absolutely no evidence for the significance of the GS, nor was there a general preference for the GS vases. Instead, the search for balance seemed to motivate the subjects' mantelpiece placement choices, guided by the area ("weight"), rather than the shape, of the vases. In addition, the results cast serious doubt on the generalizability of conclusions based on the research on rectangles to real-world aesthetic objects and choices. Other substantive and methodological issues, especially with regard to the future research on the GS, and to ecological validity, were discussed.

INTRODUCTION

As is readily apparent from the recent extensive literature reviews (Green, 1995; Höge, 1995), the golden section, known since antiquity, continues to fascinate psycho-aestheticians as a theoretical concept and research issue. The ability of this "divine proportion" to provoke debate and arouse tempers has few equals in contemporary psycho-aesthetics (e.g., Boselie, 1992; Godkewitsch, 1974; Green, 1995; McManus, 1980).

The elegance of the arithmetic, geometric, and biological contexts in which the golden ratio is found is undisputed and undoubtedly responsible for much of the

mystique (e.g., Huntley, 1970). Contemporary psycho-aestheticians have also been intrigued by the ostensibly well-documented appearances of the golden ratio in painting (Bouleau, 1963) and architecture (Borissavlievitch, 1958; Le Corbusier, 1954). One can nevertheless safely say that the seductive mathematical beauty and authoritative claims of artistic relevance have done much to muddle the thinking of many researchers interested in the golden section since, and including, Fechner in the 1870s, especially regarding methodological issues (in the broadest sense).

Sound psycho-aesthetic work on this problem should include the following approaches:

(1) a thorough study of the incidence and prevalence (in the epidemiological sense) of the golden section *within paintings* (i.e., not simply the ratio of their vertical and horizontal dimensions, which Fechner, 1876, was first to obtain massive data on) and in various periods, styles, and artists' *oeuvres*, respectively;
(2) an examination of the available evidence regarding the extent of various artists' *intentional* use of the golden section for hedonic purposes, and the degree to which this was done in order to satisfy an existing painterly convention (as opposed to a personal predilection or "manifesto");
(3) an empirical evaluation of whether the paintings that contain—*as major structural components*—the intentionally or unintentionally produced golden-section relationships are, in fact, preferred by viewers (of different degrees of expertise) to "control" paintings ("sister" or similar paintings without golden sections, various "doctored" versions, etc.);
(4) empirical efforts using a greater variety of stimuli that—while allowing full experimental control—are nevertheless more *aesthetically relevant* than the rectangles introduced by Fechner and almost obsessively pursued by the golden-section researchers since then; and,
(5) the investigation of the viewers' relative preferences for stimuli that do and do not contain golden and other appealing proportions, when such stimuli are placed into aesthetically relevant *contexts* that themselves can be arranged by the viewers to exhibit either golden-section or alternative relationships.

Knowledge gained from the first three approaches—all "analytic" ones, in Berlyne's (1974) terminology—would temper outlandish conclusions (both for and against the aesthetic significance of the golden section) that are often largely based on anecdotal evidence or unique exemplars. These three approaches would provide an empirical basis from which to evaluate the received wisdom from art history and art criticism. They, especially (3), will be mentioned again in the General Discussion section, in reference to the author's ongoing research using paintings as stimuli and painters as research participants.

The present article describes three experiments (with students as research participants), all of which fall in the category of "synthetic" approaches, but which were designed to address—as prescribed in (4) and (5) above—the problems of ecological validity that are self-evident in the research tradition that has relied so heavily and unimaginatively on rectangles (and some ellipses, concentric circles, etc.) devoid of both meaning and context.

In all three of the present experiments, the stimuli had the shape of, and were consistently referred to as, *vases*. It is not necessary to be an expert on Etruria or the Ming dynasty in order to think of vases as objects of potentially great beauty, rarity, and value. There is a host of such associations—largely nonexistent in the case of, for example, rectangles—that is likely to be triggered by even the most rudimentary representations of vases.

In addition, in all three experiments, and regardless of the details of the respective experimental tasks, research participants dealt with the "vases" in relation to a specific and meaningful real-world location, the *mantelpiece*. Even in the warm climate of southern California, the fireplace is a highly desirable and frequent feature of homes. It is the focal point of the living-room, and thus of the home, for both residents and guests. On the mantelpiece above the fireplace are typically displayed family valuables thought to be aesthetically pleasing, suitable for viewing, and of appropriate shape and proportions. A fine vase fits this role perfectly. Where, exactly, on the mantelpiece to place a vase of given proportions is a meaningful, nontrivial, aesthetic choice.

EXPERIMENT 1

Method

Research Participants and Setting

Ninety-one students (gender data were not collected), enrolled in "Psychology and the Arts," an upper-division course at the University of California, San Diego, were the research participants. All the students were juniors or senors and about 90 percent of them were majoring in psychology. The data were collected at the first class meeting, in an inclined auditorium.

Experimental Materials, Instructions, Procedure

Each student received a fifteen-page booklet. The pages were of the standard format (8.5 × 11 inches = 21.59 × 27.94 cm). Following the cover page with instructions, on each of the subsequent fourteen pages there was a solid horizontal line, 16.5 cm in length, drawn parallel to, and 6.5 cm from, the bottom of the page, with unlabeled end-points that were equidistant from the left and right edges of the page.

The students were instructed to imagine that the line on each page of the booklet represented the ten-fold-reduced length of the mantelpiece in their own living-room (1 : 10 in map terms). To facilitate their task visually, a thick line, 165 cm-long, was drawn on the blackboard—the actual length of an average real-world mantelpiece.

The task was described as an important one—of placing a cherished, valuable vase on the mantelpiece, in a location that the student would daily have to live with. It was emphasized that these were individual and aesthetic choices, with no right or wrong responses.

The first three pages of the booklet dealt with imaginary vases, in order to obtain base-rate data under minimal-information, abstract conditions, and make possible comparisons with some earlier studies. The research participants were told that their task on *page 1* of the booklet was to "write an 'x' anywhere on the line where you would place the center of the bottom of your favorite real or imaginary vase." On *page 2*, the task was to "write an 'x' for the center of the vase's bottom and draw a vertical line above it, perpendicular to the mantelpiece, indicating the height of your real or imaginary vase." For *page 3*, the students were instructed to "draw a rectangle, with its base on the mantelpiece, the horizontal dimension indicating your favorite vase's width at the widest point, and the vertical dimension indicating the same vase's height."

In the top right-hand corner of each of the remaining eleven pages (*pages 4-14*), the contour of a different vase was drawn. The basic geometry of these vases is presented in Table 1. The students were asked to indicate by an "x" on the

Table 1. Dimensions of the Vase Stimuli

Vases	Height	Width	Height-of-Intersect[a]
1	102[b]	63	39
2	63	38.9	24.1
3	38.9	24.1	14.8
4	24.1	14.8	9.2
5	14.8	9.2	5.6
6	82.5	61.8	20.7
7	82.5	41.3	20.7
8	41.3	30.9	10.3
9	41.3	20.6	10.3
10	20.6	15.2	5.1
11	20.6	10.3	5.1

[a]Distance from the center of a vase's bottom to the point of intersect between its height and greatest width; all the vases were "bottom-heavy."
[b]Values in mm in Experiment 1, in cm in Experiment 2.

"mantelpiece" on each page where they would be, in the real world, most likely to place the center of the vase with the shape and dimensions outlined on that page.

The order of presentation of the eleven vases was randomly determined and identical for all the research participants; on booklet pages 4-14, the order of the vases, in reference to Table 1, was: #9, 2, 4, 5, 8, 6, 10, 7, 1, 11, 3. (Please note that the same order of presentation was used in Experiments 2 and 3.)

Vases in Table 1 are divided into two groups, the first of which is the golden-section series ("GS," vases #1-5). Consider vase #1: The ratio of its width to its height is 0.618, and of the "height-of-intersect" (as defined in Table 1) to the width is also 0.618. The same is true for the analogous ratios in GS vases #2-5. These are truly "golden vases."

In addition, the vases within the GS series are related. As can be seen in Table 1, the width and the height-of-intersect of vase #1 are equivalent to the height and width, respectively, of vase #2; analogous relations are present throughout the series, to vase #5.

Furthermore, the GS series is related to its "mantelpiece environment" in golden-section terms, such that the ratio of the height of its top member, vase #1, to the length of the mantelpiece, is 0.618 (102 : 165).

The second group in Table 1 is the series containing vases with other appealing, but non-golden-section, proportions ("non-GS," vases #6-11). In vase #6, the ratio of width to height is 0.75, and the ratio of height-of-intersect to width is 0.33. In contrast, in vase #7 (with a height identical to that of #6, and a width equaling 0.67 of the #6 width), the ratio of width to height is 0.50, and the ratio of height-of-intersect to width also 0.50.

As can be seen in Table 1, vases #6, 8, and 10 are related and form the "plump" non-GS sub-series; similarly, vases #7, 9, and 11 form the "slim" non-GS sub-series. Finally, it should be noted that the ratio of the height of vases #6 and 7 to the length of the mantelpiece is 0.50; of vases #8 and 9 to the same length, 0.25; and of vases #10 and 11, 0.125.

The eleven-vase stimuli thus formed a very diverse pool in terms of proportions and dimensions (and, therefore, area). They consisted of a golden and a non-golden series, with the latter subdivided into two sub-series, each based on different, hypothetically very pleasing, proportions. Moreover, the GS-series vases, as well as both of the non-GS sub-series ones, were related to their environment (mantelpiece length) by similarly appealing proportions.

Results and Discussion

Booklet pp. 1-3

One of the research participants' basic tasks on pp. 1-3 of the booklet was to partition the "mantelpiece" into two segments by indicating where they would like to place an imaginary vase. In Figure 1 are presented the distributions of responses. As can be seen, the distributions are similar, including the tendency to

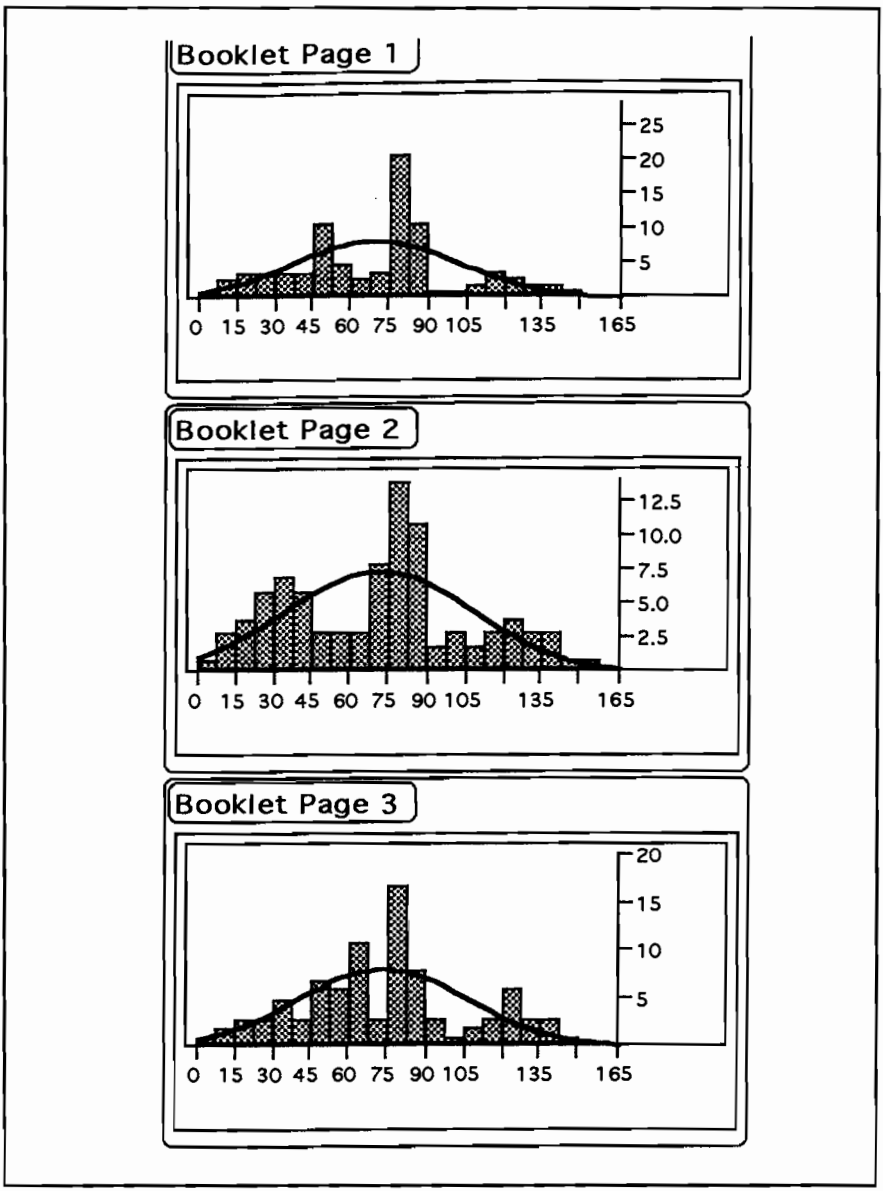

Figure 1. Distributions of the mantelpiece bi-section responses by ninety-one subjects in Experiment 1. Booklet Page 1: Bi-section by an "x" mark. Booklet Page 2: Bi-section by an "x" above which a vertical line indicated the height of the ideal vase. Booklet Page 3: Bi-section by an "x" around and above which the sides of a rectangle indicated the width and height of the ideal vase.

favor, somewhat, the left side (as one faces the mantelpiece). The distribution of choices (which were here, and throughout, measured in mm from the left end of the mantelpiece), on p. 1 has a Mean of 69.64, Median of 76, and Standard Deviation of 32.68. For page 2, these values are: $M = 71.33$, $Mdn = 75$, and $SD = 36.58$; for page 3: $M = 73.16$, $Mdn = 76$, $SD = 33.64$.

Although the task changed—from the simple bi-section of the line (on p. 1), to also indicating height (on p. 2), and then height and width (on p. 3)—the medians and *SD*s nevertheless remained steady, and the movement of the means to the right, toward the center of the mantelpiece (82.50), was negligible. Thus, the increasingly concrete representation of the vase's dimensions, and, specifically, the production of a rectangle, did not further increase the already very high proportion of respondents choosing the central area. This occurred in the context of a considerable individual consistency of the students' choices: $r = 0.77$ for responses on p. 1 and p. 2; $r = 0.65$ for p. 1/p.3; and $r = 0.81$ for p. 2/p. 3.

There are two ways to divide the 165-mm "mantelpiece" so as to obtain the golden section, at 63 mm from the left end and at 102 mm from the left end (the latter point being 63 mm from the right end). Throughout this article, the regions 61-65 mm and 100-104 mm from the left end (yielding the range of ratios around the two golden-section points of 0.59-0.65 and 1.54-1.69) are treated as "golden-section areas." (Höge, 1995, Figures 1 and 2, used 0.59-0.659 as the golden-section "class of proportions.") If choices are made in a random manner, 6 percent of them would fall in the two areas taken together; 5.5 of the ninety-one respondents would thus choose the golden-section areas by chance alone.

The data in Figure 1 for pp. 1 and 2 show that the areas around these points were infrequently chosen by the respondents (the actual numbers were three responses on p. 1 and six on p. 2). On p. 3, despite a secondary peak at 60-67.5, the actual number of golden-section-area responses was seven, only slightly above chance. Compared to the frequency of responses at and around the center of the mantelpiece, these golden-section responses pale into insignificance.

Turning to the height of the imaginary vases on p. 2—the vertical lines the respondents drew above the "x" mark—the distribution had a range from 14 to 182 mm; $M = 41.65$ mm (close to 0.25 of the mantelpiece length only because of two outliers); $Mdn = 36$; the modal 10-mm interval was 20-29 (with 27 responses; 24.5/165 = 0.15); and $SD = 25.99$. Significantly, the scatterplot relating the respondents' choices of the location of the vase on the mantelpiece to their choices of its height, as well as the various fitting attempts, all indicated that these two decisions were totally unrelated.

The distribution of heights of rectangles the respondents drew on p. 3 of the booklet had a range of 8-148; $M = 39.68$; $Mdn = 34$; the modal 10-mm interval was 20-29 (27 responses); and $SD = 24.05$. In every respect this distribution was strikingly similar to that of heights of vertical lines on p. 2. The correlation of the respondents' height choices for lines and rectangles was very high ($r = 0.86$).

Thus, significantly, the experimental requirement to indicate the vase's width and draw a rectangular area had no effect on the choice of height.

In addition, the ratio of the modal height of rectangles to the length of the mantelpiece—as was the case for the modal height of lines—was close to 0.15 and thus had little to do with either the golden section or the 0.50-0.25-0.125 progression. Tests of fit indicated that the choice of location of the rectangle on the mantelpiece was totally independent of its chosen height.

For the vases' (rectangles') widths that were drawn on p. 3, the distribution had a range of 4-145, M = 27.28, Mdn = 23, the modal 10-mm interval = 10-19 (29 responses; 14.5/165 = 0.09), and SD = 18.71. Thus, no interesting relationship emerged between the modal rectangle width and mantelpiece length. Tests of fit showed that, like the choice of heights of the vertical line and of the rectangle, the choice of width was independent of where on the mantelpiece the "vase" (rectangle) was placed.

As could be expected, the respondents' preferences for the height and width of the imaginary vase (rectangle) on p. 3 were strongly correlated, r = 0.65, and there was a good linear fit.

Because a few respondents' choices were outliers in both height and width of the rectangles they produced, the range of rectangle areas (88-18850 mm^2), the mean rectangle area (1370.89) and the SD for the distribution of the drawn rectangular areas (2320.44) were all inflated; Mdn = 768. The noteworthy finding for subsequent discussion was that of a literally 0.01 R-square for the relationship between the area of the rectangles the respondents drew on p. 3 and the position they chose for the rectangles on the mantelpiece.

The details of the imaginary vases' heights and widths (the rectangles' dimensions) on p. 3 were examined; in Figure 2 are presented the distribution of the width/height ratios and the associated descriptive statistics.

Seventy-four of the ninety-one students (81%) drew longer heights than widths, fifteen drew longer widths than heights, and two drew squares perfect to the mm. The ratio of another two respondents' choices fell in the 0.97-1.03 region, for a total of four "squares" (4.4% of the sample—as opposed to an estimated 17% in Höge's sample, 1995, his Figure 2). A total of eight respondents (9% of the sample; estimated 6% in Höge) chose the width/height ratios that fell either in the 0.47-0.529 region (7 students; here, the width of the rectangle is close to half its height) or in its inverse, 1.89-2.13 (1 student). Fifteen (16%; estimated 6% in Höge) subjects' width/height choices fell in the 0.53-0.589 region (14 respondents) or in its inverse, 1.70-1.89 (1). Note that this is a region of proportions seldom before mentioned as having any psycho-aesthetic significance whatsoever.

Finally, only five students (6%; estimated 7% in Höge) drew golden rectangles, with the width/height ratios falling in the 0.59-0.65 region; there were none in the inverse, 1.54-1.69, region. The discovery of so few subjects who drew golden rectangles illustrates the importance of closely studying distributions in the

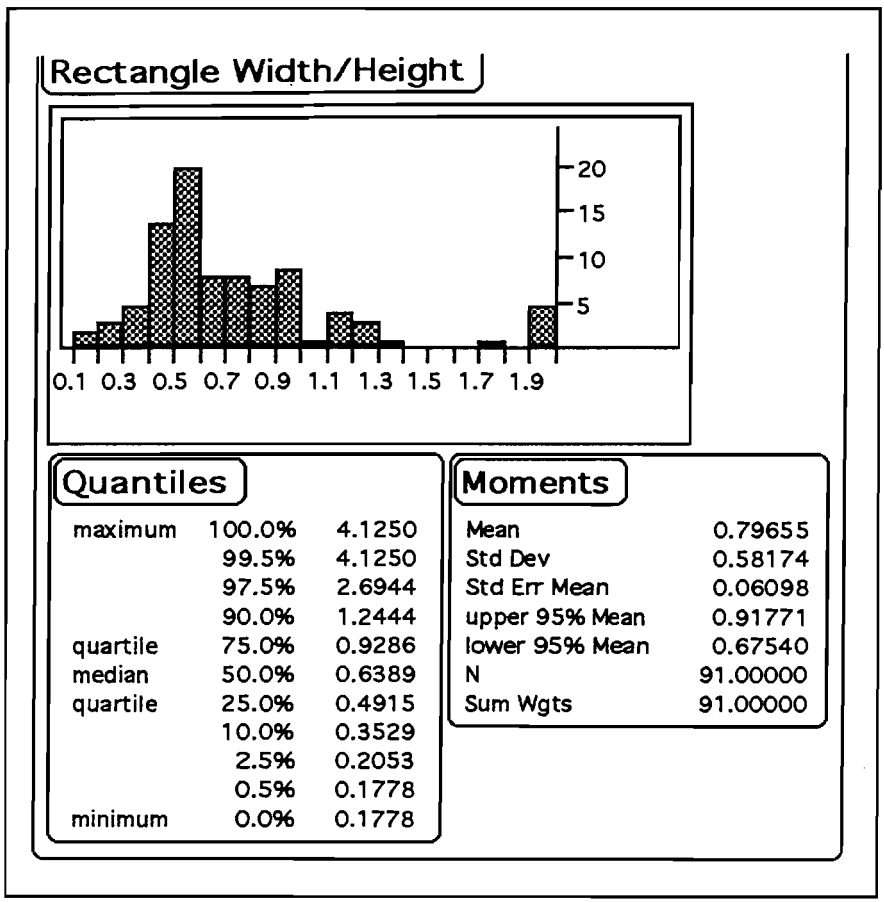

Figure 2. Distribution of the vase (rectangle) width/height ratios based on responses by ninety-one subjects in Experiment 1.

research on the golden section—due to the very nature of this concept—as opposed to relying on measures of central tendency. (In Figure 2, for example, *Mdn* = 0.64, which is misleading about the issue at hand.) This strategy has been pursued throughout the present article. Its use was first urged by Haines and Davies (1904) and later reiterated by Godkewitsch (1974), after numerous studies in the intervening years had used group means and arrived at misleading conclusions. The fact that Höge (1995) adopted the same strategy, made possible the above comparisons between the present study and his study.

A word is in order, with regard to the golden section, on the relationship between the line (mantelpiece) bi-section and the dimensions of the imaginary

vase (the drawn rectangle) serving as the bi-secting "device." Of the seven previously mentioned respondents who placed the center of the rectangle's base in the golden-section areas of the mantelpiece (6 were on the left side), two drew a perfect square and one a near-square. One sole person in the entire sample of ninety-one both placed the rectangle at the golden section of the mantelpiece *and* drew an almost-golden rectangle (0.586).

The Golden-Section Series Vases

In Table 2 is presented a summary of the students' placement of the five vases in the GS series on the mantelpiece (in the booklet pages; recall also that these 5 vases were considered one-by-one, in a random order, and interspersed with the 6 non-GS series vases).

The results in Table 2 are striking and easy to interpret. For all five vases, the mean and the median of the placements are close to the center of the mantelpiece, but as one examines the series from the largest vase (#1; see Table 1) to the smallest (#5), the dispersion increases both dramatically and in a highly orderly manner (see *SD*s, Quartile 75%, Quartile 25%, and the number of peaks, across the 5 vases). The larger the vase, the greater the number of respondents who place it close to the middle of the mantelpiece, whereas small vases are placed all over the place. Figure 3 is a graphic illustration of all of the above points.

Table 2. Placement of the Golden-Section Series Vases[a]

	Vases				
	1	2	3	4	5
Mean	81.70	78.95	81.12	80.37	74.67
SD	26.56	29.02	36.97	48.71	53.15
Quartile 75%	88.00	88.00	114.00	128.00	127.00
Mdn	80.00	81.00	80.00	79.00	80.00
Quartile 25%	76.00	72.00	55.00	37.00	19.00
Peaks	1	1	2	5	4
Highest Peak	75-82.5	75-82.5	75-82.5	15-22.5[b]	82.5-90
2nd highest			52.5-60	135-142.5[b]	15-22.5
3rd				52.5-60[c]	150-157.5
4th				75-82.5[c]	*60-67.5*
5th				120-127.5[c]	

[a]Experiment 1; $N = 91$; scale: 0-165 mm; values are distances in mm from the left end of the mantelpiece (left end = 0); golden section: 63,102 mm; golden-section areas: 61-65 and 100-104; the italicized interval contains a golden-section area.

[b] and [c] Designate two sets of shared ranks.

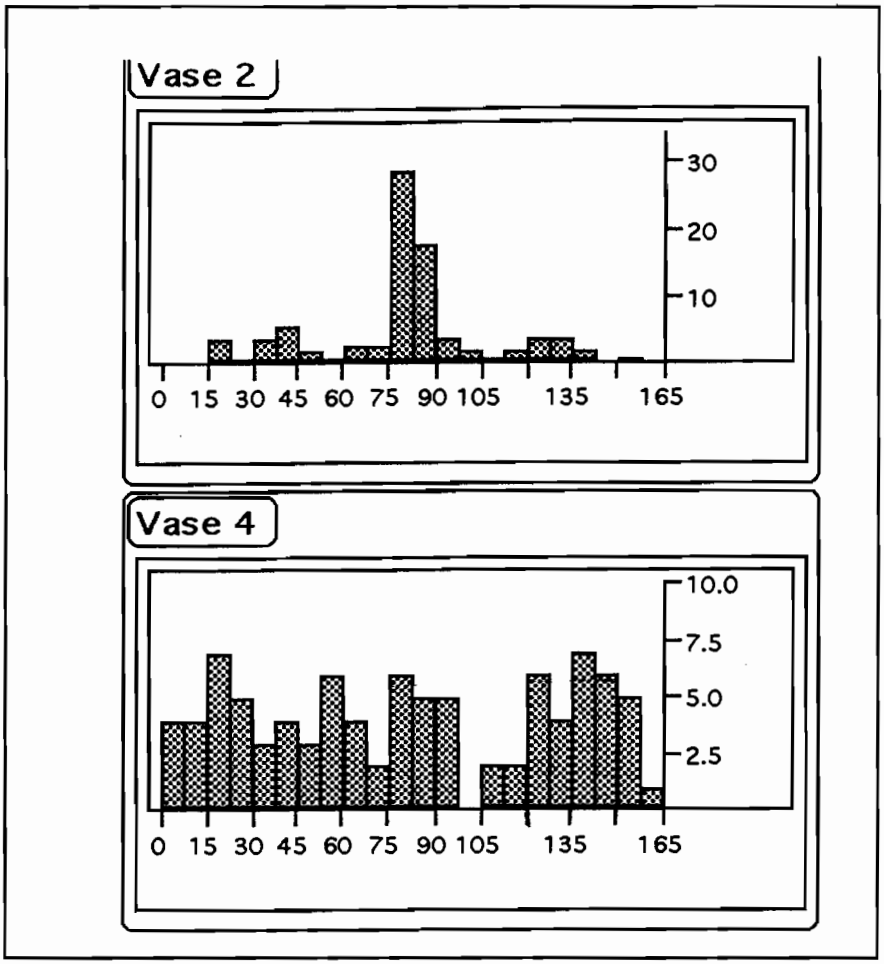

Figure 3. Distributions of placements on the mantelpiece for Vase #2 and Vase #4 (both from the GS series) by ninety-one subjects in Experiment 1.

As can be seen from both Table 2 and Figure 3, the role of the golden section is almost nonexistent. Among the peak intervals listed in Table 2, only one contains a golden-section area: This is the 4th-highest peak of the distribution for the smallest vase, #5; even this interval actually includes only four golden-section-area choices.

In short, the respondents seemed to have been seeking *balance*, not a golden-section partition of the mantelpiece by means of these GS series vases. The larger vases, even if represented only by rudimentary two-dimensional contours, and

with the response being a simple "x" on a line representing a mantelpiece on a booklet page, seemed to have not just a greater area, but a greater "weight" imputed to them—which required centralized, balanced placement. The wide dispersion of the smaller vases suggests that asymmetry was tolerable, or sought, when the "threat" to balance was minimal.

The Non-Golden-Section Series Vases

A statistical summary of the placement of the six vases in the non-GS series is presented in Table 3.

Remarkably, literally every point made in the previous section of the article regarding the placement of the GS vases, including the negligible significance of the golden section, is valid for the non-GS vases also. The findings are further illustrated in Figure 4.

As is evident in all the measures of dispersion in Table 3, the drive for balance affected very similarly the students' placements of the non-GS vases from both the "plump" (Vases #6, 8, 10) and the "slim" (#7, 9, 11) sub-series. When the six vases are considered together, it becomes obvious that the subtle differences in the respective methods of construction of the two sub-series (that resulted in different vase shapes and could have reasonably been expected to have aesthetic relevance) were, in fact, entirely overridden by the vase *area*. As has already been stated above in slightly different terms: The greater the area of a vase, the smaller the perceived latitude to place it away from the center of the mantelpiece.

Table 3. Placement of the Non-Golden-Section Series Vases[a]

	Vases					
	6	7	8	9	10	11
Mean	78.88	83.89	82.09	74.29	79.79	88.76
SD	23.00	35.20	30.70	40.10	40.94	52.01
Quartile 75%	86.00	107.00	110.00	113.00	116.00	142.00
Mdn	80.00	82.00	83.00	75.00	82.00	87.00
Quartile 25%	76.00	54.00	56.00	39.00	45.00	43.00
Peaks	1	3	4	5	5	4
Highest Peak	75-82.5	75-82.5	82.5	75-82.5	82.5-90	150-157.5
2nd		45-52.5[b]	105-112.5	45-52.5	45-52.5	82.5-90
3rd		22.5-30[b]	*60-67.5*	30-37.5	135-142.5	7.5-15[c]
4th			45-52.5	127.5	15-22.5	135-142.5[c]
5th				*97.5-105*	112.5-120	

[a]Experiment 1; *N* = 91; scale: 0-165 mm; values are distances in mm from the left end of the mantelpiece (left end = 0); golden section: 63,102 mm; golden-section areas: 61-65 and 100-104; the two italicized intervals contain golden-section areas.

[b] and [c] Designate two sets of shared ranks.

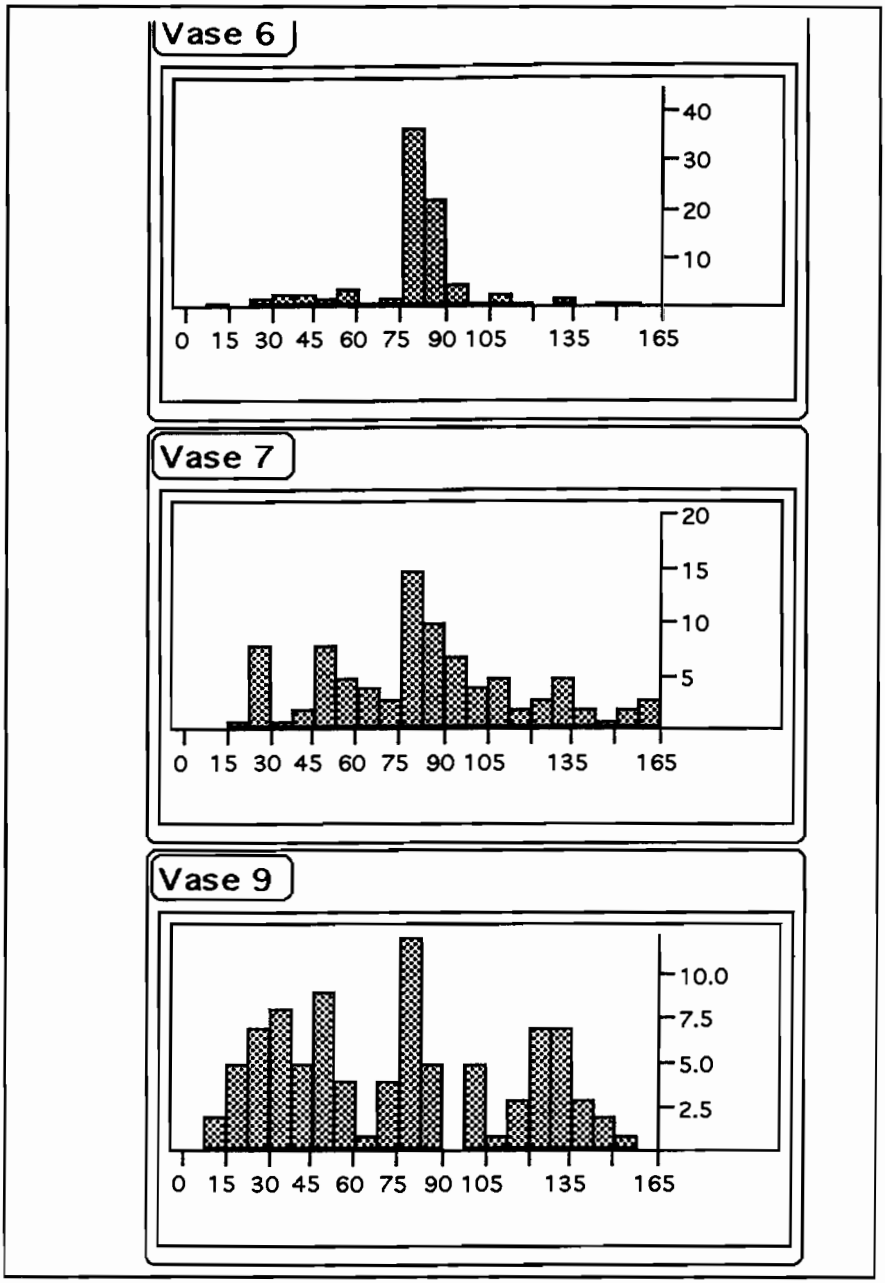

Figure 4. Distributions of placements on the mantelpiece for Vases #6, #7, and #9 (all from the non-GS series) by ninety-one subjects in Experiment 1.

As Table 4 shows, this rule is applicable to all eleven vases (the GS and the non-GS ones in both sub-series) considered together. For example, the rank-difference correlation between the area sizes of the eleven vases and the *SD*s of their placement is very high: *rho* = –0.95.

EXPERIMENT 2

The eleven "vases" used in Experiment 1 were presented as two-dimensional contours on successive booklet pages and the research participants, working in a classroom situation, "placed" them by writing an "x" on a "mantelpiece"—a 165-mm line drawn on a page. Therefore, although the conceptual introduction of an aesthetically meaningful object, which was to be related to a significant real-world location, by an aesthetically meaningful choice of placement, perhaps made the experiment a significant improvement—in terms of ecological validity—over the typical efforts in this research tradition, various aspects of the experiment were highly artificial and the possibility of generalization to real-life aesthetics remained dubious. Various features of Experiment 2 were intended to remedy some of these shortcomings.

Method

Research Participants and Setting

Eighty-seven students (gender data were not kept), drawn from various lower-division psychology courses, who received experimental credit, participated in Experiment 2. They were seen individually in a large room (length: 735 cm;

Table 4. Vase Area and the Dispersion of Placement

Vases	Area[a]	*SD*	Qtl 75% minus Qtl 25%
1	3213	26.56	12
6	2549	23.00	10
7	1704	35.20	53
2	1225	29.02	16
8	638	30.70	54
3	469	36.97	59
9	425	40.10	74
4	178	48.71	91
10	157	40.94	71
11	106	52.01	99
5	68	53.15	108

[a]Approximate area, in mm^2, Experiment 1.

width: 357 cm; height: 275 cm), which is part of the author's psycho-aesthetic laboratory suite on the UCSD campus.

Experimental Materials, Instructions, Procedure

All furniture was removed from over a half of the room and a realistic, solid, beige-colored mantelpiece, made of wood (without the fireplace), was erected, near-centrally, against the 357-cm-long wall at the room's empty end (the distance from the left end of the mantelpiece to the nearest wall was 97 cm, and from the right end 95 cm). The dimensions of the top, overhanging section of the mantelpiece were: Length: 165 cm; width: 30 cm; and height: 9 cm. The supporting bottom section had a length of 162 cm, a width of 26 cm, and a height of 127 cm. Thus the overall height of the mantelpiece was 136 cm. The shape and dimensions of this laboratory mantelpiece are entirely plausible.

The front of the top section of the mantelpiece was at its base attached by hinges; it could thus be easily and relatively unobtrusively opened by the experimenter to reveal a 0-165-cm measurement tape, spanning the entire length of the top section of the mantelpiece, the "0" point being at the left end.

Eleven vases were again used as experimental stimuli. Their dimensions (see Table 1) were ten-fold magnifications of those in Experiment 1. The vases were constructed out of black 5-mm-thick "foam core-board." At the back of each vase, there was an unobtrusively placed support-leg that allowed the vase to be free-standing.

When a student arrived, (s)he was given the following instructions by the experimenter (Robert Y. Kodama, a UCSD undergraduate assisting with this research):

> This experiment is being conducted in order to obtain more information about aesthetic preference. The study will begin by your sitting in this chair (a chair was placed centrally 350 cm from the mantelpiece) and being handed a vase (the vases were placed upright, in 3 columns, on a table at the opposite end of the room to the mantelpiece and even a cursory look revealed that they differed radically from each other in dimensions, but not in type or color), which you are then to place somewhere on this mantelpiece. The exact location is entirely up to you, and you should place the vase where you would most like it to remain. In other words, place the vase on the mantelpiece where it is most visually pleasing to you. You may take your time, move around the room, and make adjustments to the position of the vase before your final decision is reached. When your decision is final, please sit down again. I will then remove the vase from the mantelpiece, hand you a different vase, and you will then repeat the process. There will be a total of eleven different vases and all eleven of your decisions are equally important. Try to imagine and treat this as a mantelpiece in your own home. You have just bought a vase that you thought would look perfect on your mantelpiece, but you need to figure out exactly where.

Once any questions had been answered (without providing additional information), and the subject had signed the consent form, the experimental session began. The order, the same for all subjects, in which they were handed the vases to place on the mantelpiece, was identical to that in which the vases had been presented on the consecutive booklet pages in Experiment 1. After the student had finalized the position of a vase and sat down, the experimenter opened the front of the top of the mantelpiece, recorded the distance of the vase from the left to the nearest cm, removed the vase, and handed the next one to the student. An average session lasted about twenty minutes. Figures 5 and 6 show Vase #2 (from the GS series) and Vase #9 (non-GS), respectively, in different positions in the mantelpiece context.

Results and Discussion

The Golden-Section Series Vases

In Table 5 is presented a summary on the students' placement of the five GS vases on the mantelpiece.

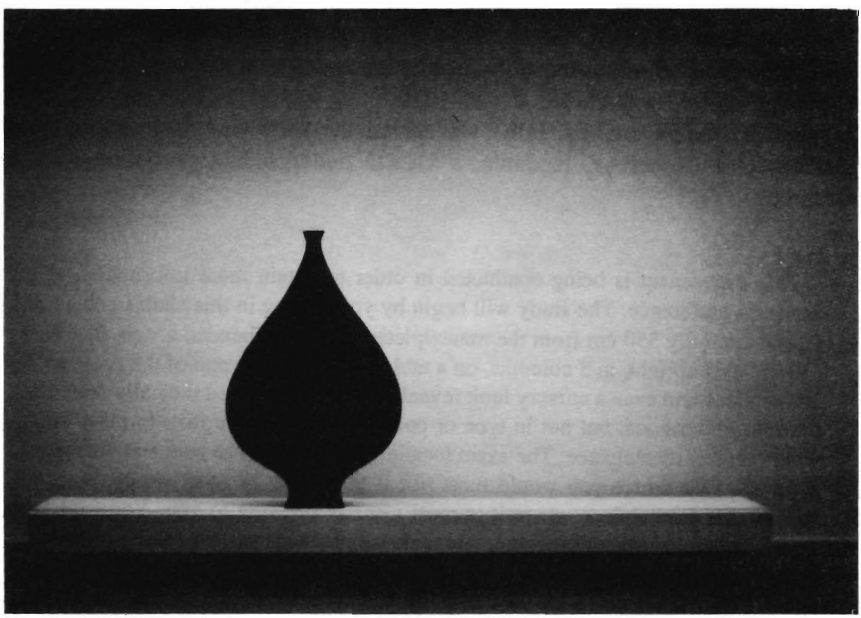

Figure 5. Vase #2 (GS series) at the left golden-section point (63 cm from the left end) of the 165-cm mantelpiece (Experiment 2).

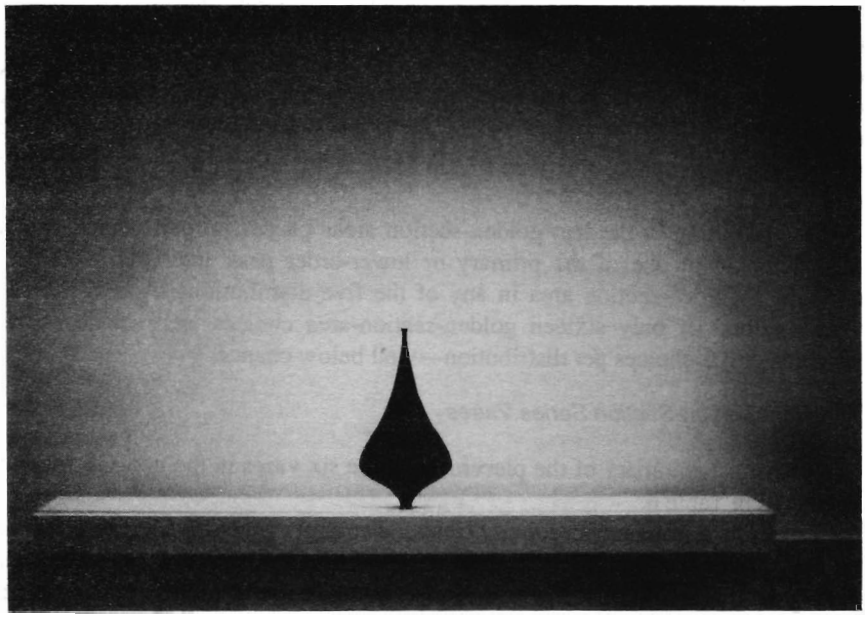

Figure 6. Vase #9 (non-GS series) at the center of the mantelpiece (Experiment 2).

Table 5. Placement of the Golden-Section Series Vases[a]

	Vases				
	1	2	3	4	5
Mean	83.46	82.77	79.49	74.29	81.78
SD	25.63	33.70	38.64	46.69	53.31
Quartile 75%	85.00	102.00	111.00	118.00	137.00
Mdn	81.00	83.00	82.00	78.00	81.00
Quartile 25%	79.00	60.00	45.00	30.00	28.00
Peaks	1	3	3	4	5
1st	80-85	80-85	80-85	80-85	80-85
2nd		20-25	40-45	45-50	155-160
3rd		130-135	135-140	10-15	5-10
4th				135-140	140-145
5th					125-130

[a]Experiment 2; $N = 87$; scale: 0-165 mm; values are distances in cm from the left end of the mantelpiece (left end = 0); golden section: 63,102 cm; golden-section areas: 61-65 and 100-104.

A comparison of the results in Table 5 with the analogous ones in Experiment 1 (see Table 2) reveals similarities that are so striking and so detailed that little comment is needed. Decreasing vase size is accompanied by a dramatic and orderly increase in dispersion from the center of the mantelpiece (82.5). For example, for Vase #1, Quartile 75 percent is 85, and Quartile 25 percent is 79; the corresponding values for Vase #3 are 111 and 45, and for Vase #5 137 and 28 (see Table 5).

Choices falling in the two golden-section areas played no part whatsoever in this picture. Not one of the primary or lower-order peak intervals in Table 5 contains a golden-section area in any of the five distributions. Across the five vases, a total of only sixteen golden-section-area choices were made by the subjects, or 3.2 choices per distribution—well below chance.

The Non-Golden-Section Series Vases

A statistical summary of the placement of the six vases in the non-GS series is presented in Table 6.

The results are again exceedingly clear and strongly supportive in every respect of the findings in both Experiment 1 (for the non-GS-series vases; see the analogous Table 3) and of those presented in the previous section of the present experiment, dealing with the GS-series vases (see Table 5). Among the similarities is the fact that a grand total of only twelve golden-section-area choices—

Table 6. Placement of the Non-Golden-Section Series Vases[a]

	Vases					
	6	7	8	9	10	11
Mean	81.91	73.13	87.00	83.94	84.28	78.59
SD	25.45	32.74	39.36	40.75	46.78	49.32
Quartile 75%	84.00	82.00	119.00	120.00	131.00	125.00
Mdn	82.00	80.00	82.00	82.00	83.00	82.00
Quartile 25%	80.00	49.00	48.00	52.00	45.00	33.00
Peaks	1	2	5	5	4	6
Highest	80-85	80-85	80-85	80-85	80-85	80-85
2nd		50-55	45-50	115-120[b]	135-140	35-40
3rd			115-120	130-135[b]	20-25	10-15[c]
4th			35-40	140-145[b]	105-110	130-135[c]
5th			140-145	20-25		150-155[c]
6th						105-110

[a]Experiment 2; $N = 87$; scale: 0-165 mm; values are distances in cm from the left end of the mantelpiece (left end = 0); golden section: 63,102 cm; golden-section areas: 61-65 and 100-104.

[b] and [c] Designate two sets of shared ranks.

very few indeed—were made by the students regarding the placement of the six vases (2.0 choices per distribution and again well below chance).

As was the case in Experiment 1, the vase-area effects on placement completely overwhelmed any differences between the "plump" vs. the "slim" subseries: The greater the area of a vase, the greater the proportion of people who found it pleasing to place that vase close to the center of the mantelpiece. (Whether or not one should properly speak of volume, rather than area, of these vases is debatable. They were free-standing objects that could be handled, and they certainly differed in weight, but were nevertheless cutouts with a negligible, and fixed, thickness. Since flowers could not be put into them, common sense favors area.) Analogously to the data presented in Table 4 regarding Experiment 1, the rank-difference correlation in Experiment 2, for all eleven vases, between their area size and the respective *SD*s of their placement, was very high: *rho* = –0.98.

EXPERIMENT 3

In the first two experiments, the research participants' relative preference for the different vases, either individually or as members of the GS series and the two non-GS sub-series, respectively, was not investigated. In the final experiment students were given the opportunity to choose their favorite among the eleven vases, with a view to placing it on a particular mantelpiece, and then to indicate where on that mantelpiece they would, in fact, place the chosen vase.

It was of interest to see whether the subjects' preferences would be guided by factors such as the geometry of the design of the vases (GS vs. non-GS, shape, size of area). Furthermore, one could examine whether the placement distributions of the most frequently selected vases matched those obtained in the first two experiments for the same vases. For example, would the golden section play a more significant part in the bi-section of the mantelpiece when the location on the mantelpiece of only one—his or her favorite—vase was being considered by a student?

Method

The main results of Experiments 1 and 2 showed, unexpectedly but unequivocally, that individual participation by the subjects, and the greater realism of the setting, materials, and measurement, all had very little effect. Therefore, in the present experiment, a mixture of elements from the first two studies was used in order to facilitate the data collection. Every attempt was made, however, to increase the generalizability of the results by frequent references in the instructions to analogous, "real-world," settings and choices.

Research Participants and Setting

Seventy-three students, enrolled in "Psychology and the Arts" at UCSD (the same upper-division course taken by the sample in Experiment 1, but taught a year later), provided the data during a class session in a state-of-the-art, inclined auditorium.

Experimental Materials, Instructions, Procedure

The eleven vases used in Experiment 2 were presented simultaneously. They were placed upright, next to each other, on the chalk tray of the blackboard. The placement of the vases from the students' left to right was identical to the order in which the vases were presented sequentially in Experiments 1 and 2 (Vase #9, #2, . . . to #3, which was rightmost). Above each vase on the blackboard, a number from "1" to "11" was written, from left to right. Elsewhere on the blackboard was drawn a thick horizontal line, 165 cm long. Each student was given a single sheet of paper with a 16.5-cm line drawn on it. The appearance of this sheet and line was identical to that of the first three booklet pages in Experiment 1.

Instructions were given orally by the author (who taught the course). "This is a standard experiment in aesthetic preference. Your participation is voluntary, anonymous, important, and much appreciated. There are no right or wrong responses. Imagine that you have moved into a new apartment, in the living-room of which there is a fireplace. Above the fireplace is a mantelpiece: Its actual size is shown on the blackboard. The horizontal line on the sheet you were given is exactly a ten-fold reduction of the length of the mantelpiece you see on the blackboard. Please treat the line on the sheet as being proportional to the mantelpiece. Now imagine that you are in a store where valuable decorative objects are sold. You came there to buy a vase which you want to put on the mantelpiece in your apartment. You want only one vase. Now imagine that these are the vases one can buy in that store. This is an important and expensive decision for you. Which one of these vases would you buy? Consider carefully and simply express your personal taste. Once you have made up your mind, please write on top of the page the number of the vase, from one to eleven, that you have chosen."

After the students made their individual choices, the instructions continued: "Now you have arrived home with your valuable purchase. You must decide exactly where on the mantelpiece to put the vase you bought. Look again carefully at the blackboard, at the vase you just chose, and write an "x" on the line where your vase would look best—keeping in mind the proportional relationship between the line on the sheet and the actual mantelpiece length on the blackboard. The exact position of the vase is also an important decision. You and your visitors will look at it daily."

Later in the course, in a lecture on the golden section, the rationale of the experiment was explained to the students.

RESULTS AND DISCUSSION

In Table 7 are presented the rather striking results of the first part of Experiment 3, the students' choices of their favorite vase. From the eleven available alternatives, thirty-five of the seventy-three subjects chose the same vase, #2. This vase is from the GS-series (see Figure 5 for its appearance), but note that the next three most-preferred vases—each, admittedly, not chosen much above chance (which was 7)—were all from the non-GS series, and together account for over 38 percent of the choices. (See Figure 6 for the appearance of Vase #9; recall that the ratio of its height, 41.3 cm, to the length of the mantelpiece, is 0.25, the same being true for Vase #8; the analogous ratio is 0.50 for Vase #7.) Also note that four of the vases, the two smallest ones from both the GS- and non-GS-series, were not chosen by a single subject.

The pattern of results was anything but random and suggests that the task was taken seriously by the students. Yet these results cannot be easily explained. The students' preferences clearly did not favor the GS-series vases as a category, nor were they sensitive to the differences between the plump vs. the slim non-GS-sub-series. The fact that in both the GS and the non-GS series the extreme members at both ends were shunned, certainly does not explain the singular popularity of Vase #2. The rank-difference correlation between vase area and choice, for the seven vases that were chosen by someone, was modest,

Table 7. Choice of Vases[a]

Vase[b]	Number and % Choosing[c]
1	1 (1.37)
2	35 (47.95)
3	4 (5.48)
4	0
5	0
6	5 (6.85)
7	9 (12.33)
8	10 (13.70)
9	9 (12.33)
10	0
11	0

[a]Experiment 3.
[b]See Table 1 for the dimensions of the vase stimuli; see Table 4 for the vase areas; see Method section, Experiment 1, for the order of presentation of vases.
[c]$N = 73$.

rho = –0.35, and quite meaningless, given that the areas of Vases #2, 7, 8, and 9 (the 4 vases that accounted for 86% of the choices) were quite unrelated to their appeal. Finally, since all the vases were in view throughout the ten-minute experiment, it makes little sense to speculate that some version of a hedonic primacy effect (assuming a left-to-right initial scan) was responsible—at least as a major factor—for the numerous choices of Vase #2 (which was 2nd from the left in the randomly determined order of presentation).

Instead, one may well have stumbled on Vase #2 as an illustration of why the prediction of aesthetic appeal and choice, especially in context, is so difficult. The shape of this vase is based on golden-section geometry, but perhaps that would have meant little, as in the overwhelming majority of findings in the experiments reported in this article, had its considerable area (large, but not extreme) not made it appropriate—given the instructions that emphasized value, aesthetics, and permanence—for something worthy of a home's aesthetic focus. Such factors may have not been enough to distinguish Vase #2 from its competitors, had the instructions not forced the choice into a highly defined setting, in geometric and aesthetic terms. As described in the Method section of Experiment 1, Vase #2 is mathematically related to the mantelpiece: The height of the vase is equal to the shorter of two segments that add up to the length of the mantelpiece, with the ratio of the two being the golden section. Even so, Vase #2 may have not been so favored had it not been the first mid-range vase the subjects saw as they scanned the row of vases from left to right.

The next issue to be addressed is the distribution of placements of Vase #2 on the mantelpiece by the thirty-five subjects who had chosen this vase. (Meaningful discussion of the distribution of placements of the other 6 vases was precluded by the low frequency of their being chosen.) The distribution is presented in Figure 7.

It is of interest to note the considerable similarity between this distribution and that for the placements of the same vase when it was presented in contour form in a booklet in Experiment 1 (see the top panel of Figure 3). Furthermore, both distributions were similar to that obtained for the placements of the same vase on the laboratory mantelpiece in Experiment 2. Thus in three different experiments, regardless of the many differences in experimental settings and tasks, one finds that a very large proportion of the placements of Vase #2 is made at the center of the mantelpiece.

Of the three Vase #2 distributions, the only one with any secondary peaks is in Figure 7 (the 37.5-45 and 120-127.5 intervals, with 4 choices in each), meaning that a total of some 23 percent of the subjects who picked Vase #2 placed it in the 0.25 or 0.75 areas of the mantelpiece. One might speculate that people dare—in significant numbers—to venture away from the center of the mantelpiece with a relatively large vase (such as #2) only when it has been "personalized" by their having picked it from among many alternatives. Even then, the shift is to proportions related to the midpoint, not to the golden section.

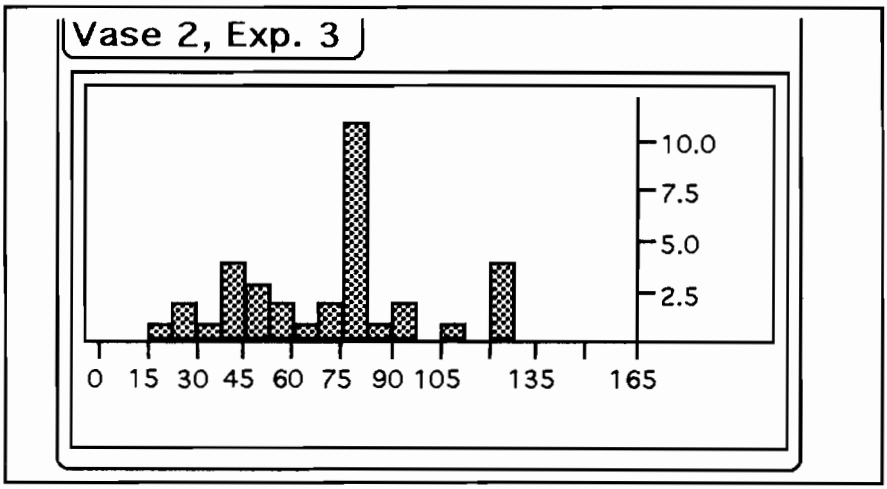

Figure 7. The distribution of placements on the mantelpiece for Vase #2 (GS series) by the thirty-five subjects who chose this vase from eleven alternatives in Experiment 3.

After all, as can be seen in Figure 7, the distribution is also similar to the other two Vase #2 distributions in that the role of the golden section was again minuscule, or, rather, in the Figure 7 data, completely non-existent: Only one subject placed Vase #2 even close to a golden-section area (60). In fact, there were literally no golden-section area placements for any of the seven chosen vases, by any of the seventy-three students, in Experiment 3.

GENERAL DISCUSSION AND CONCLUSIONS

This last part of the article is divided into three sections. The first two address substantive issues—the golden section and balance. The third deals with methodological questions, especially ecological validity.

The Golden Section

Across the three experiments, there were five general task situations in which the subjects were given an opportunity to express a preference for the golden section.

Line (Mantelpiece) Bi-Section

In the psycho-aesthetic search for the golden section, horizontal line bi-section is one of the venerable tasks that dates back to Fechner (1876) and, especially,

Angier (1903). Subjects in the experiments reported here bi-sected the mantelpiece by:

(1) an "x" mark;
(2) and "x" with a vertical line drawn above it;
(3) an "x" as the center of the base of a rectangle drawn above it;
(4) five GS series vase contours;
(5) six non-GS series vase contours [(1)-(5) in Experiment 1];
(6) five GS series free-standing vase cutouts;
(7) six non-GS series free-standing vase cutouts [(6) and (7) in Experiment 2]; and
(8) their favorite free-standing vase cutout among eleven alternatives (in Experiment 3).

Under none of these circumstances was there any evidence whatsoever for the significance of the golden section in the horizontal line (mantelpiece) bi-section.

In Angier's (1903) study, the subjects were instructed to seek the most pleasing line division other than the midpoint, and even then it was only the group mean that fell at the golden section. Fechner (1876, p. 192) far-sightedly warned that the center would overpower the golden section in horizontal line division; and Berlyne (1971, p. 226), with his usual good judgment, quoted Fechner on this point.

Conclusion 1: The golden section is seldom observed in the bi-section of a horizontal line (mantelpiece), and this is true regardless of the nature of the bi-secting task or object.

Height and Contextual (Mantelpiece) Length

The experiments reported here are the first in the literature on the golden section to examine systematically the relationship between height and its horizontal *context*, specifically:

(1) the height of the subject-produced vertical line (above the "x" line bi-section) to the horizontal line (mantelpiece length); and
(2) the height of the subject-produced rectangle (the vertical vase dimension) to the horizontal line (mantelpiece length); [(1) and (2) in Experiment 1].

The ratios of the midpoints of the respective modal intervals of (a) the vertical-line height distribution, and (b) the rectangle height distribution, to the length of the mantelpiece, were both 0.15.

Conclusion 2: The golden section does not play a role in the choice of either heights of vertical lines, or of heights of rectangles, relative to the length of the horizontal placement context (the mantelpiece).

Another point is worth making about height, horizontal context, and the golden section. In both Experiments 1 and 2, the height of Vase #1 in the GS series was in

a golden-section relationship to the length of the mantelpiece, whereas the ratio of the height of Vase #6 (the largest in the non-GS series), for example, to mantelpiece length, was 0.50. Yet there was no evidence that the respective relationships between the heights of these two vases and mantelpiece length differentially affected the research participants' placement decisions. For example, Vase #2 was just as unlikely to be placed in a golden-section area as was Vase #6.

Conclusion 3: The fact that the height of a vase was 0.618 of mantelpiece length had no particular differential effect on its placement.

Width and Contextual (Mantelpiece) Length

On p. 3 of Experiment 1, the subjects indicated the width of their ideal imaginary vase (rectangle). The ratio of the midpoint of the modal interval of the width distribution to mantelpiece length was 0.09.

Conclusion 4: The golden section does not play a role in the choice of width of a vase (rectangle) relative to the length of the horizontal placement context (the mantelpiece).

The width of Vase #1 (63 mm and cm, in Experiments 1 and 2, respectively) was 0.618 of the remaining mantelpiece length (102 mm and cm, respectively). This fact did not differentially affect the subjects' placements of the vase.

Conclusion 5: The golden-section relationship that exists between the width of a vase and the remaining horizontal space has no differential effect on its placement, compared to that of other vases.

Rectangles

To indicate the height and width of their imaginary ideal vase (p. 3, Experiment 1), each subject drew a rectangle. Only five research participants (6%, which is chance level) drew rectangles with the ratio of sides falling in the golden-section areas, as defined in this article (0.59-0.65 and 1.54-1.69).

Conclusion 6: "Golden rectangles" are infrequent; they are produced at the level expected by chance.

As noted earlier, in Höge's (1995) experiment, the result was very similar (of the 248 rectangles drawn by 62 subjects under different conditions, only 17, under 7%, drew golden rectangles—and that by Höge's, slightly more liberal definition of 0.59-0.659). This similarity is all the more impressive given a procedural difference between the experiments: Höge's subjects were given the horizontal dimension.

Another procedural difference which did not affect the relative frequency of golden rectangles in the two experiments, but may have affected the relative frequency of squares, is that whereas in Experiment 1 the term "rectangle" was used in the instructions, Höge used "quadrangle." Although, strictly speaking, squares geometrically belong to the family of rectangles, the term "rectangle" is

often used in common parlance specifically to indicate a non-square. This may have depressed the incidence of squares in the present Experiment 1. "Quadrangle," in contrast, errs in the opposite direction by too strongly suggesting "squareness"—which may have inordinately boosted the incidence of squares in Höge's study.

Finally, to emphasize a point made earlier, which stems from Conclusions 1 and 6: Only one person in the sample who drew an almost-golden rectangle (0.586) also placed the rectangle in a golden-section area of the mantelpiece.

Conclusion 7: Even when golden rectangles are produced, they are not used to bi-sect the mantelpiece in golden-section terms.

Preference for Vases

Although almost a half of the subjects in Experiment 3, when given the choice of all eleven vases, selected Vase #2, from the GS series, the results showed that there was no general preference for the vases from this series. Only five additional subjects chose GS vases other than #2, and two of the five GS vases were not chosen by a single person.

Conclusion 8: Using the golden section as the basis of the shape of an aesthetic object by itself does not ensure its appeal.

What is To Be Done?

A rather wide range of experimental tasks was used in the three experiments reported here. The golden section was looked for in traditional places (line bi-section, rectangles), new places, and all sorts of nooks and crannies—all to no avail. Particularly disappointing and exasperating was the failure to find any evidence for its importance in tasks that seemed more ecologically valid and closer to the aesthetic choices people make in the "real world." To this author, at least, the negative evidence seems overwhelming.

Two possibly useful realizations arise from all this. The first is based on the popularity of Vase #2. As was already suggested in the Discussion section of Experiment 3, perhaps the golden section does play an important role, after all, but only as a contributor to the third-, fourth-, or fifth-order interaction effects—as opposed to being a "main effect." Instead of saying (as the "GS-pessimists" do) that the golden section is a beautiful abstraction with no empirical reality in psycho-aesthetics, or that it is only one of a (relatively small) number of important aesthetic proportions (which even the "GS-optimists" concede), one ought perhaps to insist that complex and sophisticated multi-factorial experiments be done that could tease out the contribution of the golden section to aesthetic appeal.

The second realization leads to an even more critical view of the past research on the golden section and has clearer implications for future research. In this view, the problem really started with Fechner's confounding an empirical,

anti-Kantian "aesthetics from below," with the use of lay respondents, "subjects from below." One wonders why he thought that (even) museum visitors' preference between the "Darmstadt" and "Dresden" Madonnas could authenticate one as Holbein's (Marshall, Worthen, Brant, Shrader, Kahlstorf, & Pickeral, 1995). Just as Baumgarten and later Kant, in the eighteenth century, did not think of aesthetics as a discourse on beauty and taste applicable to all, neither did Zeising, in the nineteenth century, as the modern father of the golden section, think of it as a relationship visible (and audible) to all. Using and appreciating the golden section may have been a matter of education, knowledge, and cultural transmission among the creating and consuming *European elites*, across generations—from Euclid to Vitruvius to Fibonacci to Pacioli di Borgo to Kepler to Mondrian to Bouleau (to mention just a few links in the worlds of mathematics, philosophy, art, and monasteries). Berlyne (e.g., 1971), with his great erudition, but sometimes surprising methodological shortcomings, was on the right path by investigating the golden section (in rectangles) in Japan (1970; negative findings); but his (and Professor G. Hatano's) subjects were rural Japanese teenage girls. Had they also studied, as an $N = 1$, the great writer Yukio Mishima, who had a profound Hellenistic knowledge and used the golden section in his works, before his suicide by hara-kiri in the same year as Berlyne's publication, they most likely would have confirmed both the elitist and cultural points the present view advocates.

It may well be that some questions in psycho-aesthetics—and the golden section may be a prime example—cannot be properly investigated with lay subjects. Elite taste may force its way into public space in a major way, but it may not even then *permeate* public taste. Even if Ictinos, Callicrates, and Phidias (*phi* is for him) used the golden section on the Parthenon, and the Athenians loved it, it may not have become noticeable in their taste in vases.

Taking into account the issues of cultural and elitist transmission, as well as the problems inherent in $N = 1$ studies, the ongoing research program on the golden section in the author's laboratory has attempted to strike a compromise. Only well-established working painters are used as research participants. The stimuli are the slides of: (a) a subset of vases used in Experiments 2 and 3 (Vases #2, 4, 7, 9), each photographed at different mantelpiece locations [midpoint, golden-section left, golden-section right, controls left and right (0.30, 0.70); see Figures 5 and 6 as examples]; (b) eight paintings by a little-known artist, which contain—in their key structural elements—both the GS and non-GS proportions (intentionally and unintentionally produced); (c) two paintings by Whistler and two by Mondrian, each of which contains—as key structural elements—both the GS and non-GS proportions. The subjects-painters' task is to sketch the visual image in each slide "veridicaly, accurately, and realistically."

Some of the hypotheses are: (a) these trained painters will *measurably* capture, in their sketches, the "important" proportions, including the golden section, more accurately than the unimportant ones; (b) this differential effect will be stronger

with paintings as stimuli, as opposed to the vase stimuli; and (c) it will be even more pronounced with paintings by great painters, irrespective of whether a painter is known or not known to be a golden-section "specialist." These hypotheses are based on a number of assumptions, anecdotally verified in interviews with painters, about their motivation, attitude when sketching, and approach to tasks and stimuli.

Put simply, in this experimental approach, the results may subtly help understand the painters' conscious and unconscious receptivity to the presumed beauty and significance of the divine proportion.

Balance

Although the experiments reported here were primarily concerned with the golden section, many of the results were informative about the issue of balance, which is a psycho-aesthetic problem that—with symmetry as its special case—matches in importance, and is related to, that of proportion (e.g., Locher 1996; Locher & Nodine, 1989; McManus, Edmondson, & Rodger, 1985; McManus & Kitson, 1995; Pierce, 1894; Voloshinov, 1996).

When the subjects were asked to bi-sect the mantelpiece by an "x," an "x" with a vertical line above it, and by a rectangle, the three response distributions were roughly normal and similar to each other in that the respective peaks were all located close to the center of the mantelpiece. Significantly, the production of a rectangle did not further increase the proportion of respondents choosing the central area. A considerable proportion of the students thus sought a symmetrical division of the mantelpiece into two roughly equal parts, but a deeper search for balance—that would have been indicated by the subjects' greater responsivity to having produced a rectangular area—apparently did not take place.

Conclusion 9: Drawing a rectangular area that is placed in a horizontal context does not increase the need to seek balance beyond that induced by the bi-secting decisions not involving area.

Furthermore, the height of the vertical line above the "x," and the height, width, and area of the rectangles the subjects drew were all totally unrelated to their respective placement on the mantelpiece. The last of these findings is especially important.

Conclusion 10: The area size of the drawn rectangle is irrelevant to the subject's perception of its balanced placement on a horizontal line.

The results were radically different when the students' task was the placement of vases. Regardless of the details of the experimental situation, or of the stimulus (including the mode of its presentation and shape), the bigger the size of the area of a vase, the greater the proportion of respondents who placed it close to the center.

Conclusion 11: The choice of placement of a vase on the mantelpiece strongly reflects the search for balance, which is guided by the area ("weight") of the vase.

To put things somewhat dramatically, it was as if the subjects cringed at the thought of the collapse of the mantelpiece and vase breakage.

Methodological Issues

The most significant methodological lesson to be learned from the results (see *Conclusions 9, 10, and 11*) is that the data for the rectangles in Experiment 1 are radically different from the data for the vases in Experiments 1 and 2. Given the long history of psycho-aesthetic research on the golden section and other proportions that has relied on rectangles (they were used in 25 of the 32 studies that Green, 1995, listed in his Table 1, pp. 962-964, "Summary of golden-section research"), this finding is very troubling. It casts serious doubts on the applicability of conclusions from the research on rectangles to real-world aesthetic objects with or without golden-section attributes.

It is worth noting that the difference in the results occurred despite the fact that in drawing a rectangle the subjects in Experiment 1 were thus supposed to indicate the height and width of their ideal imaginary vase. These instructions were not sufficient for the subjects to treat rectangles as vase-like objects.

In terms of the placement decision, the size of area of rectangles is simply not a factor, quite unlike the case for vases. The area encompassed by even a vase-shaped contour or cutout, which are perceived as being representations of a real-world object, carries far more "weight"—taken into account in placement and balance—than does an abstract rectangular area not linked to the web of real-world associations.

Conclusion 12: Rectangles (even when thought of as providing vase dimensions) have no "weight," yet even two-dimensional contours of vases do.

Researchers who are habitually concerned with the issue of ecological validity (and this group includes the present author, who has written extensively on this topic in several areas of psychology) may not be overly surprised by the results described above. Yet their confidence—in being able to pinpoint the experimental stimuli, tasks, and procedures in which the ecological validity is low—may well be shaken by another aspect of the present experimental results. The similarity between the results for the placement of vases in Experiment 1 and 2 is striking; this occurred despite many technical differences between the two experiments; above all, the vase results of Experiment 1 were fully replicated despite the fact that the stimuli, setting, and task in Experiment 2 clearly were all far more ecologically valid.

Once the concept of a real-world object—the vase—was introduced in Experiment 1, the differences between contours and cutouts, the differences in shape, and the differences in the subjects' task behavior, among others, were all overwhelmed by the search for balance that took only vase area (and presumably the associated volume and weight) into account.

Conclusion 13: Once the associations to a real-world object and setting have been established (the vase on the mantelpiece), the need to achieve balance with regard to the object's area (volume, weight) leads to robust findings, relatively insensitive to the details of the stimuli, tasks, and procedures.

The two sets of results mentioned above (together with the comparisons drawn in an earlier section of the article to Höge's 1995 findings) teach valuable lessons in methodological humility.

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