Perception, 2011, volume 40, pages 291 – 298

doi:10.1068/p6835

Aesthetic preferences in the size of images of real-world objects

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Received 24 September 2010, in revised form 27 January 2011; published online 12 April 2011

Abstract. Konkle and Oliva (in press, *Journal of Experimental Psychology: Human Perception and Performance*) found that the preferred ('canonical') visual size of a picture of an object within a frame is proportional to the logarithm of its known physical size. They used within-participants designs on several tasks, including having participants adjust the object's size to 'look best'. We examined visual size preference in 2AFC tasks with explicit aesthetic instructions to choose: "which of each pair you like best". We also used both within- and between-participants conditions to investigate the possible role of demand characteristics. In experiments 1 and 2, participants saw all possible image pairs depicting the same object at six different sizes for twelve real-world objects that varied in physical size. Significant effects of known physical size were present, regardless of whether participants made judgments about a single object (the between-participants design) or about all objects intermixed (the within-participants design). Experiment 3 showed a reduced effect when the amount of image detail present at different visual sizes was kept constant by posterizing the images. The results are discussed in terms of ecological biases on aesthetic preferences.

1 Introduction

In earlier research, Konkle and Oliva (in press) found that the preferred visual size of a picture of an object is proportional to the logarithm of its known physical size. They showed that, when viewing pictures of objects of different physical sizes within a frame, smaller sizes within the frame were preferred for smaller objects in the real world (eg strawberries or a key), whereas larger sizes in the frame were preferred for larger real-world objects (eg a piano or chair). They called these effects 'canonical size' in analogy with Palmer et al's (1981) 'canonical perspective' effects, showing that people systematically prefer some perspective views of objects over others. Konkle and Oliva employed within-participants designs using multiple objects of differing physical sizes in several tasks, including a perceptual-preference task, in which participants were asked to view images of real-world objects on the computer monitor and to adjust the image size so that the object 'looked best'. They found that, when observers could freely resize objects on the screen, the preferred visual size of the object was proportional to the logarithm of its known physical size. Thus they concluded that knowledge about the physical size of objects systematically influences the visual size at which objects are preferentially viewed. In a similar vein, Bertamini et al (in press) recently analyzed images from two corpora of artistic images of diverse sizes of animals and found reliable positive correlations between the physical sizes of the animals depicted and the sizes of their drawn or painted images in both.

Unfortunately, neither of these findings settles the question we address here, namely whether there is an aesthetic bias for the sizes of images of objects to be systematically related to the physical sizes of those objects. Konkle and Oliva's instructions could be interpreted in two rather different ways: participants might choose the image that 'looks best' to be the one at which it 'looks most like the object it depicts' (analogous to Palmer et al's explicit instructions in their research on canonical perspective), or they might choose the image that they found to be 'most aesthetically pleasing'.

These tasks may or may not produce the same results. The findings of Bertamini et al (in press) may be interpreted as implying that the artists found the images of animals to be more aesthetically pleasing when their sizes were consistent with the sizes of the depicted animals, but we do not know that this is why they drew or painted them in this way, and we do not know whether viewers might also see them as more aesthetically pleasing when a canonical size bias is present in the images.

Because we are particularly interested in the aesthetic question (cf Palmer et al 2008; Sammartino and Palmer, submitted), we repeated Konkle and Oliva's experiment using explicit aesthetic instructions, asking participants to choose the picture that they 'liked best' (rather than the one that 'looks best'). We were also concerned about possible demand characteristics that might influence size preference judgments. Konkle and Oliva showed the same participant many objects of different sizes, which might lead him/her to feel some implicit pressure to make responses consistent with the objects' known physical sizes. They replicated their effects with more restricted ranges of object sizes, but each participant still saw several objects of different sizes. To rule out the possible influence of demand characteristics, we employed both a fully between-participants design, in which each person saw only one object, and a fully within-participants design, in which each person saw objects of all different sizes.

In previous research on aesthetic response to spatial composition of pictures containing a single object, preferences for the vertical position of single objects within a rectangular frame were examined (Sammartino and Palmer, submitted). Sammartino and Palmer found an ecological bias in which preferences were driven by the typical viewer-relative position of the object in the world. Objects that are typically positioned above the viewer in the world (eg a flying eagle or a ceiling-mounted light fixture) are preferred higher in the frame than objects that are typically below the viewer (eg a swimming stingray or a bowl on a table). This effect, which might be termed 'canonical height', is consistent with their general principle of representational fit, according to which viewers are biased toward more positive aesthetic responses when the spatial characteristics of objects in the world are reflected in corresponding spatial characteristics of their images within the frame (Gardner and Palmer 2009, 2010; Palmer et al 2011). The present experiments can thus be understood as testing for an analogous ecological bias in the size dimension.

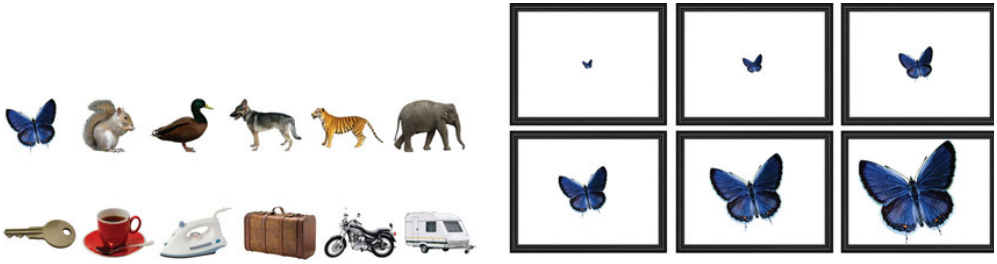
2 Experiment 1. Canonical-size effects on aesthetic judgments of multiple objects

In the first experiment, we repeated Konkle and Oliva's within-participants experiment using explicitly aesthetic instructions and a different set of objects and images. Rather than asking participants to judge images in terms of which 'looked best', we asked them to judge them in terms of which they 'liked best'. We also used a 2AFC method to avoid memory effects that may have been present in the adjustment procedure used by Konkle and Oliva.

2.1 *Method*

2.1.1 *Participants.* Twenty-three participants took part in the experiment. Fifteen were students at the University of California, Berkeley, who received credit as partial fulfilment of their course requirements. The other eight received compensation for participating. Their mean age was 20.7 years, ranging from 18 to 29 years. All were naive to the purpose 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.

2.1.2 *Design.* Each trial consisted of two images of the same object that differed only in size. There were thirty paired comparisons per object, resulting from all possible comparisons of six sizes of each object, balanced for left/right screen position. Six animals and six artifacts (see figure 1a) were used in the experiment, resulting in a total of 360 trials.



(a) (b)

Figure 1. [In color online, see http://dx.doi.org/10.1068/p6835] Examples of images used in experiment 1. Images of the animals and artifacts (a), and the full set of sizes for the butterfly image relative to the frame (b).

2.1.3 *Displays.* The estimated physical size of the objects along their longest dimension ranged from 1 inch to 12 feet for the animals and from 1 inch to 10 feet for the artifacts. High-resolution images were obtained from the Internet and their backgrounds were deleted. The images were presented in six different sizes constructed by starting with the high-resolution image at the largest size that would fill the frame without cropping and then reducing it to the smaller sizes using the bicubic resampling function in Photoshop. The sizes were reduced in equal intervals by area (ie bounding box area was 1 : 6, 1 : 3, 1 : 2, 2 : 3, and 5 : 6). For an overview of the different stimuli and sizes see figures 1a and 1b.

The monitor measured 20 inches diagonally, and had a resolution of 1280×768 pixels. Each image was presented in a frame that measured 600×450 pixels. The frames were presented side-by-side, with the center of the frames presented -125 pixels vertically and $+200$ pixels horizontally from the center of the screen.

2.1.4 *Procedure.* Participants sat in a darkened booth and were told that they would be presented with a series of image pairs that they were to judge for aesthetic preference. They were presented with a slide listing all objects that would appear in the experiment. They were also shown a slide of an object that did not appear in the experiment itself to indicate the different image sizes that would be presented in the experiment. In the 2AFC task participants were shown two centered, framed images of the same object in two different sizes relative to the frame. All object pairs were randomly intermixed. Participants were instructed to indicate which picture of each pair they liked better. A 2 s delay was enforced before participants could make their response to ensure that they really looked at the image pairs. After the 2 s delay, the statement "Please make your response" appeared at the bottom of the screen, at which time the participant had to press the left-arrow or right-arrow key, after which the images disappeared. All pairs were presented in a random order.

2.2 *Results and discussion*

The sizes of the images relative to the frame were represented as the integers from 1 (smallest) to 6 (largest). For each object and each participant, the average size chosen was calculated over all possible pairs. The averages of these data are plotted as a function of the logarithm of each object's physical size in figure 2. The correlation between the logarithm of the physical size and the average size chosen for the image of that object was +0.84 ($t_{10} = 4.9$, $p < 0.001$).

The best-fitting linear regression line predicting the average size chosen from the logarithm of the object's actual size had a positive slope of 0.30. We assessed the significance of this effect by computing the slope of the regression lines separately for each participant and found that the resulting slopes were reliably greater than zero ($t_{22} = 4.98$, $p < 0.001$).

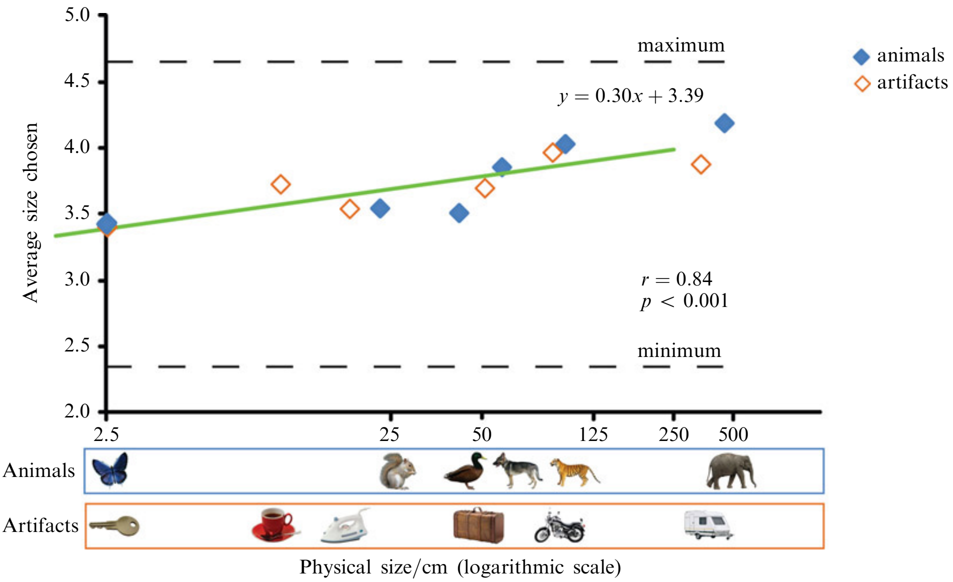


Figure 2. [In color online] Results of experiment 1. The average chosen size over all possible pairs for each animal (blue) and artifact (orange), plotted as a function of the logarithm of its physical size.

When objects have a smaller physical size, images of them tend to be preferred aesthetically when they are smaller relative to the frame and, when objects have a larger physical size, they tend to be preferred aesthetically when they are larger relative to the frame. The present results show that canonical-size effects are indeed present in aesthetic judgments, replicating Konkle and Oliva's findings for this aspect of canonical size. This result excludes the possibility that it is only present in evaluating images in terms of how much they look like the objects depicted. It is possible, however, that these effects were due to demand characteristics. In experiment 2, we addressed this issue by using a purely between-participants design.

3 Experiment 2. Canonical-size effects on aesthetic judgments of single objects

In experiment 2, we replicated experiment 1 using a between-participants design in which each participant saw only one of the animals from experiment 1. Because no participant knew that any other sizes of objects were being studied with other participants, the results should indicate whether the size effects in experiment 1 could have arisen from explicit or implicit consideration of the relative sizes of the objects they were judging. If so, the size effects in experiment 1 should disappear or be measurably reduced.

3.1 *Method*

3.1.1 *Participants.* Eighty-four participants took part in the experiment. Seventy-two of them were students at the University of California, Berkeley, who received partial course credit in an undergraduate psychology course for participating. The other twelve received compensation for participating. The mean age of the participants was 20.1 years, ranging from 18 to 29 years. All were naive to the purpose 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.

3.1.2 *Design.* Only the animal series from experiment 1 was used. In this between-participants design, each participant saw only one of the objects instead of all objects intermixed. Participants were randomly assigned to one of the six groups, each of which saw one of the 6 animals at all different sizes (see figure 1).

3.1.3 *Displays.* The displays were the same as those of experiment 1 except that each participant saw only pairs of pictures of a single animal.

3.1.4 *Procedure.* The apparatus and procedures were identical to those of experiment 1 except that each participant saw only pairs of pictures of a single animal.

3.2 *Results and discussion*

As in experiment 1, we calculated the average size chosen over all possible pairs for each object and each participant. The pattern of results replicated that in experiment 1, as indicated by a correlation of $+0.94$ ($p < 0.01$) between the average sizes chosen in experiment 1 and the average sizes chosen for the same object in experiment 2. We also analyzed the data in the same way as for experiment 1. The correlation between the average sizes chosen and the logarithm of physical sizes was $+0.76$ ($t_4 = 2.34$, $p < 0.05$, one-tailed). We then calculated a regression line to predict the average sizes chosen as a function of the logarithm of the objects' physical sizes (see figure 3). The results show a positive slope (0.40), which is not significantly different from the slope of the regression line from experiment 1 just for the animals (0.36). Because each participant saw only one size of object, within-participants regression lines could not be computed and the statistical significance of the positive slope could not be assessed.

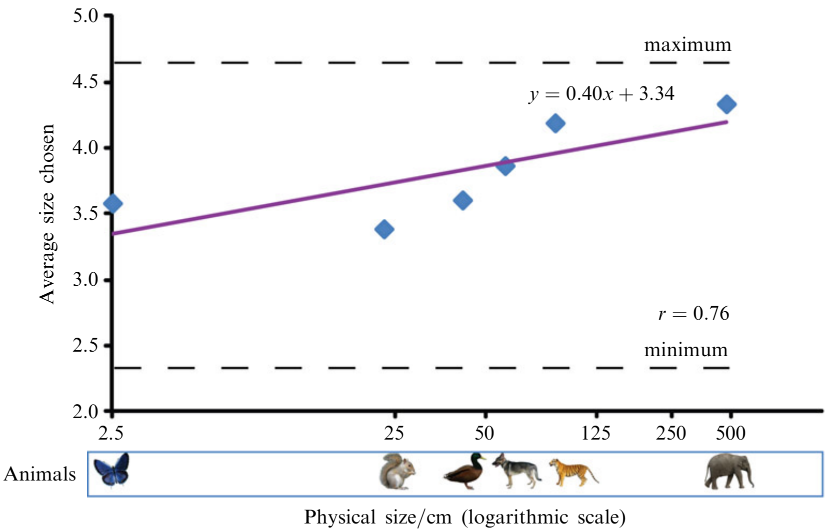


Figure 3. [In color online] Results of experiment 2. The average chosen size over all possible pairs for each animal, plotted as a function of the logarithm of its physical size.

The canonical-size effect is clearly still present when participants saw only a single object. People thus prefer pictures of smaller objects to be smaller in the frame and pictures of larger objects to be larger in the frame. We conclude that the effect of canonical size on aesthetic judgments is not driven by demand characteristics but by the relation between the viewer's knowledge of object sizes and the sizes of their images within a surrounding frame.

4 Experiment 3. Effects of detail: Posterized images

The amount of spatial detail necessarily covaries with image size in high-resolution digital photographs when displayed on a fixed resolution monitor. It is therefore possible that the canonical-size effect reported above arises from people having a preferred amount of detail for different objects rather than a preferred overall size. If people know more about the visual details of larger objects than smaller ones, for example, and if they prefer the smallest image in which the requisite spatial detail is present, then canonical-size preference effects could result from the amount of perceived detail. The images in experiments 1 and 2 were constructed by starting with a high-resolution image at a large size within the frame and reducing it (in Photoshop) to the smaller sizes (see figure 1b). This procedure necessarily reduces the amount of detail present as the size of the image decreases. In the present experiment we therefore attempted to equate the amount of image detail across image sizes by posterizing the smallest image using relatively few colors and then enlarging it without changing the spatial resolution of the vectorized image (see figure 4).

If the size effects observed in experiments 1 and 2 are influenced by the amount of image detail, they should be reduced or eliminated in the present experiment.

Figure 4. [In color online] Example images from experiment 3: The posterized butterfly and tea cup.

4.1 *Method*

4.1.1 *Participants.* All twenty-eight participants were students at the University of California, Berkeley, who received partial course credit in their undergraduate psychology course for participating. Their mean age was 19.9 years, ranging from 18 years to 25 years. All were naive to the purpose 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.

4.1.2 *Design.* The stimuli used in this experiment were posterized versions of the animals and artifacts used in experiment 1. Reducing the size of a high-resolution image reduces the amount of visual detail present in that image. More technically, a large image of a cup contains more pixels than a small image of that same cup, allowing for higher-resolution details to be visible in larger images. We therefore posterized the images in Photoshop to equate the amount of information in the different images sizes. Posterization removes all gradients of lightness and color, and replaces them with homogeneous areas of color. As part of the posterization process, the number of different colors in the resulting image can be chosen, thus affecting the amount of gradient compression (see figure 4 for two examples). We posterized the smallest version of each image using 5 different colors. These posterized versions were then converted to vector graphic images (to eliminate edge aliasing) and were scaled up to the larger sizes. As before, each trial consisted of two images of an object in different sizes. Different sizes of the same image of an object were shown in all possible paired comparisons.

4.1.3 *Displays.* The displays were identical to those of experiment 1 except that each participant saw posterized versions of the animals and artifacts.

4.1.4 *Procedure.* The apparatus and procedure were the same as in experiment 1. As before, we used a 2AFC task in which we instructed participants to indicate which picture they ‘liked best’.

4.2 *Results and discussion*

We analyzed the current data in the same way as in experiment 1. Figure 5 shows the average chosen size over all possible pairs for each object, plotted as a function of the logarithm of its physical size. The correlation between the logarithm of the physical

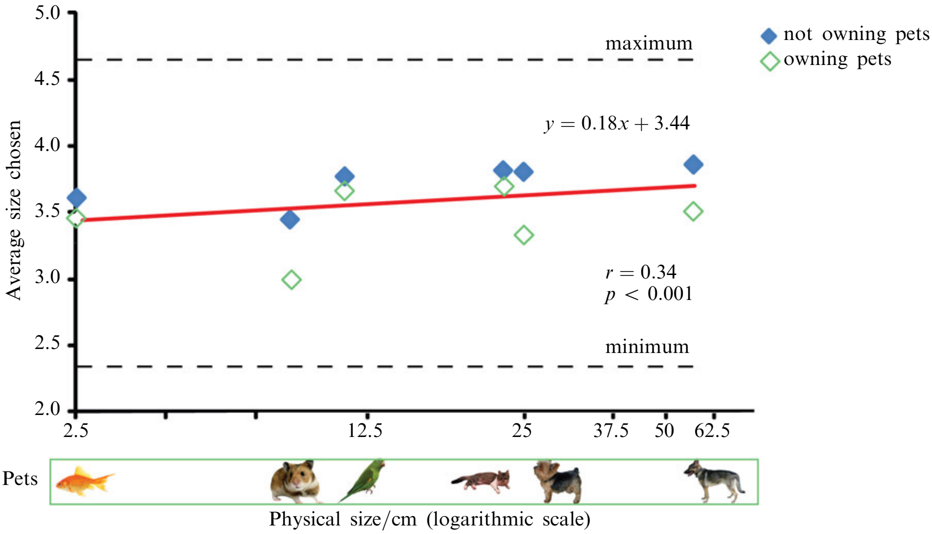


Figure 5. [In color online] Results of experiment 3. The average chosen size over all pairs for each posterized object plotted as a function of the logarithm of its physical size.

size of the object and the average size chosen for the image of that object is +0.58 ($t_{10} = 2.25$, $p < 0.05$).

As before, we calculated a regression line on the group data, which shows a positive slope of 0.17. We assessed the significance of this effect by computing the slope of the regression line separately for each participant, and the resulting slopes were reliably greater than zero ($t_{27} = 3.84$, $p < 0.001$). The slope appears to be reduced relative to the slope of the corresponding regression line in experiment 1 (0.30), however. We then tested the hypothesis that the slopes of the individual participants' regression lines in experiment 3 were smaller than those in experiment 1 and found that the between-groups difference was significant ($t_{49} = 1.72$, $p < 0.05$).

The present results demonstrate that, even when the amount of image detail is equated across sizes, objects that are smaller in physical size are preferred to be smaller in the frame and objects that are larger in physical size are preferred to be larger in a frame. This indicates that the canonical-size effects obtained in experiment 1 and 2 are not solely due to artifacts of image detail.

Nevertheless, the magnitude of the size effect is reduced somewhat when the amount of detail is objectively equated. This reduction suggests that there may be some effect of the amount of image detail present in the results of experiments 1 and 2. It is also possible that the present reduction in the slope of the size function occurs because people tend not to like posterized images when they are large enough that they begin to look like cartoons. If so, the present results with posterized images may arise from the combination of two opposite effects: a canonical-size effect with a positive slope as a function of image size and a 'cartoon' effect with a negative slope for posterized images. This question is the subject of ongoing research.

5 General discussion

In experiment 1 we asked whether canonical-size effects are present in explicit judgments of aesthetic preference. In a 2AFC task with pictures of the same object presented in different sizes relative to the frame, we found clear evidence for canonical-size effects analogous to those reported by Konkle and Oliva (in press). This finding cannot be attributed to demand characteristics related to participants considering objects of multiple sizes because it was replicated in experiment 2 in a fully between-participants experiment in which participants saw only one object. In a third experiment we manipulated the amount of visual detail present in the images by using posterized images and found good evidence for canonical-size effects, albeit with somewhat smaller slopes. It is not yet clear whether this reduction is due to there being a component of the canonical-size effects arising from preferences for specific amounts of detail or to people disliking cartoonish large images that contain little detail.

Overall, the findings support a clear bias toward canonical size in aesthetic preferences for framed 2-D images. This bias seems to be conceptually related to another ecological bias reported by Sammartino and Palmer (submitted) for objects that are characteristically located above the viewer in the world to be located high in the picture frame (eg ceiling-mounted light fixtures and flying eagles) and for objects that are characteristically located below the viewer in the world to be located lower in the picture frame (eg bowls on tables and swimming stingrays). We call these effects 'ecological' because they appear to be driven by people preferring images in which the spatial properties of the image of the depicted object within its frame fit the ecological properties of the physical object relative to the viewer. Canonical-size effects on aesthetic judgments thus indicate that people tend to prefer images in which the size of the object's image within its frame fits their knowledge of its actual physical size.

Acknowledgments. We wish to thank Rosa Poggesi, Eli Strauss, Karen Schloss, and Will Griscom for their support and assistance with the collection and analyses of data. The material described in this article is based on work supported by the National Science Foundation under Grant 0 745 820 and a Google Gift to SEP.

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ISSN 0301-0066 (print) ISSN 1468-4233 (electronic)

PERCEPTION

VOLUME 40 2011

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