# Object Color Preferences

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*Abstract: In this article, we investigate how context influences color preferences by comparing preferences for "contextless" colored squares with preferences for colors of a variety of objects (e.g., walls, couches, and T-shirts). In experiment 1, we find that hue preferences for contextless squares generalize relatively well to hue preferences for imagined objects, with the substantial differences being in the saturation and lightness dimensions. In experiments 2 and 3, we find that object color preferences are relatively invariant when the objects are (a) imagined to be the color that is presented as a small square, (b) depicted as colored images of objects, and (c) viewed as actual physical objects. In experiment 4, we investigate the possibility that object color preferences are related to the degree to which colors help objects fulfill particular functions or outcomes. We also discuss relations between our results and previous theories of color preference.* © 2012 Wiley Periodicals, Inc. Col Res Appl, 00, 000–000, 2012; Published online in Wiley Online Library (wileyonlinelibrary.com). DOI 10.1002/col.21756

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## INTRODUCTION

Numerous studies have examined human preferences for simple patches of pure color,[1–7] but how do these abstract color preferences generalize to different object contexts? In the extreme, one might argue that preferences for abstract colors are irrelevant because even the most avid blue-lover will certainly not prefer blue bananas to yellow ones or blue tomatoes to red ones. More reasonably, there is a legitimate question about whether contextless color preferences generalize to objects that could plausibly be any color, such as couches, walls, cars, or T-shirts.

In calling standard displays of colored squares "contextless," we do not mean to imply that people's preferences for colored squares are independent of their preferences for colored objects. Indeed, our ecological valence theory[7] (EVT) implies that such abstract color preferences are largely driven by preferences for the objects that are characteristically those colors: people tend to like saturated blue in large part because they generally like clear sky, clean water, and other objects that are typically blue, whereas they tend not to like dark yellow (a greenish brown) in large part because they generally do not like biological waste products and rotting vegetation. Instead, we take "contextless" to mean that participants are asked to judge their preference for the color as it appears on paper or a computer monitor without specific reference to any particular object. We acknowledge that, as Whitfield and Wiltshire[8] have argued, people may sometimes imagine a given color in some particular object context when they judge their preference for a particular colored square, but just as plausibly, they often may not.

Compared with contextless color preference, much less research has been published on color preferences for specific kinds of physical objects.[†] Still, the existing literature demonstrates that people's color preferences can vary across objects. Holmes and Buchanan[9] showed that verbal reports of "overall" (contextless) favorite colors can differ from verbal reports of favorite colors for particular artifacts (e.g., colors of walls, carpet, sofas, and shirts/blouses). For example, they found that people never reported "brown" as their overall favorite color yet frequently reported it as a favorite color for carpets and sofas.[‡] Saito[10] found some similarities in comparing preferences for contextless colored chips and images of corresponding cars [e.g., blues,

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[†] We suspect that a great deal of research on this topic may have been conducted within the corporate world to determine color preferences for specific products, but the results are seldom, if ever, published.

[‡] They used a color naming task, making it unclear which particular colors people imagined when reporting them as favorite. Also, data collected about only the favorite color for each object fail to reflect colors that are liked to a lesser degree, including somewhat disliked colors.

dark red, and white were commonly liked, whereas purples, dark yellow (olive), and light-desaturated red (pink) were commonly disliked], but also found systematic differences in the saturation and lightness dimensions. In particular, participants liked saturated and lighter colors more for contextless chips than for cars, and liked dark colors more for cars than for contextless chips.

Why might color preferences vary across different object contexts? Sivik[11] argued that colors vary in their degree of culturally conditioned "appropriateness" for different object types, with higher judgments of aesthetic preference resulting from higher levels of object-color appropriateness. For example, it would be inappropriate for homeowners in a suburban, gated community to paint their front door hot pink, because members of their community would probably dislike that color for a front door, even though the same people would find it entirely appropriate for, say, a young girl's dress or shoes. In contrast, people who live in a community where brightly colored exteriors are more conventional (e.g., Victorian houses in San Francisco or modern adobe houses in Mexico), might love the same hot pink for a front door.

Several studies have supported the hypothesis that appropriateness influences object color preferences. In terms of decorative style, Whitfield and Slatter[12,13] posit that color preferences are related to how appropriate the object's color is for the context in which it is judged (e.g., Modern room style vs. Georgian room style). In terms of emotional experience in interior spaces, Manav[14] suggested that people prefer room colors to be appropriate for the mood or feeling they desire when inhabiting the room (e.g., light blue is preferred for living rooms because it feels calm, whereas "near white" is preferred for bathrooms because it feels hygienic and pure). Similarly, de Destefani and Whitfield[15] found that when people are in the process of deciding what color to paint a room in their home in a real-life setting, they focus on the affective qualities they want the wall color to elicit and then look for color attributes—such as lightness and saturation—that they believed would produce the desired affect.[15] Furthermore, Taft[16] provided evidence that object color preferences are more likely to deviate from contextless colored square preferences when the object is associated with particular "color conventions" (e.g., computers tend to be white, black, gray, or relatively neutral in color and antique chairs tend to be shades of brown) than when the objects often come in a wide gamut of colors (e.g., bicycles and sofas).

In this article, we address three main questions about the influence of object context on color preferences. First, do color preferences for different objects vary more along some dimensions of color space than others? Saito's results[10] suggest that contextless square and car color preference deviate most in terms of saturation and lightness preference, but is that true for other objects as well? In experiments 1 and 2, we obtained color preference ratings for a relatively wide sample of colors [the 32 chromatic colors of the Berkeley Color Project (BCP-32)[7] and five achromatic colors[17]] in a variety of object contexts. Our approach is more comprehensive than previous studies, which either measure preferences for a wide range of colors with very limited contexts[10,14] or preferences for a narrow range of colors for a wide variety of objects.[12,16] The second question is, how well can people estimate their preferences for object colors under different testing conditions: namely, (a) imagining the object while viewing a colored square (experiment 1), (b) looking at a photograph of a colored object (experiment 2), and (c) viewing the physical colored object that was photographed (experiments 2 and 3). If people are reasonably good at estimating their preferences for object colors while looking at colored squares, much time and effort can be saved in future research by eliminating the need to generate images of particular objects in many different colors, or, worse still, obtaining/creating physical objects in each of the desired colors (e.g., painting many identical rooms, one in each color). The third question is why people's color preferences change according to object context (experiment 4). In particular, we test the hypothesis that people prefer objects to have colors that help achieve a certain function, such as dark couches to hide dirt and light walls to make rooms look more open and spacious. We also consider possible explanations in terms of social conventions and the desired message people want to convey by having or wearing objects of particular colors.

## EXPERIMENT 1: PREFERENCES FOR CONTEXTLESS SQUARES VERSUS IMAGINED OBJECTS

In experiment 1, we compare participants' preferences for contextless colored squares with their preferences for the same colors when imagined for walls, trim, couches, pillows, dress shirts/blouses, ties/scarves, and T-shirts. The same set of participants completed 30 different tasks on the same set of colors as part of the BCP,[7,18] but only a subset of the results will be reported here.

### Method

*Participants.* The same 48 participants (24 females) whose data have been reported in previous articles[7,18] completed the three tasks described in the present experiment. All had normal color vision, as screened using the Dvorine Pseudo-Isochromatic Plates, and gave informed consent. The Committee for the Protection of Human Subjects (CPHS) at the University of California, Berkeley approved the experimental protocol.

*Design and Displays.* The 37 colors included the 32 chromatic colors of the BCP[7] and five achromatic colors[17] (see Table A1). The 32 chromatic colors include eight hues (red, orange, yellow, chartreuse, green, cyan, blue, and purple) at each of four different saturation/lightness levels: saturated (S: the highest chroma colors we could produce on our monitor), light (L: the colors roughly midway between the saturated colors and white), muted (M: the colors roughly midway between the saturated colors and neutral gray), and dark (D: the colors roughly midway between the saturated colors and black). The five achromatic colors include black, white, and three intermediate grays (CIE illuminant C) that were approximately lightness matched to the average lightness of the light, muted, and dark colors. Colors were presented as squares (100 × 100 pixels) on a gray background (CIE $x = 0.312$, $y = 0.318$, $Y = 19.26$) with the exception of the full field preference task, in which the target color filled the entire screen. The colors were chosen in Munsell space and then translated to CIE 1931 values using the Munsell Renotation Table,[19] as described elsewhere.[7] The monitor was calibrated using a Minolta CS100 Chroma Meter. Participants viewed the computer screen from approximately 70 cm. The monitor was 18 in. diagonally with a resolution of 1024 × 768 pixels. A 400-pixel rating scale with a demarcated center point was located at the bottom of each display. Responses were scored as ranging from −100 to +100 with zero demarcated as a neutral point.

*Procedures.* There were three main tasks in this experiment, completed by the same participants on different days in the order listed below.

### *Preference for Contextless Colored Squares*

Participants were presented with each of the 37 colored squares, one at a time in a random order. They were asked to rate how much they liked each color on a scale from "not at all" to "very much" by sliding a cursor along the response scale and clicking to record their response. The color remained on the screen until participants made their response, and the trials were separated by a 500 ms intertrial interval.

Before beginning this task (and all subsequent rating tasks described in this article), participants were shown all of the colors and were asked to consider which color they liked the most and which they liked least. They were instructed that the color they liked most should be rated as "very much" and the color they liked least should be rated as "not at all." This "anchoring task" was used to help participants determine what the extremes of the scale meant for them in the context of these colors and to encourage them to use the entire range of the response scale. The data from this contextless preference task were previously reported.[7]

### *Preference for Contextless Full Screen Colors*

This task was the same as the previous task, except that the color occupied the full screen rather than a small square on a gray background.

### *Preference for Imagined Object Colors*

In this set of tasks, the displays were the same as in the contextless colored square task, but participants were asked to rate how much they would like each color as the color of the following objects: walls, trim, couches, throw pillows, T-shirts, dress-shirts/blouses, and neck-ties/scarves. Trials were blocked by object.[§]

[§]The colored object preference tasks took place across different days: walls and trim (session 3), throw pillows and couches (session 4), T-shirts (session 5), dress-shirts/blouses, and neck-ties/scarves (session 6). The order for tasks that were completed on the same day was randomized across participants.

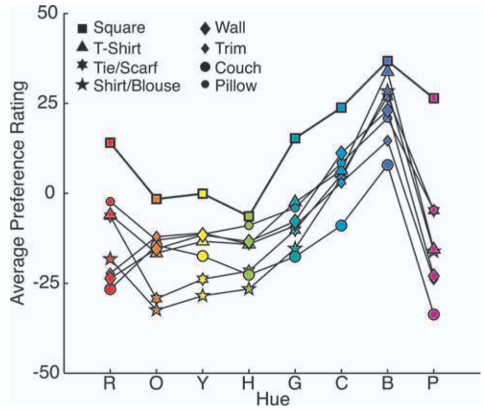


FIG. 1. Average hue color preferences (averaged over cuts) for contextless squares (squares), T-shirt (triangles), ties/scarves (six-pointed stars), dress shirts/blouses (five-pointed stars), walls (large diamonds), trim (small diamonds), couches (large circles), and throw pillows (small circles).

## Results and Discussion

Preferences for contextless colored squares and full-field colors were very highly correlated ($r = +0.90$, $P < 0.001$), indicating that field size has little influence on color preferences, at least within the limits of a computer screen. An analysis of variance (ANOVA) including the 8 hues × 4 cuts × 2 field sizes showed no main effect of field size ($F < 1$) and no interaction between field size and hue ($F(7,329) = 1.90$, $P > 0.05$) or cut ($F(3,141) = 1.22$, $P > 0.05$). There was a weak three-way interaction ($F(21, 987) = 1.79$, $P < 0.05$), as shown in Fig. B1, which was largely due to dark red being more preferred when rated as a square than as a full field. However, this difference would not be reliable after correcting for multiple comparisons. For subsequent analyses, we compared preferences for the colors of objects with preferences for contextless colored squares (as opposed to full-screen colors) because all of these tasks used exactly the same visual displays.

Figure 1 shows hue preferences for each object context, averaged over cuts (lightness and saturation levels). The main effect of hue ($F(7, 329) = 18.13$, $P < 0.001$) follows the same general shape for all contexts with a sharp peak at blue and a broad trough for warm hues (i.e., orange, yellow, and chartreuse). The fact that the hue curves are roughly parallel means that if people like blue squares they also tend to like blue walls, blue T-shirts, blue couches, and so forth. There was also a main effect of context ($F(7,329) = 17.75$, $P < 0.001$), due to the fact that people liked the colors of contextless squares in general better than they liked the same colors imagined as specific concrete objects. Indeed, contextless square colors were the only condition in which preferences, averaged over all hues and cuts, were generally positive. A closer look at this effect (see below) reveals the reason to be that people strongly disliked the objects we studied to be saturated colors (unlike contextless square colors), which

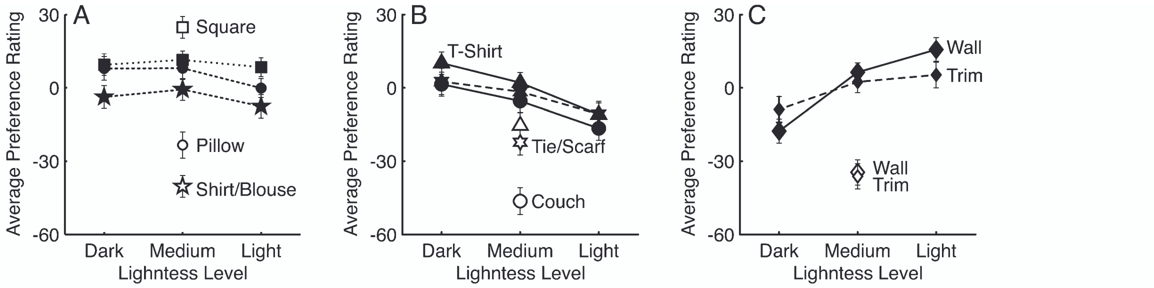


FIG. 2. Average preference ratings as a function of lightness level for (A) contextless squares (squares), throw pillows (small circles), and dress shirts/blouses (stars), (B) T-shirts (triangles), couches (large circles), and ties/scarves (six-pointed stars), and (C) walls (large diamonds) and trim (small diamonds). In the *x*-axis labels, 'Dark' refers to the colors in the dark cut, 'Medium' refers to colors in the saturated and muted cuts, and 'Light' refers to colors in the Light cut. Closed symbols represent the dark, muted, and light cuts, and open symbols represent the saturated cut. Dotted lines indicate no statistically significant effect, dashed lines indicate marginal effects, and solid lines indicate significant effects after a Bonferroni correction. Error bars represent SEMs.

decreases the overall preferences for object colors when averaged over cut.

There are clearly some exceptions to the main effects of hue and context noted above, which are sufficient to produce hue × context interaction ($F(49, 2303) = 5.48$, $P < 0.001$). One key difference is that people generally like red T-shirts, shirts/blouses, ties/scarves, and pillows better than orange or yellow ones, but they like red walls, trim, and couches less than orange or yellow ones. A possible explanation is that walls, room trim, and couches are relatively larger than the other objects, and perhaps people do not like big red things. This effect does not generalize to all reds, however, in that it is strongest for saturated red (see Fig. B2). Note also that saturated red was equally preferred as small squares and full fields. Another difference is that although people generally like purple for contextless squares, their preferences for purple objects plummets relative to the other hues.

Figure 2 shows that the primary differences between object contexts are due to effects of lightness and saturation ($F(21,987) = 18.22$, $P < 0.001$). Notice first that although saturated (S) colors (open symbols) are preferred to the average of L, M, and D colors (closed symbols) for the contextless squares ($F(1,47) = 7.91$, $P < 0.01$), highly saturated colors are much less preferred than L, M, and D colors in all object contexts ($F(1,47) = 58.89$, $P < 0.001$). The effects of lightness vary considerably for different object types ($F(14,658) = 11.79$, $P < 0.001$). To understand this interaction, an ANOVA was conducted for each of the eight object types and a Bonferroni correction was applied to account for the large number of comparisons (adjusted $\alpha = 0.006$). Figure 2(A) shows that there are no reliable lightness effects for contextless squares ($F < 1$), throw pillows ($F(2,94) = 1.79$, $P > 0.006$), and dress shirts/blouses ($F(2,94) = 1.24$, $P > 0.006$). Lightness effects are present for all other object contexts, although some are marginal ($P < 0.05$), as indicated by dashed lines in Figs. 2(B) and 2(C). These lightness values vary widely in slope across objects. Preferences for T-shirts ($F(2,94) = 9.41$, $P < 0.006$), ties/scarves ($F(2,94) = 3.73$, $P > 0.006$), and couches ($F(2,94) = 6.14$, $P < 0.006$) generally decrease as lightness increases [Fig. 2(B)], whereas the preferences for painted interior surfaces of rooms [walls ($F(2,94) = 21.50$, $P < 0.006$) and trim ($F(2,94) = 3.29$, $P > 0.006$)] generally increase as lightness increases [Fig. 2(C)]. Some of these results make sense in terms of functional considerations. Perhaps people prefer light-colored walls and trim to enhance the overall brightness and spaciousness of interior rooms but prefer dark furniture and clothing to make dirt less visible. We will return to this hypothesis in experiment 4.

The pattern of achromatic color preferences for white, grays, and black also differed across objects ($F(28,1316) = 12.85$, $P < 0.001$). To characterize these differences, an ANOVA was conducted for each object, and the Bonferroni correction was applied (adjusted $\alpha = 0.006$). Figure 3(A) shows there was no effect of lightness for couches ($F(4,188) = 1.74$, $P > 0.006$) or throw pillows ($F(4,188) = 2.18$, $P > 0.006$). This result is unlike those for chromatic colors, for which couch color preference decreased as lightness increased. Dress shirts, T-shirts, ties/scarves, and square color preferences [Fig. 3(B)] followed a quadratic pattern ($F(1,47) = 22.64, 30.12, 63.54$, $P < 0.001$, respectively), in which preferences were lowest for middle gray (A2) and increased as the colors approached white and black. T-shirt color preferences showed an additional linear component ($F(1,47) = 5.31$, $P < 0.05$), representing a strong preference for black T-shirts, which was not present for the dress shirts or squares ($Fs < 1$). This lightness effect for achromatic contextless squares is unlike that for chromatic contextless squares, for which there was no lightness effect. Figure 3(B) also shows that ties/scarves were most preferred in black with no difference between the other lightness levels ($F(4,188) = 6.27$, $P < 0.006$). Figure 3(C) shows that preferences increased monotonically as lightness increased for walls ($F(4,188) = 30.88$, $P < 0.006$) and for trim ($F(4,188) = 15.12$, $P < 0.006$). A possible explanation for why the achromatic lightness effects are different from

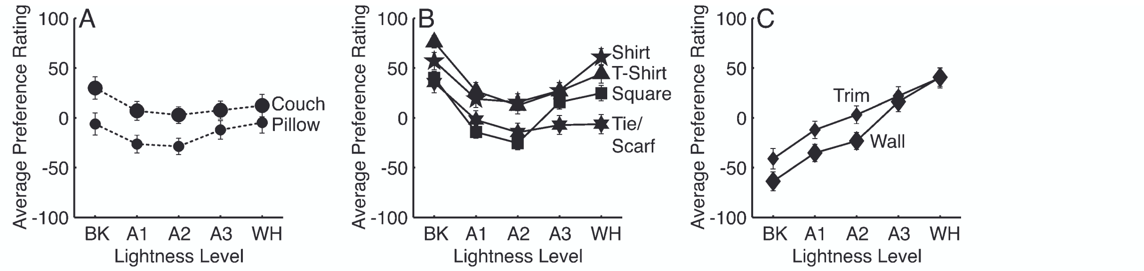


FIG. 3. Object color preferences as a function of achromatic lightness level [black (BK), dark gray (A1), medium gray (A2), light gray (A3), and white (WH)] for (A) objects with no effect [throw pillows (small circles) and couches (large circles)], (B) objects with quadratic effects [dress shirts/blouses (five-pointed stars), T-shirts (diamonds), ties/scarves (six-pointed stars), and contextless squares (squares)], and (C) objects with linear increases in preference as lightness increases [walls (large diamonds) and trim (small diamonds)]. Dotted lines indicate no statistically significant effect, dashed lines indicate marginal effects, and solid lines indicate significant effects after a Bonferroni correction. Error bars represent SEMs.

the chromatic lightness patterns is that black, white, and gray are perceived as categorically distinct[20] rather than as different lightness values on a continuous gradient. Colors of varying lightness within a particular hue are typically classified into the same category with the exception of red (i.e., light red is "pink"), orange, and yellow (dark orange and yellow are "browns").

There was also a three-way hue × cut × object interaction ($F(147,6909) = 1.82$, $P < 0.001$), as shown in Fig. B1. This complex interaction includes the decreased preference for saturated red walls and trim (i.e., dislike for saturated red things that are "big") in contrast to the increased preference for dark red in contextless squares, clothing, and throw pillows.

Previously, we showed that for the same participants, hue curves for males and females rating contextless squares had the same general shape, but that males like saturated colors more than females did, whereas females tended to like muted colors more than males did.[21] We found similar effects for object color preferences, in which males preferred saturated walls and trim more than females did ($t(46) = 2.53, 2.65$, $P < 0.05$), and females preferred muted ties/scarves more than males did ($t(46) = 2.20$, $P < 0.05$).

To examine how object types differ in terms of their contextualized color preferences, we performed a multidimensional scaling (MDS; ALSCAL) on the correlations between each pair of objects across the average preference ratings for the 32 chromatic colors. We did not include the five achromatic colors because they seemed phenomenonologically different, as described above. The two-dimensional (2D) solution (see Fig. 4) gave both a good fit (stress = 0.008) and interpretable dimensions. Dimension 1 corresponds to saturation preference (contextless squares scoring higher on this dimension than any of the objects) and Dimension 2 corresponds to lightness preference (interior surfaces scoring higher and items made of fabric generally scoring lower). We fit these dimensions to the MDS axes using the preference ratings in Figs. 2(A)–2(C). For each object, we calculated the saturation preference as the difference between preference for the saturated and muted colors and the lightness preference as the slope of the best-fit regression line through preference ratings for dark, muted, and light colors (see Table I). Indeed, saturation preference for each

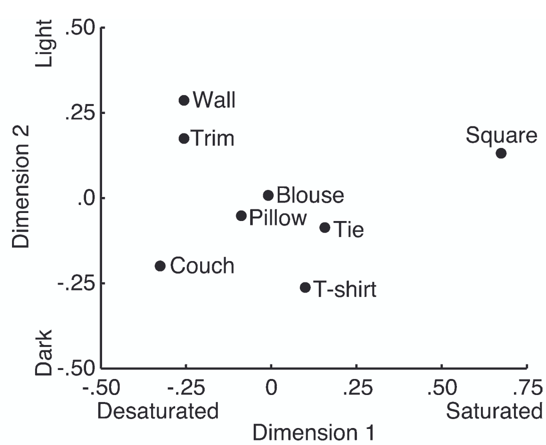


FIG. 4. A MDS solution in which objects that had similar color preferences are plotted closer together in the 2D space.

TABLE I. Indices of preference for saturation (saturation difference) and lightness (lightness slope) for each object

| Colored object | Saturation difference | Lightness slope |
|---|---|---|
| Square | 13.3 | −0.5 |
| Wall | −41.0 | 16.7 |
| Trim | −38.7 | 7.1 |
| Couch | −40.9 | −9.0 |
| Pillow | −31.5 | −4.0 |
| T-shirt | −17.4 | −10.5 |
| Blouse | −39.6 | −1.9 |
| Tie | −20.8 | −6.7 |

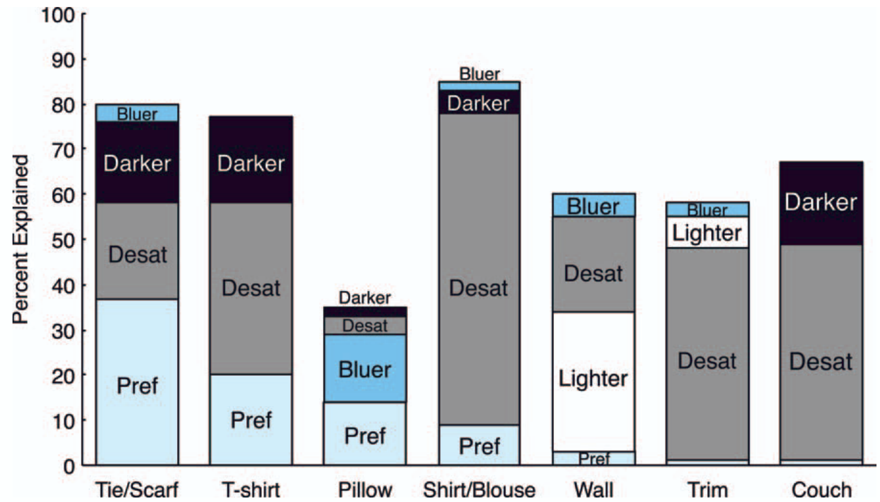


FIG. 5. The percent of variance explained in object color preferences by contextless color preference "pref" indicates a positive relation between contextless square color preferences and object color preference for the indicated object type), saturation ('desat' indicates less saturated being more preferred), lightness ('lighter' indicates lighter being more preferred and 'darker' indicates darker being more preferred), and blueness-yellowness ('bluer' indicates bluer colors being more preferred). [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

object was very highly correlated with the object's coordinate along Dimension 1 ($r = 0.96$) as was lightness preference with the object's coordinate along Dimension 2 ($r = 0.94$). Notice that although lightness and saturation are dimensions of color space, they are not explicitly represented in the data from which this scaling was derived; they emerged from the structure of the preference data.

We next conducted a multiple linear regression analysis for each set of object color preferences to further understand how they differ from contextless square color preferences. After accounting for contextless color preferences (see the bars labeled "pref" in Fig. 5), we included the same participants' ratings along color appearance dimensions (red-green, blue-yellow, light-dark, saturation) for the 37 colors.[7] This color appearance model has previously been shown to account for 60% of the variance in the contextless color preferences using yellow-blue, saturation, and light-dark as predictors.[7]

As shown in Fig. 5, the majority of the variance in preference for objects, after accounting for contextless square color preference, is carried by saturation and lightness (including both "lighter" and "darker" bars). Their combined effects range from 74% for dress shirts/blouses to just 6% for throw pillows. Three trends are noteworthy in these data. First, preference for contextless squares ("pref" in Fig. 5) explains substantially more variance for the clothing and throw pillow ratings than for the wall, trim, and couch ratings. This result could be due to a number of factors including clothing and throw pillows being smaller, less constrained by social conventions, less permanent investments, and a more typical means of self-expression (see experiment 4). Second, people generally preferred object colors to be darker, except for walls and trim, which were preferred to be lighter. Third, colors in all of the object contexts were preferred to be less saturated than they were for contextless squares. Perhaps, people prefer desaturated objects because saturated objects seem too "loud" and overbearing. Another possibility is that because objects are typically viewed in the presence of other objects (e.g., couches in the presence of other furniture, shirts in the presence of the rest of the outfit) and because people generally like more harmonious color combinations,[5] less saturated colors are preferred in object contexts because they harmonize ("go better") with each other better than more saturated colors do.

## EXPERIMENT 2: IMAGINED VERSUS DEPICTED OBJECT COLOR PREFERENCES

In experiment 1, we measured object color preferences by asking participants to imagine a named object type in a particular color by presenting that color as a homogeneous square on a computer monitor. No attempt was made to indicate what particular T-shirt, couch, or wall they were imagining. We therefore questioned whether the results might differ if participants rated their object color preferences (a) in the presence of a gray-scale picture of an instance of that object category together with a homogeneous colored square (the imagine condition) versus (b) in the presence of a full-color picture of that object depicted in that color (the depicted condition). In experiment 2, we compare preferences for imagined versus depicted object colors for T-shirts, couches, walls, and two types of cars (VW Bugs and luxury sedans). We chose a subset of three objects from experiment 1 (T-shirts, couches, and walls) so that we could directly compare the results of experiments 1 and 2 with a manageable number of trials for a single experimental session. We included the two types of cars to test for possible differences in object color preferences within the same basic level category.

## Method

*Participants.* There were 48 participants (24 females) who completed all of the tasks in this experiment. All had normal color vision and gave informed consent. The CPHS at UC Berkeley approved the experimental protocol.

*Design, Displays, and Procedures.* The same colors were tested on the same gray background using the same ratings scale as in experiment 1. Displays were presented on an 18 in. iMac monitor (1680 × 1050 pixels) using Presentation software (www.neurobs.com). The three rating tasks are described in the order in which they were completed.

### *Preferences for Contextless Colored Squares*

This task was the same as in experiment 1. Each colored square (100 × 100 pixels) was presented one at a time in a random order and participants rated how much they liked the color on a continuous line-mark scale from "not at all" to "very much."

### *Preferences for Imagined Object Colors*

Participants were presented with each colored square (100 × 100 pixels) centered on the monitor, one at a time, as before, but there was also a gray-scale image (approximately 600 × 445 pixels) of an object above it: a wall, couch, T-shirt, luxury sedan, or VW Bug. Participants were asked to imagine that the object was the color of the colored square and rate how much they would like that color for that depicted object (e.g., "How much would you like this color for this wall?") on a scale from "not at all" to "very much." Trials were blocked by object so that participants rated each color for a given object before going on to the next object. We used a blocked rather than a randomized design for object contexts for two reasons. First, we believed that it would be easier for participants to rate their preferences for all colors for a single object before going on to the next object—and thus changing contexts only at block boundaries—rather than having to change object contexts on virtually every trial. Second, the blocked design allowed them to do the "anchoring" task (see experiment 1 procedure) at the beginning of each block to determine which colors were most and least preferred in the context of each object and help them use the entire rating scale. Block order was randomized for each participant so that any effects of object order should average out across participants.

### *Preferences for Depicted Object Colors*

Participants were presented with a colored version of each of the same five images of objects centered on the screen. They were asked to rate how much they liked the color for that object on a scale from "not at all" to "very much." Each object was colored using the "Overlay Layer" feature in Adobe Photoshop (see Figs. C1 and C2). We ensured that the color of the objects matched the calibrated colored squares by displaying the colored squares on top of (overlapping) the part of the object that appeared most unaffected by shadows or highlights, and each of the three authors independently verified that the colored square appeared to match that part of the object. Again, trials were blocked by object and block order was randomized for each participant.

## Results and Discussion

In experiment 1, participants imagined how much they would like the colors for various objects while viewing colored squares. In experiment 2, other participants were given the same task, but the colored squares were accompanied by a gray scale picture of the object so that all participants were presumably attempting to imagine the same object when considering their color preferences. We examined the data from experiments 1 and 2 for differences between the most similar rating conditions (squares only in experiment 1 and squares plus gray-scale images in experiment 2) for the three objects that were common to both experiments—walls, couches, and T-shirts—as well as preference for contextless colored squares. Experiment 1 participants liked dark contextless colors better than experiment 2 participants did ($F(1,94) = 19.56$, $P < 0.001$), but there was no difference for the saturated light, or muted cuts ($P > 0.05$ in each case) contextless colors. We subtracted the preference ratings for contextless squares from the preference ratings for colored objects to eliminate these between-group differences. The difference score thus allows a direct test for effects due to presence versus absence of the gray-scale image of the object during the imagined object color preference task, uncontaminated by the group differences. Because the results showed no significant differences due to the presence of the gray-scale image, any differences between the results of experiments 1 and 2 are attributable to differences in preferences for contextless colored squares. These results also indicate there was no difference between measuring color preferences for different objects on different days (experiment 1) versus within a single, hour-long experimental session (experiment 2).

We next compared participants' color preferences for imagined objects (while viewing a colored square with the gray-scale object image) [Fig. 6(A)] with their color preferences for depicted objects [Fig. 6(B)]. As shown in the correlations placed between the graphs in Figs. 6(A) and 6(B), average color preferences for the imagined and depicted object color preference tasks were very highly correlated, from 0.89 for the VW Bug to 0.98 for the luxury sedan. Although these correlations are very high, depicted and imagined object color preferences differed in small but systematic ways for the 32 chromatic colors [see difference curves in Fig. 6(C)]. There were no such between-task differences for the achromatic colors.

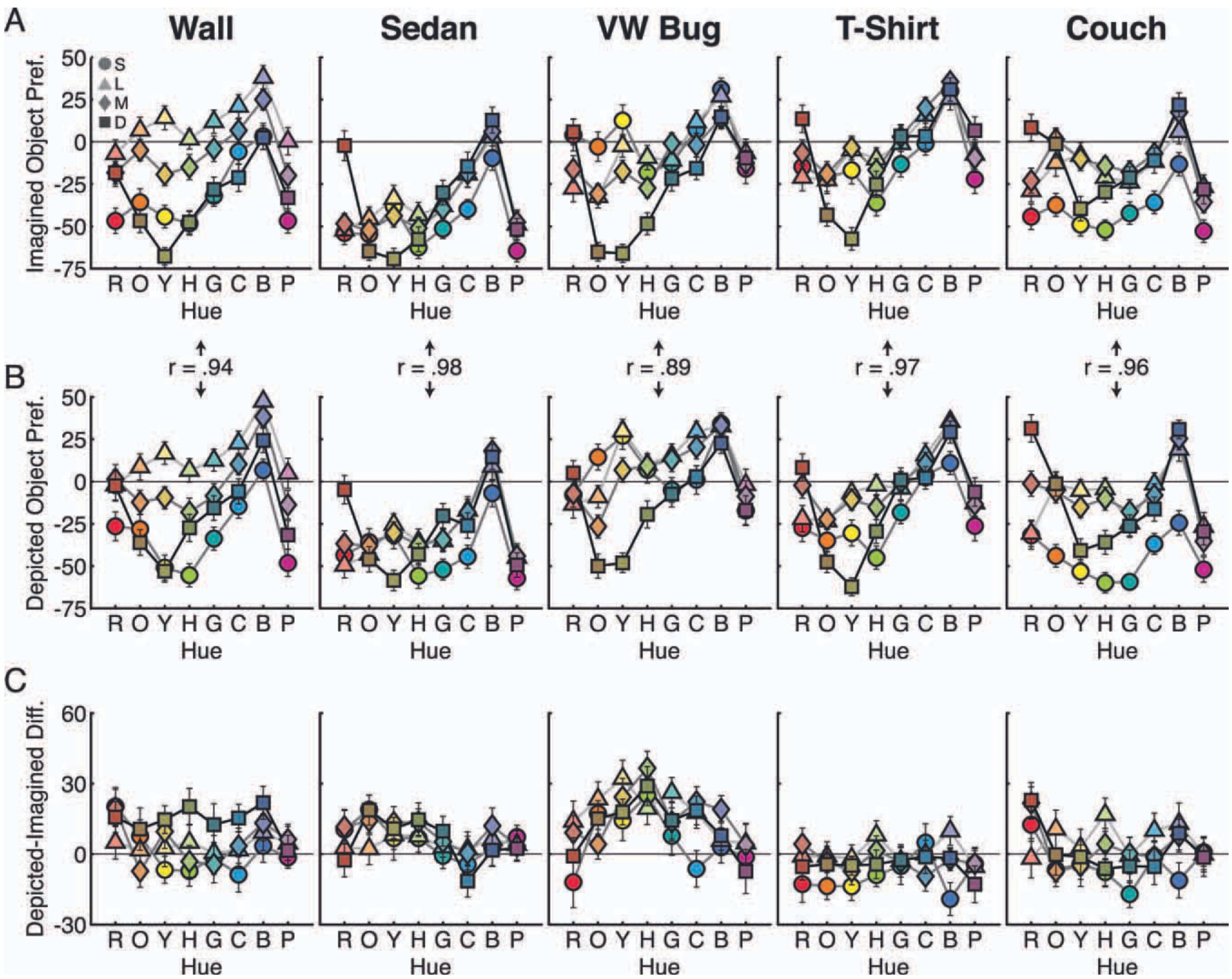


FIG. 6. Average preferences for the color of imagined objects (A), depicted objects (B), and depicted-imagined object difference scores (positive values indicate greater preference for depicted object colors than imagined object colors) (C). Separate lines represent the different 'cuts' [Saturated (S, circles), Light (L, triangles), Muted (M, diamonds), and Dark (D, squares)]. The error bars represent the SEMs.

Numerous trends are worth noting in the depicted-minus-imagined difference scores in Fig. 6(C). People liked depicted red walls and couches more than they imagined they would ($F(1,47) = 10.34, 14.13, P < 0.006$, respectively, Bonferroni-adjusted $\alpha = 0.006$). This result suggests that, although people think they will not like "big red things," as discussed in experiment 1, they may like them more than expected when they see them in pictures. Another difference for walls is that people liked dark depicted walls more than they imagined they would ($F(1,47) = 12.43, P < 0.001$). This result is interesting, because it is generally believed that walls should be light because light walls make rooms feel larger, and rooms with lighter walls are actually perceived to be taller.[22] However, the idea that walls should be light is predicated on the assumption that people prefer rooms to feel larger, which is not necessarily true. The "warm and cozy" feeling that is often obtained with dark walls maybe more valuable than spaciousness in some interior spaces, at least to some people. These interpretations are predicated on the assumption that people's preferences for depicted objects better reflect preferences for actual physical objects than imagined color preferences do. This may not be the case for reasons that we will consider in the general discussion.

For both VW Bugs and sedans, people generally liked chromatic cars better when pictured than when imagined ($F(1,47) = 4.92, 17.32, P < 0.05, 0.001$, respectively). For VW Bugs, colors in the orange to green range were more preferred when pictured than imagined ($F(7,329) = 5.05, P < 0.001$), as were colors that were lighter ($F(3,141) = 3.76, P < 0.05$). This result may occur because VW Bugs often are seen in those colors, and people may not realize that until they see the colored images. For sedans, warm hues (red, orange, yellow, and chartreuse) were liked more when depicted than when imagined ($F(7,329) = 2.26, P < 0.05$), but the reason is unclear.

T-shirts were the only objects that showed no reliable differences between the two tasks, indicating that people are particularly good at imagining how much they will like a T-shirt color from a colored square. They may be good at imagining T-shirts because they have considerable experience in judging preferences for different colored T-shirts while shopping from websites and/or catalogs, which often show a single image of an article of clothing together with square patches to show the array of available colors. One might argue that the high correlation arose because participants simply remembered their responses in the imagined object color task and responded the same way for the depicted object task to be consistent. However, the systematic differences between imagined and depicted preferences for walls and cars previously described make this possibility unlikely.

Although the color preference functions for different objects have several features in common—for example, the sharp peak at blue, the clear dip for dark orange (brown) and dark yellow (olive)—there are many differences as well, regardless of whether the colored objects are imagined or depicted. Consistent with the results of experiment 1, for example, people prefer walls to be lighter than other objects. Such differences in color preferences may be related to differences in basic functionality (e.g., making a room look more spacious), but there is one case in which functional differences seem unlikely to explain the differences in color preference: VW Bugs versus luxury sedans. Both are members of the same basic level category[23] of cars and the basic functionality of both is to transport 1–5 adults comfortably from one place to another. Nevertheless, their color preference functions are quite different. VW Bug color preferences are much more closely related to contextless color preferences ($r = 0.73$, $P < 0.001$) than are sedan color preferences ($r = 0.31$, $P = 0.07$), whereas sedan color preferences are most similar to those for couches ($r = 0.85$, $P < 0.001$) (Fig. 6). Generally speaking, people like the saturated, light, and muted chromatic colors much more for VW Bugs than for luxury sedans. This difference between VW Bugs and sedans suggests that subordinate categories (e.g., VW Bug) can be at least as important as basic level categories (e.g., car) in determining object-specific color preferences. A possible explanation for these differences is that, in additional to functional considerations, people base their car color preferences on their desired experience with the car and/or the image that they want to project about themselves through their car. Another possibility is that people like objects to be presented in colors that are more commonly observed for that particular type of object (e.g., yellow for VW Bug and black for sedans) because those objects seem like they are processed more easily (i.e., due to perceptual fluency[24,25]). We will discuss these and other possible explanations for differences in object color preference in more detail in experiment 4.

## EXPERIMENT 3: COMPARISONS AMONG IMAGINED, DEPICTED, AND ACTUAL T-SHIRTS

In experiments 1 and 2, people give very similar preference ratings when imagining how much they would like the colors of different objects from viewing a colored square and its category label and a colored square and a black-and-white picture of an instance of that category. In experiment 3, we address the further question of how well preferences for colored pictures of objects translate to preference for actual physical objects of the same colors by having participants rate their preferences for contextless square colors, imagined T-shirt colors, depicted T-shirt colors, and physical Gildan© T-shirt colors. The colors for the computer-based tasks were matched to the colors of the actual T-shirts under the illuminant in which the T-shirts were presented. We chose to test T-shirts because they are comparatively easy and inexpensive to purchase and display in a wide variety of colors.

### Method

*Participants.* There were 19 participants (10 females). All had normal color vision and gave informed consent. The CPHS at UC Berkeley approved the experimental protocol.

*Design, Displays, and Procedure.* The T-shirt colors were chosen from Gildan's© wide variety of colors to approximate the BCP saturated, light, and dark colors. We found T-shirts in (roughly) these three cuts for the following five hues: red (R), orange (O), yellow (Y), green (G), and blue (B). For purple (P), there were only light and dark colors. (See Table A2, for Gildan© T-shirt names and CIE $xyY$ values for the computer rendered colors.) The colors of the T-shirts and gray poster board background against which the T-shirts were viewed were matched with those on the computer monitor by eye. All three authors independently verified that the matches were appropriate by looking back and forth between the computer monitor, which was in a darkened booth, and the colored T-shirts, which were illuminated by a full spectrum floodlight outside the booth. The floodlight was on for at least 20 min before the physical T-shirts were viewed to ensure that its spectrum was constant over participants. Computer displays were presented on a 16 in. (diagonal) Viewsonic CRT monitor (1024 × 768 resolution) on a gray background (CIE $x = 0.306$, $y = 0.334$, $Y = 9$ cd/m$^2$) using Presentation software (www.neurobs.com). They were viewed from a distance of approximately 60 cm. The four rating tasks in this experiment were completed by the same participants in the order given below.

### *Preference for Contextless Colors*

This task was the same as in experiments 1 and 2, but for the T-shirt colors rather than the BCP colors. Participants rated how much they liked each colored square (200 × 200 pixels), one at a time in a random order.

### *Preference for Imagined T-Shirt Colors*

This task was the same as in experiment 1 but using the T-shirt colors. Participants were presented with each of the colored squares alone (without a gray-scale photograph of the T-shirt) and were asked to rate how much they thought they would like each color for a T-shirt.

***Preference for Depicted T-Shirt Colors***

This task was the same as in experiment 2 but using the T-shirt colors. Participants were presented with color-modified photographic images of each of the colored T-shirts (which were colored using the same procedure as described in experiment 2, see Fig. B2) and were asked to rate how much they liked each color for the T-shirt.

***Preference for Physical T-Shirt Colors***

Participants were brought into a different booth, which contained a black clothes rack with each T-shirt hanging on a black hanger. All of the T-shirts were behind a gray poster board. The T-shirts were rated in a randomized order for each participant. The experimenter moved each T-shirt in front of the gray poster board for participants to rate using a line-mark rating scale on a computer, as in all other experiments. After the participant made the rating, the experimenter moved the shirt behind the gray board and put the next shirt in front of it. This procedure was followed until all T-shirts had been rated.

### Results

Average preferences for physical T-shirts were highly correlated with average preferences for imagined T-shirts ($r = 0.94$, $P < 0.001$) and depicted T-shirts ($r = 0.95$, $P < 0.001$) of the corresponding colors. As in experiment 2, depicted and imagined T-shirts were also highly correlated ($r = 0.97$, $P < 0.001$). Contextless square color preferences were only moderately related to T-shirt color preferences for the imagined ($r = 0.49$, $P < 0.05$), depicted ($r = 0.42$, $P = 0.06$), and physical ($r = 0.51$, $P < 0.05$) T-shirt tasks, as reported in experiments 1 and 2.

Because the experimental design for the chromatic colors was nonorthogonal [all hues came in three cuts (saturated, light, and dark) except for purple, which was only light or dark], we conducted two separate ANOVAs comparing the different T-shirt tasks, one including all hues for only the light and dark cuts and the other including all hues except for purple for all cuts. In both ANOVAs, there was no main effect of task, and no interactions with task (all $F$s $< 1.17$, $P > 0.05$). For the achromatic colors (black, white, and two intermediate grays), there was a slight main effect of task in which depicted T-shirt colors were more preferred than imagined T-shirts or physical T-shirt colors ($F(2,36) = 3.35$, $P < 0.05$), but task type did not interact with T-shirt lightness ($F(3,54) = 1.08$, $P > 0.05$) and did not exceed the Bonferroni correction for multiple comparisons.

From these results, it is clear that people's preferences for imagined and depicted objects, at least for T-shirts, generalize very well to preferences for actual T-shirts. This finding bodes well for using imagined or depicted objects in future experiments on object color preferences rather than having to find or produce physical objects in every color to be studied.

## EXPERIMENT 4: FUNCTIONAL FEATURES IN OBJECT COLOR PREFERENCES

In the final experiment, we explored the reasons why color preferences might vary for different categories of objects. In particular, we investigated whether people prefer objects to have colors that help achieve certain functions (e.g., light walls making rooms look more open and spacious and dark couches hiding dirt), and/or to make people feel a certain way (e.g., to feel calmer or to project an informal, sporty image).

To address such questions, we first collected open-ended, preliminary data on which features people mentioned as important when choosing the color of the objects studied in experiment 2: walls, couches, T-shirts, luxury sedans, and VW Bugs. Some responses reflected factors that were highly personal, such as how well a T-shirt color complements someone's own skin tone, whereas others were more general, such as how open and spacious a wall color makes a room feel. We organized the list of feature descriptions into a set of dimensions (Table II), some of which were general (e.g., timeless vs. trendy) and some which were specific for particular objects (e.g., open vs. spacious for walls). Participants rated each of the colors for each of the objects along these dimensions so we could test whether the degrees to which colors had those features for a particular object were related to how much people liked those colors for the object. We also tested whether the degrees to which people valued those object features were related to how much they liked colors that encapsulated those features for particular objects.

### Method

*Participants.* There were two groups of participants for this experiment. The first group consisted of the 48 participants from experiment 2, who completed the feature importance and skin tone rating tasks ($n = 48$, 24 females). The second group consisted of 28 other people (17 females), who completed the other colored object feature ratings. All participants had normal color vision and gave informed consent. The CPHS at UC Berkeley approved the experimental protocol.

*Design, Displays, and Procedures.* There were three main tasks in this experiment.

***Feature Importance***

This task was completed by experiment 2 participants after they rated their color preferences for depicted objects. For each object, participants were asked to rate how important the following dimensions were to them when con-

TABLE II. Correlations between object color preferences predictor dimensions for each object

| Wall | Wall color preference | Wall appropriateness | Open/spacious | Relaxing |
|---|---|---|---|---|
| Wall appropriateness | 0.72*** | | | |
| Open/spacious | 0.60*** | 0.15 | | |
| Relaxing | 0.71*** | 0.91*** | 0.17 | |
| Contextless preference | 0.46** | −0.06 | 0.46** | 0.12 |
| Couch | Couch color preference | Couch appropriateness | Dirt hiding | |
| Couch appropriateness | 0.88*** | | | |
| Dirt hiding | 0.24 | 0.38* | | |
| Contextless preference | 0.12 | −0.22 | −0.45** | |
| T-shirt | T-shirt color preference | T-shirt appropriateness | Dirt hiding | |
| T-shirt appropriateness | 0.72*** | | | |
| Dirt hiding | 0.19 | 0.36* | | |
| Contextless preference | 0.58*** | −0.07 | −0.42** | |
| Sedan | Sedan color preference | Sedan appropriateness | Luxurious | Not attract police |
| Sedan appropriateness | 0.88*** | | | |
| Luxurious | 0.89*** | 0.78*** | | |
| Not attract police | 0.75*** | 0.94 | 0.63*** | |
| Contextless preference | 0.31 | −0.09 | 0.18 | 0.17 |
| VW bug | Bug color preference | Bug appropriateness | Luxurious | Not attract police |
| Bug appropriateness | 0.43** | | | |
| Luxurious | 0.69*** | 0.55*** | | |
| Not attract police | 0.24 | 0.93 | 0.35* | |
| Contextless preference | 0.73*** | −0.07 | 0.53*** | 0.22 |

*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$.

sidering their color preferences for that object: conventional versus unique, neutral versus loud/flashy, and timeless versus trendy (may go out of style). Additional rating dimensions for couches and T-shirts were hides dirt well versus shows dirt easily; for cars - luxurious versus non-luxurious and likely to get you pulled over versus unlikely to get you pulled over [by police]; for walls dlosed/constricted versus open/spacious. These dimensions were chosen based on pilot data in which participants were asked to describe the features that are important to them when choosing the color of a wall, couch, T-shirt, luxury sedan, and VW Bug.

### *T-Shirt Skin Tone Complementarity*

This task was completed by the first group of 48 participants after completing the feature importance task. For each T-shirt image, participants rated how well the color went with their skin tone.

### *Colored Object Feature Ratings*

This task was completed by the second set of 28 participants. They were presented with the same colored objects as in the depicted object color task of experiment 2. For all objects, they rated each color along the same dimensions as described above for the feature importance task. The participants who completed this feature-rating task never judged color preferences in their experimental session.

## Results

Functional aspects of objects influenced people's object color preferences in several ways. First, strong interdimensional correlations were present between three dimensions that were rated for all objects: conventional versus neutral ($r = +0.88$), conventional versus timeless ($r = +0.97$), and neutral versus timeless ($r = +0.88$). We therefore reduced the number of dimensions by conducting a factor analysis on all pairwise correlations across the average ratings for all 37 colors for all five objects (185 data points). A single factor explained 95% of the variance in these three dimensions, so we simply averaged these ratings to give a single value, which we will call appropriateness on the grounds that the colors that are conventional, neutral, and timeless for a given object tend to be more appropriate for the category as a whole, and the colors that are unique, loud/flashy, and potentially trendy for a given object tend to be less appropriate for the category as a whole. Moreover, we believe that this dimension roughly reflects the concept of appropriateness as discussed by Sivik[11] and Taft.[16]

Figure 7 shows the appropriateness data for each color for each object. There are a number of features that are common to all objects. Overall, the saturated colors were judged to be relatively inappropriate for all objects, although somewhat less for VW Bugs and somewhat more for couches and luxury sedans. Furthermore, blue is judged to be the most appropriate hue for all cuts (saturation/lightness levels) for each object. A three-way hue × cut × object interaction reflects the fact that the appropriateness of the colors varies somewhat across objects ($F(84,2268) = 3.05$, $P < 0.001$). Relative to the other objects, dark red is judged particularly appropriate for sedans and T-shirts, saturated yellow is particularly appropriate for VW Bugs, and all the oranges except for saturated orange are particularly appropriate for couches. For the achromatic colors (black, white, and three intermediate grays), the lighter colors were more appropriate for walls (with black being especially inappropriate) and darker colors being more appropriate for all the other objects $F(16, 432) = 20.43$, $P < 0.001$).

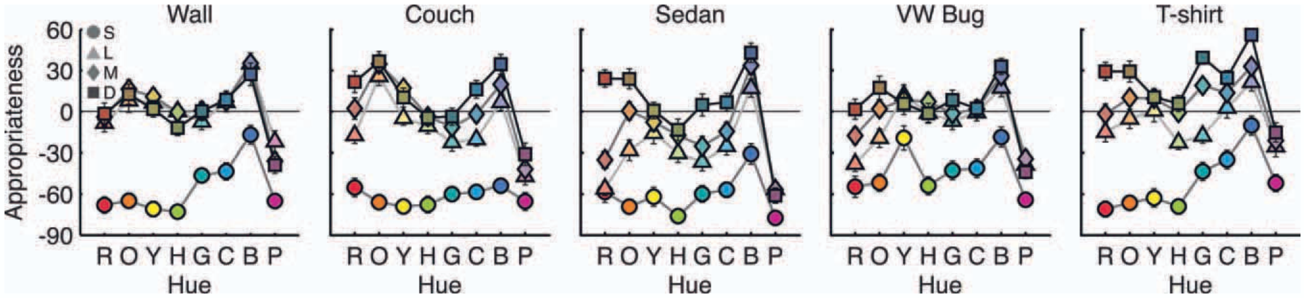


FIG. 7. Average ratings on the aggregate appropriateness dimension for each object type, calculated by averaging the highly correlated conventional versus unique, neutral versus loud/flashy, timeless versus trendy (may go out of style) dimensions. Separate lines represent the different 'cuts' [Saturated (S, circles), Light (L, triangles), Muted (M, diamonds), and Dark (D, squares)]. The error bars represent the SEMs.

For each object, we calculated the correlation between color preferences for the object and the color-feature ratings on the relevant dimensions for that object (Table II). The ratings of each color for each object on these dimensions can be found in Fig. B2. We also calculated pairwise correlations between the color-feature ratings. For each object, the color preference ratings were significantly related to the ratings of the appropriateness of the colors for that same object (see Table II): that is, the average appropriateness ratings of the 37 colors for walls was correlated +0.72 with the average preferences of the 37 colors for walls, and the corresponding correlations for the other four objects ranged from a low of +0.43 for VW Bugs to a high of +0.88 for couches and sedans. As expected, people reliably preferred wall colors that were more open/spacious and relaxing. Couch color and T-shirt color preferences were positively related to how well the color hides dirt, but not significantly so. Sedan and VW bug color preferences both increase as the colors become more luxurious and are less likely to cause one to be pulled over by the traffic police, but those relations were stronger for sedans than VW bugs. Another difference between the two car types, as mentioned in experiment 2, is that VW Bug color preferences were more closely related to contextless color preferences than sedans color preferences were.

Next, we conducted multiple linear regression analyses for each object to determine how much variance in the object color preferences could be explained by the factors listed in Table II, after accounting for contextless color preference (Fig. 8). The degree to which appropriateness explains object color preference is inversely proportional to the degree to which contextless color preference is important. Appropriateness was most strongly correlated with couch and sedan color preferences and least correlated with VW Bug and T-shirt color preferences. This pattern supports Taft's[16] proposal that object color preferences deviate most from contextless color preferences when objects have conventional colors.

Of course, the finding that appropriateness is closely related to object color preferences does not answer the question of why some colors seem more appropriate for a given object than others. Below, we consider several of possible sources of object-color appropriateness. One possibility is that more conventional colors tend to be less "loud and flashy" (i.e., less saturated), and people prefer their artifacts to be more subdued. One can imagine certain types of personalities, however, who might prefer colored objects that are less conventional because they want to stand out (e.g., pop musicians and visual artists). Another possibility is that conventional object colors serve particular purposes for the object. For example, wall colors are conventionally lighter because people prefer colors that make rooms look brighter and feel more open and spacious ($r = 0.60$, $P < 0.001$), as lighter walls do.[22] However, this factor does not account for additional variance after accounting for appropriateness and is only weakly correlated with appropriateness ($r = 0.15$, $P > 0.05$). A third possibility is that appropriate colors make objects seem more recognizable, as can be inferred from theories of perceptual fluency.[24,25] For example, a VW Bug that is presented in a prototypically saturated yellow may be more easily recognized as a VW Bug (harking back to the 1960s), and therefore be preferred to a dull, grayish VW bug. In contrast, a luxury sedan presented in saturated yellow may be confusable with a not-so-luxurious taxicab and would be more easily recognized as an upscale car in a more "luxurious" feeling color, such as black or gray. A fourth potential cause for object-color appropriateness depends on one's desired experience with the object. This possibility is consistent with the claim that people choose room colors to make them feel the way they want to feel in that room.[15] People may prefer the car's color to project what they want to feel when driving it or what they want others to think when they see it (e.g., a mature and conventional person vs. a sporty and playful person).

The idea that object color preferences are influenced by the degree to which colors help objects fulfill a particular function or outcome suggests that correlations between individuals' object color preferences and object color feature ratings should be related to how much they value that feature. For example, the more individual participants care about having appropriately colored objects, the more their individual object color preferences will be related to this aggregate dimension of object-color appropriateness.

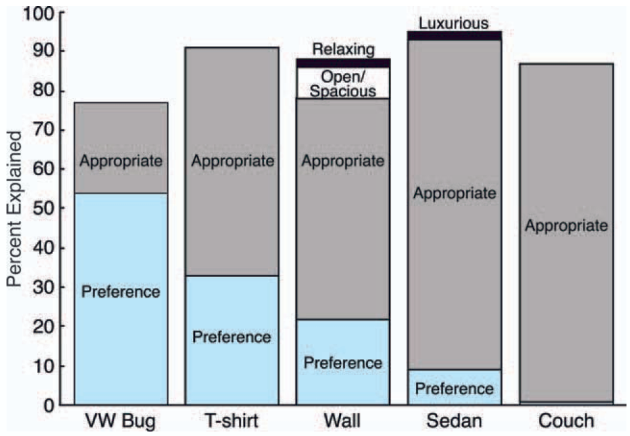


FIG. 8. Results of linear regression models showing the percentage of variance explained in object color preference by the contextless color preference, appropriateness, and likelihood to show dirt, openness, and luxuriousness. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

Table III shows that these correlations were positive for all the relevant features for each object. There was an especially strong relation between how much a given individual values appropriateness with how much the individual likes object-appropriate colors. These systematic individual differences support the hypothesis that desired function/outcome of objects is related to object color preferences.

Furthermore, support for functionality comes from an analysis of the relation between individuals' T-shirt color preferences and the degree to which those colors complement their skin tone. For each subject, we correlated his or her own color preference ratings for depicted T-shirts (from experiment 2) with his or her own ratings of how well the T-shirt colors matched his or her skin tone, and then averaged these correlations across participants.[¶] The average of the individual correlations was highly reliable ($r = +0.66$, $P < 0.001$), suggesting that people do consider their skin tone when making their T-shirt color preference ratings. To test whether variability in T-shirt color preferences is truly related to individual differences in skin tone, we compared within-participant correlations between T-shirt color preference and skin-tone complementarity with the average of between-participant correlations. Indeed, the average of the between-subject correlations is significantly lower ($r = +0.26$) than the within-subject correlations reported above ($t(47) = 10.42$, $P < 0.001$). It thus appears that the degree to which people think they "look good" in a color plays a role in their T-shirt color preferences.

[¶]To average the individual subjects' correlations, we first calculated the inverse hyperbolic tangent of the correlations to unconstrain their limits. Then, we averaged these transformed scores and calculated the hyperbolic tangent of the average to convert them back to the normal range of correlations ($-1$ to 1). *t*-Tests comparing distributions of correlations were also calculated on the unconstrained, inverse hyperbolic tangents of the correlations.

## GENERAL DISCUSSION

In this article, we have presented substantial evidence that color preferences vary reliably and systematically for different object contexts. In experiment 1, we demonstrated that hue preferences for contextless squares generalize relatively well to hue preferences for imagined objects with a few exceptions. One exception is that people do not seem to like big things, such as couches and walls, to be highly saturated red, although they like them better when depicted than imagined (experiment 2). Another is that they tend to like purple objects relatively less than they like purple contextless squares. The majority of the differences between object color preferences, however, are due to differences in saturation and lightness. People liked saturated colors least for every object context we tested, even though they like saturated colors most for contextless squares. Preferences also varied considerably as a function of lightness: color preferences for most objects increased as the colors became darker, but wall and trim color preferences increased as the colors became lighter, and contextless square preferences were relatively invariant over lightness levels.

The results of experiment 2 showed that imagined object color preferences when viewing colored squares and black-and-white pictures of the object were closely related to object color preferences when viewing colored pictures of the same objects. Still, there were some minor, but reliable, differences. First, people liked pictures of "big red things"—that is, couches and walls—better than they imagined they would when viewing small colored squares. Second, participants like pictures of dark walls better than they imagined they would. In both cases, we do not know which testing method yields preferences that are closer to those that would be experienced when people view the actual physical objects, because we have no data on color preferences for actual physical walls or couches. It might be that preferences for pictures of colored objects would be better approximations because they look more like the actual object than a simple square does. Given that the differences tend to involve large objects; however, it is also possible that imagining the object gives better estimates, because the pictures of large objects are themselves small and therefore misleading about size-related differences in color pref-

TABLE III. Correlations between the degree to which individual object colors that have the listed features and how much people value that feature

| Object feature | Wall | Couch | T-shirt | Sedan | VW bug |
|---|---|---|---|---|---|
| Appropriate | 0.45** | 0.54*** | 0.37** | 0.34* | 0.44** |
| Open/spacious | 0.006 | – | – | – | – |
| Relaxing | 0.38** | – | – | – | – |
| Dirt hiding | – | 0.22 | 0.21 | – | – |
| Luxurious | – | – | – | 0.13 | 0.14 |
| Not police attracting | – | – | – | 0.17 | 0.41** |

*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$.

erences. Further research will be required to answer such questions.

Experiment 3 revealed no differences between preferences for the color of imagined, depicted, and actual T-shirts. This finding, along with those of experiment 2, demonstrate that people are relatively good at imagining how much they will like an object color when presented with the color as a square patch, at least for the case of T-shirts. Therefore, in future experiments on object color preferences, it will seldom be necessary to present actual objects or even depicted colored objects. There may be small differences between preferences for the color of imagined versus depicted objects if they are large and/or dark, as found in experiment 2 for walls, but the general shape of the depicted color preference functions for the objects we studied can be well approximated by asking people to imagine objects from color samples presented on computer screens.

In experiment 4, we tested the hypothesis that object color preferences are related by the degree to which colors help objects fulfill particular functions or outcomes. People generally liked colors that were "appropriate" for the particular object, but which colors were appropriate varied across objects. Other dimensions that were specific to particular objects were also important, such as how open/spacious a wall color made a room seem, and how luxurious a sedan color made a sedan feel. We also found that the degree to which individuals value certain features for objects is correlated with the degree to which people like object colors that express those features.

A question of considerable interest is how the present preference effects for colors of concrete objects relate to different theories of color preference. As discussed above, the data show both considerable commonalities among color preferences for different objects and nontrivial differences between those for objects as similar as different kinds of automobiles. Both types of findings require explanation.

Broadly speaking, theories of human color preference can be classified into three types: phenomenological, biological, and ecological.[18] Phenomenological theories claim that color preferences are caused by some aspect of the conscious experiences a person has while viewing that color, much like the "yum/yuck" dimension of the taste a person experiences while eating various foods. Although it is hard to deny that there is a phenomenological component to color preferences, it is unclear that it is the cause of those preferences rather than the result. Even if color preferences were caused by the degree of pleasure one experiences while viewing the colors, the appearance of such pleasurable experience appears to require further explanation. Nevertheless, it seems fairly clear that such an explanation would be able to account for commonalities of color preferences across objects, because the same color experience is presumably evoked while observing different objects. It is far less clear from a phenomenological perspective why the same colors in different objects should produce different degrees of pleasurable experiences, even when the objects themselves are relatively similar (e.g., disliking yellow luxury sedans versus liking yellow VW Bugs).

Biological theories of color preference appeal to the underlying neural substrate of the color vision system to explain color preferences.[6] It might be, for example, that neural activity of the blue-signaling response in blue-yellow opponent neurons[26,27] tends to cause activation of reward centers in the brain, whereas neural activity in the yellow-signaling response of those same blue-yellow opponent neurons tends to cause inhibition in those same reward centers. Again, it is hard to deny that there must be some aspect of the neural response to viewing colors that correlates with color preference, but this does not mean that it can easily explain why such neural responses would differ when they were associated with objects as similar as luxury sedans versus VW Bugs. Something other than an appeal to neural responses seems to be required.

Ecological theories are far more promising in accounting for differences in object color preferences because they can be specifically grounded in people's affective responses to different kinds of objects. Palmer and Schloss's[7] ecological valence theory (EVT), for example, explicitly posit that abstract color preferences are largely determined by people's average degree of liking for the correspondingly colored objects with which they have had experience. In an experiment designed to test this hypothesis, they found that 80% of the variance in average color preferences for contextless squares was explained by a measure, called the weighted affective valence estimate (WAVE), of how much people like the objects that are associated with each presented color, weighted by how well each object's characteristic color matches the presented color. Although these results are correlational, further studies have supported the EVT's notion that color-specific object preferences influence abstract color preferences.[17] It should be noted that the kinds of objects studied in this experiments are not included in calculating the WAVE, because the WAVE measures only preferences for objects that have a characteristic color and specifically excludes objects that could be any color. The WAVE captures the overall preference for saturated colors and purples in the contextless color preferences quite well,[7] even though the objects color preferences tested here were low for saturated colors and purples. The EVT implies that abstract preference for a given color is essentially a summary statistic about the valences of their experiences with all objects of that color. That is, the positivity/negativity of all experiences a person has had with all objects of a given color contribute to his/her abstract color preferences, including objects that come in a wide variety of colors, such as cars, couches, walls, and T-shirts.

The most obvious way of adapting the ecological rationale of the EVT to object-specific color preferences is simply to restrict the set of relevant objects to a given category, such as the set of all couch experiences or the set of all VW Bug experiences. Color preferences for couches, then, would theoretically be determined by the summary statistics of one's affective reactions to all couches he/she has experienced in each color tested. In its strict form, however, this idea is viable only if people have indeed had affective reactions to couches in all of the tested colors. This assumption seems unlikely for these experiments, however, especially for the highly saturated colors in which couches are seldom, if ever, seen.

The question then becomes how the actual experiences one has had with couches of different colors might be extrapolated to judgments of couches of other colors. One possibility is to consider one's desired experience with the object, as others have suggested.[14,15] Even if one has never actually seen a couch in saturated red, for example, one might want the couch to blend harmoniously with its surrounding furniture and walls, and prior research has demonstrated that saturated colors—and especially saturated reds—are generally disharmonious in combination with other colors.[18] Similarly, experiences with both light and dark couches may have revealed that dark couches stay clean looking longer than light couches, so dark couches may be preferred even in hues in which couches have never been seen. Desired experiences with objects may differ even for objects within the same basic level category. VW Bugs and sedans are both cars, for example, but people may want a sedan to look and/or feel "mature and luxurious," which is more compatible with darker colors, whereas they may want a Bug to look and/or feel "fun and playful," which is compatible with more saturated, warmer colors. Further effects may be due to the way objects are portrayed in advertisements, where ads directed toward "young, hip" individuals present cars in bright, saturated colors where as those directed toward "mature, sophisticated" individuals present cars in blacks and silvers. Such factors can be viewed as functions that act on the baseline contextless color preferences to shape object color preferences. The degree to which these other factors influence object color preferences may well differ across individuals, depending on how much a given person values the feature in question.

Another aspect of people's affective experience with specific objects is how they feel about the image others have about them when they are associated with the object. As Whitfield and Wiltshire[28] argues, people infer the personal and social features of another individual, based, in part, on the features of objects that are associated with that individual. More socially, conservative people may tend to like conventional colors for objects, and less conservative people may tend to like more unique colors for objects. We believe that the results described in this article concerning average preference for colored objects can help frame future investigations on the difficult, but fascinating, questions of how and why individuals differ in their preferences for differently colored objects.

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## APPENDIX A

TABLE A1. CIE 1931 values and Munsell values for the 32 chromatic colors[7] and CIE 1931 values for the five achromatic colors (CIE illuminant C)[17]

| Color | | x | y | Y | Hue | Value/chroma |
|---|---|---|---|---|---|---|
| Red | Saturated | 0.549 | 0.313 | 22.93 | 5 R | 5/15 |
| | Light | 0.407 | 0.326 | 49.95 | 5 R | 7/8 |
| | Muted | 0.441 | 0.324 | 22.93 | 5 R | 5/8 |
| | Dark | 0.506 | 0.311 | 7.60 | 5 R | 3/8 |
| Orange | Saturated | 0.513 | 0.412 | 49.95 | 5 YR | 7/13 |
| | Light | 0.399 | 0.366 | 68.56 | 5 YR | 8/6 |
| | Muted | 0.423 | 0.375 | 34.86 | 5 YR | 6/6 |
| | Dark | 0.481 | 0.388 | 10.76 | 5 YR | 3.5/6 |
| Yellow | Saturated | 0.446 | 0.472 | 91.25 | 5 Y | 9/12 |
| | Light | 0.391 | 0.413 | 91.25 | 5 Y | 9/6.5 |
| | Muted | 0.407 | 0.426 | 49.95 | 5 Y | 7/6.5 |
| | Dark | 0.437 | 0.450 | 18.43 | 5 Y | 5/6.5 |
| Chartreuse | Saturated | 0.387 | 0.504 | 68.56 | 5 GY | 8/11 |
| | Light | 0.357 | 0.420 | 79.90 | 5 GY | 8.5/6 |
| | Muted | 0.360 | 0.436 | 42.40 | 5 GY | 6.5/6 |
| | Dark | 0.369 | 0.473 | 18.43 | 5 GY | 4.5/6 |
| Green | Saturated | 0.254 | 0.449 | 42.40 | 3.75 G | 6.5/11.5 |
| | Light | 0.288 | 0.381 | 63.90 | 3.75 G | 7.75/6.25 |
| | Muted | 0.281 | 0.392 | 34.86 | 3.75 G | 6/6.25 |
| | Dark | 0.261 | 0.419 | 12.34 | 3.75 G | 3.75/6.25 |
| Cyan | Saturated | 0.226 | 0.335 | 49.95 | 5 BG | 7/9 |
| | Light | 0.267 | 0.330 | 68.56 | 5 BG | 8/5 |
| | Muted | 0.254 | 0.328 | 34.86 | 5 BG | 6/5 |
| | Dark | 0.233 | 0.324 | 13.92 | 5 BG | 4/5 |
| Blue | Saturated | 0.200 | 0.230 | 34.86 | 10 B | 6/10 |
| | Light | 0.255 | 0.278 | 59.25 | 10 B | 7.5/5.5 |
| | Muted | 0.241 | 0.265 | 28.90 | 10 B | 5.5/5.5 |
| | Dark | 0.212 | 0.236 | 10.76 | 10 B | 3.5/5.5 |
| Purple | Saturated | 0.272 | 0.156 | 18.43 | 5 P | 4.5/17 |
| | Light | 0.290 | 0.242 | 49.95 | 5 P | 7/9 |
| | Muted | 0.287 | 0.222 | 22.93 | 5 P | 5/9 |
| | Dark | 0.280 | 0.181 | 7.60 | 5 P | 3/9 |
| Achromatic | Black | 0.310 | 0.316 | 0.30 | | |
| | Dark gray | 0.310 | 0.316 | 12.34 | | |
| | Med gray | 0.310 | 0.316 | 31.88 | | |
| | Light gray | 0.310 | 0.316 | 63.90 | | |
| | White | 0.310 | 0.316 | 116.00 | | |

TABLE A2. Gildan© names for the T-shirt colors and corresponding CIE 1931 *xyY* values for the T-shirts, matched until a full spectrum flood light

| Gildan© color | CIE *x* | CIE *y* | CIE *Y* |
|---|---|---|---|
| Cherry red | 0.530 | 0.320 | 3.2 |
| Light pink | 0.321 | 0.316 | 29.5 |
| Maroon | 0.402 | 0.290 | 1.7 |
| Orange | 0.562 | 0.368 | 11.0 |
| Tangerine | 0.486 | 0.403 | 22.0 |
| Dark chocolate | 0.344 | 0.356 | 1.5 |
| Daisy | 0.420 | 0.470 | 33.0 |
| yellow haze | 0.355 | 0.390 | 40.0 |
| Old gold | 0.420 | 0.418 | 10.5 |
| Irish green | 0.256 | 0.480 | 9.0 |
| Pistachio | 0.325 | 0.415 | 31.0 |
| Forest | 0.284 | 0.392 | 1.5 |
| Sapphire | 0.191 | 0.238 | 6.0 |
| Sky | 0.236 | 0.296 | 27.5 |
| Navy blue | 0.240 | 0.250 | 1.0 |
| Purple | 0.240 | 0.153 | 1.3 |
| Orchid | 0.294 | 0.285 | 19.0 |
| Black | 0.300 | 0.335 | 0.8 |
| Charcoal | 0.300 | 0.330 | 3.4 |
| Ice gray | 0.300 | 0.330 | 21.0 |
| White | 0.300 | 0.330 | 45.0 |

## APPENDIX B

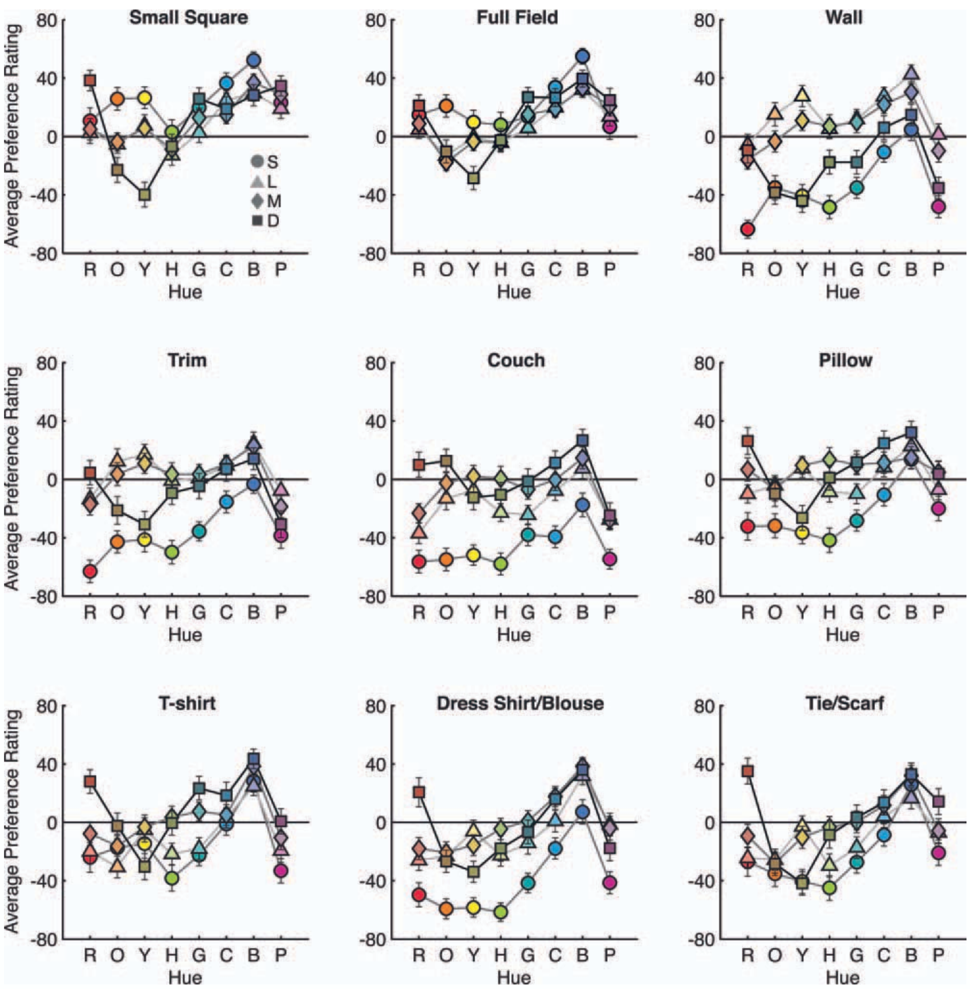


FIG. B1. Average preference ratings for each object context (subplot titles) as a function of hue (*x*-axis) for the saturated (circles), light (triangles), muted (diamonds), and dark (squares) cuts. Error bars represent SEMs.

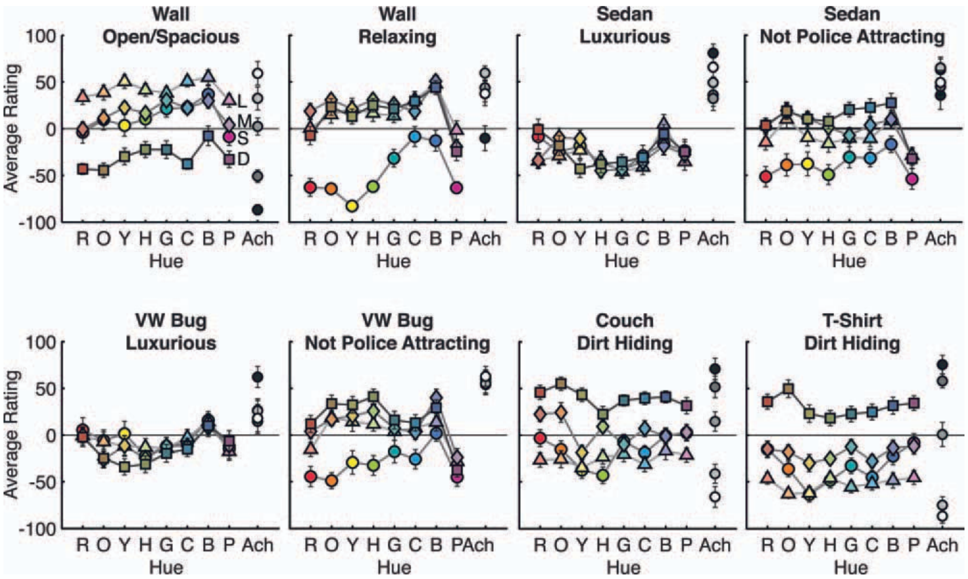


FIG. B2. Average ratings of each color for each object along the titled dimension, as a function of hue for the saturated (chromatic circles), light (triangles), muted (diamonds), and dark (squares) cuts. Achromatic circles (Ach) represent black, white, and three intermediate grays. Error bars represent SEMs.

## APPENDIX C

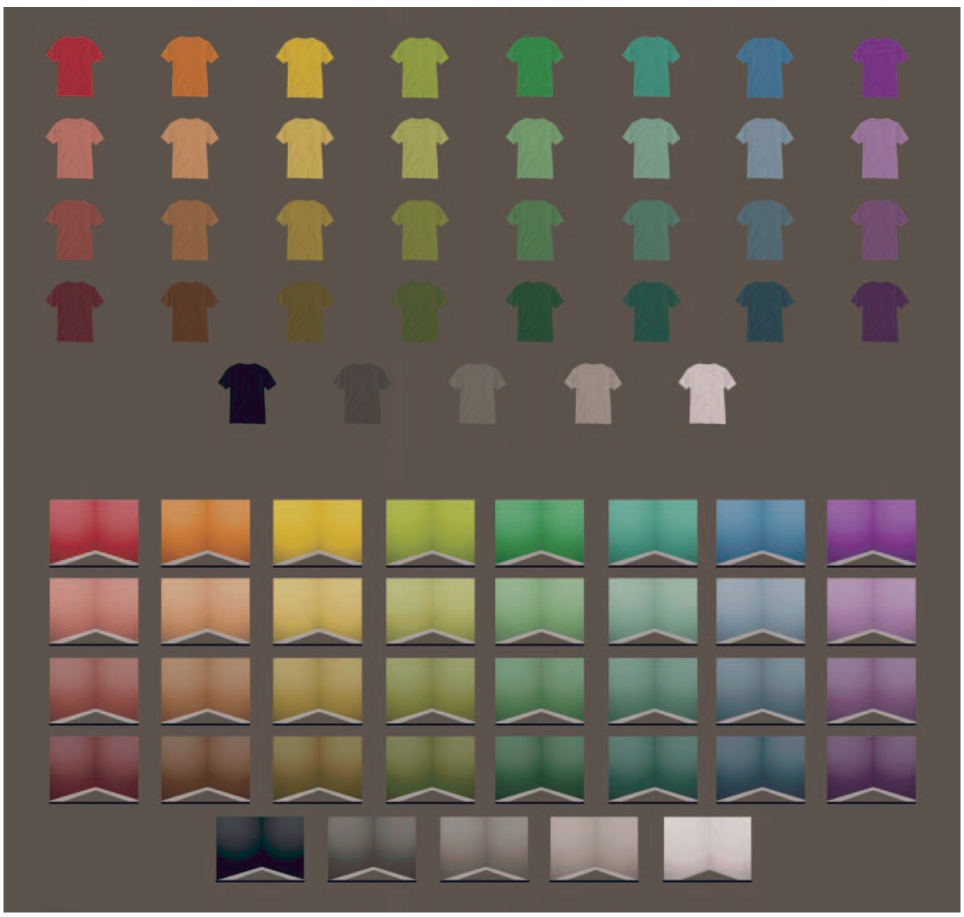

FIG. C1. Images of colored T-shirts and walls used in experiments 2 and 4. Within each object group, the rows (top to bottom) include the saturated, light, muted, and dark cuts, followed by the achromatic colors. The columns (left to right) include the red, orange, yellow, chartreuse, green, cyan, blue, and purple hues.

FIG. C2. Images of colored VW Bugs, sedans, and couches used in experiments 2 and 4. Within each object group, the rows (top to bottom) include the saturated, light, muted, and dark cuts, followed by the achromatic colors. The columns (left to right) include the red, orange, yellow, chartreuse, green, cyan, blue, and purple hues.


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