The Effects of Color-Taste Associations on Color Preferences

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Abstract

Though several color preference theories have been developed and tested, none have provided a wholly conclusive and universally applicable theory like the ecological valence theory. According to the Ecological Valence Theory (EVT), color preferences are determined by people's average affective response to experiences with correspondingly colored objects (Palmer and Schloss, 2010). The EVT implies that preference for a given color can be changed by positive or negative experiences with objects of that color. In the present study, we investigated whether tasting colored water that was sweet (positive) would increase preference for its color and tasting colored water that was sour (negative) would decrease preference for its color. Participants first rated their color preferences for 37 colors on a color preference task. They then tasted eight water samples of four different colors: two each that were red, green, yellow, and brown. For one group of participants, red and brown water samples were soured and green and yellow water samples were sweetened. A second group of participants received the opposite treatment: red and brown samples were sweetened and green and yellow water samples were soured. After tasting each sample, participants were asked to identify the flavor of each sample (mint, cherry, lemon, etc.) as well as to rate the sourness, sweetness, and preference. Finally, all participants repeated the initial color preference task. The drink samples affected color preference ratings in the predicted direction, where preferences for sour-associated colors decreased and those for sweet-associated colors increased. These results support the EVT's claim that color preferences are determined by positive and negative experiences with salient colored objects, making this study the first to demonstrate a definitive causal claim using the ecological valence theory of color preference.

Introduction

Development of Color Preference Theory

Color preference is an influential aspect of perception and evaluation. Though color preference has been a special focus for artists in creating aesthetically pleasing drawings and paintings, color preference also influences selection of other common items and appliances (Palmer & Schloss, 2010). Since color selection and preference are foundational to preference and selection in colored items, the question was raised of whether or not color preferences can be measured and studied. Cohn (1894) proposed that there is no general trend across individuals in color preference, and that color preference can only be observed individually. This argument was supported by later researchers who found that their group data was simply too variable, and that color preferences could only be determined on an individual basis (Dorcus, 1926; Von Allesch, 1924). Walton, Guilford and Guilford (1933) challenged this claim by suggesting that their participants maintained a “common basis of feeling”, meaning their participants demonstrated similar color preferences, for different colors. Walton, Guilford and Guilford (1933) also claimed that color preferences have a natural, biological cause, a theory that was firmly supported by the work of other color preference theorists (e.g., Garth, 1922). This research formed the basis for future study on color preferences.

There have been several studies dedicated to determining which colors people prefer (e.g., Washburn, 1911; Eysenck, 1941; Palmer and Schloss, 2010). Though Cohn (1894) originally argued that color preference trends across different individuals do not exist, his work was the first to report that people have a general preference for saturated colors, which are colors with high vividness and intensity. Similar results have been found by several different researchers, further supporting the claim that humans have a preference for single saturated colors (e.g., Walton & Morrison, 1931; Palmer & Schloss, 2010). However, Washburn (1911) challenged this claim, arguing that tints and shades are a more deciding factor in color preference. Titchener’s (1901) research sought out to test whether tint, shade, or saturation is the most important factor in color preference. Titchener’s results may have validated all of the previous studies surrounding this debate by suggesting that there are two types of observers: those who prefer saturated colors, and those who prefer unsaturated colors. In the years following Titchener’s theory, Eysenck (1941) created a study which analyzed the results of subjects who were asked to rank order colors in preference, leading to two distinct groups that prefer either saturated or unsaturated colors. Subsequently, numerous studies found a general preference for blue hues and a dislike for yellow hues (e.g., Guilford & Smith, 1959; McMannus, Jones, & Cottrell, 1981; Palmer & Schloss, 2010).

These previous studies were primarily aimed at determining existing color preferences, but do not address why people like the colors they do, or where color preferences originate from. Humphrey (1976) suggested that color preference is based on various “approach” and “avoid” signals sent out by objects in nature. Humphrey’s theory explains that objects emit natural approach or avoid signals, such as how the colors of specific flowers will attract pollinating bees and bats, or how the colors of a poisonous snake act as a warning to all surrounding animals to keep a distance. Though Humphrey states that color symbolism in nature has less of an influence on humans in modern times due to exposure to a variety of arbitrarily colored material items everyday (e.g., shirts and cars), he argues that these color signals could still have an impact upon our color preferences. Willson, Graff, and Whalen (1990) tested Humphrey's theory by studying food preferences of frugivorous birds. According to Humphrey's theory, these birds should be attracted to red and black, the most common colors of fruits in their diet, and should avoid yellow, the color of unripened fruit. However, Humphrey found that there was little tendency for these birds to favor red or black or to avoid yellow, suggesting that his approach and avoid theory may only apply in very specific and focused circumstances, and that a more comprehensive theory is needed. Hurlbert and Ling (2007) studied color preferences from a physiological perspective, relating them to the cone receptor outputs within the human eye. An important premise for their theory is that primates have developed three cones for color vision to better discriminate between yellow and red hues of ripe fruit against green foliage (Regan et al., 2001). They argue that women, as gatherers, needed to better discriminate reddish hues in order to find fruit in primitive human society, so they should prefer reddish hues more than males do. Hurlbert and Ling (2007) found that 70% of the variance in their average color preference data could be explained by outputs from the cone opponent systems (L-M and S-(L+M)). In particular, females preferred hues weighted more positively on the L-M dimension, indicating that they preferred colors that were more red to colors that were more blue-green, and males showed the opposite pattern. Though the hunter-gatherer account explains females' preference for reddish hues, it does not explain why males prefer blue-greenish hues to reddish hues – as they were probably not searching for leaves among the berries – or why both males and females preferred colors that were more violet to those that were more yellow-green, which was their largest effect.

Ou, Luo, Woodcock, and Wright (2004) proposed that color preference may be related to the "color-emotions" associated with certain colors. The study tested several color-emotion dimensions and found that certain color-emotion associations are highly correlated with color preferences. Within these color-emotion associations, it was discovered that colors associated with cool, active, or light color-emotions were preferred over colors associated with warm, passive, or hard color-emotions. A regression model based on these factors accounted for 67% of the variability in color preference in their study. These findings suggest that color preferences may be based on the emotions that are associated with colors. However, the reason for these emotional responses was not investigated, nor was the reason that certain colors and their associated emotions are better predictors of color preferences than others.

Due to the considerable amount of counter evidence against the "approach" and "avoid" theory of color preference, the cone receptor output theory, and the color-emotion association theory of color preference, for the purpose of this study, we addressed color preference using a more conclusive color preference theory known as the ecological valance theory. The ecological valence theory (EVT), proposed by Palmer and Schloss (2010), explains color preference as an adaptive process, through which color preferences depend on positive-to-negative experiences with all correspondingly colored objects. The EVT differs from the color-emotion theory of color preference in one important way. While the color-emotion theory suggested that the emotional perception of a color would solely determine color preference, EVT suggests that the affective response to items of a specific color will then influence a person's color preference for the color of that object. The EVT suggests that humans have a greater preference for blue because it is associated with positive things like clear sky and clean water, but a lower preference for dark greenish-brown, which is associated with negative things like rotting food and vegetation (Palmer & Schloss, 2010). To test the EVT, Palmer and Schloss conducted three tasks. In the object-association task, one group of participants were shown each of the Berkeley Color Project's (BCP) 32 chromatic colors and were asked to list as many objects as they could that were associated with that color. In the object-valence rating task, a different group of participants were given the names of objects reported by the object-association task participants and were asked to rate how affectively positive-to-negative each object was. In the color-object matching task, a third group of participants were given both the name of each object and the color for which it was reported and were asked to rate how much the characteristic color of the object matched the color on the screen. The data from these three tasks were used to calculate the weighted affective valence estimate (WAVE). The WAVE for each of the 32 colors is defined as the average value of the average valence for each object named for that color times the average match score for that object with the given color. These 32 WAVE values, which contain no free parameters, accounted for 80% of the variance in a different group's average preference ratings for the same colors. The WAVE predicts color preferences better than the previous models suggested by Ou et al. (2004) and Hurlbert and Ling (2007). This study established a strong correlation between color preference and preference for associated objects. However, the results are correlational and thus cannot support claims about the causal direction of the relation between object preference and color preference. Palmer and Schloss (2010) claim that object preferences cause color preferences, but the reverse could equally well be true – color preferences might cause object preferences – or some third factor might cause both color preferences and object preferences.

Schloss, Poggesi, and Palmer (in press) looked for causal evidence for the EVT by testing college students' color preferences at two rival institutions with strong color associations: the University of California, Berkeley (blue and gold) and Stanford University (red and white). Their logic was that the more positive affect (i.e., school spirit) students have for their own university and the more negative affect they have about their rival, the more they should like the colors of their own school and the less they should like the colors of their rival school. Indeed, university students prefer their school's colors to their rival's, and the degree to which they did so was positively related to their degree of self-reported school spirit. It is highly unlikely that students choose their institution and cultivate their degree of school spirit based on their existing color preferences, so any differences between Berkeley and Stanford students' color preferences have presumably been acquired through their affiliation with their university. Even so, these results are correlational, given that university affiliation is not experimentally manipulated. An experimental manipulation is required in order to provide a definitive test of the causal claim that object preferences cause color preferences.

Strauss, Schloss, and Palmer (in preparation) performed such a test by presenting participants with positive and negative images of items of a specific color. After participants completed a color preference task to establish baseline color preferences, they were divided into two groups: the +R/-G group saw positive red images (e.g., roses) with negative green images (e.g., moldy bread), whereas the +G/-R group saw positive green images (e.g., ripe kiwi) and negative red images (e.g., open wounds). Participants were then given the color preference task again to observe whether or not the positively or negatively charged images had altered corresponding color preferences, with increases in preference for red and decreases for green in the +R/-G group and increases in preference for green and decreases for red in the +G/-R group. A significant interaction was obtained between image exposure group and color preference change, but it was due mainly to the influence of the positive images. That is, positive images reliably increased color preferences, whereas negative images did not reliably decrease color preferences. Though these results support the EVT's general prediction, the evidence would be stronger if there were a significant impact of negative stimuli as well as positive stimuli. We reasoned that such effects might be achieved through tasting colored liquids that were soured and sweetened, respectively.

The primary aim of the present study was to further test the EVT's causal claim that object preferences influence color preferences by using color-flavor associations to try to change people's color preferences over the course of a 1-hour laboratory experiment. It was hypothesized that tasting colored water that was sweet (positive) would increase preference for its color and tasting colored water that was sour (negative) would decrease preference for its color. If color-taste associations indeed changed color preferences, that would provide strong evidence for the EVT's causal claim.

Experiment Objective

The primary aim was to test whether color-taste pairings can influence color preferences. According to the EVT, preference for colors paired with positive (sweet) drinks should increase after drink tasting and preference for colors paired with negative (sour) drinks should decrease.

The experiment was framed for participants as two separate, interwoven experiments, one on flavor perception and one on color preferences. Different experimenters conducted the taste and color preference tasks to increase the likelihood that participants would see them as entirely distinct experiments. First, participants took part in an initial drink exposure to encourage them to believe the primary goal of the experiment was to study taste perception. They then were asked to rate their color preferences for the Berkeley Color Project (BCP) 32 chromatic colors (Palmer & Schloss, 2010) in the initial color preference task in order to establish a color preference baseline. Participants were tested individually after random assignment to one of two main drink exposure groups. The +RB/-YG group consumed sweetened red and brown drink samples and soured yellow and green drink samples, and the –RB/+YG group consumed soured red and brown sampled and sweetened yellow and green drink samples. For each drink sample, participants completed a flavor identification task, a sourness and sweetness perception task, and a taste preference task. Immediately following the taste samples, participants were administered a color preference task identical to the initial color preference task. These color preference ratings were compared to the first color preference data to determine whether the drinks systematically and significantly changed color preferences.

Method

Participants

There were 22 participants (13 female, 7 males, mean age = 20, age range). All were volunteer psychology students at the University of California, Berkeley, who received course credit. Participants were tested for color deficiency with Dvorine Pseudo-Isochromatic Plates, and none were found to be color deficient. None of the participants reported having food related diseases or allergies. All participants gave informed consent, and the experiment protocol was approved by the UC Berkeley Committee for Protection of Human Subjects.

Design, Displays, and Procedure

In order to make it appear as though the color preference and taste experiments were entirely distinct and unrelated, they were conducted in different rooms, which were located on different floors of the Psychology Department, by two different experimenters, one for the color preference tasks and one for the taste tasks. There were a total of four phases to the entire experiment: (1) initial drink exposure, (2) initial color preference task, (3) drink tasting tasks with the experimental manipulation, and (4) post-exposure color preference task.

Initial drink exposure.

The experiment started with an initial drink exposure task so that participants viewed the study as one primarily about taste. We believe this made them less likely to catch on to the manipulation than if we had started with the initial color preference task. All participants were given the same four drink samples in the following order: an orange-colored orange-flavored drink, a blue-colored vanilla-flavored drink, a blue-colored blueberry-flavored drink, and an orange-colored grape- flavored drink. The drink stimuli were all presented in small, transparent cups. The drinks were comprised of non-carbonated Safeway Select water and placed on a table in drinking order from left to right before the participant arrived.

After tasting each sample, participants completed three tasks: (a) flavor identification, (b) sweetness and sourness ratings, and (c) a preference rating. These tasks were conducted so that participants would think that the experiment was about how the color of the drinks influenced flavor perception and preference, rather than about manipulating color preference. All answers were recorded on a survey (see Appendix). In the flavor identification task, participants were asked to identify the flavor of each drink from a checklist of the four possible flavors in the drink exposure, and the participants were permitted to check as many flavor options as the felt were appropriate. In the sweetness and sourness rating task, participants rated how sweet and how sour they felt each drink was by circling a number on a scale from -5 (“not at all”) to +5 (“very much”) for each attribute. In the drink preference rating task participants rated how much they liked each sample by circling a number on a scale from -5 (“not at all”) to and +5 (“very much).

Initial color preference experiment.

In this phase of the experiment, participants were presented with each of Berkeley Color Project (BCP) 37 colors (see Table 1 for CIE 1931 xyY and Munsell coordinates), one at a time (Palmer & Schloss, 2010; Schloss, Poggesi & Palmer, in press). The colors included independent combinations of eight hues (red, orange, yellow, chartreuse, green, cyan, blue, and magenta) with four saturation-lightness conditions (high saturation at medium lightness, and medium saturation at medium lightness, high lightness, and low lightness). The remaining 5 achromatic colors were of 5 separate levels of gray, including both black and white. All color stimuli were presented on a medium gray background (CIE x = 0.312, y = 0.318, Y = 19.26).

Colors were rendered and displayed using Presentation (www.neurobs.com) on a ViewSonic Graphic Series G70f computer monitor with a 1024x768 resolution. This monitor was calibrated using a Minolta CS100 Chroma Meter. Colors were presented as squares (100 px x 100 px) in the center of the screen. The participants rated how much they liked each color on a scale ranging from “not at all” to “very much”, by sliding the cursor along a 400 px response scale at the bottom of the screen and clicking to record their response. The center of the scale was indicated as a neutral point, and was demarcated with a line. Ratings were rescaled to range from –100 to +100.

Each color was presented twice, once in Block 1 and once in Block 2. In each block, the colors were presented individually in a random order. Colors remained on the screen until participants made a response, and the next trial began 500 ms later. After participants rated all 37 colors in both blocks, the experimenter calculated the correlation between their preferences for the same colors in Block 1 and Block 2. Participants’ preferences were considered unstable and they were disqualified from the experiment if this correlation was not 0.70 or above (a total of five participants, which were already excluded from the 22 tested). If this Block 1 and Block 2 correlation criterion was met, participants went on to the next phase on the experiment. Otherwise they were excused from the session but given the same course credit as those who passed the correlation criterion.

Drink exposure with experimental manipulation.

This drink exposure phase mirrored the initial drink exposure phase except that there were eight drink samples total, two each of the following colors: saturated yellow (Y), dark green (G), dark red (R), and dark orange (B), otherwise known as brown. Participants were divided into two groups. The +RB/-YG group received sweetened R and B samples and soured Y and G samples. The –RB/+YG group received sweetened Y and G samples and soured R and O samples. Kroger food coloring was used to color each sample, and the amount of coloring for a given hue was always constant. The solutions used to sweeten and sour drinks were 3 Capella Liquid Sweetener and 3 Capella Tart & Sour Drops, respectively, both of which were uncolored. All sour drop amounts remained constant within sour samples, and all sweetener amounts remained constant within sweetened samples.

In order to reduce the possibility of participants making a conscious association between color and sweet and sour effects, each drink also received one of the following flavor treatments: banana, cherry, chocolate, coffee, lemon, mint, pear, or raspberry. Of the eight drink flavors, four were paired with “appropriate” colors while the other four were paired with “inappropriate” colors. Within each of the +RB/-YG and –RB/+YG drink exposure groups, participants were randomly assigned to one of two flavor exposure conditions. Half of the participants received “appropriate” lemon-Y, mint-G, cherry-R, and coffee-B flavor-color pairings while also receiving “inappropriate” banana-B, pear-R, raspberry-G, and chocolate-Y flavor-color pairings. The other half of the participants received “appropriate” banana-Y, pear-G, raspberry-R, and chocolate-B flavor-color pairings and “inappropriate” lemon-B, mint-R, cherry-G, and coffee-Y flavor-color pairings. The amount of flavoring in each sample of identical flavor remained constant, and all samples were flavored using unsweetened and uncolored Capella banana, cherry, chocolate, coffee, lemon, mint, pear, or raspberry flavor drops.

The order of drink consumption was randomized for each participant to reduce any taste-order effect. After each drink sample, participants also ate a small piece of white Wonder Bread to help eliminate the taste of the previously tasted drink.

After tasting each sample, participants completed the flavor identification task, sourness and sweetness perception task, and the drink preference rating task, just as they did in the initial drink exposure phase. Once all drink samples were consumed, participants were asked to describe what they thought the experiment was about. This was done to encourage them to believe that the taste aspect of the experiment was complete, and not related to the following color preference task. If participants described that the experiment was about changing color preferences through taste associations, their data was eliminated, though no participants guessed the manipulation at this phase.

Post-exposure color preference experiment.

This phase of the experiment was identical to the initial color preference phase, except that participants were told that this experiment would contain some colors different from the first color task to make the separate experiment framework more believable. To make this statement true, two irrelevant, non-BCP colors were added to the experiment, which were identical for all participants. After completing this task, participants were asked to describe what they thought was the purpose color preference experiments. If they successfully described the experiment manipulation, their data was removed (only three participants did so, and their data were excluded from the 22 participants whose results are described below). Participants were then debriefed as to the actual purpose of the experiment.

Results

Color Preference Experiment Results

To determine whether or not the taste stimuli induced a change in color preference, participants' average color preferences from the initial color preference experiment for the colors used with the taste stimuli (red (R), brown (B), yellow (Y), and green (G)) were subtracted from the average color preferences for these colors in the post-taste exposure color preference experiment. As shown in Figure 1 there was an interaction between taste exposure group and change in color preference ($F(1,20) = 12.61$, $p < .01$). Participants in the +RB/-YG taste exposure group showed an increase in preference for R and B relative to that for Y and G ($t(11) = 2.76$, $p < .05$), whereas participants in the –RB/+YG group showed the opposite pattern ($t(9) = 2.32$, $p < 0.05$). There was no main effect of color, indicating that there was no overall difference in preference change between the two color sets ($F < 1$).

We also compared the effects of colors that covaried within groups of sweetness and sourness. There was no main effect of color with R and B ($F(1,20) = 1.71$, $p > .05$), and there was no interaction between color and group ($F < 1$). There was no main effect of Y and G ($F < 1$), but there was an interaction between color and group ($F(1, 20) = 4.38$, $p < .05$).

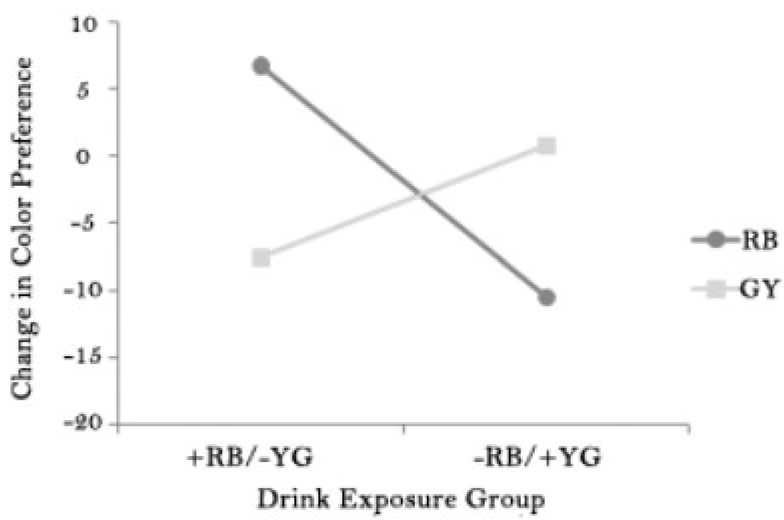

Figure 1. Changes in color preference between drink exposure groups for red and brown (dark gray circle points) and green and yellow (light gray square points).

Looking at each of the four colors separately (see Figure 2), there was a clear difference between groups for G ($t(20) = 2.36$, $p < .05$) and R ($t(20) = 3.44$, $p < .01$) , but not for Y ($t(20) = .39$, $p > .05$) or B ($t(20) = 1.23$, $p > .05$). While there was no main effect of color, there was an interaction.

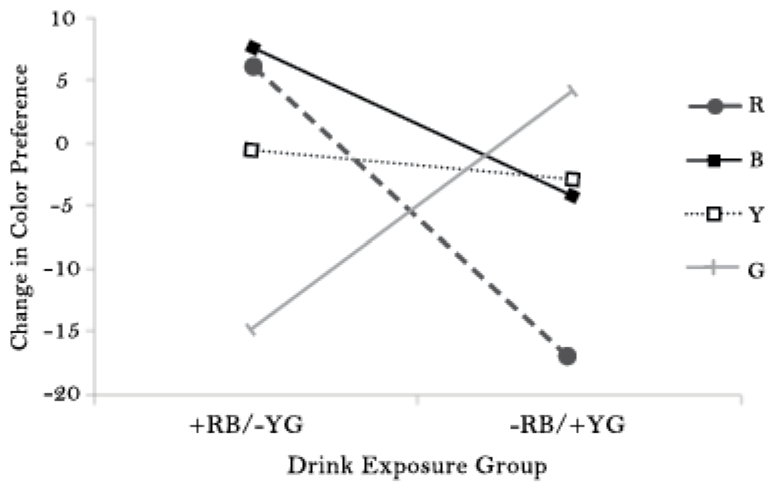

Figure 2. Changes in color preference between drink exposure groups for red (circle points), brown (square points), green (bar points), and yellow (hollow square points).

We also ran a comparison between groups, finding that people in the +RB/-YG taste exposure group had an increase in preference for R and B relative to those in the –RB/+YG ($F(1,20) = 3.57$, $p < .01$). This between group comparison found that the decrease in preference for Y and G in the +RB/-YG group and the decrease in preference for R and B in the –RB/+YG group was significant ($t(20) = 2.43$, $p < .05$), but that the increase in preference for R and B in the +RB/-YG group and the increase in preference for Y and G in the –RB/+YG groups was not significant ($t(20) = 1.04$, $p > .05$).

Discussion

Color Preference Experiment Discussion

As predicted, participants exposed to the +RB/-YG stimuli reported an increase in preference in R and B compared to their change in preference for Y and G. These findings support the main EVT hypothesis suggesting that sweet-associated colors would increase in average preference, whereas sour-associated colors would decrease in average preference. The data demonstrate that the drink samples acted as salient objects that became associated with the color of the objects, resulting in the change in color preference. Participants appear to have associated the specific colors of the drinks with the pleasant experiences of tasting sweet drinks and the unpleasant experiences of tasting sour drinks. This demonstrates that experiences with colored objects can influence color preference, as EVT suggests. Additionally, by using taste stimuli as a manipulated variable to produce changes in color preference, the results of this support the causal claim of the EVT, which is stronger than the correlative evidence reported previously. For this reason, the use of taste samples as positively or negatively valenced stimuli to alter color preference response appears to be a compelling experiment method for testing the

EVT, and should be useful for further tests.

In ensuring that there was justification in combining the average for R and B and the average for Y and G by comparing the effects of colors that covaried within groups of sweetness and sourness, it was determined that there was no main effect of color with R and B and no interaction between color and group. This means that the color preferences for these colors were moving in the same direction. However, although there was no main effect of Y and G, there was an interaction between color and groups where G showed the predicted direction in which the -RB/+YG drink exposure group had an increase in preference relative to those in the +RB/-YG drink exposure, but there was no effect for Y. Overall, R and G had the most powerful changes in preference, suggesting that future taste-color associated EVT color preference studies should include only those colors to maximize the strength of the effects. When observing each of the four colors separately, as seen in Figure 2, R and B produced the predicted interaction while Y and G did not. Although it is unclear why Y and B tend to prod01uce less robust changes, the data continues to suggest that R and G may be the best options for EVT research on color preference change.

In our between groups comparison, we observed that the decrease in preference for the soured colors was significant, but the increase in preference for sweetened colors was not significant. This supports past literature suggesting that differences in valence extremities between positive and negative stimuli is an evolutionary adaptation (Rozin, Gruss, & Berk, 1979). Humans have evolved to become more sensitive to negative experiences and associative objects (such as the taste samples), making changes in their response to these objects and experiences more extreme.

Another consideration in explaining the difference in preference changes between sour associated and sweet associated colors would be the novelty of sour drinks versus sweet drinks. The fact that the soured drinks are potentially new experiences suggests that the changes in preferences for sour-associated colors these wasn't due to priming, or activating known experiences and associations to encourage a bias in rating preferences. Instead, these soured drinks create new salient experiences with color objects, thus updating the associative memory that underlies color preference. As a result, the sour drink experiences would have been perceived as much more novel than the sweet drink experiences, and so it is possible that this also caused the difference in valence extremities between the sweet and sour stimuli.

Experimental Design Discussion

Though our data suggest that the EVT is significant in predicting the influence of color-taste associations on color preferences, it's important to recognize that the sample size of 22 is relatively small, especially when trying to establish a baseline color preference. However, while the sample size is small, this report presents a preliminary data set, and we plan to conduct more research of this nature in the near future.

Conclusion

The hypothesis that sweet-associated colors would increase in average preference whereas sour-associated colors would decrease in average preference was strongly supported by the results. The positively and negatively valenced taste samples changed color preferences as predicted by the EVT, meaning that the results support the causal claim of the EVT that object preferences impact color preferences. In providing support for the EVT, it suggests that the EVT should be used as an accurate tool to predict and influence color preferences, which may be extremely useful in both the fields of cognitive science as well as marketing and sales.

Future Research on the EVT

An important variable as yet unstudied is the time span over which the taste stimuli in this study would continue to influence color preferences. The present experiment was designed to test the immediate impact that pleasant and unpleasant colored drink samples have on color preferences, but it is not yet known how long these effects will last. The EVT suggests that, after a unique experience (e.g., like the drink samples that are not be repeated), color preferences should gradually return to baseline. An interesting extension of this study would thus be to have participants return after a set time interval to complete a third color preference survey to determine whether or not their color preferences remained changed after a longer length of time.

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Appendix A

For Drink 1, please bubble in which flavor(s) the drink contained:

Banana	Cherry	Chocolate	Coffee Bean	Lemon	Mint	Pear	Raspberry
○	○	○	○	○	○	○	○

For Drink 1, please rate how sour/tart this drink was, with -5 being the least sour/tart and 5 being the most sour/tart. Circle your response.

-5 -4 -3 -2 -1 0 1 2 3 4 5

For Drink 1, please rate how sweet this drink was, with -5 being the least sweet and 5 being the most sweet. Circle your response.

-5 -4 -3 -2 -1 0 1 2 3 4 5

For Drink 1, please rate how much you liked the drink, with -5 being that you liked the drink very little and 5 being that you liked the drink very much.

-5 -4 -3 -2 -1 0 1 2 3 4 5

Appendix B

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		