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The color of emotion: A metric for implicit color associations

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ABSTRACT

Color cues impact the chemosensory perception of foods and beverages. Evidence suggests that color exerts these effects through a link with emotion. In this study, color associations to 20 emotion terms were obtained by having 194 participants use a touch-screen display to select a matching color. The resulting color matches were displayed visually and their coordinates in the L*a*b* system were analyzed statistically. Matching colors were found to differ as a function of emotion, with participants' age and sex somewhat moderating color matches. Color matches were also obtained to nine beverage-related sensory scenarios. The results indicate that consumers have pre-existing expectations regarding the appropriate color for specific flavors and types of drinks. Quantitative assessment of color-emotion associations may help clarify the cross-modal effects of color on taste and smell.

1. Introduction

Consumer expectations play a major role in the sensory perception of food and drink. These expectations may be culturally based or the result of cues provided by the product's packaging and presentation (Piqueras-Fiszman & Spence, 2015; Spence & Piqueras-Fiszman, 2012). The consumer's perception of flavor also depends upon a host of multisensory cues, among them sound, scent, and color (Shankar, Levitan, Prescott, & Spence, 2009; Zellner & Durlach, 2003; see Spence, Levitan, Shankar, & Zampini, 2010 for a review). These sensory factors themselves may be interrelated. For example, smells are associated with specific colors independent of any particular context (Gilbert, Martin, & Kemp, 1996; Kemp & Gilbert, 1997; Maric & Jacquot, 2013). Emotion may mediate the associative links between color and scent (Porcherot, Delplanque, Gaudreau, & Cayeux, 2013; Schifferstein & Tanudjaja, 2004), and between color and music (Palmer, Schloss, Xu, & Prado-León, 2013).

In product design, for example, consumers are presumed to associate colors with specific emotions and mental states. Thus, a single color palette would not be expected to work as well for an energy drink as for a calming herbal tea. Such assumptions remain untested systematically. Does the scientific literature offer any insights into designing for affective impact with color?

How color relates to emotion is the subject of much psychological research, but the results are difficult to marshal for practical use.[1] The reasons for this are both technical and conceptual. As a technical matter, color-emotion data have been gathered with experimental methods that vary widely in precision and scope, as we describe below. To our knowledge, no study to date has used an objective, open-ended method to specify the color that best matches a given emotional stimulus.

Conceptually, the link between color and emotion is complicated by the existence of two different experimental approaches. The first approach asks participants to specify, "what color is associated with emotion *x*?", whereas the second reverses the sequence and asks, "what emotion is associated with color *y*?" Both approaches match colors to emotion-related stimuli, and although the results might appear superficially equivalent, e.g., "angry is red" and "red is angry," these results are not transitive. Thus, red may connote anger, but it may also connote jealousy, irritation,

[1] In this paper we use the word "emotion" as shorthand to refer to the use of verbal stimuli that contain terms such as "sad," but also moods such as "calm" and even motivational states such as "hungry." We do this advisedly, knowing that some readers might prefer the broader term "affect," and with full appreciation of the historic and philosophical conundrum that the term "emotion" presents to investigators who endeavor to define its bounds, or specify and categorize it operationally (see, e.g., Barrett & Russell, 2009; Fridlund, 2015; Fridlund & Russell, 2006; Russell, 2003, 2015).

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and pride. Conversely, anger may be associated with red but also with black.

Practical application often favors one of these approaches over the other. A product designer honing the emotional appeal of a brand may be free to use the most effective color from an unconstrained palette; in this case the first approach supplies the most relevant results. Alternatively, a designer may need to determine the emotional associations to a brand's existing color scheme. In this case, the second approach is most relevant. Our focus in this paper is the former question, namely "what color is associated with emotion *x*?"

The basic method for answering this question is to present a printed emotion or mood term and ask participants to provide the best-matching color. The color response options used in previous studies are summarized in Table 1, which also categorizes the options as objective or subjective (i.e., physical color samples versus verbal reply), and constrained or unconstrained (i.e., a selected subset of colors versus all available colors). Studies with objective response options are preferable for many reasons, yet it is apparent from Table 1 that every such study has used a limited numbers of colors. Similarly, studies using unconstrained options capture the greatest range of response, but to date such studies have used only subjective responses. Thus, the link between emotion and color has yet to be studied with a color-matching method that is both unconstrained and objective. This technical limitation impedes the psychological study of the relation between color and emotion, and makes it difficult to implement the results in the applied field of sensory design.[2]

Our interest is in developing a method that permits consumers to specify color matches to a wide range of stimuli, including emotional stimuli, in a way that is minimally constrained yet yields precise and quantitative research data. An ideal experimental technique would: (1) allow each participant to select a single best color match from the entire visible spectrum, (2) quantify that color match according to a standardized system, and (3) enable the display of individual data points as well as group summaries. Here we introduce a touchscreen color-selection application that achieves these objectives. In addition, we analyze the data using three standard systems for color classification, and compare the resulting outcomes.

2. Methods

2.1. Participants

The study included 194 participants: 84 teenagers (42 female, 42 male, ages 13–16 years), 53 young adults (28 female, 25 male, ages 25–35 years), and 57 older adults (27 female, 30 male, ages 36 through 45 years).

Potential participants were recruited by telephone from a prescreened, sensory-study database. To qualify for this study, individuals must have purchased and consumed carbonated beverages within the prior three months. Individuals were rejected if they had participated in a market-research interview of one hour or more within the previous three months; or if they or anyone in their household were employed by an advertising agency, a market research company, a manufacturer or retailer of healthcare products, or the news media. As an incentive and to defray travel expenses, each participant was compensated monetarily. Testing occurred over four consecutive weekdays at a commercial consumer testing facility in suburban New Jersey.

[2] Like most previous investigators, we used emotion-related words as stimuli for color matching. We do not know (nor did we intend) that the stimuli evoked in the participants the emotions to which they refer. The stimuli let us demonstrate that participants make emotion-color matches; further research would be needed to determine *why* those matches were made.

Table 1
Experiment methods used in previous studies to identify colors associated with emotions or mood states.

Study	Color response option	Constrained/ unconstrained	Objective/ subjective
Odbert, Karwoski, and Eckerson (1942)	First color name that comes to mind	Unconstrained	Subjective
Wexner (1954)	Eight sheets of colored art paper	Constrained	Objective
Murray and Deabler (1957)	"	Constrained	Objective
D'Andrade and Egan (1974)	157 Munsell chips	Constrained	Objective
Johnson, Johnson, and Baksh (1986)	"	Constrained	Objective
Cimbalo, Beck, and Sendziak (1978)	Seven colors of crayon	Constrained	Objective
Rader (1979)	Distribute five "points" across 11 color names	Constrained	Subjective
Hupka, Zaleski, Otto, Reidl, and Tarabrina (1997)	Rate 12 color names on six-point scales	Constrained	Subjective
Sutton and Altarriba (2015)	First color name that comes to mind	Unconstrained	Subjective

2.2. Stimulus presentation

Testing was conducted with custom software installed on an Apple iPad 2. At the beginning of a test session, the experimenter either specified parameters for a new study (e.g., the downloaded stimulus set, number of trials, stimulus order, etc.), or selected from a list of previously designed studies. At this point, the program began the trials for the next participant. Each participant's dataset was labeled with the study name, numbered consecutively within the study to preserve anonymity during data analysis, and date- and time-stamped. The program presented a new screen for each trial; the screen displayed an emotion term and a prompt for the participant to select a color match using a color wheel and light/dark slider.

The program's on-screen layout was designed to resemble that used by Simner and Ludwig (2012) except that the subject responded directly on the iPad's touchscreen rather than with a keyboard and mouse. With each stimulus trial, the program recorded the RGB (Red, Green, Blue) color space values of the selected color and also calculated their equivalent in the CIE L*C*h° (Lightness-Chroma-Hue) color system using the equations provided in Tkalčič and Tasič (2003). At the conclusion of a test session, the program was able to display the results for any test item in the form of a Mondrian in which each square represents the color selected by one participant. The RGB and L*C*h° data, along with start/finish time-date stamps and other file-header information, were automatically exported from the program via the iPad's email function in CSV format for ready import into Excel and SPSS for statistical analysis.

2.3. Test procedure

Participants were given an iPad and told they would be completing a self-administered questionnaire. A test administrator was available to answer questions. Once the participant completed the name and sex fields, an initial welcome screen provided the following instructions: "We will describe a mood or emotional situation. We'd like you to pick a color that best represents it. There are no right or wrong answers. Practice using the color circle and brightness slider to pick different colors. When you find one you