Color and Psychological Functioning

Andrew J. Elliot[1] and Markus A. Maier[2]

[1]University of Rochester and [2]University of Munich, Munich, Germany

ABSTRACT—*Color is a ubiquitous perceptual experience, yet little scientific information about the influence of color on affect, cognition, and behavior is available. Accordingly, we have developed a general model of color and psychological functioning, which we present in this article. We also describe a hypothesis derived from this model regarding the influence of red in achievement contexts. In addition, we report a series of experiments demonstrating that a brief glimpse of red evokes avoidance motivation and undermines intellectual performance, and that it has these effects without conscious awareness or intention. We close with thoughts on the need for rigorous scientific work on color psychology.*

KEYWORDS—*color; red; avoidance; approach; motivation*

Every visual stimulus processed by the human perceptual system contains color information. Given the prevalence of color, one would expect color psychology to be a well-developed area. Surprisingly, little theoretical or empirical work has been conducted to date on the influence of color on psychological functioning, and the work that has been done has been driven mostly by practical concerns, not scientific rigor. As such, although the popular and applied literatures are replete with statements regarding the content of color associations and their presumed impact on behavior (e.g., "Green is peaceful and helps people relax"), the lack of theory and carefully controlled experimentation makes clear conclusions about color associations and their implications elusive (Levy, 1984; Whitfield & Wiltshire, 1990).

Given the disparity between the ubiquity of color stimuli and the dearth of extant theory and research on color psychology, we have developed a general model of color and psychological functioning. In this article, we set a conceptual and empirical context for our model, present the model, and describe one main hypothesis derived from it. Then, we overview a research program designed to test various aspects of this hypothesis. Finally, we briefly describe a second hypothesis generated from our model, and close with thoughts on the need for rigorous scientific work on color psychology.

Address correspondence to Andrew Elliot, Department of Clinical and Social Sciences in Psychology, University of Rochester, Rochester, NY, 14227; e-mail: andye@psych.rochester.edu.

EXTANT THEORETICAL AND EMPIRICAL WORK

Most existing work on color and psychological functioning is applied, as opposed to theoretically based. The questions that drive this type of research include: What colors influence retail behavior? What colors influence food preference? What colors influence worker mood and productivity? What colors influence physical health and aggressive behavior? What color preferences are associated with different personality types? Such research simply seeks to establish relations between color stimuli and affect, cognition, or behavior for pragmatic purposes; it seeks neither to explain why such relations occur nor to test basic principles regarding psychological functioning.

Of the existing research that is theoretically based, most has been loosely guided by Goldstein's (1942) proposal that red and yellow are naturally experienced as stimulating and disagreeable, that these colors focus people on the outward environment, and that they produce forceful, expansive behavior, whereas green and blue are experienced as quieting and agreeable, focus people inward, and produce reserved, stable behavior. Subsequent researchers have tended to interpret Goldstein's proposal in terms of wavelength and arousal: Longer-wavelength colors like red are experienced as arousing, and shorter-wavelength colors like green are experienced as calming (e.g., Stone & English, 1998).

Aside from Goldstein's proposal and its derivatives, most theoretical statements about color rely on general associations. Different colors are presumed to have different associations, and viewing a color is thought to trigger psychological responses consistent with these associations. For example, Frank and Gilovich (1988) posited that black is associated with evil and death and, therefore, leads to aggressive behavior. Likewise, Soldat, Sinclair, and Mark (1997) proposed that red and blue are associated with happiness and sadness, respectively, and therefore lead to cognitive processing and behavior consistent

with those emotions. Such models tend to focus on one or two colors/associations and typically propose general links between colors and functioning across situations.

Existing research on these proposals tends to be sparse and spotty, occasionally supporting some hypotheses but not others. Although the popular and even scientific literatures commonly state as fact that long-wavelength colors are arousing and short-wavelength colors are calming, the actual data simply are not supportive. Frank and Gilovich's (1988) proposal is supported by some data, but that proffered by Soldat et al. (1997) is not. Furthermore, the extant research on color and psychological functioning in general is plagued by several weaknesses. First, perhaps due to the applied nature of the work, many studies have neglected to follow basic experimental procedures such as experimenter blindness to hypothesis and condition. Second, many of the manipulations in these studies have been uncontrolled (e.g., presenting color on an office wall for 4 days) or have altered participants' typical perceptual experience (e.g., presenting color via overhead lights). Third, and most important, almost no extant research has examined the effect of hue while controlling for lightness (similar to brightness) and chroma (similar to saturation), despite the fact that these other color attributes can themselves influence psychological functioning.

A MODEL OF COLOR AND PSYCHOLOGICAL FUNCTIONING AND A HYPOTHESIS DERIVED FROM THE MODEL

We (Elliot, Maier, Moller, Friedman, & Meinhardt, 2007) have developed a general model of color and psychological functioning, the core premises of which are stated in the following. First, colors can carry specific meanings. Color is not just about aesthetics—it also communicates specific information. Second, color meanings are grounded in two basic sources: learned associations that develop from repeated pairings of colors with particular messages, concepts, or experiences; and biologically based proclivities to respond to particular colors in particular ways in particular situations. Some color associations may emerge from learning alone, but color theorists suspect that many such associations emerge from evolutionarily ingrained responses to color stimuli (Mollon, 1989). Research indicates that colors often serve a signal function for nonhuman animals (e.g., the redness of fruit signals readiness for eating), thereby facilitating fitness-relevant behavior (Hutchings, 1997). If, as we suspect, humans are "prepared" to respond to color stimuli in a similar fashion, then at least some color associations may represent a cognitive reinforcing or shaping of biologically based response tendencies. Third, the mere perception of color evokes evaluative processes. Color computations occur at an early level within the visual system, and evaluative processes are so fundamental that they are present, at least in rudimentary form, in all animate life (Schneirla, 1959). By "evaluative processes" we mean basic mechanisms that discern whether a stimulus is hostile or hospitable (Elliot & Covington, 2001). Fourth, the evaluative processes evoked by color stimuli produce motivated behavior. Color stimuli that carry a positive meaning produce approach responses, whereas those that carry a negative meaning produce avoidance responses. Fifth, color typically exerts its influence on psychological functioning in an automatic fashion; the full process from evaluation of the color stimulus to activation and operation of motivated behavior typically takes place without conscious intention or awareness. Given that the influence of color tends to be nonconscious in nature, color effects tend to persist, even when they are deleterious. Sixth, color meanings and effects are contextual. A given color has different implications for feelings, thoughts, and behaviors in different contexts (e.g., achievement contexts, relational contexts).

Our research to date has focused primarily on the color red in achievement contexts. Our hypothesis is that red carries the meaning of danger in such contexts, specifically the psychological danger of failure (Elliot, Maier, Moller, et al., 2007). One source of this red–danger link is presumed to be teachers' use of red ink to mark students' mistakes and errors. This specific association is likely grounded in a more general societal association between red and danger where negative possibilities are salient, such as stop signs and warning signals. These learned associations may be bolstered by or even derived from an evolutionarily ingrained predisposition across species to interpret red as a signal of danger in competitive contexts. For example, in primates, red on the chest or face (due to a testosterone surge) signals the high status, and thus danger, of an opponent; Setchell & Wickings, 2005). Thus, through both specific and general associative processes that may themselves emerge from biologically based proclivities, red carries the meaning of failure in achievement contexts, warning that a dangerous possibility is at hand. This warning signal is posited to produce avoidance-based motivation that primarily has negative implications for achievement outcomes. The influence of red in achievement contexts is presumed to take place outside of individuals' conscious awareness.

OUR EMPIRICAL WORK ON RED IN ACHIEVEMENT CONTEXTS

We began our empirical work with four experiments designed to test the effect of red on intellectual performance (Elliot, Maier, Moller, et al., 2007, Experiments 1–4). In the first experiment, participants completed an anagram test that contained a red, green, or black subject number in the upper right-hand corner. Green provided a chromatic contrast to red, its opposite in several color models, and green has some general associations with approach motivation. Black, an achromatic color, served as a neutral control. At the end of this and all experiments in this research program, participants received a careful debriefing that probed their awareness of the purpose of the experiment. Results indicated that participants shown red solved fewer anagrams than those shown green or black; those shown green or black did not

Fig. 1. An example test cover used in our experiments.

differ. Participants were unaware of the purpose of the experiment. Additional experiments replicated this finding using different achromatic controls (white, gray), a different method of presenting color (on a test cover; see Figs. 1 & 2), and color stimuli equated on all color parameters except hue (this was true in all experiments reported below). In some of these subsequent experiments, participants' motivation and perceived competence were assessed with self-report measures; null results were obtained on these measures, indicating that participants were unaware of the effect color had on their motivation and performance.

Given that our initial experiments showed no effect of red on conscious reports of avoidance motivation, we conducted two additional experiments to examine the effect of red on nonconscious avoidance motivation (Elliot, Maier, Moller, et al., 2007, Experiments 5–6). Both of these experiments manipulated color using the test-cover procedure described above. In one experiment, after the color manipulation and before (ostensibly) taking a test, participants selected the number of easy and moderately difficult items they wanted on the test; selection of easy items is a classic indicator of avoidance motivation. Results indicated that participants shown red selected more easy items than those shown green or gray; participants shown green or gray did not differ. In the other experiment, after the color manipulation and prior to (ostensibly) taking a test, participants' prefrontal cortical activity was assessed using electroencephalography (EEG); right (relative to left) prefrontal cortical activity indicates that avoidance motivation has been activated in the brain. Results indicated that participants shown red evidenced more right prefrontal cortical activity than those shown green or gray; participants shown green and gray did not differ.

In a separate set of experiments, we examined the effect of red on physically enacted avoidance behavior (Elliot, Maier, Binser, Friedman, & Pekrun, 2007). In a first experiment, participants were shown red or green on the cover of an analogies test that they would (ostensibly) take in an adjacent lab. Participants shown red, relative to those shown green, knocked fewer times on the door of the adjacent lab as they anticipated taking the test. In a second experiment, participants were shown red, green, or gray on the cover of an IQ test that they would (ostensibly) take. A sensor was placed on participants to assess their body movement upon presentation of the test cover. Participants shown red moved their bodies away from the test cover to a greater degree than did those shown green or gray; those shown green or gray did not differ (see Fig. 3). Debriefing indicated that the effect of red in these experiments occurred without participants' awareness.

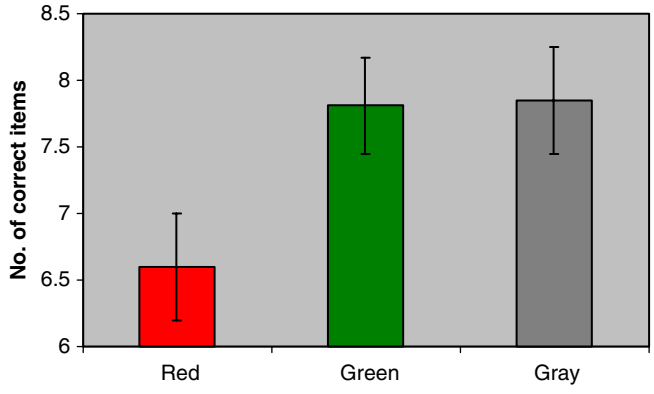

Fig. 2. The effect of color on IQ test performance in Elliot, Maier, Moller, et al. (2007, Experiment 4): Mean number of correctly solved items by color on the cover of the test (means are adjusted for general ability, premanipulation performance, and gender). Confidence intervals (95%) are indicated by vertical lines. "Red" participants performed significantly worse than "green" participants and "gray" participants, who did not differ from each other.

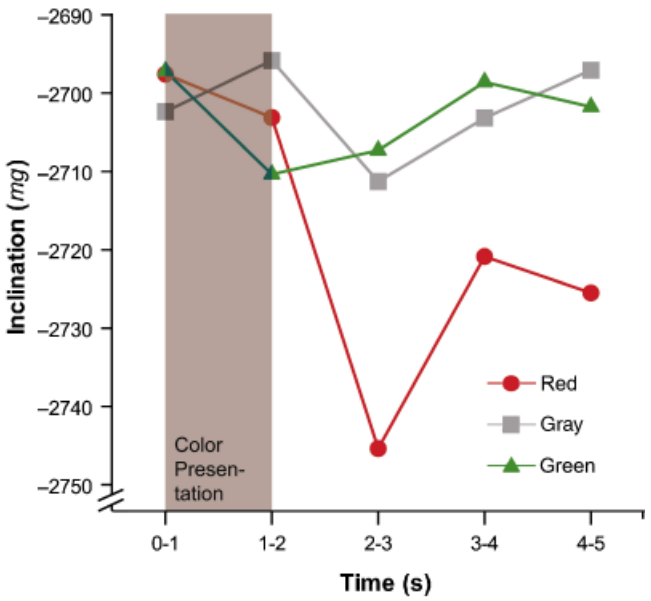

Fig. 3. The effect of color on body movement in Elliot, Maier, Binser, Friedman, and Pekrun (2007, Experiment 2). Mean inclination of the upper body over time in milli g (*mg*) units as related to the color on the cover of the IQ test. Negative *mg* values indicate angle adjustment away from the test cover.

Finally, we conducted four experiments designed to test whether nonconscious avoidance motivation mediates the deleterious effect of red on intellectual performance (Maier, Elliot, & Lichtenfeld, 2007). In the final experiment in this series, participants were shown red or gray on the cover of an IQ test and then completed a visual-matching task assessing local (relative to global) processing of stimuli. Local processing represents an often rigid constricting of attention to the "trees" as opposed to the "forest" and is a well-established indicator of avoidance motivation. After the visual-matching task, participants completed an IQ test. Results indicated that participants shown red performed worse and evidenced more local processing than did those shown gray. Furthermore, local processing was shown to mediate the direct effect of red on performance—that is, red led to more local processing, which in turn undermined performance.

OTHER CONTEXTS AND COLORS

All of the research that we have overviewed has been conducted in achievement contexts, but we are currently examining a second hypothesis that focuses on the color red in relational contexts (Elliot & Niesta, 2007). We posit that in relational situations, specifically those involving sexual attraction, red carries the meaning of love, passion, and sexual readiness. These associations are likely grounded in the use of red hearts to symbolize romance on Valentine's Day; the use of red lipstick, rouge, and lingerie to heighten attractiveness; and the use of red light to signal sexual availability in brothels. These learned associations may be bolstered by or even derived from the biologically ingrained use of red to attract mating partners during estrus in many nonhuman female mammals (Mollon, 1989). Thus, through associative processes that may themselves emerge from evolutionarily based proclivities, red signals love, passion, and sexual readiness, and the perception of red is presumed to produce approach-motivated behavior outside of individuals' conscious awareness.

Color effects on psychological functioning are not thought to be constrained to red. Other colors undoubtedly impact affect, cognition, and behavior as well, and research to examine such possibilities is needed. A core premise of our model is that color effects are context specific, and it will be important to attend carefully to this issue in subsequent research. Thus, in the United States, green may be linked with money and facilitate spending in consumer contexts, but green (especially blue-green) may be associated with mold and quash one's appetite in culinary contexts. Likewise, in the United States, black may be linked with evil/death and lead to aggression in zero-sum competitive contexts, but black may be associated with eroticism and enhance arousal in sexual contexts. Furthermore, although we believe that some color meanings and effects (such as those that are the focus of our work thus far) are biologically based and pancultural, it is likely that at least some color meanings and effects are entirely learned and vary by culture (e.g., black has negative associations in the United States that are not present in other countries lacking a history of prejudice against African Americans). As such, "context" must be considered not only in terms of domain but also in terms of culture.

CONCLUSION

Our research both provides a conceptual framework to guide research in the neglected area of color psychology and illustrates how rigorous empirical work in this area may be conducted. We think that this is a highly promising research area in which many pressing questions await empirical consideration (e.g., How do color associations develop, and how does this development differ when biologically based predispositions are present versus absent? How potent are color effects in real-world contexts containing a wide variety of color stimuli? What is the duration of color priming?). The scientific study of color and psychological functioning is not an easy enterprise, as it requires careful assessment and calibration of lightness and chroma, as well as hue. However, we believe such efforts pale in comparison to the benefits of documenting the influence of a ubiquitous feature of the perceived social environment on important affective, cognitive, and behavioral processes outside of conscious awareness. Social-cognitive research on priming focuses extensively on the effects of lexical, contextual, and relational stimuli on psychological functioning; we think the time has come to broaden this focus to include color stimuli.

Recommended Reading

Elliot, A.J., Maier, M.A., Moller, A.C., Friedman, R., & Meinhardt, J. (2007). (See References)

Fehrman, K.R., & Fehrman, C. (2004). *Color: The secret influence* (2nd ed.). Upper Saddle River, NJ: Prentice Hall.

Whitfield, T.W., & Wiltshire, T.J. (1990). Color psychology: A critical review. *Genetic, Social & General Psychology Monographs*, *116*, 387–412.

REFERENCES

Elliot, A.J., & Covington, M.V. (2001). Approach and avoidance motivation. *Educational Psychology Review*, *13*, 73–92.

Elliot, A.J., Maier, M.A., Moller, A.C., Friedman, R., & Meinhardt, J. (2007). Color and psychological functioning: The effect of red on performance attainment. *Journal of Experimental Psychology: General*, *136*, 154–168.

Elliot, A.J., Maier, M.A., Binser, M.J., Friedman, R., & Pekrun, R. (2007). The effect of red on avoidance behavior in achievement contexts. Manuscript submitted for publication.

Elliot, A.J., & Niesta, D. (2007). [The effect of red on sexual attraction]. Unpublished raw data.

Frank, M.G., & Gilovich, T. (1988). The dark side of self and social perception: Black uniforms and aggression in professional sports. *Journal of Personality and Social Psychology*, *54*, 74–85.

Goldstein, K. (1942). Some experimental observations concerning the influence of colors on the function of the organism. *Occupational Therapy and Rehabilitation*, *21*, 147–151.

Hutchings, J. (1997). Color in plants, animals, and man. In K. Nassau (Ed.), *Color for Science, Art, and Technology* (pp. 222–246). Amsterdam: Elsevier.

Levy, I.B. (1984). Research into the psychological meaning of color. *American Journal of Art Therapy*, *23*, 58–62.

Maier, M.A., Elliot, A.J., & Lichtenfeld, S. (2007) Nonconscious avoidance motivation mediates the negative effect of red on intellectual performance. Manuscript submitted for publication.

Mollon, J.D. (1989). "Tho' she kneel'd in that place where they grow . . ." *Journal of Experimental Biology*, *146*, 21–38.

Schneirla, T. (1959). An evolutionary and developmental theory of biphasic processes underlying approach and withdrawal. In M. Jones (Ed.), *Nebraska Symposium on Motivation* (pp. 1–42). Lincoln: University of Nebraska Press.

Setchell, J.M., & Wickings, E.J. (2005). Dominance, status signals, and coloration in male mandrills (*Mandrillus sphinx*). *Ethology*, *111*, 25–50.

Soldat, A.S., Sinclair, R.C., & Mark, M.M. (1997). Color as an environmental processing cue: External affective cues can directly affect processing strategy without affecting mood. *Social Cognition*, *15*, 55–71.

Stone, N.J., & English, A.J. (1998). Task type, posters, and workspace color on mood, satisfaction, and performance. *Journal of Environmental Psychology*, *18*, 175–185.

Whitfield, T.W., & Wiltshire, T.J. (1990). Color psychology: A critical review. *Genetic, Social & General Psychology Monographs*, *116*, 387–412.