Color in Achievement Contexts in Humans

Contents

1. Color-in-Context Theory

1.1. Assumptions

Although interest in color psychology and color research has a long tradition (e.g., Cohn, 1894), a review of this literature covering the past 120 years (Elliot & Maier, 2014) highlighted the lack of a coherent theoretical basis. In addition, the empirical standards met in color studies are quite low. More recent work on color in achievement contexts has tried to remedy these flaws by (i) establishing a theoretical framework from which specific propositions about the effect of color on psychological function can be derived, and (ii) conducting carefully designed experimental work. This chapter presents a theoretical framework termed Color-in-Context (CIC; Elliot & Maier, 2012) and experimental studies related to it. In the following we will briefly describe the central assumptions of the CIC theory.

The CIC theory makes specific propositions about color features and its psychological functioning. It serves as a starting point to understand and predict color effects, particularly with regard to the role of colors in the domain of achievement. Color is defined by three properties: lightness, chroma, and hue. In this chapter we focus on the hue dimension, primarily on red, blue, and green, since experimental work has focused on these colors. Whilst the other two attributes are also crucial in color research, we do not highlight their significance in this chapter since lightness and chroma were (mostly) held constant across hue conditions in the research described to ensure a clear interpretation of the reported hue effects and to enable proper replication attempts.

There are six premises of the CIC framework (see CIC; Elliot & Maier, 2012, chapter 2 for a detailed description): (1) Each color activates associations that contain psychologically-relevant messages. (2) As such, viewing a color influences psychological functioning and might foster motivational and behavioral processes, such as approach or avoidance tendencies. In addition, (3) the extraction of color information and the activation of affect, cognition, and behavior are usually processed without intention or awareness. (4) These associations can be rooted in learning and/or innate predispositions and (5) the relation between color perception and affect, cognition, and behavior are reciprocal. Hence, not only does color perception influence affect, cognition, and behavior, but also affective, cognitive, and behavioral states can influence color perception. (6) Finally, and most importantly, as the term CIC implies, the effects of color are context-specific and thus can result in opposite motivational processes (i.e., approach or

avoidance tendencies) in different contexts. That is, color information is primarily derived from a number of circumstances under which the color is perceived. This is called context.

1.2. What is context?

At this point some clarifications are needed: What does context exactly mean in the framework of the CIC theory? The definition of context is construed differently throughout psychological disciplines (Avramova, Stapel, & Lerouge, 2010; Bazire and Brézillon, 2005). Refering to Bazire and Brézillon (2005) as well as Zimmermann, Lorenz, and Oppermann (2007), context in the CIC theory is defined as a set of physical or psychological circumstances that determine a color's meaning. Recent color research (e.g., Elliot, Maier, Moller, Friedman, & Meinhardt. 2007; Maier, Elliot, & Lichtenfeld, 2008) has focused on the achievement domain. Achievement contexts are defined as situations in which competence is evaluated and both positive and negative outcomes are possible (Elliot, 1999). Within such a context, the color red seems to be especially salient.

Since early school education, students have consistently received feedback regarding mistakes and errors in red color, potentially leading to a specific red-failure association (Mehta & Zhu, 2009; Moller, Elliot, & Maier, 2009; Pravossoudovitch, Cury, Young, & Elliot, 2014; Rutchick, Slepian, & Ferris, 2010). In addition, red carries the meaning of danger in life-threatening situations, such as blood, fire, and warning signals. Hence, one can assume that the association of red and danger is present across one's whole life. These learned associations may themselves be bolstered by or even emerge from an evolutionarily engrained predisposition to interpret red as a danger signal in competitive contexts in which negative possibilities are salient. In a number of different vertebrate species, including nonhuman primates (e.g., gelada baboons and mandrills), a bodily display of red is an indicator of dominance, aggressiveness, or attack readiness of an opponent (Dunbar, 1984; Gerald, 2003; Pryke, Andersson, Lawes, & Piper, 2001; Setchell & Wickings, 2005). Similarly, in humans, red on the face of an opponent may signal anger and aggressiveness (especially relative to pallor, which signals fear; Changizi, Zhang, & Shimojo, 2006; Drummond, 1997; Levenson, 2003; Young, Elliot, Feltman & Ambady, 2013) or may serve as a testosterone-based indicator of dominance (Archer, 2006; Hill & Barton, 2005; Mazur, 2005). Thus, through both specific and general associative processes that may themselves

have derived from biologically-based proclivities, red is frequently associated with dangerous situations and competitors.

Research on nonhuman primates in competitive encounters indicates that red displays and other threat-relevant cues prompt avoidance by conspecifics, as indicated by submission and appeasement gestures and actions (Gerald, Waitt, & Little, 2008; Setchell & Wickings, 2005). In humans, encountering a negative object, event, or possibility, including the possibility of failure, is known to automatically evoke a motivational tendency to avoid that object, event, or possibility (Bargh & Chartrand, 1999; Cacioppo, Gardner, & Berntson, 1999). In addition, research has demonstrated that avoidance motivation in achievement settings evokes anxiety, task distraction, and a number of self-protective processes (e.g., disidentification, self-handicapping; Birney, Burdick, & Teevan, 1969; Elliot & Church, 2003; Elliot & McGregor, 1999; Hembree, 1988; Osborne, 1995; Zuckerman, Kieffer, & Knee, 1998) that negatively influence performance on tasks requiring flexible mental manipulation (i.e., tasks commonly encountered at school and work). Accordingly, viewing red in an achievement context is posited to impair performance attainment because it evokes avoidance, which in turn, is inimical to performance. The activation, operation, and influence of avoidance motivation in this hypothesized red effect is thought to take place outside of conscious awareness; that is, it acts in an implicit rather than explicit fashion (see Friedman & Förster, 2010).

Researchers have begun to explore such red associations in different variants of achievement situations, such as sporting contests, exam-like situations, and competence evaluations within impression formation scenarios. In the remainder of the chapter we provide an overview of empirical work on the effects of red on sport performance, cognitive mechanisms, behavioral processes, and psychophysiological activity in evaluative contexts.

2. Red in evaluative contexts

2.1. Red in sporting contexts

Exploring premise 2 and 4 of the CIC theory, several studies have investigated whether color has a psychological impact that influences performance and outcomes in sports. This work was inspired by potential parallels between the effects of color in humans and non-human species. Hill and Barton (2005) noted that, amongst anthropoid primates and birds, dominance is frequently signaled by bare patches of highly vascularized skin, which appear bright red due to

the presence of oxygenated blood. It is presumed that the ability to shunt oxygenated blood to the periphery is an honest signal of the animal's current condition. Furthermore, contest outcomes can be influenced by artificial red stimuli, such as red bands attached to the legs of male zebra finches (Cuthill, Hunt, Cleary, & Clark, 1997). Hill and Barton (2005) used a natural experiment to test whether similar effects occur in humans. In four combat sports (boxing, Taekwondo, and two styles of wrestling) at the Athens Olympic Games in 2004, competitors were randomly assigned to wear either red or blue. In each sport red-wearing competitors won more bouts than blue-wearing competitors, and across all four sports the effect was statistically significant with red-wearing competitors winning 55% of bouts. Not surprisingly, the strength of the effect was influenced by the difference in competitive ability: the effect increased with decreasing competitive asymmetry of the contestants, as measured by the absolute points difference between them, with red-wearing competitors winning over 60% of close matches. Barton and Hill (2005) found no significant effects in female combat sports, but it was unclear whether this was attributable to low statistical power or a genuine sex difference. Hence, while possible sex differences in color effects require further study, Hill and Barton (2005) provided compelling support for red stimuli influencing the outcomes of individual competitive interactions.

Enhanced results associated with wearing red have also been found in team sports. Hill and Barton (2005) found that red-wearing teams in the Euro 2004 football tournament scored more goals and garnered more points than when the same teams played in their alternative colors. Attrill, Gresty, Hill, and Barton (2008) analyzed long-term data from the English Football League between 1945 and 2006. They found that the median league position and the mean percentage of maximum possible points were greatest for teams that wear red. The difference was significant only for matches played at home, when teams were guaranteed to be wearing their usual strip. In a matched-pairs analysis, Attrill et al. (2008) also found that red-wearing teams performed significantly better than non-red-wearing teams from the same urban region. Similarly, after controlling for confounding variables, Piatti, Savaga, and Torgler (2012) found enhanced performance of red-wearing teams over a 30-year period in Australian Rugby League. Such effects may not be common because of the many confounding variables influencing long-term performance in team sports and frequently low statistical power in such data sets. Indeed, others found that teams wearing red shirts did not perform better than others in elite soccer leagues in Germany, Poland, and Spain (García-Rubio, Picazo-Tadeo, & González-Gómez, 2011;

Kocher & Sutter, 2008; Szmajke & Sorokowski, 2006), and the National Hockey League in North America (Caldwell & Burger, 2011), while Allen and Jones (2014) found that the greater home advantage for red-shirted teams within the English Premier League disappeared when controlling for team ability. Greenlees, Eynon, and Thelwell, (2013) showed that viewing red (relative to blue and green) on a goalkeeper's uniform undermines penalty kick performance, although Pollet and Peperkoorn (2013) found no evidence that the color of shorts influenced the outcome of fights in the ultimate fighting championship. In contrast, Ilie, Ioan, Zagrean, and Moldovan (2008) showed that the red advantage may occur even within a virtual arena. They analyzed the outcomes of an online combat game over a three-month period, and found that red consistently teams won more games than blue. Whilst the effects are not always present, therefore, they are detected across a range of sports and domains and we predict that, where color effects on performance are found, they will favor red-wearing teams.

Recent research has tested hypotheses about the mechanisms underlying these effects. Wearing red has been found to be associated with physiological responses. Heart rate was elevated in fighters assigned to wear red compared to those assigned to wear blue, before, during, and after physical combats (Dreiskaemper, Strauss, Hagemann, & Büsch, 2013). In this case, color appears to have a causal influence on physiology, but the causal relationship may also work the other way around. Farrelly and colleagues (2013) showed that individuals choosing to be identified by a red symbol in a competitive interaction had higher testosterone levels than those choosing blue. Hackney (2006), in turn, failed to demonstrate a significant effect of wearing red versus black on testosterone levels of individuals in a rowing contest. However, sample size was limited to five matched pairs, severely limiting statistical power, and differences were in the predicted direction in each of three time blocks.

One important question is whether causal effects on outcomes arise from performance enhancement in red-wearers, performance reduction in their opponents, different judgements of performance by referees and judges, or some combination of these possibilities. In support of effects on opponents of red-wearers, experimental studies have found that viewing red stimuli has a negative effect on motor performance (Payen, Elliot, Coombes, Chalabaev, Brisswalter, & Cury, 2011; Elliot & Arts, 2011, Dreiskkaemper et al., 2013), and provokes physical avoidance (Elliot, Maier, Binser, Friedman, & Pekrun, 2009). Similarly, Greenlees and colleagues (2008) found that soccer goalkeepers viewing videos of individuals preparing to take a penalty rated the

competence of the penalty taker higher and the chances of the penalty being saved as lower when the penalty taker wore red relative to those who wore white. Even abstract shapes are rated by viewers as more “dominant”, “aggressive”, and more likely “to win a fight” when colored red than blue (Little & Hill, 2007). Ten Velden and colleagues (2012) demonstrated both actor- and opponent effects in a poker tournament, with individuals assigned to red more likely to make a competitive approach and perceivers more likely to withdraw. Similarly, Feltman and Elliot (2011) showed both wearer- and perceiver effects on perceptions of relative dominance in subjects imagining themselves in tae kwondo bouts. Finally, Hagemann, Strauss, and Leissing (2008) found that digitally reversing the colors apparently worn by tae kwondo fighters in video-recorded bouts affected the points awarded by judges, with significantly more points awarded to a competitor in the red condition than to the same individual in the same recording when digitally changed to blue. In a similar experiment, Krenn (2014) illustrated that referees judged tackles from behind more harshly for players wearing red when compared to blue. Thus, wearer effects, perceiver effects, and effects on third-judges may all operate and serve to influence sporting outcomes.

2.2. Red in academic achievement contexts

2.2.1. Red and its associations

In a recent series of studies Moller et al. (2009) investigated the first premise of the CIC theory. According to this, color can carry psychologically relevant meaning in an associative manner. Specifically, the authors experimentally explored hue-meaning associations and tested the existence of red-failure and green-success links that are relevant for psychological functioning in the achievement context, by using the so-called Stroop Task. The data were in line with premise 1 of the CIC model and showed that red seems to facilitate semantic concepts related to failure and inhibit those related to success. In addition, green seems to facilitate semantic representations of success, but no inhibition of failure concepts was observed. A number of other studies have shown this red-failure association (Mehta & Zhu 2009, Moller, Elliot, & Maier, 2009; Pravossoudovitch et al., 2014; Rutchick et al., 2010), including studies on emotion-induced memory (Kuhbandner & Pekrun, 2013). In this latter study, red has been shown to increase memory for negative words, whereas green increased memory for positive words.

Some researchers even focused on whether experience, besides biologically based proclivities and early-learned associations, do change the psychological effects of the color red. Zhang and Han (2014) showed that in the context of the Chinese stock market where red represents a rise and green a decrease in stock price, red (compared to green) increases stockbrokers' performance on an IQ test. Similarly, Jiang and colleagues (in press) showed that culturally-specific environment cues influence implicit associations of red-up and green-down, or vice verca. This shows that experience indeed influences red associations.

In sum, psychologically meaningful associations of red and green were successfully established supporting one basic assumption derived from the CIC theory (Elliot & Maier, 2012).

2.2.2. Red and avoidance motivation

Given the existence of the above mentioned color associations, further research has tested premise 2 of the CIC theory. According to this, basic behavioral response tendencies such as avoidance reactions should be initiated when red-failure associations were activated in an achievement context (Elliot & Maier, 2012). Avoidance motivation can be assessed on different levels of human psychological functioning. In the following section, we focus on studies exploring the influence of the color red on behavioral as well as psychophysiological indicators of avoidance motivation. Task choice, for instance, is a well-established behavioral indicator of motivation. More precisely, the selection of an easy rather than a difficult task indicates that the individual is avoiding failure and hence experiences avoidance motivation (Atkinson & Litwin, 1960; Ceranski, Teevan, & Kalle, 1979). In Elliot et al. (2007), the authors examined the influence of the color red on such a task choice assessment, by instructing participants to choose between easy and difficult analogy tests. Results revealed that red (compared to green or gray) leads participants to select more easy items. In further experiments Elliot and colleagues (2009) concentrated on the effect of the color red on the physical enactment of avoidance behavior. Within situations where individuals were forced to approach a potentially dangerous outcome, an inhibited motor action toward that goal could be interpreted as an indicator of avoidance motivation (Lewin, 1935; Geen, 1987; Gray & McNaughton, 1997). Elliot et al. (2009) used reduced frequency of knocking on a door leading to the testing room as a measure of inhibited motor actions (see also Robinson, Wilkowski, & Meier, 2008) and a backward postural movement (see, Hillman, Rosengren, & Smith, 2004; Lewin, 1935; Miller, 1944) as another

indicator of avoidance motivation. Analyses revealed that participants in the red condition knocked fewer times when anticipating to do a test and had greater backward movement than those in the control conditions. These results again highlight the fact that the color red affects basic behavioral avoidance tendencies in an achievement situation. Similarly, Thorstenson (submitted) provided support for the hypothesis that red and enacted avoidance behavior both represent comparable avoidance-based cues.

Psychophysiological measures, specifically frontal cortical asymmetry, are another indicator of avoidance motivation. A stronger right hemispherical activation compared to the left frontal area is indicative of avoidance-based affective processes (Davidson, Schwartz, Saron, Bennett, & Coleman, 1979; Sutton & Davidson, 1997). Elliot and colleagues (2007) showed that participants in the red condition showed greater right, relative to left, frontal cortical activation than those in the green or gray conditions. This red-dependent difference in brain activity again provides evidence for the idea that red produces avoidance motivation in an achievement setting. In addition, Elliot and colleagues (2011) conceptually replicated these results by focusing on high frequency heart rate variability (HF-HRV) as assessed via electrocardiogram (ECG). In an achievement setting low levels of HF-HRV are correlated with high levels of anxiety and worry (Friedman, 2007; Friedman & Thayer, 1998), what can be understood as affective components of avoidance motivation. Results revealed that participants in the red condition exhibited lower HF-HRV than those in the control condition. The development of avoidance motivation and behavior in red conditions has also been shown by others using different indicators of avoidance motivation, such as less risky investment decision making (Kliger & Gilad, 2012; Shavit, Rosenboim, & Cohen, 2013).

A comparative perspective suggests that avoidance of red is not limited to humans but has deep evolutionary roots related to its evolved role in dominance signaling. Rhesus macaques (*Macaca mulatta*) presented with food items placed in front of two human experimenters, one dressed in red and one in green, chose the latter significantly more often (approximately 70%) than the former (Khan, Levine, Dobson, & Kralik, 2011). There was no significant difference when the monkeys chose between blue and green, reinforcing the conclusion from human experiments that it is red in particular that is salient in avoidance paradigms. This result is particularly interesting, as, like humans (Stephen, Coetzee, Law Smith, & Perrett, 2009; Stephen, Oldham, Perrett, & Barton, 2012), rhesus macaques do not have any dramatic natural red

coloration, but do show subtle variation in facial redness associated with hormonal and emotional state and dominance.

Red thus seems not only to be associated with failure in achievement settings, but seems also to have basic behavioral effects such as activating avoidance motivation. Thus, in a number of studies premise 2 of the CIC theory is supported.

2.2.3. Red and intellectual performance

According to premise 3 of the CIC theory, color information should affect cognitive mechanisms even without intention or awareness of its influence. In a series of experiments Elliot and colleagues (2007) tested the influence of the color red on complex cognitive processes, such as intellectual performance, and results confirmed that participants in the red condition performed worse than those in the control conditions, whereas those in the green, black, white or grey conditions did not differ in their performance. Interestingly, this effect held up even when using a much more subtle and indirect method of color manipulation. In four experiments Lichtenfeld, Maier, Elliot, and Pekrun (2009) showed that reading the word red undermines intellectual performance in the same manner as when the color is actually perceived. This was true when color words were presented in the center of the front page of an IQ test, when colors words were hidden in the sample item and combined with another noun (red-alder vs. grey-alder, which are actually existing types of trees), and when the color words were presented outside the participants' focus of attention (copyright notes at the end of a page containing the words red, grey, and green, respectively). These data indicate that reading or just peripherally noticing a color word has the same effect on cognitive performance as actually perceiving the color. Interestingly, the subtlety of the color word presentations in combination with the fact that none of the individuals were aware of an influence of the color support the idea that color effects are based on implicit associations and automatically affect our cognitive processes. The effectiveness of the presentation of color words on cognitive processing implies that the same or closely related associative areas in the brain might be involved in color word reading and color perception. From a neuropsychological point of view, this seems quite reasonable, as research shows that the same color processing brain regions are activated when actual colors as well as corresponding color words are presented (Moscoso del Prado Martín, Hauk, & Pulvermüller, 2006; Simmons, Ramjee, Beauchamp, McRae, Martin, & Barsalou, 2007).

Other researchers successfully replicated the red effect by using additional chromatic controls and cognitive tasks (e.g., verbal reasoning, working memory, attentional interference, detection, creativity, and language proficiency; Buiks, 2013; Elliot et al., 2011; Gnambs, Appel, & Batinic, 2010; Houtman & Notebaert, 2013; Hulshof, 2013; Ioan et al., 2007; Jung, Kim, & Han, 2011; Maier et al., 2008, Thorstenson, submitted; Yamazaki & Eto, 2011). Also within a Chinese sample, red has been shown to undermine the intellectual performance of students (Shi, Zhang, & Jiang, in press). However, there are some non-supportive studies for the red effect in the achievement context, too. Smajic, Merritt, Banister and Blinebry (2014), for instance, could not provide any evidence for the negative effect of red on performance, nor the link between red and either anxiety or affect. Hulshof (2013) showed that viewing red (relative to blue) on a carrel wall actually leads to even better performance on a rote memory task.

Even though some research does not support premise 3 of the CIC theory, across a variety of different measures of complex cognitive processes, a broad range of individuals, and in controlled lab studies as well as more 'natural' settings, implicit negative effects of the color red on performance in cognitively demanding tasks were obtained. These results highlight the subtle but far reaching consequences of color on performance in achievement contexts.

2.2.4. Mediation of the influence of red on intellectual performance

So far we provided a literature review that documents different but related effects of the color red in achievement contexts. Red had an effect on avoidance motivation across a wide range of indicators for avoidance and also negative effects on complex cognitive processes such as temporarily reduced intellectual abilities in a variety of cognitive performance tests. A key question is thus whether avoidance motivation mediates the effect of the color red on intellectual performance. There are a lack of empirical studies within priming research addressing the question of mediation (see Bargh, 2006) but in the following we describe several studies that attempt to fill this gap.

Maier and colleagues (2008) used an experimental-causal-chain approach to explore whether an attentional process grounded in avoidance motivation (i.e., local relative to global processing bias) mediates the negative influence of red on intellectual performance. Several theorists have contended that negative, avoidance motivational states - like anger, anxiety, depression, and failure - predict local biases consistent with narrowed attention. That is to say,

aversively motivated individuals focus on more concrete, detailed aspects of the environment and miss the forest for the trees (Derryberry & Reed, 1998; Förster, Friedman, Özelsel, & Denzler, 2006; Fredrickson & Branigan, 2005; Mikulincer, Kedem, & Paz, 1990). This attention bias was assessed with a visual matching task (see Kimchi & Palmer, 1982) presumed to reflect automatic perceptual and attentional processing (Andres & Fernandes, 2006; Poirel, Pineau, & Mellet, 2006). Previous research showed that individuals with a constricted attentional focus due to avoidance motivation exhibit a local relative to global processing bias (Friedman & Förster, 2010; Gasper, 2004). Performing the first step of the experimental chain approach revealed the predicted effect: Red negatively influenced intellectual performance compared to a gray baseline condition (Maier et al., 2008). The authors then manipulated the independent variable (i.e., color) and explored the effect on the candidate mediator (i.e., local processing bias). Results showed that participants in the red condition evidenced more local relative to global processing bias than those in the gray condition. Finally, the authors manipulated the candidate mediator (i.e., local processing bias) and tested the effect on the dependent variable (i.e., intellectual performance). In the local processing condition, participants were instructed to select which of the two comparison figures corresponded to the local details of the target figure and in the global processing condition, participants were instructed to select which of the two comparison figures corresponded to the global details of the target figure. Results revealed that participants in the local processing condition performed worse than those in the global processing condition on an IQ test. Hence, these two experiments indicate that local processing bias accounts for the observed direct effect of red on intellectual performance and thus satisfy the requirements for testing mediation via the experimental-causal-chain approach.

Further, the authors tested mediation via the measurement-of-mediation approach using a similar procedure to the previous experiment. The results showed that participants in the red condition performed worse than those in the gray condition. Also, participants in the red condition exhibited more local relative to global processing on a visual matching task than those in the gray condition. Finally, when the effect of color on performance was tested with the attentional bias measurement included as a covariate, local relative to global processing bias was shown to be a negative predictor of performance, and the direct effect of red on performance was significantly diminished. Thus, mediation of avoidance motivation in the color – performance link could also be documented via the measurement-of-mediation approach.

In sum, the idea that the effect of the color red on complex cognitive performance outcomes is in part mediated by avoidance motivation seems to be well-established (see also Lichtenfeld et al., 2009). This supports the propositions made in the CIC theory that color affects behavioral and cognitive processes in a subtle way. The results are also in line with research that has demonstrated that avoidance motivation in achievement settings evokes anxiety, task distraction, and a number of self-protective processes (e.g., disidentification, self-handicapping; Birney et al., 1969; Elliot & Church, 2003; Elliot & McGregor, 2001; Hembree, 1988; Osborne, 1995; Zuckerman et al., 1998) that negatively influence performance on tasks requiring flexible mental manipulation. In addition, these findings can also explain red-induced improved performance in tasks that require a local attentional processing style (see Mehta & Zhu, 2009). Thus, through the motivational nature of the effects of the color red on performance, red fosters specific motivational processes that might improve or reduce performance depending on how well the activated motivational goal matches the task requirements.

2.2.5. The influence of red as a function of the psychological context

One central premise of the CIC theory is the idea of context-specific variations of the meaning of colors. Drawing on similarities to word processing Elliot and Maier (2012) state that *"…much like the meaning of a word in language is determined by the context in which it is embedded (Kinsch & Mangalath, 2011), the meaning of a color is determined by its contextual surround. Some colors, especially those most salient across time, language, and culture (i.e., white, black, and red; see Berlin & Kay, 1969; Kay & Maffi, 1999; Kuehni, 2007), may have default meanings. Such meanings would represent either the most salient association to the color (e.g., purity for white) or its most negative meaning (e.g., danger for red), given the "bad is stronger than good" principle (Baumeister, Bratslavsky, Finkenauer, & Vohs, 2001). In instances in which contextual cues are neither strong nor salient, the default meaning is activated. However, in the main, color meanings are contextually constructed, and failure to attend to this basic reality is problematic. Indeed, the vast majority of research on color psychology has neglected to consider color-in-context, and we believe that this oversight (in conjunction with the aforementioned methodological problems) is largely responsible for the accumulation of inconsistent empirical data that have hampered progress and growth in this promising area* (p. 72)." Thus far we have focused on the default meaning of the color red as a

signal of either status in contests or danger of failure in achievement settings. Next we report a number of studies that tested the potential attenuating role of situational circumstances that might produce experimentally induced variations in strength and direction of the motivational meaning of the color red.

Meier, D'Agostino, Elliot, Maier, and Wilkowski (2012) introduced an experimental manipulation of the context in which the color red was perceived. Participants were told that they will be interviewed by another person in a separate room about "dating" (i.e., a romantic context) or about "your intelligence" (i.e., an achievement context) and were shown a color-primed picture of one of the several possible interviewers. Earlier research had shown that in dating situations red activates approach tendencies (e.g. Elliot & Niesta, 2008), whereas in achievement situations, red was shown to produce avoidance reactions (see above). Results revealed that red indeed had differential implications for walking behavior as a function of the context in which the color was perceived. More precisely, whereas red increased the walking speed of participants to an ostensible dating interview (i.e., it activated approach-like behaviors), it decreased the walking speed to an ostensible intelligence-related interview (i.e., it initiated avoidance reactions in an achievement situation). These results are in line with the CIC theory and provide the first experimental evidence that the influence of red on psychological functioning in humans varies by psychological context in which it is presented. Similar context-specific variations of the meaning of the color red have also been observed in toddlers (Maier, Barchfeld, Elliot, & Pekrun, 2009). In addition, Rook (2014) showed that the effect of the color red on creative thinking varies depending on someone's appetitive (vs. aversive) motivational orientation (which could be understood as context). Also, results of Maier and colleagues (2013) revealed that a male in red is perceived to be less intelligent and that this negative effect of red was strongest within the job application context and became weaker in an affiliation condition. These findings imply that the red-failure link strongly depends on the emphasis of competence evaluations and it seems that such specific association can be turned on or off depending on the situational circumstances under which an individual is perceived. The message derived from these studies is that red effects on motivation and impression formation should not be considered in isolation and that context might play an important role.

Conclusion

In this chapter, we have reviewed research that concentrates on the effects of color on sports performance, cognitive and behavioral processes, and psychophysiological activity in evaluative contexts. These studies indicate that the color red represents a psychologically relevant visual stimulus that carries meaning of failure in the achievement context. In addition, this red-failure link was shown to influence avoidance motivation, and mediational studies showed this avoidance motivation to account for the negative effect of red on intellectual performance. Comparative data suggest that the psychological effects of red have deep evolutionary roots in dominance signaling.

Given that the effects of color take place without participants' awareness, even when presented in a very subtle fashion, it is important to carefully use color in empirical research. Studies that use colors in their procedures (e.g., Dijksterhuis & Smith, 2002; Förster, Higgins, & Idson, 1998; Grant & Beck, 2006; Mostofsky, et al., 2003; Rothermund, Wentura, & Bak, 2001; Trommershauser, Maloney, & Landy, 2003; Vanbeselaere, 1996) without considering color associations, run the risk of undesirable confounds produced by these colors. The use of red on IQ tests, like Raven's Colored Progressive Matrices, certainly needs investigation. In addition, calibration of color attributes, that is, lightness, chroma, and hue, is indispensable in color research to ensure interpretation of hue effects and enable replication attempts.

Finally, it is worth considering the effects of color in daily life. As red has been shown to decrease intellectual performance, both teachers and students are best advised to avoid red in evaluative contexts. In addition, in physical contests, red is associated with threat and dominance (Feltman & Elliot, 2011; Hill & Barton, 2005; Little & Hill, 2007). Hence, it remains important to use red in a strategic way. Nevertheless, achievement contexts are nuanced and complex and the work done to date is at a preliminary stage of development. As such, any implications should be viewed with caution and future studies will help to get a better understanding of the color effects. We hope that the chapter provides a foundation for future work addressing remaining questions about color and its impact on the social world.

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