

# The Influence of Red on Perceptions of Relative Dominance and Threat in a Competitive Context

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Recent research has revealed that a person or team wearing red is more likely to win a physical contest than a person or team wearing another color. In the present research, we examined whether red influences perceptions of relative dominance and threat in an imagined same-sex competitive context, and did so attending to the distinction between *wearing red oneself* and *viewing red on an opponent*. Results revealed a bidirectional effect: wearing red enhanced perceptions of one's relative dominance and threat, and viewing an opponent in red enhanced perceptions of the opponent's relative dominance and threat. These effects were observed across sex, and participants seemed unaware of the influence of red on their responses. Our findings lead to practical suggestions regarding the use of colored attire in sport contexts, and add to an emerging, provocative literature indicating that red has a subtle but important influence on psychological functioning.

**Keywords:** color, red, perceived dominance, perceived threat, competition

In a variety of animal species, including nonhuman primates, red is an indicator of dominance, and is associated with competitive victory in physical contests (Andersson, 1994; Barton & Hill, 2005; Bergman, Ho, & Beehner, 2009; Pryke & Griffith, 2006; Setchell & Wickings, 2005). Recently, researchers have begun to investigate whether red provides an analogous advantage for humans in competitive contexts. Indeed, most studies to date have found that a person or team wearing red is more likely to win a physical contest than a person or team wearing another color (Attrill, Gresty, Hill, & Barton, 2008; Hackney, 2006; Hagemann, Strauss, & Leissing, 2008; Hill & Barton, 2005; Ilie, Ioan, Zagrean, & Moldovan, 2008).

This provocative line of research has focused nearly exclusively on the influence of red on win/lose outcomes in human competition, and has virtually ignored the influence of red on cognition and perception in such contexts. Only two studies have focused on this issue. Little and Hill (2007) showed that red circles are perceived to be more dominant and likely to win a (metaphorical) fight than blue circles, and Greenlees, Leyland, Thelwell, and Filby (2008) found that goalies perceive penalty kickers in red, relative to white, as having more positive characteristics in

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general. No research to date has examined whether red influences perceptions of relative dominance and threat in human sport contexts, and the present research was designed to address this lacuna.

A limitation of all research on red in human sport contexts, whether focused on win/lose outcomes or perceptions, is that it has neglected to consider the distinction between *wearing red oneself* and *viewing red on an opponent* (see Attrill et al., 2008, for a call for such work). Research on nonhuman primates suggests that red influences the behavior of both the animal displaying red and the animal viewing red on an opponent. For example, male mandrills displaying the most red on their face have been shown to be the most aggressive toward conspecifics; these mandrills have also been shown to readily submit to the conspecific displaying the most prominent red coloration (Setchell & Dixson, 2001; Setchell & Wickings, 2005). In the present experiments, we examined the influence of both wearing red (Experiment 1) and viewing an opponent in red (Experiment 2) on perceptions of relative dominance and threat. Based on the findings with nonhuman primates, we predicted a bidirectional effect: that wearing red would enhance perceptions of one's relative dominance and threat, and that viewing an opponent's red would enhance perceptions of the opponent's relative dominance and threat.

We focused on a same-sex competitive context in our research, and an intriguing question is whether the aforementioned predictions should be made for male participants only or for female participants as well. On one hand, the red-dominance link in nonhuman primates appears to be specific to males (Elliot et al., 2010), suggesting moderation by sex. On the other hand, both men and women undoubtedly learn cultural associations between red and dominance/status (e.g., the red power tie, rolling out the red carpet for dignitaries). Accordingly, we made no a priori predictions regarding sex differences.

Color comprises three components, lightness (essentially brightness), chroma (essentially saturation), and hue. Each of these can vary independently, and each can have an influence on perception and behavior (Valdez & Mehrabian, 1994). Thus, without controlling for lightness and chroma it is unclear whether any observed difference is due to lightness, chroma, hue, or an interaction therein (Feltman & Elliot, 2009; Whitfield & Wiltshire, 1990). None of the aforementioned studies have attended to this issue; we do so herein by testing for a hue effect while systematically controlling for lightness and chroma at the spectral level.

## Experiment 1

### Method

**Participants.** Thirty-two (15 male, 17 female) U.S. undergraduates participated for extra credit. In this and the subsequent experiment, institutional approval was obtained and all participants provided informed consent. Participation in this and the subsequent experiment was limited to individuals who did not have a color deficiency. The mean age of participants was 20.16 years ( $SD = 1.16$ ); ethnicity was as follows: 21 Caucasian, 5 Asian, 3 African American, 2 Hispanic, and 1 "other."

**Design and Procedure.** Participants were randomly assigned to one of two between-subjects conditions: the wearing red condition and the wearing blue

condition. The experimenters in this and the subsequent experiment were blind to hypotheses and experimental condition. Participants were seated in front of a computer with a 17-inch monitor. They were informed that they would imagine competing in a Taekwondo match against a same sex opponent and that the first part of the experiment would be administered by computer.

First, Taekwondo was introduced by describing the equipment (e.g., dobok, hogu), the World Taekwondo Federation scoring system, the size of the sparring mat, the length of each match, and how and why color is assigned to each competitor. Participants were told that color assignments are determined randomly before the match and that color is worn to make scoring easier. Then, participants in the red (blue) condition were informed that they would imagine wearing a red (blue) hogu (i.e., body protector); the opponent was assigned white in both conditions.

Next, participants were shown the following three pictures (for 5 s each) to both facilitate engagement in the imagination exercise and allow visual presentation of the color manipulation: (1) the room where the match would take place, (2) the white shirt that participants would wear underneath their hogu, and (3) the hogus that contained the color manipulation. The participant's hogu was presented to the left of a vertical line bisecting the picture and the opponent's hogu was presented to the right; Adobe Photoshop was used to manipulate the color of the hogus. A spectrophotometer was used to match the lightness and chroma of the red and blue hogus based on the CIELCh color model (red LCh [60.9, 86.6, 26.9], blue LCh [60.4, 86.1, 264.6]).

For the imagination exercise, participants were instructed to write down their thoughts and feelings about an imagined match for 5 min. Then, participants were given a questionnaire containing the perceived dominance and threat items, and completed questions assessing the perceived influence of color on their questionnaire responses.

## Measures

**Perceived Dominance and Threat.** A set of six face valid questions asked participants to rate themselves and their opponent on dominance (e.g., "How dominant (powerful, strong) did you imagine yourself (your opponent) feeling?"). Participants responded on a 1 (*Not at all*) to 9 (*Extremely*) scale. The opponent-based items were reversed scored and responses to the six items were averaged to form a perceived dominance index ( $\alpha = .77$ ).

A second set of six face valid questions asked participants to rate themselves and their opponent on threat (e.g., "How threatening (intimidating, aggressive) did you imagine yourself (your opponent) feeling?") Participants responded on a 1 (*Not at all*) to 9 (*Extremely*) scale. The opponent-based items were reversed scored and responses to the six items were averaged to form a perceived threat index ( $\alpha = .72$ ).

**Perceived Influence on Responses.** Three items were used to assess participants' perceptions of the influence that various factors had on their questionnaire responses: (a) the color of the hogus, (b) the description of the sport, and (c) the imagination exercise instructions. Participants responded on a 1 (*Not at all*) to 9 (*Extremely*) scale.

## Results and Discussion

Preliminary 2 (color condition: red vs. blue)  $\times$  2 (sex: male vs. female) between-subjects ANOVA revealed no main or interactive effects of sex on perceived dominance or perceived threat, so sex was omitted from further consideration. The analysis on perceived dominance revealed a significant effect of color,  $F(1, 30) = 6.06, p < .05, d = .90$ . Participants in the red condition perceived themselves to be more dominant ( $M = 4.18, SD = 1.24$ ) than did those in the blue condition ( $M = 3.11, SD = 1.09$ ). The analysis on perceived threat also revealed a significant effect of color,  $F(1, 30) = 8.47, p < .01, d = 1.06$ . Participants in the red condition perceived themselves to be more threatening ( $M = 4.00, SD = 1.18$ ) than did those in the blue condition ( $M = 2.71, SD = 1.26$ ).

Paired samples  $t$  tests indicated that the perceived influence of color was significantly lower than the perceived influence of the description of the sport,  $t(31) = 4.72, p < .01, d = .98$ , and the imagination exercise instructions,  $t(31) = 3.39, p < .01, d = .70$ . The relevant means were as follows:  $M_{\text{color}} = 3.34 (SD = 2.48)$ ,  $M_{\text{description of sport}} = 5.72 (SD = 2.36)$ , and  $M_{\text{imagination instructions}} = 5.09 (SD = 2.54)$ .

In sum, wearing red relative to wearing blue led participants to perceive themselves as more dominant and threatening than their opponent. Males and females responded to the color manipulation in similar fashion, and participants reported that color had a relatively minor effect on their responses, suggesting minimal awareness of the color effect. In Experiment 2 we shifted the focus from wearing red to viewing red on an opponent.

## Experiment 2

### Method

**Participants.** Forty-nine (12 male, 37 female) U.S. undergraduates participated for extra credit. The mean age of participants was 19.76 years ( $SD = 1.42$ ). Participant ethnicity was as follows: 35 Caucasian, 9 Asian, 3 African American, 1 Hispanic, and 1 “other.”

**Design, Procedure, and Measures.** Participants were randomly assigned to one of two between-subjects conditions: the viewing red condition and the viewing blue condition. The procedure was identical to that used in Experiment 1 with one exception: participants were told that *their opponent* would wear a red hogu or a blue hogu. In both conditions, participants themselves were assigned a white hogu. The measures used in this experiment were the same as those used in Experiment 1, although in this experiment, the self-based items were reverse scored and added to the opponent-based items ( $\alpha = .95$  and  $\alpha = .90$  for the perceived dominance and perceived threat indexes, respectively).

## Results and Discussion

A preliminary 2 (color condition: red vs. blue)  $\times$  2 (sex: male vs. female) between-subjects ANOVA revealed no main or interactive effects of sex on perceived dominance, so sex was omitted from further consideration. The analysis revealed

a significant effect of color,  $F(1, 47) = 6.55, p < .05, d = .75$ . Participants in the red condition perceived their opponent to be more dominant ( $M = 6.03, SD = 1.77$ ) than did those in the blue condition ( $M = 4.75, SD = 1.71$ ). A preliminary ANOVA on threat perceptions revealed a significant sex main effect,  $F(1, 46) = 4.26, p < .05$ , but no interaction, so sex was included as a covariate in the final analysis. The analysis revealed a significant effect of color,  $F(1, 46) = 3.97, p \leq .05, d = .59$ . Participants in the red condition perceived their opponent to be more threatening ( $M = 6.16, SD = 1.69$ ) than did those in the blue condition ( $M = 5.05, SD = 1.75$ ).

Paired samples  $t$  tests indicated that the perceived influence of color was significantly lower than the perceived influence of the description of the sport,  $t(48) = 5.34, p < .01, d = 1.00$ , and the imagination exercise instructions,  $t(48) = 5.98, p < .01, d = 1.11$ . The relevant means were as follows:  $M_{\text{color}} = 3.32 (SD = 2.57)$ ,  $M_{\text{description of sport}} = 5.71 (SD = 2.19)$ , and  $M_{\text{imagination instructions}} = 5.98 (SD = 2.19)$ .

In sum, viewing red relative to viewing blue on an opponent led participants to perceive their opponent as more dominant and threatening than themselves. As in Experiment 1, males and females responded to the color manipulation in similar fashion, and participants' ratings of the factors influencing their responses suggested minimal awareness of the color effect.

## General Discussion

The present research demonstrates that red influences perceptions of relative dominance and threat in an imagined sport context and, critically, documents that this influence is bidirectional. Red not only affects perceptions of the person wearing red, but also affects perceptions of the person viewing red on an opponent. In addition, participants showed minimal awareness of these red effects, which suggests that red may be exerting an automatic influence in this context (see Bargh, 1990; Elliot & Maier, 2007).

We found red effects for both male–male and female–female dyads in our experiments. Although sex specificity is sometimes viewed as evidence for the biological (rather than learned) basis of an effect, it is also the case that cultural learning and biological explanations may complement, rather than contradict, each other in many instances (Elliot, Maier, Moller, Friedman, & Meinhardt, 2007; Simpson & Gangestad, 2001). In the present case, we suspect that sex-general cultural associations between red and dominance/status are themselves rooted in a deeply engrained biological predisposition to interpret red as a dominance cue in competitive contexts. Future research would do well to focus directly on the root causes of the red effects documented herein and that have been documented for competitive outcomes in other work (e.g., Hill & Barton, 2005).

It would also be beneficial for future research to examine red relative to other colors and red in other contexts. In our experiments, we compared red to a chromatic color, blue. Blue is ideal as a contrast color because it is commonly used in sport contests and, as a chromatic color, it allowed us full control of non-hue color properties. Subsequent research could seek to extend this work by using other chromatic contrast colors (e.g., green), and perhaps even an achromatic contrast (e.g., gray).

In our experiments, we investigated red in an imagined physical, face-to-face, competitive context. This is an optimal starting point, as prior work has observed a

red-outcome effect in face-to-face competitive contexts (e.g., Hill & Barton, 2005), and our findings reveal a potential mediator of this effect. Subsequent research is needed to examine the link between perceived dominance and performance outcomes, and to test whether our red-perception findings generalize to physical competitions without a face-to-face component (e.g., weight lifting; for related research see Elliot & Aarts, in press), intellect-based competitions (e.g., chess; for related research see Elliot, Maier, Binser, Friedman, & Pekrun, 2009), and person perception contexts more generally (e.g., romantic contexts; for related research see Elliot et al., 2010). At present, our findings apply exclusively to face-to-face competitive contexts.

A limitation of our work is the use of a scenario methodology as opposed to a live performance setting; it is possible that viewing color in an actual, as opposed to imagined, competition may produce different effects (although see Papaxanthis, Pozzo, Skoura, & Schieppati, 2002, for evidence favoring congruent effects). We adopted a scenario approach because it enabled us to cleanly and systematically isolate the *wear red* versus *view red* distinction that is the centerpiece of our research. It is difficult to envision how this type of experimental control could be obtained in a live competitive context (not to mention equating actual clothing on lightness and chroma), but if so, such work would nicely extend the present research. Our use of undergraduate participants in this work seems both a strength and a limitation. It is a strength in that most studies in the nascent literature on red in competitive contexts have focused on professionals or experts, and our work clearly applies to a much larger segment of the population. It is a limitation in that undergraduates represent only one small segment of the larger population, and it remains to be seen how extensively our findings generalize. Finally, additional work is needed to further examine other processes that may be evoked by red in competitive contexts, such as worry (Lichtenfeld, Maier, Elliot, & Pekrun, 2009) and narrowed attentional focus (Maier, Elliot, & Lichtenfeld, 2008).

From a practical standpoint, our research suggests that red attire grants competitors an unfair advantage in sport contexts, and raises the question of whether use of this color should be regulated accordingly (see also Hill & Barton, 2005). From a conceptual standpoint, our research joins an emerging, provocative body of work indicating that color is not just about aesthetics, but represents a subtle, nonlexical stimulus that can have important effects on perception and behavior.

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