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*Psychological Science* 2008 19: 769  
DOI: 10.1111/j.1467-9280.2008.02155.x

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## Short Report

## When the Referee Sees Red . . .

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Hill and Barton (2005) showed that wearing red sports attire has a positive impact on one's outcome in a combat sport (e.g., tae kwon do or wrestling). They suggested that this effect is due to an evolutionary or cultural association of the color red with dominance and aggression, proposing that this association triggers a psychological effect in an athlete who wears red (or in his or her opponent; e.g., Cuthill, Hunt, Cleary, & Clark, 1997; Milinski & Bakker, 1990; Setchell & Wickings, 2005). Rowe, Harris, and Roberts (2005) criticized this argument and instead attributed the bias evident in these and other data (judo) to differences in opponents' visibility.

We disagree with both interpretations (see also Barton & Hill, 2005), arguing that this phenomenon is actually due to a perceptual bias in the referee. That is, we propose that the perception of colors triggers a psychological effect in referees that can lead to bias in evaluating identical performances. Referees and umpires exert a major influence on the outcome of sports competitions (Plessner & Haar, 2006). Athletes frequently make very rapid movements, and referees have to view sports competitions from a very disadvantageous perspective, so it is extremely difficult for them to make objective judgments (Oudejans et al., 2000). As a result, their judgments may show biases like those found in other social judgments (Frank & Gilovich, 1988; Plessner & Haar, 2006; Ste-Marie & Valiquette, 1996). Therefore, we believe that it is the referees who are the actual cause of the advantage competitors have when they wear red. Because the effect of red clothing on performance and on the decisions of referees may well have been confounded in the original data, we conducted a new experiment and found that referees assign more points to tae kwon do competitors dressed in red than to those dressed in blue, even when the performance of the competitors is identical.

## METHOD

We investigated the effect of the color of the protective gear (trunk and head protectors) in tae kwon do on the decisions of referees. A total of 42 experienced referees (13 female, 29 male; mean age = 29.31 years,  $SD = 10.56$ ; mean experience as a

referee = 8.02 years,  $SD = 6.27$ ) individually watched videotaped excerpts from sparring rounds of five different male competitors of similar abilities. Each of two blocks contained 11 clips, with an average length of 4.4 s. The video images measured  $1,024 \times 768$  pixels and were displayed on a notebook computer with a 15.4-in. screen.

In each video, one competitor was wearing red protective gear, and the other was wearing blue protective gear. (Underneath this gear, each competitor wore a white tae kwon do uniform.) The two blocks contained the same clips, but with the colors of the competitors reversed. We reversed the colors using digital graphics, animation, and image-compositing software (Adobe After Effects 7.0).

After viewing each clip, participants indicated how many points they would award the red and the blue competitors. Following the rules of the World Taekwondo Federation,<sup>1</sup> participants awarded points when permitted techniques were used to deliver attacks to the legal scoring areas of the body: Specifically, 1 point was awarded for an attack to the trunk protector (fist and foot techniques), and 2 points were awarded for an attack to the face (only attacks by foot technique are permitted). Additional points could be awarded if a contestant knocked down his opponent. Prohibited acts could be counted as a deduction of 1 point.

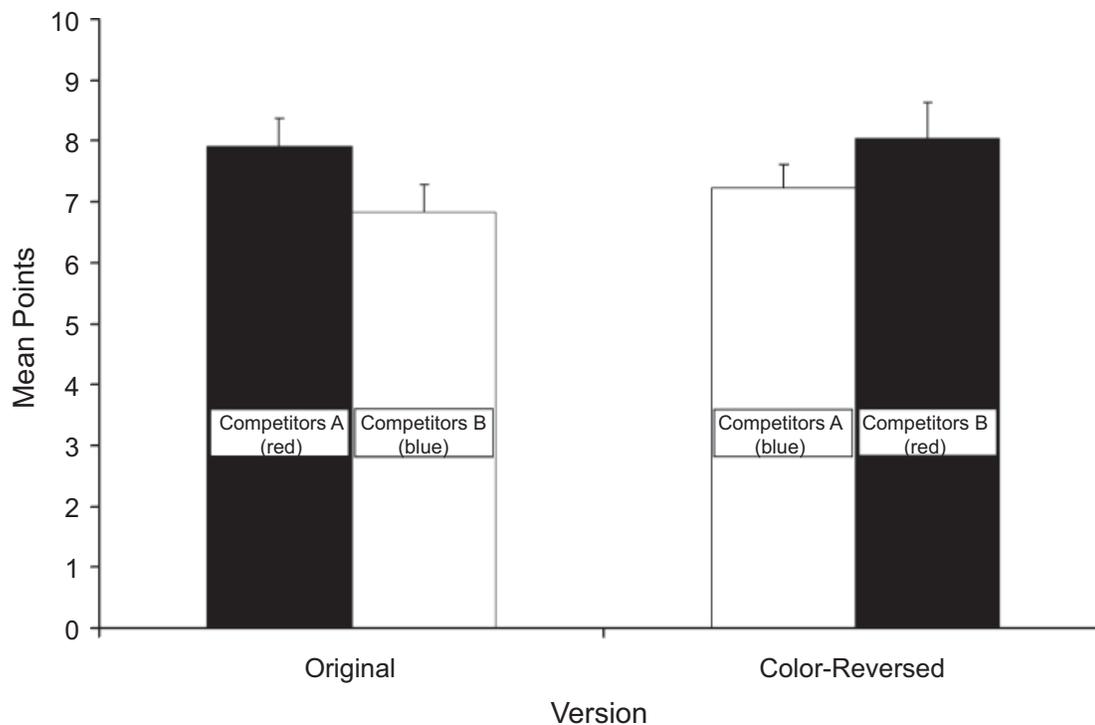
The video clips were presented in random order within each block, and the order of the blocks was counterbalanced across participants. For each referee, we calculated the total number of points for the red and blue competitors, and these values were subjected to separate dependent *t* tests. We used Cohen's *d* as our measure of effect size. We expected that changing the color of the protective gear from blue to red would lead to an increase in points awarded, whereas changing the color from red to blue would have the opposite effect.

## RESULTS AND DISCUSSION

Figure 1 shows the effect of the color of the protective gear. The competitor wearing red protective gear was awarded an average

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<sup>1</sup>In a regular competition, the match score is the sum of points in three 2-min rounds. Unless there is a knockout, withdrawal, or disqualification, the winner is usually determined by points: The winner has the higher final score, exceeds the opponent's score by 7 points, or reaches the maximum of 12 points.



**Fig. 1.** Mean number of points awarded to tae kwon do competitors in the original and color-reversed versions of the video clips. Each clip depicted a sparring round with one competitor dressed in red and the other dressed in blue. Competitors A wore red in the original clips and blue in the color-reversed clips, and Competitors B wore blue in the original clips and red in the color-reversed clips. Error bars indicate standard errors.

of 13% (0.94 points) more points than the competitor wearing blue protective gear,  $t(41) = 2.85$ ,  $p < .01$ ,  $d = 0.35$ . The number of points awarded increased for a blue competitor who was digitally transformed into a red competitor,  $t(41) = 2.45$ ,  $p < .01$  (one-tailed),  $d = 0.36$ , and decreased for a red competitor who was digitally transformed into a blue competitor,  $t(41) = 1.66$ ,  $p < .05$  (one-tailed),  $d = 0.25$ . The gender of the referee, total number of points awarded in the two versions of the video clip (original vs. color-reversed), and the order in which the two versions were presented had no effect on the referees' decisions.

Thus, competitors dressed in red are awarded more points than competitors dressed in blue, even when their performance is identical. The effect found in this experiment can also explain why the effect of clothing color on the outcome is stronger when competitors have similar abilities than when there is a large asymmetry in their abilities (Hill & Barton, 2005). Referees' decisions will "tip the scales" when athletes are relatively well matched, but have relatively small influence when one is clearly superior. Even though the color of athletes' sportswear may well exert an influence on their performance (through associations with dominance or differences in visibility of the opponent), we argue that the referees are responsible for the advantage conveyed to athletes who wear red. Although there is a need for further research (including research on the effects of different

colors), our results suggest a need to change the rules (i.e., forbid red sports attire) or support referees by providing electronic decision-making aids (e.g., electronic trunk protectors) in those sports in which this color bias may be a problem.

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(RECEIVED 12/16/07; REVISION ACCEPTED 2/13/08)