

Research article

Do Red and Blue Uniforms Matter in Football and Handball Penalties?

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Abstract

Past research has revealed ambiguous results on the impact of red uniforms in sports competition. The current study was aimed at analyzing the role of red and blue uniforms in football and handball penalties. Two experiments were conducted using a within subjects design, where participants rated uniform color-manipulated video clips. In the first study, participants (n = 39) watched footage of football players kicking a penalty, whereas in the second study (n = 118) videos of handball penalty takers, handball goalkeepers and football goalkeepers preparing themselves to score/save a penalty were shown. Participants rated player's/goalkeeper's level of confidence and the expected position of the ball crossing the goal line in the first experiment and additionally the probability of scoring the penalty against the goalkeepers in the second experiment. The videos stopped at the point where the ball was leaving the foot and hand respectively. Results did not show any beneficial impact of red uniforms. Rather, football players wearing blue were rated to kick the ball higher. The study contradicts any positive effect of red versus blue uniforms in the context of football and handball penalties, which emphasizes the need of searching for potential moderators of color's impact on human behavior.

Key words: Color, hue, performance, decision, cognition.

Introduction

Color plays a ubiquitous role in the individual and societal life of human beings. However, little is known about its impact on psychological aspects like cognition, emotion or motivation. Only in the last decade has research started to investigate the effects of color on psychological functioning more comprehensively and has been able to broaden the scientific discussion about the role of color in human daily life (Changizi, 2010; Elliot, 2015; Elliot and Maier, 2014). Besides a few studies dealing with the impact of Black (Caldwell and Burger, 2011; Frank and Gilovich, 1988; Tiryaki, 2005; Webster et al., 2012), Green (Akers et al., 2012; Krenn, 2015; Lichtenfeld et al., 2012) or Yellow (Chantal and Bernache-Assollant, 2015, 2016), the vast majority of studies was focused on the color Red revealing its significance by showing an impact on attractiveness (e.g., Elliot and Niesta, 2008; Elliot and Pazda, 2012; Hesslinger et al., 2015), avoidance and/or approach motivation (e.g., Elliot et al., 2009; Mehta and Zhu, 2009; Meier, et al., 2012) and noteworthy sports competition (Hagemann et al., 2008; Hill and Barton, 2005). However, effect sizes and generalizability of these results turned out low and several studies failed to replicate the reported findings (Elliot, 2015; Elliot and Maier,

2013; Francis, 2013; Lehmann and Calin-Jageman, 2017; Peperkoorn et al., 2016; Steele, 2014). Thus, still many open questions remain and research has barely touched the underlying mechanisms clarifying the impact of color on human behavior.

In 2005 Hill and Barton reported a slight benefit for athletes wearing red (versus blue) by analyzing the results of the Olympic Games in 2004 of boxing, taekwondo and wrestling. They argued an association of the color red with dominance and/or aggression, which might cause beneficial effects in sports for those wearing red. Their assumption built the cornerstone for a row of studies questioning the role of uniform color in sports, even though inconsistent findings were revealed. On the one hand, conducive effects of red were corroborated: Feltman and Elliot (2011) showed that athletes imagining they were wearing red rated themselves as more dominant, but also rated the opponents as more dominant when imagining them wearing red. Boxers and wrestlers were perceived as more aggressive and likely to win when wearing red instead of blue or green uniforms (Krenn, 2015). In addition, Hagemann et al. (2008) revealed a referee's bias towards red-dressed fighters, given that referees tended to award them more points. Also, in association football by investigating the results of the first three divisions in England, a tendency towards teams donning a red uniform winning the most was found (Attrill et al., 2008). On the other hand, several studies reported null results refuting any beneficial impact of red uniforms in combat sports (Carazo-Vargas and Moncada-Jiménez, 2014; Pollet and Peperkoorn, 2013) and football (García-Rubio et al., 2011; Kocher and Sutter, 2008) or rather reported negative outcomes (e.g. harsher tackle judgements in football; Krenn, 2014). Most notably, Allen and Jones (2014) found in an exploratory analysis, that teams wearing red at home games succeeded more often in their away games, where they mostly did not wear red: Thus, Attrill et al.'s (2008) reported benefit might be independent of red uniforms and rather be due to specific team characteristics (cf. Allen and Jones, 2014). Hence, the impact of red uniforms in sport seems rather vague and research left many questions unsettled. This conclusion is even substantiated by considering some methodical limitations of the conducted studies (a.o. varying interaction of hue, saturation and lightness; vague categorization of uniform color without incorporating any distractors - e.g. uniform designs, additional color spots, sponsors, numbers; see also Elliot, 2015) as well as their lack of any theory-based approach. Most of the studies were focused on solely detecting any red effect by analyz-

ing experimental data or archival data in several sports but did not claim to profoundly investigate the underlying mechanism of a potential impact of the color red.

In this regard, merely Color-in-Context Theory (Elliot and Maier, 2007, 2014) constituted a broad theoretical framework predicting color impact on psychological functioning. It was suggested that colors may have associations to specific meanings, which may affect psychological functioning without conscious intention or awareness (Elliot and Maier, 2014; Elliot et al., 2007). These associations seem to be built by social learning processes (e.g. Red in traffic signs signifies something important/to be taken care of) and/or biologically-based proclivities (Hill and Barton, 2005; see also Pryke, 2009; Setchell and Wickings, 2005). However, these color-meaning associations were assumed to be contextual (Elliot and Maier, 2014; Elliot et al., 2007; Maier et al., 2009). One color may have different associations, whereas the context in which the color is perceived affects which association(s) is (are) assessed. Exemplarily, the color red was found to increase avoidance behavior in achievement contexts, but enhance approach motivation in romantic contexts (Elliot et al., 2009; Elliot and Niesta, 2008; Mehta and Zhu, 2009; Meier et al., 2012). Thus, context seems to play a crucial role in understanding the relationship between color and psychological functioning (Maier et al., 2009). So far, sports research has not challenged this assumption, implying a universal achievement context in sports. Any differing situational cues of sports were ignored, whereas past research already indicated discriminative characteristics and associations (Koivula, 2001; Maxwell et al., 2009; Pedersen, 2007; Seungmo et al., 2008). However, the differential context of various sports or rather the differing experimental approaches (e.g. lab versus field study) may provide a potential moderator affecting color's impact. In this regard, studies questioning color's role within the specific context of penalty kicks in football revealed interesting findings.

At a penalty kick a player individually faces a goalkeeper in the penalty area, representing a face-to-face situation. The goalkeeper may affect penalty taker's attention by assuming a certain posture, like choosing his position or showing specific movements (Noel et al., 2015; Wood and Wilson, 2010). Following this, wearing a specific uniform color may affect penalty taker's or goalkeeper's behavior by attracting more (or less) attention (Greenlees et al., 2008; Memmert et al., 2013). Greenlees et al. (2008) found that English goalkeepers rated red-clad penalty takers more competent and reported lower expectancies of saving penalties against them in comparison to white-clad penalty takers. In addition, facing a goalkeeper wearing red resulted in fewer goals being scored than facing a goalkeeper wearing blue, green or yellow (Greenlees et al., 2013). Thus, both studies suggest a benefit of red uniforms in football's context of penalty kicks. In contrast, Furley et al. (2012) did not observe any impact of penalty takers' red uniforms (in comparison to white uniforms) after analyzing a German sample. However, these studies showed different approaches analyzing uniform color mainly in interaction with additional variables (gaze or nonverbal behavior) as well as some me-

thodical limitations restricting the generalizability of their results. They fell short of standardizing color manipulation (controlling for varying saturation and lightness) and large sample sizes (the number of participants ranged from twelve to 40). In addition, they partly showed a limited number of trials (e.g., rating four color manipulated videos) and used footage of players strictly instructed to show a very specific gaze or nonverbal behavior (e.g., gazing 90% of time at the goalkeeper). Thus, more research is needed to broaden the empirical fundament as well as clarify these contradictory findings within the context of penalties in sport.

The current study aimed to deepen our understanding of uniform color's role by taking penalties in team sports into focus: First, any potential benefit of red uniforms in penalty kicks was examined to complement the findings of Greenlees et al. (2013, 2008) and Furley et al. (2012). Second, the chosen experimental approach was transferred to handball penalties representing similar contextual variables like penalties in football (a.o. team sports, face-to-face situation). The comparison of the results was intended to increase generalizability of findings and cast a light on the range of any potential impact of uniform color on penalty situations. By having two similar situations in two different sports any differential impact of uniform color may also help to better understand the basic mechanism of how colors may affect psychological functioning and athletic performance. In the first experiment, participants had to rate color-manipulated video sequences (red versus blue uniforms) of penalty takers in football. In the second study, participants rated football and handball goalkeepers preparing themselves to save a penalty as well as penalty takers in handball. In dependence on studies in combat sports (e.g., Dreiskaemper et al., 2012; Hill and Barton, 2005) the colors of red and blue were focused questioning a potential transfer of the reported results in combat sports to the different context of football and handball penalties.

EXPERIMENT 1

In the first experiment, video clips showing a football player taking a penalty were recorded and color-manipulated. The clips ended when the player struck the ball. In two created versions of the same footage - one in which a player wore a red jersey and red shorts and one in which he wore a blue jersey and blue shorts - participants rated the player's level of confidence to score and the expected position of the ball as it hit the goal (within-subjects design). The task of anticipating where the ball should hit the goal was chosen to reveal any tendency of uniform color to affect the penalty's quality: Kicking the ball closer to the corners and closer to the crossbar decreases the goalkeeper's probability of saving the penalty (Bar-Eli and Azar, 2009). However, to define the best strategy of where to kick a penalty seems to be ambiguous and is affected by a shooter's technical potentialities and goalkeeper's behavior (Memmert et al., 2013). To kick more closely to the corners and crossbar may also increase the risk to miss the penalty (Bar-Eli and Azar, 2009; Bar-Eli et al., 2009).

Methods

Twenty-four video clips of seven different male players ($M_{\text{height}} = 1.84$ m, $SD_{\text{height}} = 0.08$; $M_{\text{weight}} = 78.71$ kg, $SD_{\text{weight}} = 8.64$) were recorded using two GoPro Hero3-Black Edition cameras (60 frames/sec; 1920x1440 pixel; wide field of view). The players, students of sport science, were asked to volunteer for this study. They showed extensive football playing experience ($M = 12.14$ years, $SD = 6.18$). All players were Caucasian and their average age was 25.57 ± 2.30 . The players were provided with red and blue jerseys with short sleeves and red and blue shorts (Jako 'Winner' red and blue). The uniforms were devoid of logos and any brandings, so that no associations with existing football teams could be formed. The socks and shoes were brought by the players on their own and were not controlled for color. The players were asked before kicking the penalty to announce where they were going to hit the ball. The goal was divided into six equal areas and penalty takers had to choose one out of four: Top left, bottom left, top right and bottom right. Each area consisted of 297685 cm^2 ($244 \times 122 \text{ cm}$). Because of the position of the camera in the middle of the goal, they were told not to kick the ball to one of the two central areas (top/bottom). During recording the goal was kept free of any goalkeeper. Any penalty misses were not selected for the experiment.

The camera was positioned six meters in front of the goal at a height of 60cm, which was in line of the viewing angle when the goalkeeper focuses on the ball, standing at the goal line. For this conclusion, we analyzed every penalty taken at the group stage of the world championship in Brazil in 2014 ($n = 10$): At the time the player kicked the ball, the height of the goalkeeper's head was consistently between 120 and 140 cm. Goalkeepers were not standing straight; instead they crouched down, prefer-

ring a low center of gravity in order to jump as quickly as possible to one corner of the goal. The color of the jerseys and shorts from the original video clips (red) was changed to blue using Adobe After Effects 13.0. We merely used recorded videos of players wearing red because of the higher homogeneity and quality of color manipulated videos resulting from it. The analysis of the scoring rates of both uniform colors did not show any discrepancy. Hue, saturation, and lightness of uniform color changed between the recorded videos. However, saturation and lightness were controlled for both color conditions, so that merely hue was manipulated. For each of the 24 video clips, two versions were created: One showing the penalty taker wearing a red jersey and shorts, and a second one showing the same video but the hue of the player's jersey and shorts was changed to blue. The recorded players were without exception right-footed. To ensure a valid distribution of penalties kicked by a left-/right-footed player, eight mirror-inverted clips were generated (randomly chosen) to achieve at least a third of penalties kicked by a left foot (cf. Dohmen, 2008). Figure 1 shows an exemplary frame of a video clip.

Each video clip lasted four seconds and ended three frames after the ball was kicked. Participants had to rate player's confidence to score as well as the expected position of the ball hitting the goal by watching a picture of an empty goal and choosing their expected position via 23in. touchscreen (Acer T231H, 60Hz, 2ms response time). Its color mode was standardized and measured using a spectrophotometer (i1 pro x-rite).

Participants

In total, 43 Austrian nonprofessional male football players with an average age of 25.64 ± 4.90 years participated in this study. Participants stated to have any kind of color-deficiency were excluded from further data analysis



Figure 1. Four single frames for each experimental category of both studies: Football (left) and handball penalties (right) from goalkeeper's (top) or penalty taker's (bottom) perspective.

($n = 4$). They quoted themselves to exercise 5.21 ± 2.38 hours per week and had played football for 6.28 ± 3.87 years at a registered club ($n = 29$). Ten players stated themselves to have played regularly on a casual basis in their spare time. Fifteen players did not show any experience in goalkeeping, whereas 16 had played as a goalkeeper on a casual basis in their spare time and eight in a registered club.

Design and procedure

Participants were recruited at local football tournaments for nonprofessional players. The research was presented as dealing with anticipation cues during penalty kicks in football. The experiment was conducted in a mobile laboratory: For this, the loading space of a van was shaded and equipped with two desks separated by a dividing wall. During the experiment the doors of the van were closed to reduce background noise and assure steady conditions. Lighting conditions were kept constant by using artificial light. The experiment opened with the obtaining of informed consent and ended with a debriefing, in which the background and target of the research was explained.

At each desk, participants had to take a seat and start the experiment by touching on the screen. At the beginning, questions on sociodemographic and football-biographical variables were answered using the touchscreen. Afterwards the experimental task was introduced: Participants were to watch each video until the end (4 sec) and then a) rate the penalty taker's confidence to score from 1 (very low) to 9 (very high), and b) anticipate the position where they thought the ball would hit the goal by choosing the position on a picture of an empty goal. The goal was pictured from the back, so that participants did not have to mirror-invert their impressions of the kick; instead they had the same view as the goalkeeper. For each rating, reaction time was limited to three seconds. Participants were asked to decide as quickly as possible. The order of rating these two variables –confidence and ball position – was randomized by the software DirectRT (empirisoft).

The experiment was divided into two parts with a short delay in between: In the first part, participants had to rate 24 video clips of penalty kicks. The order and the color condition of each clip was randomized (software DirectRT), but it was ensured that by watching a video in a specific color condition (red or blue) their color-manipulated counterpart was shown in the second part. This design was chosen to impede any memory effects but especially to impede the obviousness of showing the same videos in two color conditions. At the end of the experiment, participants were asked for any kind of color-blindness or deficiency in color perception and to guess the specific purpose of the study (manipulation check). Their comments showed that they did not suspect the purpose of the study.

To analyze the data, the means of player's confidence to score, the height of the ball's expected position as well as its mean deviation from the center was calculated for red and blue uniforms. For multiple testing of the

ball's position (height/laterality) Bonferroni adjustment was conducted ($\alpha = 0.025$). To compare the means t-tests for dependent samples were conducted.

Results

Data analyzes did not find any significant impact of uniform color on ratings of player's confidence ($t(38) = 0.94$, $p = 0.351$, $d = 0.07$; $M_{\text{blue}} = 5.48 \pm 0.80$, $M_{\text{red}} = 5.42 \pm 0.77$) and expected lateral position of the ball ($t(38) = 0.81$, $p = 0.422$, $d = 0.06$; $M_{\text{blue}} = 234.76 \pm 36.69$ cm, $M_{\text{red}} = 232.61 \pm 36.75$ cm). However, a small significant impact of uniform color was revealed for the expected height of the ball's position ($t(38) = 2.42$, $p = 0.020$, $d = 0.16$). Penalty takers wearing a red uniform ($M = 93.91 \pm 25.85$ cm) were expected to kick the ball lower than penalty takers wearing blue ($M = 98.29 \pm 27.41$ cm).

Discussion

The first experiment did not find any benefit of red versus blue uniforms on football penalty kicks. Contrary to the findings of Greenlees et al. (2008) we did not reveal any impact of uniform color on the ratings of penalty takers' confidence, nor on expected lateral ball position. This result is in line with Furley et al. (2012). However, a small but significant impact of color was observed on the height of the expected ball position. The ball was anticipated to be kicked a little higher by a player wearing blue rather than red. This difference in height for both colors merely turned out 4.48 centimeters. The small effect size and methodical limitations restrict the practical validity of this finding. Most notably, the camera perspective deviated from an authentic goalkeeper's view and athletes' probability of success was not explicitly rated. As a consequence, in Experiment 2 these critical aspects were considered more comprehensively. The focus was directed towards the goalkeeper's uniform color, as opposed to the penalty taker's uniform color, and the sportive setting was changed to a handball penalty situation.

EXPERIMENT 2

In view of the finding that wearing red was accompanied by a benefit for goalkeepers at penalty kicks (Greenlees et al., 2013), the second experiment shifted a) its focus to the role of goalkeeper uniform color and b) expanded its focus to handball by keeping the contextual variables of a penalty. The apparent similarity between football's penalty kicks and handball's penalty shots should enhance the generalizability of our findings by representing an equivalent situation within a face-to-face context of team sports. Following Color-in-Context Theory (Elliot & Maier, 2007, 2014) color-meaning associations should be reliant on the context, in which a color is perceived. By refuting any beneficial impact of red versus blue uniforms in football penalties in Experiment 1, we expected the corroboration of this finding in Experiment 2 due to the similar context of penalties in both sports.

Methods

In accordance with Experiment 1, video clips of handball penalty takers but also of football and handball goalkeepers were recorded ($k = 25$). The camera was positioned to be exactly in the middle of the goal line at a height of 170 cm. To lessen the variance of players' optical characteristics, only two male players were selected for recording: Player A (23 years of age, 175 cm, 78 kg) and Player B (25 years of age, 171 cm, 79 kg) were Caucasian and showed extensive handball playing experience (6 and 15 years). For football and handball goalkeepers, video footage was recorded by positioning the camera eleven (football, $k = 25$) and seven (handball, $k = 25$) meters distant from the centralized goal at a height of 170 cm. For handball, two (30 years of age/176 cm/ 93 kg and 26 years/194 cm/ 87 kg) and for football one goalkeeper was selected (23 years, 179 cm, 73 kg), again showing extensive handball/football playing experience (26/4/16 years).

At recording, athletes were provided with red jerseys and red shorts (Jako 'Winner' red). For handball goalkeepers a red jersey with long sleeves and grey trousers were chosen to increase face validity. Handball videos were recorded at a gym showing light brown wooden planking in the background and a grey floor. Football videos were recorded at the same pitch as was chosen in Experiment 1, showing bushes and trees behind the goal.

Color manipulation and editing of the videos was conducted as described for Experiment 1. For handball penalty takers, the videos ended three frames after the ball was thrown. Handball videos showing the goalkeepers were created by showing the hand throwing the ball towards the goal. Thus, the penalty taker stood next to the camera and his arm throwing the ball emerged from the left or right side (balanced) of the camera angle. The sequences were stopped three frames after the ball left the hand of the player. For football goalkeepers, a different procedure was chosen due to the distance of the camera position and the foot kicking the ball. Here we stopped the videos three frames after the ball appeared within the camera angle (the ball was kicked from a position below the camera). Figure 1 shows an exemplary frame for each video category.

Participants

The sample was composed of 146 non-color-blind students of sport sciences. The research was presented again as dealing with penalty kicks/shots in handball and football. At the end of the experiment participants were asked about their thoughts on the experiment and the specific research question (manipulation check): Twenty-eight students stated that they suspected the research was at least to some extent dealing with uniform color in sports. These students were excluded from further data analysis (*By not excluding the students guessing the main purpose of the study correctly, the general results would not have been affected*). The high number of students who correctly guessed the purpose of the experiment was due to students' knowledge about the research activity of the department. The remaining 118 students (22.25 ± 2.87 years; 55 female/63 male) showed sufficient knowledge

and experience in both sports due to their academic studies. Sixty-one are quoted to have played football matches regularly: Their competitive football experience was 9.25 ± 5.24 years. In handball fifteen participants were stated to have played matches regularly. Their competitive handball experience was 8.54 ± 5.08 years.

Design and procedure

The experiment was conducted individually in a laboratory using artificial light (kept constant). Again, the experiment began with participants filling out an informed consent form and ended by a debriefing explaining the main research question. Each of the three parts of the experiment (handball penalty takers/handball goalkeepers/football goalkeepers) were divided into two segments showing 25 video clips in a randomized order in a within-subjects design. After rating half of the video clips a short delay was implemented enabling participants to briefly relax. In total, participants rated 150 video clips. Procedure and equipment was chosen as in Experiment 1. However, in addition to participants' ratings of player's confidence and expected position of the ball, for videos showing a goalkeeper they also had to rate the probability of the penalty being scored from 1 (low) to 9 (high).

To analyze the data, the means of player's confidence level, probability of success, the height of the ball's expected position as well as its mean deviation from the center were calculated for red and blue uniforms. For each dependent variable repeated measures ANOVA was conducted considering gender as between-subjects factor.

Results

At first, the means for football goalkeepers were examined: Repeated measures ANOVA did not show any significant impact of uniform color on ratings of goalkeepers' confidence ($F(1, 116) = 0.73, p = 0.394, \eta^2 = 0.01$), probability of success ($F(1, 116) = 0.01, p = 0.97, \eta^2 = 0.00$), or the expected position of the ball (height: $F(1, 116) = 0.04, p = .846, \eta^2 = 0.00$; side: $F(1, 116) = 0.17, p = 0.680, \eta^2 = 0.00$). Even the interaction of uniform color and gender did not reveal any significant effect (confidence: $F(1, 116) = 1.91, p = 0.169, \eta^2 = 0.02$; probability of success: $F(1, 116) = 2.45, p = 0.121, \eta^2 = 0.02$; height: $F(1, 116) = 0.582, p = 0.447, \eta^2 = 0.01$; side: ($F(1, 116) = 0.54, p = 0.465, \eta^2 = 0.01$).

For the uniform color of handball goalkeepers repeated measures ANOVA again did not show any impact of red uniforms on goalkeepers' confidence ($F(1, 116) = 0.08, p = 0.779, \eta^2 = .00$), probability of success ($F(1, 116) = 0.66, p = 0.419, \eta^2 = 0.01$), or expected ball position (height: $F(1, 116) = 0.81, p = 0.371, \eta^2 = 0.01$; side: $F(1, 116) = 3.69, p = 0.057, \eta^2 = 0.03$). Also the interacting effect of uniform color and gender did not turn out significant (confidence: $F(1, 116) = 2.49, p = 0.118, \eta^2 = 0.02$; probability of success: $F(1, 116) = 1.29, p = 0.258, \eta^2 = 0.01$; height: $F(1, 116) = 0.08, p = 0.773, \eta^2 = 0.00$; side: ($F(1, 116) = 0.01, p = 0.993, \eta^2 = 0.00$).

Finally, the role of the handball penalty taker's uniform color was examined. For handball goalkeepers, any potential benefit of red uniforms did not turn out

significant (confidence: $F(1, 116) = 0.42, p = 0.519, \eta^2 = 0.00$; height: $F(1, 116) = 0.14, p = 0.711, \eta^2 = 0.00$; side: $F(1, 116) = 0.54, p = 0.465, \eta^2 = 0.01$), neither did it in interaction with gender (confidence: $F(1, 116) = 0.09, p = 0.769, \eta^2 = 0.00$; height: $F(1, 116) = 0.14, p = 0.708, \eta^2 = 0.00$; side: $F(1, 116) = 0.63, p = 0.429, \eta^2 = 0.01$).

Discussion

In accordance with Experiment 1, any potential benefit of red uniforms on football and handball penalties was not significant in comparison to blue. Neither the ratings of player's/goalkeeper's confidence level, probability of scoring the penalty, nor the expected position of the ball differed significantly for blue and red uniforms. This result contradicts the finding of Greenlees et al. (2013), who observed fewer scores against red-clad goalkeepers. However, they also did not find an impact of uniform color on players' expectancy of success. These contradictions emphasize that more research is needed to better understand the underlying mechanism causing any impact of uniform color in penalties. Our results were consistent within the context of football and handball penalties, neglecting any impact of uniform color. Thus, the current study seems to be in line with past research, which also failed to reveal any potential benefit of red uniforms in sports (Allen and Jones, 2014; García-Rubio et al., 2011; Kocher and Sutter, 2008; Krenn, 2014; Pollet and Peperkoorn, 2013).

General Discussion

Within this study two experiments were conducted revealing consistent findings: Red uniforms did not show any potential benefit on ratings of confidence, probability of success or expected ball position in football and handball penalties. However, a potential advantage for blue uniforms in football penalties was seen only in one experiment: Football players wearing blue were rated to kick the ball higher to the goal than those wearing red. In respect of the results of Bar-Eli and Azar (2009) that kicking the ball more up to the goal decreases goalkeeper probability of saving the penalty, this may be interpreted cautiously as a benefit for those wearing a blue uniform. On the other hand, kicking the ball higher might also increase the risk of missing the penalty (Bar-Eli and Azar, 2009; Bar-Eli et al., 2009). However, effect size turned out to be small and the observed difference lacked in practical validity: Converting the mean difference on the screen to the real height of a football goal (244 cm) the means merely deviated 4.48 centimeters from each other. Thus, in consideration of the statistical significance of this finding, its practical and scientific value has to be interpreted carefully.

The reported results contradict the findings of Greenlees et al. (2008, 2013), who found a beneficial impact of red uniforms on football penalty kicks. Different methodical aspects have to be considered when analyzing these contradictory findings. Greenlees et al. (2008) compared red to white uniforms, whereas we questioned red to blue uniforms, similar to studies of combat

sports. Thus, the question of whether opposing red with white instead of red with blue would have resulted in a benefit remains open. In addition, the colored clothes varied between the studies: Whereas jerseys with long sleeves (Greenlees et al., 2008) and knee-length socks were worn (Furley et al., 2012; Greenlees et al., 2008), in our study short sleeve tops (cf. Furley et al., 2012) and no colored socks were provided (cf. Greenlees et al., 2013). Also football players/goalkeepers' shorts were color-manipulated in the current study (cf. Furley et al., 2012; Greenlees et al., 2008), which was not incorporated by Greenlees et al. (2013). Thus, the studies vary in the area and the amount of color analyzed, which impedes the comparison of their results and may also cause the differing effects. However, most notably, Greenlees et al. (2013) did conduct a field study on the football pitch. They analyzed the impact of uniform color by combining the effects of wearing red and viewing red. Their revealed impact of uniform color might be caused by a goalkeeper behaving differently when wearing red and/or by the penalty taker performing differently when viewing red. Here our research has remained limited to the manipulation of uniform's hue on video footage and analyzing its impact on participants viewing and rating these videos. Future research has to overcome this restriction by focusing more comprehensively on the impact of wearing versus viewing uniform color in sport. In addition, research suggesting a benefit of the color red in football was conducted in England solely, whereas research denying such an impact was conducted in Austria, Germany or Spain (Allen and Jones, 2014; Attrill et al., 2008; Furley et al., 2012; García-Rubio et al., 2011; Kocher and Sutter, 2008; Krenn 2014). Thus, the assumption raised by Greenlees et al. (2008; Furley et al., 2012), that a culturally-based social learning process may have generated this benefit of the color red in England, represents an additional option for explaining the contradictory findings. Thereby future research is challenged to focus on cultural differences of color-meaning associations more comprehensively, as well as its origin and impact.

The fragmentary research questioning the impact of uniform color on sports has received an additional part of the puzzle via this study. Taking the previously published findings on the color red in sports into consideration an unclear picture consisting of heterogeneous results has to be drawn. Several studies were able to show a slight benefit of red uniforms (Attrill et al., 2008; Dreiskaemper et al., 2013; Feltman and Elliot, 2011; Hagemann et al., 2008; Hill and Barton, 2005; Krenn, 2015), whereas others reported null results (Allen and Jones, 2014; Furley et al., 2012; Garcia-Rubio et al., 2011; Kocher and Sutter, 2008; Krenn, 2014; Pollet and Peperkoorn, 2013). According to Color in Context Theory color's impact arises due to color-meaning associations, which are unconsciously brought to individual's mind by the context (Elliot and Maier, 2007, 2014). So far, sports research has implied a universal achievement context in sports without further reflection. To our opinion, these studies fell short of considering differing situational cues of diverse sports. We assume that the differential context of varying sports or rather the differing experimental

approaches (e.g. lab versus field study) may provide a potential moderator affecting color's impact. In this regard, red was argued to be associated with dominance and/or aggressiveness in sports competition (Dreiskaemper et al., 2013; Hill and Barton, 2005; Krenn, 2015). Thus, the impact of red uniforms in combat sports may be enhanced by the context representing higher amounts of explicit body contact, violence and aggression (Koivula, 2001; Pedersen, 2007). In team sports like football or handball these situational cues do not seem to be as remarkable and manifest as in combat sports (Maxwell et al., 2009). In this regard, the differing situational cues of sports may cause a discrepant impact of red uniforms, which may help to bring in the line the contradictory findings of our study with the previously published research showing red uniforms' benefit (Feltman and Elliott, 2011; Greenlees et al., 2008; 2013; Hill and Barton, 2005). Future research is challenged to cast more light on the context, at which the color is presented and analyzed.

Limitations of the study

A few limitations have to be considered. At first, within both experiments we did not compare any direct duels between red and blue; instead we compared ratings of athletes wearing only one of these colors. This represents a clear discrepancy from tackles in football or fights in combat sports, where two athletes are facing each other. To deal with this important aspect, further research is needed to analyze entire duels between penalty takers and goalkeepers within the same experiment. In addition, it has to be noticed that the task – to judge the ball's expected position as well as the probability of scoring the penalty after stopping each video immediately after kicking/shooting the ball – has challenged participants. We expected that the unconscious associations between colors and meanings should be more easily exposed by a challenging task, in which participants had to guess the ball's expected position. For future studies it might also be beneficial to ask participants for the anticipated ball speed, which may be associated more strongly with acting dominantly and aggressively than the more complex ratings of probability to score. In addition, it has to be noted that in both experiments we did not control for any movements of the penalty takers and goalkeepers. The assumption that red uniforms may receive more attention, which affects penalty takers and/or goalkeepers did not find any empirical support in our study (cf. Greenlees et al., 2008; Memmert et al., 2013). The recorded athletes in both experiments did not receive any instruction on how to behave, just to kick/shoot the ball to the selected area and to save the penalty respectively. As a consequence, the videos of the goalkeepers in particular showed a range of different preparations prior to the penalty. The clips varied from calmly standing at the goal line and waiting for the kick to agitatedly jumping, moving and trying to irritate the penalty taker. However, if uniform color impacts the behavior of athletes in the preparation for a penalty has yet to be proven. Nonetheless, this aspect seems important and therefore has to be taken into consideration more properly in future research.

Conclusions

The current study adds to the growing body of literature that has questioned the role of uniform color in sport. The results suggest that there is no potential advantage of wearing red in football and handball penalties for either goalkeeper or penalty taker. However, still many questions remain unanswered in this research area and more studies are needed to understand how colors may affect athletic performance. Most notably, the analysis of contextual variables moderating color's impact as well as to question the potential interaction of viewing and wearing are representing two essential aspects of future research. Above all, further studies are challenged to advance the theoretical framework trying to explain how color's impact may rise and unfold.

Acknowledgements

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article. The experiments comply with the current laws of the country of the authors' affiliation. Open access funding provided by University of Vienna.

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Key points

- In two video-based experiments no potential advantage of wearing red versus blue in football and handball penalties for either goalkeepers or penalty takers was found.
- The roles of contextual variables differing in various sports are discussed as potential moderator of color's impact on human behavior.

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