HUMAN MOVEMENT

THE INFLUENCE OF THE “RED WIN” EFFECT IN SPORTS:
A HYPOTHESIS OF ERRONEOUS PERCEPTION OF OPPONENTS
DRESSED IN RED – PRELIMINARY TEST


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ABSTRACT
Purpose. Psychological research indicates that, in contact sports, the results of sports competitions might be influenced by the color of an athlete’s uniform (especially the color red). However, previous research has not yet experimentally verified whether this hypothesis might be a consequence of perceptual distortion caused by moving objects of a certain color, such as red. Therefore, the aim of this study was to determine the effect of an object’s color on the efficiency of performing simple tasks in a basic computer game. Methods. 225 participants aged between 16 and 30 years played nine different “arcade” games of skill, differed by the rules and colors used in the game, where the subjects were tested on their ability to hit, escape from, or outmaneuver certain objects of a certain color (either blue, red or black). The score achieved was then correlated to what effect the color of the objects had on a subject’s visual perception. Results. It was found that the study participants were able to hit red moving objects significantly better than blue and black objects. No difference was found in the ability to avoid elements, in all three colors. Conclusions. The obtained result finds that in some games of skill, the color of the used stimulus might significantly influence perceptual efficiency and, therefore, the results and performance of individuals. The results of our study suggest that future research is needed in investigating the meaning and role of colors, as this may be very important, in various sports. The colors used in sports equipment, uniforms, environment, etc., should be empirically verified if they can influence the results of sports competitions.

Key words: sport, color, “red win effect”, agility, cognition, gender differences

Introduction

Interest in the influence of color on the psychology of human functioning might have had a long history, but (up to the end of the last century) little has been achieved in terms of empirical research. An example of this would be the research performed on the color red. For many years different studies have suggested that the color red symbolizes fire, energy, passion and love, with it standing as a metaphor for war, madness and rage. Within such a context, it was expected that the color red ought to stimulate or excite the human organism [1]. However, the vast majority of experimental studies have not confirmed this assessment [2, 3]. It is for this reason that the most recent studies on this phenomenon are of considerable importance, in which it was found that the color red affects the human motivational process [4–7], can act as a distraction [8], or influence the perceived attractiveness of sexuality in humans [9–11].

One of the main aspects of psychologists’ research on the color red is the effect it has on the functioning of an athlete. The aim of this study presented here is in verifying one of the mechanical hypotheses on the impact of sportswear’s color on the results of sports competition. Literature on the subject includes several existing studies on this topic [12–24], which mostly relate to the color black or red. Probably the first of these experimental studies was conducted by Frank and Gilovich [12]. They found that NHL and NFL players who had black as their team color were more often punished for aggressive game behavior when compared to players in different team colors. They also found that there exists a stereotype of a team wearing black being portrayed as the “bad, aggressive” one. The observers also found aggressive behavior more prevalent if the “aggressor” (athlete) was dressed in black, as well as finding that if the “aggressor” (especially within a group of individuals) was dressed in black, he acted even more aggressively than when if he were dressed in a different color [12].

Several years ago, Hill and Barton [14] initiated a new wave of research on the impact of color in sports uniforms in competition, this time with the color red. As is well known, during Olympic boxing, taekwondo, classic wrestling and freestyle wrestling competition, the player’s uniform color (red or blue) is randomly selected. Thus, the number of wins by players in blue should be, throughout an entire tournament, similar to the amount of wins scored by players in red uniforms. More specifically, the frequency of wins by those in “red” or “blue” should not differ significantly

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from a random value of 0.5. However, as was demonstrated by Hill and Barton, during the Olympic Games in Athens in the above mentioned disciplines (totaled all together) the ratio was 0.55 to 0.45 in favor of those dressed in red ($p < 0.03$). The effect of “red win” was even stronger when the fight could be considered even, where one of the competitors succeeded with a small point win in favor of the “red” opponent (0.62 to 0.38; $p < 0.005$). Hill and Barton argued that the effect of “red win” is based on a biological-evolutionary foundation. The color red and red-tinted skin or the adornment of “red ornaments” in many animals is associated with both gender and the level of testosterone that signifies the male quality [25, 26]. Therefore, having “red ornaments” (even artificial, as sports attire) could work as a stimulant, increasing the “will to fight”, the strength of desire for domination, etc. All of this can have a real bearing on the results obtained in sports competition.

However, translating the obtained results by the above researchers [14] is a bit troublesome within the context of various ethological studies, which find that male dominance in animals can in fact be experimentally increased by attaching artificial red stimuli to them [27], but which does not add or prove anything to its male quality. Moreover, the results of research performed on animals’ senses found that mammals, other than chimpanzees, did not show any signs of self-consciousness (for example, in recognizing themselves in a mirror) [28, 29]. Finally, in a study by Hackney [30] where the testosterone levels of humans wearing red and black shirts were measured, it was found that simply wearing a colorful shirt did not increase the testosterone levels of anyone tested. This suggests that the explanation of the effect as proposed by Hill and Barton may in fact be incorrect. It seems that the cause of this phenomenon is located in the “observer” (the opponent of the “red rival”) rather than in the one adorned in any red decorations. Seeing a “red rival” apparently causes some sort of process in the “observer”, a process that reduces his chances of victory.

Therefore, a plausible hypothesis would be that the effect of “red win” is a consequence of “rival intimidation”, with the biological reasoning behind this being that the “red rival” might be more dangerous, brave, dominant, etc. This hypothesis is supported by research performed by Elliot et al. [4], who demonstrated the impact of color on the efficiency of solving certain mental tasks. A subject’s visual exposure to a red stimulus decreased their mental problem solving ability (anagrams) as well as performance in IQ tests. The authors suggested that the reason for this reduction in mental ability was conditioned motivation: a red stimulus blocks the motivation to achieve and activates the desire to avoid. As has been found [4], after concentrating on a red stimulus, subjects often preferred easier tasks to harder ones. In addition, EEG measurements found that a red stimulus induces a stronger activation of the right rather than the left frontal lobe of the brain, and, in accordance with the findings of Davidson et al. [31], this asymmetry gives prominence to the desire to avoid. Thus it was demonstrated that the color red (through the processes of motivation) might affect the efficiency of processing information. It is therefore likely that the color red may also affect the efficiency of performing fundamental motor functions. However, as of now, no studies have been conducted that clearly confirm the above stated hypothesis in sport.

Another explanation that goes against Hill and Barton’s [14] proposal is a process where color is used to assess a fight by a referee [21]. The effect of “red win” may be a consequence of that fact that the “red” player may seem to be to the observer (the referee) stronger, more aggressive, faster, etc., and this causes, especially when there is an evenly matched fight, to identify him more as a winner during a fight, and therefore, award him more points. Such a hypothesis is quite plausible within the context of Hill and Barton’s [14] results, in which the amount of winners in red was particularly high in fights that were evenly matched. It is exactly in such fights were the points awarded by referees explicitly decide who the winner is, and what is more, in the case of a de facto tied score in some disciplines (e.g. wrestling), the referee chooses the winner based on the more combative player.

This hypothesis, confirmed by Hagemann et al. [21], found that referees who kept score in the same taekwondo match, during an experiment in which the competitors changed their uniform color, awarded an average of 13% more points to the “red” rather than the “blue” players. This result also seems to be consistent with the results obtained by Sorokowski and Szmajke [18], where test subjects had to choose which boxer they wished to hypothetically fight against, one in a red and one in a blue shirt. The color of the shirt did not significantly influence the choice of opponent. However, there was influence on the trend-level of assessing the bravery and aggressiveness of the boxers (the boxer in the red shirt was evaluated as more brave and aggressive than the one in a blue shirt), even though there was no measured influence on the assessment of the supposed boxers’ technical skill or physical characteristics (strength, endurance). The above mentioned hypothesis was also indirectly confirmed by a simple experiment in which a test presented two circles, one red and one blue [32]. In this study the red circle was rated as more dominant and aggressive.

In subsequent studies, attempts were made to verify the universality and repeatability of the results previously obtained by Hill and Barton [14]. It seemed unlikely that simply dressing up in a red or black outfit (for example: chimney sweeps or Santa Claus) could
have any effect on their bravery, aggressiveness or dominance. Yet the question stood, does this effect in fact occur in every form of individual and team competition, such as in boxing, golf and chess? Presently, there is no convincing evidence confirming the existence of the “red win” effect in team sports, at least in football. Although it is true that Attrill et al. [23], in presenting data from the English Football League from 1947 onwards, as well as analysis of match results when the English team wore white and red team uniforms, did suggest that this effect is present in football; however, two similar studies did not confirm this effect in the Polish [17] and German [24] League.

It is also worth noting that the effect described by Frank and Gilovich [12], on the impact of athletes’ black uniforms on aggressiveness, was not confirmed in an analysis of matches in the Turkish Football League [16]. Instead, the study suggested that the impact of a uniform’s color on people could only be understood within a context of rivalry (including sports) as well as in a confrontation that had elements of aggression. In the case of the sports effect of the “red/black win”, this could be in the domain of sport where there is a direct fight between only two opponents. It also needs mentioning that research performed on the universality of this phenomenon did present another hypothesis that could explain its functioning. Rowe et al. [15], when examining the reliability of Hill and Barton’s results [14], found that judo players in blue won more often than those dressed in white. While it is true that the results of Dijkstra and Preenen [22] indicated that this result [15] could have been caused from that fact that, at least in the initial rounds of the judo match, the uniforms’ colors were not allocated randomly as well as being linked to other variables, such as the length of rest between the matches, however, further analysis by Matsumoto et al. [19] confirmed Rowe et al.’s data [15]. Matsumoto, besides being psychologist, was also a former athlete and is now a world-class referee and coach. In addition, his study was published in the Research Journal of Budo, giving credence to its reliability. In explaining another hypothesis that could explain this phenomenon, these researchers [15, 19] suggested that the effect of color on winning may in fact be a consequence of disrupting the perception of moving objects in a certain color. Certain colors, more than others, could be more conducive in making errors in the perception of moving objects. Rowe et al. [15] suggested that this has to do with the contrast of the background on which the objects are perceived. According to this hypothesis, the effect of “red win” is due to the fact that an opponent of a “red” team commits minor errors in their perception of the “red” team’s speed, distance, etc., which may be very relevant in elementary sports skills and therefore cause the player competing against an opponent in a red uniform to lose.

However, this hypothesis, that the effect of “red win” may be a consequence of perceptual disruption of moving objects in red has not yet been experimentally verified. Therefore, the study presented in this article will attempt to verify this hypothesis and also test the effects of the colors blue and black. The aim of this study is to determine the effect of an object’s color on the level of efficiency of performing low-skill tasks performed in a computer game.

**Material and methods**

110 women aged between 16 to 26 years (M = 18.45, SD = 1.6) as well as 115 men aged 16 to 30 years (M = 20.21, SD = 2.4) took part in the study. The respondents were overwhelmingly high school students and university students (studying various subjects). The subjects were randomly assigned into nine research groups (N = 25 for each group), where each group had three different arcade games to perform on a computer, where the effect of objects, in this case, balls, in three different colors were tested (blue, red and black) (see Fig. 1).
Each of participants in the first phase of the game took part in a trail round, in which they were informed about the rules of the game. In the trial round, in order to be neutral, each of the balls in the groups were white. The subjects then took part in one of three games, the details of which are described below (which, as mentioned, differed from each other by the colored balls: red, blue and black). The visual background in all of the games was a very light beige color. For each game, the board size was approximately 19 × 14 cm. In all of the games, the players were able to move, depending on the goal of the game, a square around the board by using four arrow keys (▲, ▼, ◀, ◁). The study was conducted on a computer laptop with a 15.4" glossy screen (BrightView), set at a resolution of 1280 × 800 pixels. The subjects were tested independently in separate rooms, however they were each guaranteed quiet testing conditions as well as similar lighting conditions. The three games used in the study were as follows (see also Figure 1):

**Game 1.** In this game, colored balls with a diameter of 2 cm “fell” from the top to the bottom of the board, with their rate of movement increasing with each successive second (total game time: 60 s). The location of the balls starting at the top of the board was randomly selected (i.e., each of the succeeding balls that appeared in at the game). The direction of the balls’ movement was entirely random (either more “left” or more “right” or straight down). The object of the game was shooting down as many balls as possible, in other words, by aiming a “sight” at the moving balls using the arrow keys and shooting it down by hitting the space bar on the keyboard. The intention of the authors was for the game to represent an easy way to simulate attempts at shooting down objects of a certain color.

**Game 2.** Here, colored balls with a diameter of 2 cm “fell” from the top to the bottom of the board, with their rate of movement increasing with each successive second (total game time: 60 s). The location of the balls starting from the top of the board was randomly selected (i.e., each of the succeeding balls that appeared in the game). The direction of the balls’ movement was entirely random (either more “left” or more “right” or straight down). The player had to direct a square that was fixed at the bottom of the board either right or left and “avoid” being hit by any of the falling balls. The intention of the authors was for the game to represent an easy way to simulate attempts at hitting objects of a certain color.

**Game 3.** This game also had colored balls with a diameter of 2 cm start “falling” from the top as well as from the right and left of the board. The balls’ rate of movement increased with each successive second (total game time: 60 s). The location of the balls starting from the top and sides of the board was randomly chosen (i.e., each of the succeeding balls that appeared in the game). The direction of the balls’ movement was entirely random. The player had to direct a square, which could move across the entire board (up, down, left and right), and the goal was to escape from as many of the falling balls as possible. The intention of the authors was for the game to represent an easy way in simulating an escape/evade attempt before being hit by objects of a certain color, which “attack” the player from different directions.

**Results**

For each of the individually played games, one way ANOVA analysis was performed on the results as a set of 3 (the color of the objects, i.e., balls) × 2 (subjects’ gender).

**Game 1 – hitting a moving object of a specific color**

The dependent variable in the first test was the number of balls that were “shot down” by the study participants. Analysis found that the gender of the participants was significant $F(1, 69) = 15.5, p = 0.0002$, specifically, that men ($M = 47.7, SD = 9.8$) shot down more balls than women ($M = 40.8, SD = 11.2$). Also, the color of the balls also was found to be significant ($F(2, 69) = 3.2, p = 0.04$). Post-hoc LSD tests (least significant difference) found that the subjects were able to shoot down more red colored balls ($M = 44.7, SD = 10.8$) than blue ($M = 38.4, SD = 12.1$) or black ones ($M = 38.5, SD = 10.4$) (with $ps$ at least < 0.04) (see Fig. 2). Interactive significance, when calculating for “ball color × subjects’ gender”, was not found ($F(2, 69) = 0.4, p = 0.7$).

**Game 2 – escaping/evading objects of a certain color**

The dependent variable in the second test was the number of balls that the test subject failed to “escape” from. Analysis found that the gender of the participants did not have any significance ($F(1, 69) = 2.0, p = 0.2$), nor was there significance of the balls’ color ($F(2, 69) = 0.3, p = 0.8$) (see Fig. 2) or interactive significance of “ball color × subjects’ gender” found ($F(2, 69) = 0.4, p = 0.7$). Also, no significant differences were found in the above mentioned results in post-hoc tests (LSD test, $ps > 0.1$).

**Game 3 – escaping/evading objects of a certain color, which “attack” the player from different directions**

The dependent variable in the third test was the number of balls that the player failed to escape from. Analysis found that the gender of the participants was significant ($F(1, 69) = 2.0, p = 0.2$), finding that men ($M = 31.9, SD = 6.5$) “escaped” from more balls than women ($M = 38.2, SD = 15.6$) (which also means that
The obtained results indicate that in certain types of action/skill games the color of any stimuli can significantly affect performance efficiency. It was found that the study participants are more likely to hit moving objects that are red in color than objects that are black or blue. However, there was no difference found in the number of objects that the study participants had to effectively escape from. Thus, the obtained results are inconsistent with the originally mentioned research hypothesis; they do not explain the proposed effect of “red win” by Hill and Barton [14]. In addition, in light of the results presented in this study, the effect of “red win” occurs despite the fact that, in all reality, it is easier to “hit” objects that are red rather than another color. This suggests that, in real contact sports, an athlete’s red uniform ought to facilitate rather than impede their rival.

However, what was found in this study is not sufficient enough evidence for the total rejection of the originally proposed hypothesis. The cause (observed in actual sports competitions) of the relationship between a uniform’s color and the final game score could be the result of conditional errors (differences) made in the perception of moving objects of a certain color. Colors have different properties, including different wavelengths (the wavelengths of red and orange are considerably longer than, for example, the wavelengths of blue and green), different frequency (the frequency of red is lower than in other colors) or other physical characteristics such as the reflectance of each color (an overview of this is found in [33]).

All of these parameters can affect, for example, the rapidity of perceptually recognizing objects in different colors, which has been confirmed in experimental studies. It was found that red and purple are perceived, in a horizontal perspective, earlier than the colors black, blue or green [34]. Therefore, it cannot be definitively ruled out that the opponent of a “red/black/blue” player might not commit minor errors in their perception of their rivals’ speed, distance, etc., which may be relevant in fundamental sports performance. The results of our study only suggest that, in a confrontation with a “red rival”, it is unlikely that losing to a player in red would be a consequence of perceptual errors or that the opponent in a red uniform is more difficult to hit (the study results suggest quite the opposite). However, our results do not exclude the possibility that red sportswear might not cause one to commit other perceptual errors. The results obtained in this study appear to be important and interesting even though they did not confirm the originally stated hypothesis. First of all, this study is one of few that confirmed the significant impact of color in performing simple low-skill tasks. Generally, the effect of color on the performance efficiency of certain activities has not been fully explored, and in those studies that attempted to study this phenomenon, the results of some (due to the used procedure) are difficult to interpret [35] or found that color has no effect on fundamental motor tasks (e.g., catching cricket balls of different colors) [36].

We feel that our results are of some practical importance. These results are a further confirmation of the data presented earlier [14, 15, 19, 21], suggesting that the random assignment of colored uniforms may not be entirely fair. The basic principles of fair play state that at the beginning of a competition, each of the opponents must be entirely equal and provided with equal opportunities. The experimentally confirmed effect of color on the outcome of a sport/game, in our opinion, justifies the need to change the rules of some sports so that the results obtained by athletes are as objective and fair as possible. Discussions on this issue have already occurred in some sports disciplines. For example, the International Judo Federation (despite opposition from the Japanese Federation) decided in 1997 that one of the players in a fight will be required to wear a blue judogi. Some suggested that this change be preceded by research on the possible impact this might have on athletic performance [37]. After several years, we now hold data that states that the change of the judogi’s color did in fact have an effect on athletic performance (“blue winning against white”). Therefore, judo federations and other sports federations should make use of the latest scientific research and perform their own similar analysis (for ex-
ample, it would be worthwhile to see if the red uniform of a target shooter does not in fact distract other opponents).

The presented study has shown that color can affect the perception of moving objects, which may then affect the performance level of completing certain tasks (e.g., aiming, hitting objects of different colors). Therefore, the results of our study justify increased interest in the study of color’s importance in various sports disciplines as well as the experimental verification of whether and how color affects or how color may affect (such as clothing, equipment, surrounding environment, etc.) competition results. This appears to be of particular importance when worldwide sports federations are enacting numerous changes in the rules, equipment, etc., of a game to make it more visually appealing as well as increase the viewership of certain disciplines.

Some of these changes, perhaps unintentionally, resulted not only in changes of the disciplines’ colors (literally), which could have had, as was reported in this study, a significant impact on the cognitive processes and motivation of players, eventually affecting their performance. It is evident that when making such decisions, one should be aware of all possible effects, and the results of research on the various issues raised in this article should provide relevant premise. For example, recently in volleyball, the official ball used in the most important tournaments classified as “world-class” changed to the Mikasa ball, which is blue-yellow. Previously, the ball used in these types of games was the Molten, which sports red elements. This change was made for purely marketing reasons, with no one checking whether the Molten ball with its red elements was easier for players’ perception (in light of the results of this study, the red elements of the ball ought to have made it “easier to hit”). Therefore, there are reasons to believe that this change could have adversely affected the quality and continuity of the game (e.g., with fewer digs or blocks). What is more, all of these changes occurred at a time when the world’s volleyball authorities introduced special changes in the rules of the game to make playing defense easier.

A significant difference revealed in this study that finally needs mentioning was the difference in the results of men and women, as found in Games 1 and 3. This is not an unexpected result. Several studies have demonstrated the differences between genders in a variety of simple fitness tests [38], especially those that require hand-eye coordination (catching or stopping a flying ball, throwing objects at a target, etc.) had men perform far more successfully (a review can be found in [39]). However, in the case of the study presented here, we suggest that the observed differences are related primarily to the fact, as has been demonstrated in several studies, that men more often and are more likely to play computer games [40, 41]. Therefore, it can be said that the boys and men who took part in this study had a higher probability of having more skills and experience in computer games, which may have influenced the results of this study.

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References


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