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Original article

Perceiving red decreases motor performance over time: A pilot study

Percevoir rouge diminue la performance motrice au cours du temps : une étude pilote

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ABSTRACT

Introduction. – Colors may influence motor performance.
Objective. – The present study aimed to compare the effects of perception of red and green environments on physical (performance and heart rate) and psychological (perceived effort, anxiety and enjoyment) parameters during cycling trials.
Method. – Ten cyclists achieved two identical series of three randomized 7-minute trials on home trainers, during which they were continuously exposed to red, green, and gray environments. Covered distance and heart rate were recorded during each trial, after which participants answered items intended to assess perceived effort, anxiety, and enjoyment experienced during the trial.
Results. – Results showed that covered distance ($ps \leq .02$) and heart rate ($ps \leq .03$) were lower in the red environment than in the gray and green environments. Enjoyment was higher in the green environment than in the red environment ($p = .006$). The colored environments did not influence perceived effort and anxiety ($ps > .05$).
Conclusion. – This study is the first to show that perceiving red is detrimental for motor performance over an extended period of time.

Mots clés :
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RÉSUMÉ

Introduction. – Les couleurs peuvent influencer la performance motrice.
Objectif. – La présente étude avait pour but de comparer les effets de la perception des environnements rouge et vert sur des paramètres physiques (performance et fréquence cardiaque) et psychologiques (perception d'effort, anxiété et plaisir) durant des épreuves de cyclisme.
Méthode. – Dix cyclistes ont réalisé deux séries identiques de trois épreuves randomisées de 7 minutes sur *home trainer*, durant lesquelles ils étaient continuellement exposés à des environnements rouge, vert et gris. La distance parcourue et la fréquence cardiaque étaient enregistrées durant chaque épreuve, après quoi les participants ont répondu à des items de perception d'effort, d'anxiété et de plaisir ressentis durant l'épreuve.
Résultats. – Les résultats ont montré que la distance parcourue ($ps \leq .02$) et la fréquence cardiaque ($ps \leq .03$) étaient plus basses en environnement rouge qu'en environnements gris et vert. Le plaisir était plus élevé en environnement vert qu'en environnement rouge ($p = .006$). Les environnements colorés n'ont pas influencé la perception d'effort et l'anxiété ($ps > .05$).
Conclusion. – Cette étude est la première à montrer que percevoir rouge a des effets délétères sur la performance motrice au cours d'une période de temps étendue.

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Colored environments have visual properties that, once treated by the perceptual system, may develop meanings, depending on biology, context or learning, thereby leading to influence affects, perceptions and behaviors. Research on the effects of colors on human functioning gained its impetus since Hill and Barton (2005) provided evidence that wearing red has a powerful effect on competitive outcomes in sports. On the basis of archival data of outcomes in Olympic games, the authors have demonstrated that athletes who were wearing red had greater probability of winning contests than those who were wearing blue. Studies supported Hill and Barton's (2005) findings by showing that (virtual or real) achievers wearing red reported higher levels of sport or motor performance (e.g., Attrill, Gresty, Hill, & Barton, 2008; Dreiskaemper, Strauss, Hagemann, & Büsch, 2013; Ilie, Ioan, Zagrean, & Moldovan, 2008).

Some hypotheses have been proposed to explain the powerful effect of red on performance. Hill and Barton (2005) suggest that red is a testosterone-based cue that reflects dominance. However, the authors failed to clarify the origin of such an effect: Does this effect originate in actor or observer (e.g., referee, opponent)? Focused on gambling activity, Ten Velden, Baas, Shalvi, Preenen, and De Dreu (2012) reported that players who played with red poker chips took more betting risk than those who played with blue poker chips, suggesting that wearing red would develop a sense of competitiveness. Moreover, Hagemann, Strauss, and Leißing (2008) reported that tae kwon do referees made beneficial decisions toward the fighters wearing red than toward those wearing blue, suggesting that observing red would bias one's own judgments. In a recent study, Wiedemann, Burt, Hill, and Barton (2015) provided evidence that men wearing red were perceived to be more aggressive and dominant than those wearing blue or gray. This supports the hypothesis that red is a dominance-related cue (Hill & Barton, 2005).

The literature of color psychology clearly distinguishes studies focused on "wearing red" from those focused on "perceiving red". Research on the effect of perceiving red on performance revealed that red impaired performance on challenging intellectual tasks (Elliot, Moller, Friedman, Maier, & Meinhardt, 2007), and this would be due to the fact that red would be associated with anxiety and would evoke avoidance motivation in such contexts (Elliot & Maier, 2007; Elliot, Maier, Binser, Friedman, & Pekrun, 2009). In the context of motor performance, Elliot and Aarts (2011) examined whether perceiving red might influence maximal short-term performance (using pinchgrip and handgrip tasks), and found that red facilitated force and the velocity with which that force was developed. These findings led the authors to suggest that perceiving red increases force via the activation of the avoidance system that mobilizes energy for protective action.

Interestingly, drawing a parallel with studies focused on the effects of wearing red on performance (e.g., Attrill et al., 2008; Hill & Barton, 2005) that showed that competing against an opponent wearing red might precipitate negative outcomes, Elliot and Aarts (2011) suggested that "...Red may even prove deleterious for engagement in simple motor tasks over an extended period of time, as this requires sustained mental focus", and that "...Subsequent research would be welcomed on issues pertaining to the length of exposure to red and the duration of the red effect." (p. 448). Consistent with Elliot and Aarts' (2011) assumptions, the processing efficiency theory (e.g., Eysenck & Calvo, 1992; Eysenck, Derakshan, Santos, & Calvo, 2007) proposes that anxiety would increase the amount of effort during a short period of time by mobilizing cognitive capacity, while it would be responsible for decreasing performance over time once cognitive capacity is consumed. Therefore, the present study aimed to examine the effect of exposure to red on endurance performance.

Although the color red has received a particular attention from scientists, the color green has recently elicited their curiosity because green is considered as the primitive visual feature of nature (e.g., Akers et al., 2012; Barton, Griffin, & Pretty, 2012). Research has revealed that "green exercise", referring to performing physical activity in natural environments, fostered health-related outcomes, in terms of enjoyment, self-esteem (Barton et al., 2012) and well-being (Kaplan, 2001). In a noteworthy investigation, Akers et al. (2012) examined the effect of colored environments (green, red, or gray) on several feelings during moderate-intensity 5-minute cycling tasks, and found that the green environment decreased mood disturbance and perceived effort. The beneficial effect of viewing green while performing a motor task would be caused by a phylogeny-based association between the color green and the notion of fertility of natural environment (Wilson, 1984), thereby leading to activate an approach motivation (Elliot & Maier, 2007; Elliot et al., 2009). Although Akers et al. (2012) are the first to exhibit positive green exercise outcomes, they did not examine whether viewing green while performing a motor task might be beneficial for motor performance. Accordingly, the present study sought to *explore* whether green exercise might improve motor performance.

1. The present study

This study, conducted on a relatively small sample size, was a pilot study that aimed to explore the effect of prolonged exposure to red and green on physical and psychological parameters. Consistent with Elliot and Aarts' (2011) assumptions, it was expected that an exposure to red over an extended period of time would be deleterious for endurance performance. This means that we expected that perceiving red would be related to lower levels of endurance performance and heart rate. Additionally, because of the supposed links between red and avoidance motivation (e.g., Elliot & Maier, 2007), one can expect that perceiving red would be related to higher levels of anxiety (even if no strong prediction can be proposed since the literature did not reveal consistent findings; see Elliot et al., 2007; Zhang & Han, 2014). Furthermore, and consistent with studies on green exercise (e.g., Akers et al., 2012), it was expected that an exposure to green over an extended period of time would be beneficial for endurance performance. More specifically, it was expected that perceiving green would be related to higher levels of endurance performance and heart rate. Also, given the beneficial effects of green on enjoyment (Barton et al., 2012) and perceived effort (Akers et al., 2012), it was expected that perceiving green would be related to higher levels of enjoyment, and to lower levels of perceived effort.

Using an endurance task within colored environments represents a methodological challenge because "...ambient color may not be sufficient to produce an effect, or prolonged exposure to color may lead to habituation over time" (Elliot & Maier, 2014, p. 103). As a result, attempting to follow the Elliot and Maier's (2014) recommendations, we combined objective (i.e., excluding color deficient participants, and controlling hue, brightness, and intensity of colors) and subjective controls (i.e., controlling perceived typicality of colors).

2. Materials and methods

2.1. Participants

Ten French males cyclists (age: 17.4 ± 1.1 years; height: 1.8 ± 6.6 m; body mass: 67.8 ± 5.7 kg), competing at regional level, volunteered to contribute to the present study. They provided their written consent. Written parental consent was also provided for those who were under 18 years. Participants were recruited from several clubs in Guadeloupe with the consent of their coaches. The coaches were contacted and queried as to whether cyclists would be interested in performing some physical trials on home trainer