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Revisiting the Red Effect on Attractiveness and Sexual Receptivity: No Effect of the Color Red on Human Mate Preferences

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Leonard S. Peperkoorn[1], S. Craig Roberts[2], and Thomas V. Pollet[1]

Abstract

Color-in-context theory is the first theoretical framework for understanding color effects in human mate preferences, arguing that red clothing enhances attractiveness ratings. Here we present three empirical studies failing to support this prediction. We aimed to extend the current literature by differentiating color effects by temporal context (short-term vs. long-term mating). Experiment 1 involved Dutch participants rating a woman in red, white, and black on (sexual) attractiveness. Experiment 2 replicated the first experiment with an American sample. In the final experiment, we aimed to replicate a study that did find evidence of a red effect, using a substantially larger sample size. The results from each of the three studies (totaling $N = 830$ men) fail to support the red effect. We discuss the implications of our results and avenues for future research on red effects and attractiveness.

Keywords

color, red, black, white, attraction, sexual attraction, human mate preferences, sexual receptivity

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In recent years, several researchers have argued that humans might be affected by the presence of color cues in opposite-sex conspecifics (e.g., Elliot & Niesta, 2008; Pazda, Elliot, & Greitemeyer, 2014; Roberts, Owen, & Havlicek, 2010). Color-in-context theory (Elliot & Maier, 2012) is the first theoretical framework formulated by social psychologists aimed at understanding the effects of color in mate choice. Color-in-context theory has six core premises. First, color is argued to be not merely of aesthetic value but rather carries symbolic meaning and may have a utility function as well. Second, the perception of a color affects psychological functioning in line with the meaning of that color. For instance, if a certain color carries positive connotations, then it will evoke approach-related psychological processes. Third, color effects take place largely outside of conscious awareness (i.e., they are automatic). Fourth, color meanings are derived from both innate preferences and learning (culture). These are not seen as mutually exclusive processes: instead, the latter builds upon the former and may even extend the association between color and meaning beyond biological signals to artificial displays and ornamentation, as in clothing and cosmetics. An example of the former would be reddening of the skin that can potentially cue sexual receptivity in females (Elliot & Maier, 2012), whereas the latter can be exemplified by women wearing a red dress to signal interest in casual sex (Elliot & Pazda, 2012; also see Beall & Tracy, 2013). Fifth, it is postulated that color influences not only affect (e.g., excitement and attraction; anxiety and fear), cognition (e.g., flexible global processing; narrow rigid processing) and behavior (e.g., approach behavior; avoidance behavior), but that a reverse effect also exists: affective, cognitive, and behavioral processes impact on color perception (e.g., Bubl, Kern, Ebert, Bach, & van Elst, 2010). Finally, color can encompass diverse meanings in different contexts and

[1] Department of Experimental and Applied Psychology, Vrije Universiteit Amsterdam, Amsterdam, the Netherlands
[2] Division of Psychology, Faculty of Natural Sciences, University of Stirling, Stirling, UK

Corresponding Author:
Leonard S. Peperkoorn, Department of Experimental and Applied Psychology, Vrije Universiteit Amsterdam, Amsterdam, North Holland 1081 BT, the Netherlands.
Email: l.s.peperkoorn@vu.nl

therefore elicit different behavioral responses. The ruby red surroundings of the Red Light District invite the perceiver to approach, whereas the flashing red lights of the fire brigade warn perceivers to keep their distance. Elliot and Maier (2012) argue that, in a similar way, red can undermine intellectual performance in the achievement domain (Elliot, Maier, Moller, Friedman, & Meinhardt, 2007; Maier, Elliot, & Lichtenfeld, 2008) but can enhance attractiveness in the affiliation domain (e.g., Elliot & Niesta, 2008; Niesta Kayser, Elliot, & Feltman, 2010). It is this affiliation context, more specifically the mating context in which men evaluate women's attractiveness, which forms the focus of this paper.

Empirical Evidence for the Red Effect in Human Mate Preferences

Background color. In their seminal work, Elliot and Niesta (2008) demonstrated that the color red has a significant impact on opposite-sex ratings of attractiveness. Across four experiments they found that a black-and-white photo of a woman in front of a red background was deemed more attractive and sexually desirable by men, and participants wanted to engage in more sexual behavior with the woman, than the same woman in front of a white, gray, or green background. Schwarz and Singer (2013) extended research on the red effect by distinguishing women of reproductive age from menopausal women by showing men a photograph of a young woman versus an older woman in front of a red or white background. No support for the red effect was found for physical attractiveness ratings for either the old or young woman. However, the young woman in the red condition received higher sexual attractiveness ratings compared to the same woman in the white condition. Moreover, Elliot, Tracy, Pazda, and Beall (2013) presented preliminary evidence for the potential universality of the red effect in human mate preferences in a relatively isolated community in Burkina Faso. In this study, the stimulus woman in the red condition was deemed more attractive and increased men's willingness to meet and court her. However, there was no significant difference in the willingness to have sexual intercourse with the woman, or in the perceived sexual interest of the woman. Lastly, Young (2015) presented participants with 40 images to investigate the influence of baseline attractiveness on the red effect. The red effect emerged for female faces prerated as attractive but not for unattractive female faces using gray and blue as contrast colors.

Clothing color. Most studies investigating color effects on attractiveness ratings have manipulated the clothing color of the target. Across studies, mixed results have been obtained. Elliot and Niesta (2008: Study 5) found that a stimulus woman dressed in a red shirt received higher ratings on perceived attractiveness, sexual desire, desired sexual behavior, and willingness to date and spend money on the woman compared to the same woman dressed in a blue shirt. Providing additional insight into color effects, Roberts, Owen, and Havlicek (2010) compared red clothing with five contrast colors: black, white, yellow, blue, and green employing a within-participant design. In Study 1, stimulus women in red clothing were not significantly different from black or blue clothing in terms of the attractiveness ratings received by men. However, women dressed in red apparel received higher attractiveness evaluations by men rating photographs than women in green, yellow, and white colors. Similarly, in Study 2, women wearing red shirts did not receive higher attractiveness ratings compared to black, blue, and green contrast colors but were significantly different from yellow and white shirts. Importantly, in Study 3, it was demonstrated that clothing color has psychological effects not only on perceivers but also on wearers. Women in red clothes may feel more desirable and consequently behave differently than women wearing other colors, underlining the importance of distinguishing perceiver from wearer effects when investigating the red effect. Guéguen (2012b), presented a photograph of a young woman in a red, white, blue, or green shirt. Higher attractiveness scores were obtained for the woman in a red shirt compared to the same woman in green or blue shirts. However, there was no significant difference between the red and the white condition. Similarly, Pazda, Elliot, and Greitemeyer (2012) demonstrated higher attractiveness evaluations and heightened sexual desire by men for a woman in a red shirt compared to the same woman in a green shirt. The authors reported in a later study (Pazda et al., 2014) that the woman in a red knee-length dress received significantly higher attractiveness ratings compared to the white knee-length dress. Yet, no significant difference on the attractiveness measure was found between the red and the black dress. Wen, Zuo, Wu, Sun, and Liu (2014) investigated sexual dimorphism as a potential moderator of the red effect. In their study, feminine women dressed in red did receive significantly higher ratings on sexual attractiveness compared to the same women dressed in white or blue apparel. Masculine women did not differ over color conditions. Overall, there were no significant differences in general attractiveness when presenting men with pictures of women in red, white, or blue clothing. In an experiment by Lynn, Giebelhausen, Garcia, and Patumanon (2016), no red effect was found in a large ($N = 1{,}075$) online experiment using a hypothetical tipping scenario. In fact, men tipped the waitress in red clothing significantly less than the waitress in black, whereas no significant difference was found between red and white shirts. Also, there were no significant differences in attractiveness ratings for the waitress in red, white, or black apparel.

Moving beyond attractiveness ratings, Niesta Kayser et al. (2010) showed in a laboratory study that men asked women wearing a red shirt more intimate questions and sat closer to where a woman in red was expected to sit, compared with women wearing green or blue shirts.

Guéguen (2012a) extended these laboratory-based findings to the field: hitchhiking women in red clothing were offered more rides than women dressed in other colors. Guéguen and Jacob (2013) performed another field study to find out if women would receive more responses to their online personal profile if they wore red compared to five other colors, which was indeed the case. In another field study, men were found to

give waitresses higher tips when they were dressed in red compared to other colors (Guéguen & Jacob, 2014). Relating to the signaling function of red, it appears the red-attraction link is mediated by sexual receptivity, where women choosing to present themselves in red clothing are regarded to be sexually receptive and have more sexual intent than women in white, green, or blue clothing (Guéguen, 2012b; Pazda, Elliot, & Greitemeyer, 2012). However, whereas Pazda, Elliot, and Greitemeyer (2014) found higher sexual receptivity ratings for a woman in red versus the same woman in white, ratings for red, and black did not differ significantly.

Face and body coloration. Research investigating the red effect on attractiveness has also considered facial coloration. Redness in women's faces is preferred by men as these are rated to be healthier (Re, Whitehead, Xiao, & Perrett, 2011; Stephen, Coetzee, Law Smith, & Perrett, 2009) and more attractive (Re et al., 2011) than unrubified female faces. Similarly, redness in women's facial lips enhanced the apparent femininity and attractiveness of female faces to male participants (Stephen & McKeegan, 2010). In a more applied setting, Guéguen (2012c) examined the effect of lipstick in two field studies. Women who wore red lipstick were approached by more men in a bar compared to the brown lipstick or no lipstick condition, whereas red and pink lipstick were not significantly different. Similarly, women with red lipstick were approached by men sooner than women in the no lipstick condition. Guéguen and Jacob (2012) also found that women with red lipstick received tips more frequently than women with brown lipstick or no lipstick, with no significant difference between red and pink lipstick. The amount of tips women received were higher for women in the red lipstick condition compared to the no lipstick condition. Furthermore, women with a red hair color (Guéguen, 2012d) did not receive more tips than women with either blond, brown, or black hair color. Finally, contrary to the suggestion by Morris (1967), research found that red vulval skin color did not increase men's sexual attraction compared to pale pink, light pink, or dark pink contrast colors (Johns, Hargrave, & Newton-Fisher, 2012).

Object color. To our knowledge only one study has investigated the effect of nearby red objects to women's attractiveness. Lin (2014) found that women with red laptops were significantly more attractive and had more sex appeal than women with black, silver, or blue laptops. Furthermore, women with red laptops enhanced men's desired sexual activity with the woman compared to women with silver laptops. No significant differences were found on the desired sexual activity measure between red, black, and blue laptops.

Strategic Clothing Color Preference

Elliot and Pazda (2012) demonstrated that women are more likely to choose to wear red when imagining being interested in casual sex, and more likely to advertise themselves in red clothing on their web profile when indicating desire for casual sexual relations compared to women who do not express such desires. Incidentally, in this study black is by far the most preferred clothing color in both the casual sex web profiles and the nonsexual profiles. However, the preference for black clothing does not shift contingent on women's desires. Similarly, women expecting to converse with an attractive versus a nonattractive man were more likely to choose to wear red clothing rather than green clothing and more likely to wear red clothing over blue clothing when expecting to converse with an attractive man versus an attractive woman (Elliot, Greitemeyer, & Pazda, 2013). These findings are corroborated by a study by Niesta Kayser, Agthe, and Maner (2016) where significantly more red was displayed by women expecting to meet an attractive versus an unattractive man. The women also displayed a larger quantity of red and more conspicuous red in the former condition. In line with these studies, Prokop and Hromada (2013) report that women indicated a preference for red clothing in situations where the probability of meeting a potential mate was high (e.g., going to a party or on a date) compared to situations where the chance of meeting a potential mate is low (e.g., working in the garden or visiting grandparents). Recently, some research has also investigated the effect of fertility status on clothing color preferences. Beall and Tracy (2013) found that women wearing red or pink were substantially more likely to be at the high conception risk phase of the menstrual cycle as compared to women not wearing these colors (for a critical discussion, see Gelman, 2013). According to Tracy and Beall (2014), the red-dress effect may be moderated by weather conditions and they found that fertility is most predictive of pink or red clothing choice during colder but not warmer weather. Prokop and Hromada (2013) did not find support for the cycle-phase red effect using the counting method to determine the menstrual phase of women. Eisenbruch, Simmons, and Roney (2015), however, used hormonal measurements to assess women's ovulatory timing. Their results supported the cycle phase effect for red clothing preferences.

Sexual Strategies in Men

Thus far it seems that the physical attractiveness ratings of red have been examined without paying attention to the potential role of sexual strategies. Buss and Schmitt (1993) proposed in their sexual strategies theory that men have evolved distinct psychological mechanisms that underlie short-term (ST) and long-term (LT) strategies. A man acting on his ST mating desires may benefit reproductively by attempting to inseminate multiple fertile women. Men pursuing a LT strategy, however, may benefit in reproductive terms by attempting to monopolize one woman's lifetime reproductive capacity so as to increase their paternity certainty over any conceived children. In line with this argument, men typically indicate a preference for overt sexual availability in women when pursuing a ST mating strategy (e.g., Oliver & Sedikides, 1992; Regan & Berscheid, 1997; Schmitt, Couden, & Baker, 2001). This preference is argued to solve the ST adaptive problem for men of gaining sexual access swiftly and easily, without displaying

commitment first. In contrast, men who desire a LT partner prefer women who are sexually exclusive. Their restricted sexual access to other men would solve the LT adaptive problem of paternity certainty while investing heavily in one's mate and potential offspring.

ST Red and LT White

Given that red is commonly associated with lust, love, sexuality, and passion (Elliot & Maier, 2012) and that sexual receptivity has been argued to act as a mediator between red and sexual attraction, we expect the signaling function of red to be especially pronounced in a ST mating context. For example, studies described above indicate that women might use red clothing to advertise a potential interest in casual sex by choosing to wear red when imagining being interested in sex and actually advertising themselves in red clothing on casual sex dating websites (Elliot & Pazda, 2012). Indeed, Pazda et al. (2012) predict that the red effect is specific to ST mate evaluations, and Schwarz and Singer (2013) state that the red effect should be much stronger in a ST versus LT mating context.

While such cultural and social associations involving the color red have been much discussed in recent studies reviewed above, other associations with different colors do exist and are worthy of brief consideration, not least because they are relevant to alternative conditions in tests of the red-attraction effect, especially to studies exploring context-dependent effects. For example, the color white can also be argued to serve an important signaling function. In several societies, white symbolizes chastity, purity, high virtues, and innocence (Aslam, 2006; Grieve, 1991; Hutchings, 2004; Monger, 2004; Philip, 2011). Common expressions include ''whiter than white'' (very pure, honest, and moral), ''pure as the driven snow,'' and ''white lie.'' Interestingly, John Lydgate's poem King Henry VI's Triumphal Entry into London (Ford, 2012; circa 1435 CE) includes the sentence ''Alle cladde in white, in tokne off clennesse, Lyche pure virgynes'' (loosely translated as, ''All were dressed in white, as a symbol of their purity, as if they were pure virgins''). From about the middle of the 18 century, white became widespread as a symbol of virginity in western societies (Monger, 2004). Philip (2011) reports that the word ''white'' is the main collocate of the word ''wedding.'' Indeed, in modern western societies (including those tested in this paper) brides typically wear a white gown. In addition, the white Japanese wedding kimono, *shiro-maku* (translated as white and pure, respectively) symbolizes innocence (Dennis-Bryan, Hodgson, & Lockley, 2008). However, in other cultures (e.g., in China, Vietnam, and India), women typically select a red wedding dress instead of a white dress, symbolizing pure love, happiness, and good fortune (Dennis-Bryan et al., 2008; Hutchings, 2004; Monger, 2004). It has been argued that when seeking a LT mate, an important trait for males to consider for a woman would be premarital chastity and sexual fidelity, given the problem of paternity uncertainty (e.g., Buss, 1989, 2003; Buss & Schmitt, 1993). Hence it could perhaps pay for women to signal these traits in a LT context (see, e.g., Fisher, 2013). Based on this argument, we might predict that in many societies (especially many western countries), men pursuing a LT sexual strategy would find women in white more attractive due to the color's associations with purity and chastity. Thus, we select the color white as our contrast color to red as this color is likely to be associated with LT interest.

Apart from red and white, other colors have been argued to carry important color-meaning associations in affiliation contexts that may potentially impact opposite-sex evaluations (e.g., Pazda et al., 2014 have investigated the influence of the color black). In Color-in-context Theory (Elliot & Maier, 2012), no argument derived from evolutionary theory is provided for a ''black effect.'' Rather, Pazda et al. (2014) argue that, in modern societies, black clothing is seen as fashionable and wearing such fashionable clothes is seen as attractive (hence the term, ''little black dress''). Indeed, fashionableness was found to be a mediator for the link between black and attractiveness (Pazda et al., 2014). Given that black is also seen as attractive in modern western societies, we select this color as our control color as it should not differ contingent on the temporal context.

Research Overview

The current research aims to conceptually replicate the red effect while distinguishing between short- and LT mating motivations. Elliot and Niesta (2008) were the first to investigate the red-attraction effect. Hence, we selected this study to assess attractiveness ratings of a woman dressed in white, black, or red clothing. However, to make a sharper distinction between attractiveness and sexual attractiveness, we chose to ask participants more explicit questions used by Schwarz and Singer (2013) to assess sexual attractiveness. Lastly, Elliot and Pazda (2012) were the first to use a scenario methodology to examine the red effect. In the present study, we use a similar scenario design that allows us to manipulate short- and LT mating motivations.

As argued above, we expect a signaling function of red to be especially pronounced in a ST mating context. In contrast, white is associated with chastity, purity, and innocence, and we therefore expect a potential signaling function of white in a LT mating context. Black has been argued to signal fashionableness and as such it might not be very useful in differentiating between a LT and ST mating context. This leads us to the following hypotheses:

1. Women in red are considered the most attractive in both mating contexts[1] (ST, LT) in comparison to black and white, but especially in a ST context.
2. Women in white are considered more attractive in a LT context than in a ST context.
3. Women in black are considered equally attractive in a ST context as in a LT context.

4. In a LT context, women in white are considered to be more *faithful* in comparison to women in red or black.
5. In a ST context, women in red are considered more *sexually* attractive than women in white or black.

Experiment 1

In Experiment 1, we tested the above hypotheses in a Dutch student sample using a picture of a woman in a red, black, or white shirt. Temporal context was manipulated using a scenario methodology in which participants were randomly assigned to either the ST or LT mating condition.

Method

Participants

Two hundred and six male participants participated in this study. Their mean age was 23.67 years ($SD = 4.14$ years; range = 18–40 years) and 87.6% of participants indicated that they had the Dutch nationality only (others include Moroccan Dutch, Turkish Dutch, Surinam Dutch). The sample was restricted to individuals who indicated that they were heterosexual ($n = 204$) or bisexual ($n = 2$) in orientation. Excluding these two bisexual participants does not alter the conclusions (see Online Supplementary Material 1A). Participants were recruited at the main building of the Vrije Universiteit Amsterdam and received €2 compensation for their participation. This experiment was approved by the psychology ethics committee of the university.

Design, Procedure, and Materials

Participants were randomly assigned to one of six between-subject conditions[2] (mating context: ST, LT; color: red, black, white): ST-red ($n = 34$), ST-black ($n = 37$), ST-white ($n = 34$), LT-red ($n = 33$), LT-black ($n = 32$), and LT-white ($n = 36$). After providing informed consent, participants were given a tablet (Samsung Galaxy Tab 2 10.1) and a manila folder containing the photo of the woman. Participants were told that the experiment concerned first impressions of other people. Participants were instructed not to open the folder until told to do so in the questionnaire on the tablet. They could look at the photo for as long as they felt necessary and completed the experiment individually. Upon completion students returned the tablet and manila folder, filled out the reimbursement form, were paid, and debriefed (via e-mail after data completion had finished).[3]

The scenarios describing the allocated ST and LT mating contexts were based on Elliot and Pazda's (2012) scenario descriptions, as follows:

> ST scenario: Imagine that you have decided to make use of a dating website because you've heard that this is a good way to find a one-night stand. After indicating your preferences you've found a match. Open the folder and view the photo of the woman with whom you have a match and then answer the following questions.
>
> LT scenario: Imagine that you have decided to make use of a dating website because you've heard that this is a good way to find a partner for a committed relationship. After indicating your preferences you've found a match. Open the folder and view the photo of the woman with whom you have a match and then answer the following questions.

The female photo was selected from the webpage of American Apparel (http://www.americanapparel.net). Our choice of which specific white, red, or black color to use was based on the color labels provided by the American Apparel webpage as representing that particular color in the shirt chosen. The picture was cropped (16 cm width × 9 cm height) to include only the head and upper torso (from above the bust) of an attractive young woman with brown hair, wearing a plain white T-shirt (with a round neck) and having a neutral facial expression. The background color of the cropped image was a very light gray and the surrounding unprinted area had a plain white color of the paper itself. In a pilot test with a sample of 101 men from the Universiteit van Amsterdam, the attractiveness of the woman was rated as $M = 6.84$ ($SD = 1.18$) on a 9-point Likert-type scale ranging from 1 (*not at all attractive*) to 9 (*extremely attractive*). The photo was sent to a professional photo editing company to digitally color the shirt in red and black. The image area of the colored T-shirt was approximately 8 cm in width and 2.5–3 cm in height. The photos were printed on Epson matte white paper using an Epson Stylus Photo R800 color printer. The color parameters for the red shirt (Lightness, Chroma, hue: LCh[54.2, 70.8, 28.7]) were obtained using a GretagMacBeth Eye-One Pro spectrophotometer using the CIELCh color model, which defines color in terms of the parameters lightness, chroma, and hue (Fairchild, 2013). Even though the color parameters for white and black are customarily not reported as these achromatic colors cannot be matched on chroma or lightness (Elliot & Maier, 2012, p. 77), the following values are obtained for white (LCh [93.4, 6.5, 274.4]) and black (LCh [21.0, 0.4, 14.1]).

Measures

In order to capture more variance and avoid a possible ceiling effect, an 11-point scale was used for all our dependent measures ranging from 1 (*not at all*) to 11 (*extremely*). The instructions and questions were presented in Dutch. All participants evaluated the woman's attractiveness with a scale composed of the same 2 items used in Elliot and Niesta (2008): "how attractive do you think this woman is?" and "how pretty do you think this woman is?" ($\alpha = .88$). Students assigned to the ST scenario answered questions about sexual attraction, using two of the three sexual attraction items used by Schwarz and Singer (2013): "how much do you want to be intimate with this person?" and "how much do you want to have sex with this person?" ($\alpha = .89$). In contrast, those assigned to the LT

scenario answered two questions pertaining to the woman's perceived faithfulness: "how faithful do you think this person is in a relationship?" and "how polygamous do you think this person is in a relationship?" Internal consistency was unacceptably low ($\alpha = .05$), possibly due to the fact that the word "polygamous" is rarely used in colloquial language. In fact, two students indicated to the researcher that they were unclear about this question. Hence, only the first item was used in our analyses. Furthermore, in line with Elliot and Niesta's (2008) procedure, participants indicated to what extent the rating of the woman's attractiveness was influenced by (a) the woman's facial expression, (b) the woman's clothing, or (c) the color of the woman's shirt, to probe for respondents' awareness of the effect of color. Irrespective of condition, all participants responded to the attitude facet of the revised Sociosexual Orientation Inventory (SOI-R) to control for differing sexual attitudes (Penke & Asendorpf, 2008; Cronbach's $\alpha = .83$). An example item is "sex without love is OK" scored from 1 (*strongly disagree*) to 9 (*strongly agree*). After answering the main questions, participants provided demographic information (such as age, sexual orientation, relationship status, and birth country) in addition to some items serving exploratory purposes (i.e., participant's height, weight, and muscularity), which are not discussed here. All statistical analyses were conducted with SPSS Version 22.0 (IBM Corp., 2013).

Results and Discussion

Before conducting the analyses, one extreme outlier on the attractiveness scale was removed during preliminary data screening (>3 interquartile range [IQR]). This single extreme score may have a disproportionate impact on the outcome of the data analysis. However, the removal of data points may also change the outcome of the analysis. For this reason, we ran the analysis both including and excluding the extreme outlier. Including this single outlier does not alter the conclusions (see Online Supplementary Material 1B).

A 3 (color condition: red, black, white) × 2 (mating condition: ST, LT) between-group analysis of variance (ANOVA) on perceived attractiveness was used to assess the first three hypotheses. The analysis revealed a nonsignificant Color × Condition interaction, $F(2, 199) = .08$, $p = .920$. The main effect for condition was also nonsignificant, $F(1, 199) = .86$, $p = .354$. The main effect for color was significant, $F(2, 199) = 3.17$, $p = .044$, partial $\eta^2 = .03$. Participants assigned to the white condition ($M = 7.59$, $SD = 1.32$) rated the woman as more attractive compared with those in the red ($M = 7.06$, $SD = 1.44$) and black ($M = 7.06$, $SD = 1.45$) conditions. However, Tukey post hoc tests[4] did not reveal a significant difference, both $p > .075$. Results are shown in Figure 1.

Limiting the sample to other age-groups (i.e., including participants up to age 35, 30, and 25) did not result in the predicted red effect (see Online Supplementary Material 1C). Contrary to our predictions, the woman in red was thus not deemed the most attractive overall (Hypothesis 1), nor was there a difference in attractiveness ratings between the LT context and ST context for the woman in white (Hypothesis 2). In line with Hypothesis 3, women in black were judged equally attractive across both mating conditions.

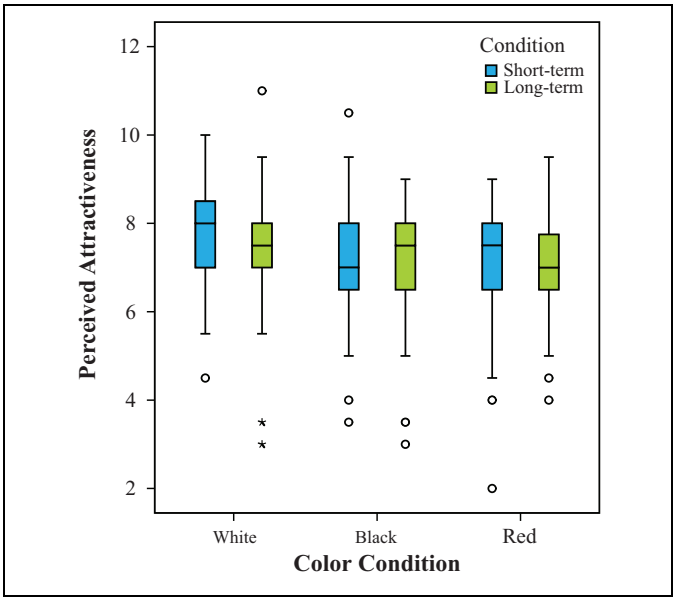

Figure 1. Box plots from Experiment 1 depicting attractiveness ratings as a function of color and temporal context. The whiskers indicate the 1.5 interquartile range (IQR) beyond the upper and lower quartiles.

To assess whether participants in the LT mating condition consider the woman in white to be more faithful in comparison to the woman in red or black (Hypothesis 4), a one-way ANOVA was conducted with perceived faithfulness as the dependent variable. The ANOVA did not show a significant effect for color, $F(2, 98) = 1.42$, $p = .25$: the woman dressed in white ($M = 6.70$, $SD = 1.59$) was not rated as significantly more faithful than the woman dressed in either red ($M = 7.08$. $SD = 1.52$) or black ($M = 7.31$, $SD = 1.36$).

Next, in order to evaluate whether participants in the ST mating condition consider the woman in red to be more sexually attractive than the woman in black or white (Hypothesis 5), another one-way ANOVA was conducted with sexual attraction as the dependent variable. The ANOVA was nonsignificant, $F(2, 102) = .23$, $p = .79$, the woman in red ($M = 6.18$, $SD = 2.03$) was not considered to be significantly more sexually attractive than the woman dressed in either black ($M = 5.84$, $SD = 2.13$) or white ($M = 6.08$, $SD = 2.39$). All of the above results were qualitatively identical when controlling for the sexual attitudes facet of the SOI-R (see Online Supplementary Material 1D) or for relationship status (see Online Supplementary Material 1E).

Lastly, color was viewed by participants as having the least influence of the three factors: $M_{facial\ expression} = 6.16$ ($SD = 2.02$), $M_{clothing} = 4.06$ ($SD = 2.18$), $M_{color} = 3.77$ ($SD = 2.18$); paired samples *t*-tests indicated that the rating for the influence of color was significantly lower than those for both the woman's facial expression, $t(205) = 11.61$, $p < .001$, and the woman's clothing, $t(205) = 2.15$, $p = .03$.

In summary, the results for this experiment were inconsistent with our predictions. Higher attractiveness ratings were not found for the woman in red. Instead, a marginally significant white effect on attractiveness emerged. No difference was found between mating conditions for the woman in white, contrary to our hypothesis. Women in white were not perceived to be more faithful in the LT condition nor were women in red considered more sexually attractive in the ST condition. Participants did indicate, however, that color had the least influence on their evaluations of the woman. This prompted us to replicate the experiment and further explore the robustness of the red effect.

Experiment 2

In Experiment 2, we aimed to replicate Experiment 1 while changing the population from Dutch to American participants and changing the medium through which the survey was administered, from a tablet to an online crowdsourcing service: Amazon's Mechanical Turk (https://www.mturk.com), which has been shown to generate high-quality data (e.g., Buhrmester, Kwang, & Gosling, 2011; Paolacci & Chandler, 2014). Furthermore, as M-Turk does not by itself differentiate by participant sex, we devised an additional hypothesis which involved female participants rating female photographs and reported feelings of jealousy. It should be noted, however, that our main focus is on opposite-sex ratings, hence we will not discuss same-sex effects here (see Online Supplementary Material 2E and 2F for the results on women rating the female photograph).

Method

Participants

We recruited 191 men ($M_{age} = 30.13$ years, $SD = 9.78$ years, range = 16–72 years) and 181 women ($M_{age} = 31.98$ years, $SD = 11.80$ years, range = 18–67 years) as participants in this study. Participants were predominantly U.S. American (85.8% U.S. Americans, 3% other, and 11.1% unspecified. Participants accessed the experiment through Amazon's Mechanical Turk's channel via Crowdflower (www.crowdflower.com) and received US$0.25 for their contribution.

Design, Procedure, and Materials

As in Experiment 1, male participants were randomly assigned to one of six between-subject conditions: ST-red ($n = 33$), ST-black ($n = 30$), ST-white ($n = 36$), LT-red ($n = 29$), LT-black ($n = 31$), and LT-white ($n = 32$). This study was approved by the psychology ethics committee of the lead author's university.

The welcome screen presented the consent form and explained the experiment was about first impressions. After reading the scenario, respondents were presented with the same photo of the woman from Experiment 1 and could look at the photo for as long as they felt necessary (display resolution: 1,032 × 572 pixels). The last sentence of the scenario as described in Experiment 1 was changed to accommodate for the different presentation of the female photo: "Click further to see the photo of the woman with whom you have a match and proceed to the following questions."

Measures

All participants evaluated the woman's attractiveness with the same 2 items used in the previous experiment (Cronbach's $\alpha = .93$). Male respondents assigned to the ST scenario answered questions about sexual attraction, the same as those from Experiment 1 ($\alpha = .95$). Male participants assigned to the LT scenario condition received two questions pertaining to the woman's perceived faithfulness: "how faithful do you think this person is in a committed relationship?" and "how likely is this person to have an affair while in a committed relationship?" Note that we changed the second question in this experiment as compared to Experiment 1 to avoid possible confusion about the meaning of the question. Internal consistency for this scale was satisfactory ($\alpha = .72$) and so both items were combined in a single measure. The awareness probe and the demographical items were the same as in Experiment 1. Participants were asked to indicate the woman's shirt color to control for color blindness (out of the original 201 male participants 95.02% of men correctly identified the woman's shirt color). Those who did not correctly indicate the color were excluded from analyses. In contrast to Experiment 1, we did not employ the revised sociosexual inventory (Penke & Asendorpf, 2008) to assess sexual attitudes, due to the need for brevity.

Results and Discussion

Before conducting the analyses, we conducted preliminary data screening and found one extreme outlier on the attractiveness scale which was removed from the male analyses (>3 IQR). Including this outlier does not alter the conclusions (see Online Supplementary Material 2A). As in the first experiment, we used a 3 (color condition: red, black, white) × 2 (mating condition: ST, LT) between-group ANOVA on attractiveness ratings made by men. The analysis revealed a nonsignificant Color × Condition interaction, $F(2, 184) = .32$, $p = .730$. The main effect for condition was nonsignificant, $F(1, 184) = .26$, $p = .611$. The main effect for color was also not significant, $F(2, 184) = .07$, $p = .931$. Consistent with Experiment 1, the woman in red was not considered the most attractive by men[5] (Hypothesis 1), nor was there a significant difference in attractiveness ratings between the LT context and ST context for the woman in white (Hypothesis 2). In support of Hypothesis 3, the woman in black was judged equally attractive by males across both mating conditions. Results are shown in Figure 2. The conclusions do not change when limiting the sample of male participants to the age of 35, 30, or 25 years (see Online Supplementary Material 2B), including only male participants with a heterosexual orientation (see Online Supplementary Material 2C), or controlling for men's relationship status (see

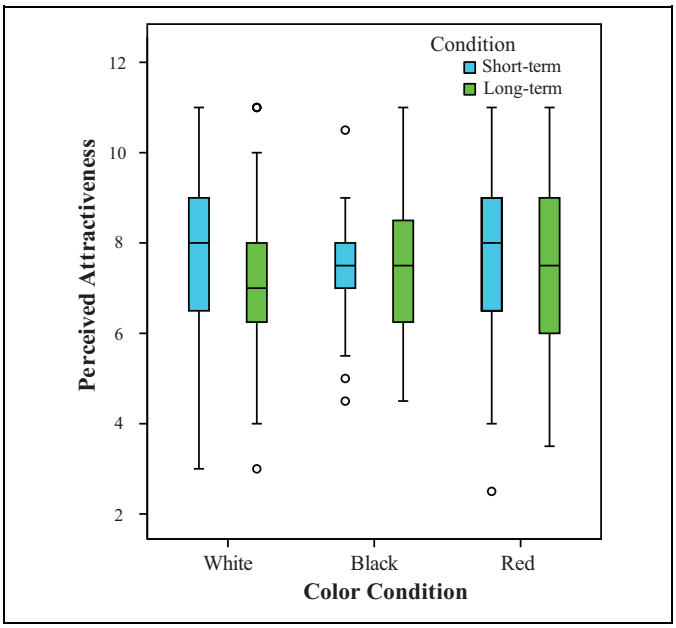

Figure 2. Box plots from Experiment 2 depicting attractiveness ratings as a function of color and temporal context. The whiskers indicate the 1.5 interquartile range (IQR) beyond the upper and lower quartiles.

Online Supplementary Material 2D) for this and the subsequent hypotheses.

To assess whether male participants in the LT mating condition consider the woman in white to be more faithful in comparison to the woman in red or black, a one-way ANOVA was conducted with perceived faithfulness as the dependent variable. The ANOVA was not significant, $F(2, 89) = 2.11$, $p = .128$, the woman dressed in white ($M = 7.89$, $SD = 1.56$) was not considered significantly more faithful than the woman dressed in either red ($M = 7.31$, $SD = 1.36$) or black ($M = 7.19$, $SD = 1.39$).

Further, to evaluate whether male participants in the ST mating condition consider the woman in red to be more sexually attractive than the woman in black or white, another one-way ANOVA was conducted with sexual attraction as the dependent variable. The ANOVA was nonsignificant, $F(2, 96) = .52$, $p = .598$, the woman in red ($M = 7.06$, $SD = 3.18$) was not considered to be significantly more sexually attractive than the woman dressed in either black ($M = 6.38$, $SD = 2.56$) or white ($M = 6.97$, $SD = 2.80$).

In the awareness probe, color was again viewed as having the least influence of the three factors on men's judgments of attractiveness: $M_{facial\ expression} = 5.16$ ($SD = 1.98$), $M_{clothing} = 4.05$ ($SD = 2.12$), $M_{color} = 2.88$ ($SD = 1.83$); paired samples t-tests indicated that the rating for color was significantly lower than the ratings for the woman's facial expression, $t(189) = 13.06$, $p < .001$, and the woman's clothing, $t(189) = 8.70$, $p < .001$.

In summary, the results for this experiment were again inconsistent with our predictions: the woman dressed in red was not rated the most attractive across conditions. No significant difference was found for the woman in white between mating contexts. In line with our expectations, there was no difference between mating conditions for the woman in black. However, the woman dressed in white was not perceived to be more faithful in the LT context as compared with other colors and the woman in red was not considered more sexually attractive in the ST context. Consistent with Experiment 1, color had the least influence on participant's ratings of the woman.

Experiment 3

In the previous experiments the results did not support the existence of a red effect on mate preferences. Although we think our design provided a fair test of the proposed hypotheses, it could be argued that differences in experimental design between our experiments and those in the published literature were responsible for null effects. We therefore decided to conduct a replication of a previous experiment that did find results indicative of the red effect. We selected experiment 1a in the paper by Pazda et al. (2012) because they employed Amazon Mechanical Turk to obtain participants, thus allowing us to follow an identical procedure. Note that we did not select the web study by Pazda et al. (2014) as in this study a woman was presented in a knee-length dress while in Pazda et al. (2012) the woman was presented in a shirt, a style of dress that is more comparable to our present studies. In order to obtain the exact questions and stimulus materials, we contacted the authors who helpfully sent us all necessary materials. Although Pazda et al. (2012) included only male participants, we did not exclude women from this study. This allowed us to compare potential sex differences in color effects as well as to further explore the jealousy questions asked in Experiment 2 with a larger sample size. However, we do not discuss the results of the jealousy study below as it is beyond the scope of this paper (see Online Supplementary Material 3A for complete results on female participants) and support the null findings we report above for Experiment 2. Again, we set out to investigate opposite-sex red effects and hence we focus here on the replication of the Pazda et al. (2012) study, although all results on female participants are available in Online Supplementary Material 3A.

Method

Participants

We recruited 433 men ($M_{age} = 29.71$ years, $SD = 9.40$ years, range = 16–72 years) and 436 women ($M_{age} = 33.92$ years, $SD = 11.60$ years, range = 16–75 years) as participants in this study. The majority identified themselves as U.S. American (88.6% U.S. Americans, 6.1% other, and 5.3% unspecified). Participants accessed the experiment through Amazon's Mechanical Turk (advertised via Crowdflower) and received US$0.25 for their contribution.

Design, Procedure, and Materials

Following Pazda et al. (2012), male participants were randomly assigned to one of two between-subject conditions: red ($n = 215$) and white ($n = 218$). The research procedure (including statistical methodology) and stimulus material was the same as described by Pazda et al. (2012). The welcome screen and instructions were provided by the original authors by sending us the URL of a forthcoming web study. The participants entered a welcome screen, stating that the experiment was on first impressions and would involve viewing a picture of a female for 5 s, followed by a questionnaire. The indicated time to complete the study was specified to take less than 10 min. The instructions read, "the next screen will display a picture of a female. Please look at the picture for 5 s, then proceed with the survey." The picture displayed a moderately attractive young woman with brown hair and a tanned to mid-brown skin tone. The measurements of the image were 350 × 450 pixels. We should note that the informed consent form may differ between surveys, as the policies differ between universities. Also, we employed Qualtrics (www.qualtrics.com) to administer the survey, whereas Pazda et al. (2012) may have used SurveyGizmo (www.surveygizmo.com) as the URL of a forthcoming web study directed to this platform. Finally, we used a substantially larger sample size (the original Study 1a had $n = 11$ in the red condition and $n = 14$ in the white condition).

Measures

As in the Pazda et al. (2012) study, male participants rated the perceived sexual receptivity of the woman on 4 items (i.e., "how sexy is this person acting," "how seductive is this person," "how flirtatious is this person," and "this person is interested in sex" summed into a scale $\alpha = .92$) using a 1 (*not at all*) to 9 (*extremely)* scale. Participants were asked to guess the purpose of the experiment and to indicate the woman's shirt color (out of the original 438 male participants, 98.86% correctly identified the woman's shirt color, resulting in our sample of 433 men).

Results and Discussion

An independent samples *t*-test indicated no effect of color on men's ratings of sexual receptivity, $t(431) = -1.23$, $p = .219$. Participants in the red condition ($M = 3.57$, $SD = 1.82$) did not rate the woman as more receptive than participants in the white condition ($M = 3.79$, $SD = 1.81$), $d = -.12$ (95% CI LL: −.31; UL: .07). When asked about the purpose of the experiment, 17 participants mentioned color; however, results did not change when excluding them from the analyses (see Online Supplementary Material 3B). The conclusion did not change when limiting the sample to heterosexual participants (see Online Supplementary Material 3C), limiting participants to the age of 35, 30, or 25 years (see Online Supplementary Material 3D), or controlling for relationship status (see Online Supplementary Material 3E).

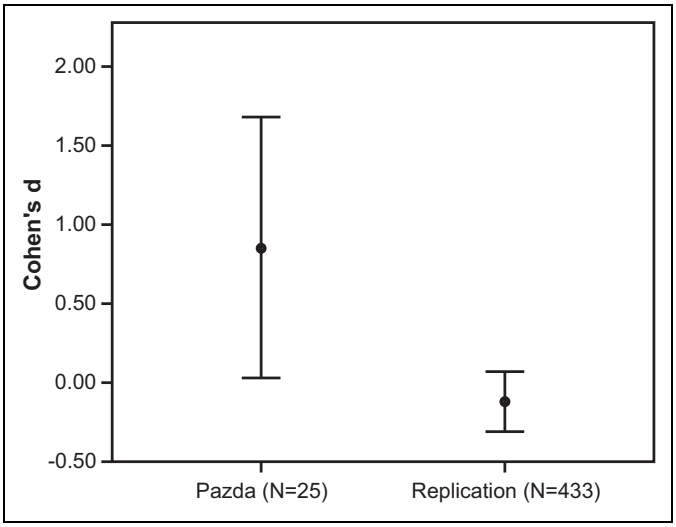

Figure 3. Comparison of Cohen's *d* effect sizes contrasting Pazda et al. Study 1a (2012) with Experiment 3. Error bars indicate the 95% CI for Cohen's *d*.

Figure 3 depicts a comparison of effect sizes between studies.

Discussion

We began this study to test for the red effect on attractiveness and to further extend the increasing literature by distinguishing between temporal contexts (ST, LT). Contrary to our expectations, participants' judgments did not differ across color conditions. We shall discuss each hypothesis separately in light of the results from the first two experiments.

First, we hypothesized that the woman in red should be rated by men as the most attractive compared to the same woman in white or black, especially so in a ST mating context. The results from the first two experiments do not support our hypothesis: there is no significant difference between attractiveness ratings of the woman in the three different colors. Second, it was predicted that women in white would receive higher attractiveness ratings in a LT context as opposed to a ST mating context. The results do not provide support for the hypothesis: there is no difference between temporal contexts for the woman in white. Third, the woman in black was expected to be equally attractive in a short- or LT context. This expectation is supported by our results. The aforementioned findings from the first two hypotheses are at odds with previous research manipulating shirt color where red is contrasted with white and black (i.e., Pazda et al., 2014; Roberts et al., 2010): in these studies, a stimulus woman in a red or black shirt was found to be significantly more attractive than the same woman dressed in white. However, other studies also failed to find a significant difference between attractiveness ratings of a woman dressed in red versus white (e.g., Lynn, Giebelhausen, Garcia, Li, & Patumanon, 2016).

Fourth, we predicted that men in the LT mating context would rate the woman in white to be more faithful than the

same woman dressed in red or black. We do not find support for our hypothesis. To our knowledge, no previous research has investigated the "white effect" on faithfulness so we cannot compare our results with other studies.

Finally, we hypothesized that in a ST mating context, a woman in red clothing would receive higher sexual attractiveness ratings as compared to the same woman in white or black clothing. The hypothesis is not supported by the results. Until now, there has been no study investigating *sexual* attractiveness where a woman dressed in red is compared with a woman dressed in black. However, one recent study by Wen et al. (2014) measured sexual attractiveness in men and women rating the opposite sex in red, blue, and white apparel. The red effect on sexual attractiveness emerged for feminine women rated by male participants. In addition, higher sexual attractiveness ratings have been found in a study manipulating shirt color using blue (Elliot & Niesta, 2008, Study 5) or green (Pazda et al., 2012, Study 2) as a contrast color. In addition, studies investigating sexual receptivity (Guéguen, 2012b; Pazda et al., 2012, Study 1; Pazda et al., 2014) found women in red clothing to be more sexually receptive compared to women in white clothing. These studies hint at the possibility that women in red clothing would be evaluated as more sexually attractive as compared to women in white clothing; however, we do not find support for such a prediction.

The consistent null findings from our first two studies prompted us to conduct a direct replication of a study (Pazda et al., 2012, Study 1a) that did find support for the red effect in men rating a woman on sexual receptivity. Contrary to Pazda et al. (2012), we did not find any evidence for the original study's higher sexual receptivity ratings for the woman in red clothing over the woman in white clothing, even though we sampled from the same study population, employed identical questions, displayed the same photo materials, utilized the same medium through which to administer the survey, analyzed the data using the same statistical tests, and used a sample size ($N = 433$) more than 17 times as large than used in the original study ($N = 25$; $d = .86$, [95% CI LL: .03; UL: 1.68]). The lack of evidence for a red effect in our three experiments therefore leads us to question the robustness of the red effect in human mate preferences. Consistent with our results are two large studies on the red effect in the affiliation domain, which also failed to find evidence of the red effect (i.e., Lynn et al., 2016, $N = 1{,}075$; Elliot & Maier, 2013, $N = 144$; the latter being a reply to Francis (2013) on publication bias in this research area), although note that Pazda et al. 2014 ($N = 361$) did find support for both a red effect (mediated through sexual receptivity) and a black effect (mediated through fashionableness) on attractiveness ratings.

Small studies are likely to end up in a file drawer as compared to large studies when they fail to find significant results (Button et al., 2013). This may also apply to investigations within color research into the red effect where many attempts may not have led to publications. Indeed, it would be in line with The "Many Labs" Replication Project (Klein et al., 2016), when significantly stronger effect sizes are found for the original research group (i.e., the investigators who first reported the red effect (Elliot & Niesta, 2008), than publications by independent scholars over the next decades. However, differences in obtained effect sizes between laboratories could be based on methodological variations such as by using different chromatic color comparisons or variations in chroma and lightness (Elliot, 2015). Conducting research on the psychological effects of color requires understanding of the complexities involved in generating appropriate stimulus materials. However, it should be noted that such differences should lead to increased noise in the data: causing overestimations of the red effect at one instance and underestimations of the red effect at other instances. It is possible that null findings, in particular, are not shared within the scientific community. The value of sharing null findings and replicating experiments to arrive at a better understanding of the influence of color on attractiveness has been illustrated by Seguin and Forstmeier (2012). It has been presumed in behavioral ecology for some time that red-color bands affect male courtship rates in zebra finches (*Taeniopygia guttata)*. Seguin and Forstmeier (2012) demonstrate with meta-analytic techniques that the influence of color bands appears to be a false positive.

The current study has several potential limitations, some of which are shared by the studies it sought to replicate. In the first experiment, we used a tablet to administer the survey, which might be an unfamiliar way to respond to survey questions on mate preferences. Participants in Experiments 1 and 2 could look at the picture for as long as they felt necessary, which differs from some other studies investigating the red effect (e.g., Elliot & Niesta, 2008; Pazda et al., 2014; Schwarz & Singer, 2013) where participants are instructed to look at the photo for 5 s. However, it should be noted that in our close replication, Experiment 3, we used the same procedure as Pazda et al. (2012) and found no support for the hypothesis. We also believe the theoretical and practical significance of the red effect would be limited if the red effect could only emerge with an exposure time of less than 5 s. More studies are however needed to determine if the red effect is bounded by viewing time (especially over 5 s). Similarly, in line with previous work, we presented just one female target to investigate the red effect in Experiments 1 and 2 (the same target in both experiments), which does not allow us to compare different women who might vary, for instance, in skin tone and hair color. However, it should be noted that also no red effect was found in Experiment 3, using a photo of a *different* woman with a darker skin tone (as compared to the woman in the other experiments) and that this photo was used before. Future studies may present participants with a large set of photographs of diverse models to control for idiosyncrasies of the depicted models. For instance, a recent study by Young (2015) presented participants with 40 images to investigate the influence of baseline attractiveness on the red effect. The red effect emerged for female faces prerated as attractive but not for unattractive female faces. Our Experiments 1 and 2 used a photograph of a woman from the website of American Apparel. Given that the woman is a model, the probability of finding supportive evidence for

the red effect in these experiments should be higher compared to an average looking woman.

We also used a between-subject design in which the target woman was seen in different colors by different men, rather than a within-subject design in which the same raters saw the target in different colors (see, e.g., Roberts et al., 2010). However, it should be noted that other papers reporting significant red effects also use between-subject designs, including the studies we sought to conceptually replicate (Experiments 1 & 2) or closely replicate (Experiment 3). Given the paucity of color research employing a within-subject design, future research might benefit from a combination of both designs in a single paper so as to guarantee good methodological practice. Even though we did not find evidence of the red effect in our experiments, there might in fact be a red effect outside the laboratory due to psychological effects on the wearer, possibly feeling more desirable in red and behaving in a more attractive manner (Roberts et al., 2010).

We initially set out to replicate and extend research documenting the red effect on attractiveness. To our surprise, however, we found no support for the red effect in our empirical studies. In other words, we did not find support for the premise that color affects psychological functioning in the affiliation domain: the women in red were not deemed more attractive than women in white or black clothing (Experiments 1 and 2) or more sexually receptive compared to only white clothing (Experiment 3). The finding that the red effect does not emerge when contrasted with black is a challenge to color-in-context theory, as there is a clear theoretical rationale for a positive red effect (rooted in biology and culture), but such an elaborate explanation is lacking for a black effect, which is seen as fashionable and hence attractive (see Pazda et al., 2014). Future research might benefit from exploring why black clothing does not lead to substantially different effects from red clothing (Roberts et al., 2010), and we suggest that it would be desirable to incorporate black as a standard control condition in research on mate preferences and color.

Future research might further investigate the robustness of the red effect using large samples. It must be said that the samples for experiments in this research area tend to be small, instigating what is known as the ''winner's curse'' effect (Button et al., 2013). Perhaps it is even worth considering whether one aspect, such as shirt color, would be predicted a priori to have such a dramatic effect on attractiveness (Cohen's *d* ranges from 0.73 to 1.55 in Elliot & Niesta, 2008 and from 0.77 to 0.99 in Niesta Kayser et al., 2010). We argue instead that if red has an effect on human mate preferences, then it is likely to be small. We also note that in our experiments the color of clothing was rated as a substantially less important trait than other aspects for attractiveness, such as facial attractiveness or clothing.

In summary, we did not find empirical support for the red effect on attractiveness judgments across three experiments. We therefore call for more empirical research on the red effect in romantic contexts, focusing on rigorous hypothesis testing rather than exploration. We are hopeful that in time larger studies will be conducted, providing clear answers on the robustness of the red effect on mate preferences. Future research on the red effect is needed as it has important implications for researchers in the domains of sales, advertising (e.g., Aslam, 2006), politics (e.g., Kramer, 2016), public relations, and fashion (e.g., Ellinwood, 2011), where such findings might have applied value. Finally, we hope that our research provides an incentive for researchers to share their (null) findings, so as to efficiently and effectively allocate resources in examining and understanding our colorful world.

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Supplemental Material

The online [appendices/data supplements/etc.] are available at http://journals.sagepub.com/doi/suppl/10.1177/1474704916673841.

Notes

1. Note that we distinguish perceived physical attractiveness from sexual attraction in line with Elliot and Niesta (2008) who suggest that the former refers to a positive judgment regarding the target's physical appearance, whereas the latter refers to a further desire, based on this judgment, to become romantically involved with the woman. In this sense, physical attractiveness will be useful information both for men pursuing a short-term mating strategy and for those pursuing a long-term strategy.
2. The present study aimed to partially replicate and extend the literature on red effects on attractiveness. Note, however, that by today's standards the between-subject design we employed in Experiments 1 and 2 may have too small a sample size per condition, making the design not particularly robust. However, given that the reported effect sizes in previous studies range from medium to large, our sample sizes are still adequate to detect a medium effect if the effect indeed exists (See Online Supplementary Material 4 for anticipated power values using G*Power 3.1). We also reflect on this matter in the General Discussion.
3. Participants in the red condition were asked what the color of the woman's shirt was to control for color blindness: none of the heterosexual or bisexual participants were found to be color-blind.
4. The Tukey post hoc tests provided the following results: Contrast white versus black: Mean difference = .53, standard error (*SE*) = .243, $p = .075$. Contrast white versus red: Mean difference = .53, $SE = .243$, $p = .075$. Contrast red versus black: Mean difference = .00, $SE = .241$, $p = 1.00$.
5. Participants assigned to the red condition ($M = 7.45$, $SD = 1.95$) did not rate the woman as more attractive compared to those in the white ($M = 7.57$, $SD = 1.83$) or black ($M = 7.47$, $SD = 1.45$) conditions.

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