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Extending Color Psychology to the Personality Realm:

Interpersonal Hostility Varies by Red Preferences and Perceptual Biases

Adam K. Fetterman, Tianwei Liu, and Michael D. Robinson

North Dakota State University

Note: Correspondence can be sent to Adam Fetterman, who is now at the Knowledge Media Research Center, Schleichstrasse 6, 72076 Tübingen, Germany. Internet correspondence can be directed to A.Fetterman@iwm-kmrc.de (Phone: +49 7071 979-226; Fax: +49 7071 979 200).

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Abstract

Objective: The color psychology literature has made a convincing case that color is not just about aesthetics, but also about meaning. This work has involved situational manipulations of color, rendering it uncertain as to whether color-meaning associations can be used to characterize how people differ from each other. The present research focuses on the idea that the color red is linked to, or associated with, individual differences in interpersonal hostility. Method: Across four studies (N = 376), red preferences and perceptual biases were measured along with individual differences in interpersonal hostility. Results: It was found that: (a) a preference for the color red was higher as interpersonal hostility increased, (b) hostile people were biased to see the color red more frequently than non-hostile people, and (c) there was a relationship between a preference for the color red and hostile social decision-making. Conclusions: These studies represent an important extension of the color psychology literature, highlighting the need to attend to person-based, as well as situation-based, factors.

KEYWORDS: color, red, hostility, personality, interpersonal

Extending Color Psychology to the Personality Realm:

Interpersonal Hostility Varies by Red Preferences and Perceptual Biases

Color psychology has a long and a short history. Its long history can be traced to popular ideas about the impact of color and scattered research reports of a brief and largely applied nature, typically rooted in aesthetics (Elliot & Maier, 2007; Valdez & Mehrabian, 1994; Whitfield & Wiltshire, 1990). Its short history represents a move toward more systematic and rigorous laboratory-based research designed to investigate links between color, meaning, and psychological functioning (Bruno, Martani, Corsini, Oleari, 2013; Elliot, Maier, Moller, Friedman, & Meinhardt, 2007; Meier, Robinson, & Clore, 2004; Palmer & Schloss, 2010; Stephen, Smith, Stirrat, & Perrett, 2009).

A core "take home" message from this new wave of research is that color can convey psychological meaning and, therefore, is not merely a matter of aesthetics. Additionally, color-meaning associations are thought to be implicit in several respects. They are non-semantic, concern a non-focal property of objects (i.e., their color), and participants rarely have insight into the influence of color on their affective, cognitive, and behavioral responding. Reaction time paradigms have also yielded data supporting the implicit nature of color-meaning associations (Fetterman, Robinson, & Meier, 2012; Moller, Elliot, & Maier, 2009). Finally, these associations are thought to have biological and evolutionary roots, in addition to being grounded in classical conditioning processes (Elliot & Maier, 2012).

Of the chromatic colors, red has received the greatest amount of attention in this emerging, empirically-based literature. There are sound reasons for focusing on the psychology of red. In their cross-cultural analysis of color words, Berlin and Kay (1969) concluded that after

white and black, red is the next color recognized by people in most cultures. In an anthropological investigation of non-Western cultures, Needham (1973) found that connotations concerning red (e.g., danger, aggression) were largely shared across cultures, whereas this was less true for other chromatic colors. Further, the color red was fundamental to our hunter-gatherer ancestors because it signaled potential danger in the form of poisonous plants and insects (Schmidt & Schaefer, 2004), conspecifics who might inflict harm (Muller & Wrangham, 2004), and exposed wounds and blood (Levenson, 2003).

There are now a number of experimental investigations of the color red, most documenting the influence of exposure to red stimuli on subsequent outcomes such as achievement performance or personal attraction (e.g., Elliot & Niesta, 2008; Houtman & Notebaert, 2013; Genschow, Reutner, & Wänke, 2012; Greenlees, Eynon, & Thelwell, 2013; Guéguen, 2012; Roberts, Owen, & Havlicek, 2010; Ten Velden, Baas, Shalvi, Preenen, & De Dreu, 2012). The present investigation has a different focus, both in terms of the type of question examined and in terms of the color-meaning association involved. First, the main focus of the present research was not on whether exposure to the color red has a causal effect on subsequent outcomes, but rather on the relatively orthogonal (Funder, 1995; Kenrick & Funder, 1988) question of whether *individuals* who prefer the color red or who are biased to perceive red are different from those who do not exhibit such preferences or biases. That is, we pursued the entirely novel question of whether color-meaning associations can provide a basis for understanding variations in personality. In addition, we also focused on a relatively understudied (at least in social-personality psychology) potential associate of redness, namely that of hostility.

The Color Red and Hostility

Hostility may be defined in terms of antagonistic thoughts concerning, and relations with, others (Martin, Wan, & Watson, 2000). There are several reasons for positing that the color red may be associated with hostility. The emotion that often follows from hostility is anger (Buss & Perry, 1992) and anger is metaphorically linked to the color red (e.g., "seeing red" is a common metaphor for anger: Gibbs, 1994). There is a physiological basis for this relationship in that angry faces are often redder in coloration due to increased facial flushing (Drummond, 1997; Levenson, 2003). Testosterone, a hormone associated with hostility and aggression, also results in red coloration in a number of species (Dixson, 1998; Ligon, Thornhill, Zuk, & Johnson, 1990; Milinski & Bakker, 1990) and may predispose people to self-identify with the color red (Farrelly, Slater, Elliott, Walden, & Wetherell, 2013). Furthermore, red coloration covaries with hostile behavior in several species, including primates (Dunbar, 1984; Setchell & Dixson, 2001; Setchell & Wickings, 2005). Consistent with this point, artificially adding redness to an animal (e.g., by attaching a red plastic ring to its leg) results in more hostile, dominant behaviors by the animal, likely because interaction partners perceive the animal to be more hostile and act submissively in turn (Burley, Krantzberg, & Radman, 1982; Cuthill, Hunt, Cleary, & Clark, 1997). When violent confrontations do occur between conspecifics, exposed blood is red.

Existing evidence for a systematic association between redness and hostility among humans primarily comes from the ethology literature. In the 2004 Olympics, competitors in four combat sports (e.g., boxing) were randomly assigned red or blue uniforms. Hill and Barton (2005) found that red-wearing individuals won these aggressive contests more often than their blue-wearing counterparts. Attrill, Gresty, Hill, and Barton (2008) reported similar results in a 55-year analysis of soccer contests in England (see Elliot & Maier, 2014, for a review of this literature). Feltman and Elliot (2011) reported a plausible explanation for these results. In two

laboratory-based experiments, they showed that participants who imagined themselves wearing a red uniform in a competitive contest felt more aggressively capable (Experiment 1), and participants who imagined themselves facing an opponent wearing a red uniform perceived the opponent to be more aggressively capable (Experiment 2). Consistent with the latter result, Hagemann, Strauss, and Leissing (2008) found that referees awarded more points – representing successful hostile actions – to tae kwon do competitors wearing red rather than blue uniforms. In addition, there is some cognition-based evidence for an implicit association between hostile thoughts and redness (Fetterman, Robinson, Gordon, & Elliot, 2011). Altogether, there appears to be a link between hostility and the color red, one that we sought to capitalize upon.

Individual Differences in Hostility in terms of Red Preferences and Biases

The central focus of the present research was on the possibility that red-hostility associations may shed light on *individual differences* in hostility. Individual differences have not been the focus of a great deal of attention in the color psychology literature and establishing a connection between red and hostility from an individual differences perspective would therefore represent an important extension of this literature. Supportive evidence of this type would also be consistent with efforts to integrate social-cognitive and trait perspectives of the individual, both in general terms (Cervone & Mischel, 2002) and in terms of embodied processes (Robinson & Fetterman, in press).

In the domain of taste experience, researchers have found that people prefer experiences that are metaphorically consistent with their personalities. For example, more agreeable, nicer people prefer sweet (but not other) food types to a greater extent (Meier, Moeller, Riemer-Peltz, & Robinson, 2012). Preference judgments may also have utility in the color psychology literature. Given a link between hostility and redness, hostile people may prefer red to a greater

extent than non-hostile people. This possibility was examined in Study 1. Fetterman et al. (2011) found that hostile thought primes biased people to perceive the color red in ambiguously colored stimuli. From a chronic accessibility perspective, hostile people should have more accessible hostile thoughts irrespective of such priming factors (Higgins, 1996). It was therefore proposed that higher levels of interpersonal hostility would be systematically associated with greater biases to perceive the color red. This possibility was examined in Studies 2 and 3. Study 4 returned to the color preference assessment of Study 1, but in the context of social decision-making. A preference for the color red was hypothesized to covary with greater hostility in social decision-making in two different tasks. Throughout Studies 1-4, we examine red preferences or biases as a predictor of hostility. However, this is merely a matter of presentation rather than an assumption of causal direction. In actuality, we believe that relations between redness and interpersonal hostility may be bidirectional, a point revisited in the General Discussion.

Study 1

Robinson and Fetterman (in press) proposed a general compatibility principle whereby people prefer perceptual experiences that are consistent with their personality dispositions, much as compatibility principles have been widely supported in the social cognition literature (Gawronski & Strack, 2012). Support for the personality-preference compatibility principle has been found in studies examining relations between variations in agreeableness and preferences for sweet foods – i.e., nicer people have sweeter food preferences (Meier et al., 2012). Study 1 sought to extend this preference-based approach to personality to its possible manifestations in the color preference realm (Palmer & Schloss, 2010). Given that the color red is implicitly associated with hostility, it was hypothesized that people with a preference for this color (over blue) would score higher in interpersonal hostility.

Method

Participants, Materials, and Procedures

Participants in Study 1 were 97 (49 female) undergraduates from North Dakota State University (NDSU) who received course credit. They entered the lab in groups of 6 or less and received very general instructions about a "personality and cognition study with multiple parts". The consent form, which was signed, was equally general. Participants then sat at semi-private personal computers for the remainder of the hour. Two different Medialab programs were created. The first presented a large number of preference-based questions, the vast majority not involving colors (e.g., do you like cats or dogs better?), thereby precluding a possible (though unlikely) discernment of the hypothesis. The key preference question asked participants whether they preferred the color red or blue in forced-choice terms. Perhaps in part because the color red connotes hostility and aggression (Needham, 1973), a minority (M = 32%) of participants preferred the color red over blue (also see Madden, Hewett, & Roth, 2000). Such individuals, however, should be higher in interpersonal hostility.[1,2]

The second Medialab program assessed variations in personality. A number of measures were administered to preclude awareness of the hypothesis, but only one was relevant to it. Interpersonal hostility is well-captured by the coldness-warmth dimension of the interpersonal circumplex (Wiggins, 1979). In support of this point, and on the basis of approximately 10 years of research, Wiggins and Broughton (1991) found that relatively cold individuals were hostile, antagonistic, argumentative, aggressive, narcissistic, and antisocial. In addition, interpersonally cold individuals have been found to be argumentative in everyday life (e.g., Moskowitz, 2010). Thus, variations in coldness versus warmth can be recommended in assessing interpersonal hostility (Smith, Glazer, Ruiz, & Gallo, 2004). In more particular terms, participants completed

the warmth-coldness dimension of the Interpersonal Adjective Scale Revised (IAS-R: Wiggins, Trapnell, & Phillips, 1988), a well-validated measure (Wiggins, Phillips, & Trapnell, 1989). They did so by indicating the extent to which 16 markers of hostility (e.g., coldhearted) versus its opposite (e.g., kind) described them, with the latter items reverse-scored (M = 1.96; SD = .61; alpha = .90). Note that the measure was scored so that higher numbers reflected greater hostility, a term that will also be used in characterizing the results.

Results and Discussion

It was hypothesized that preferences for the color red over blue would be characteristic of people higher in interpersonal hostility. This hypothesis was examined in a one-way ANOVA with color preference (blue versus red) as the independent variable and continuous variations in hostility as the dependent variable. As hypothesized, a Color Preference main effect was found, F (1, 96) = 4.21, p = .04, partial eta square = .04: Participants who preferred the color red scored higher in interpersonal hostility (M = 2.15; SD = .67) than did participants who preferred the control color blue (M = 1.88; SD = .57). There were no moderating effects for sex in this study, nor in Studies 2-4, all ps > .15. In sum, preferences for red (over blue) characterize people who are more hostile. Study 2 sought to extend this analysis to biases to see the color red.[3,4]

Study 2

In Study 2, we sought to test whether hostile people not only prefer the color red, but are also biased to perceive this color to a greater extent than non-hostile people. In doing so, we presented participants with degraded red or blue stimuli and asked them to categorize the stimuli as red or blue. The task was difficult, but correct responses could be made. Signal detection procedures were used to quantify red-responding biases independent of perceptual sensitivity for red, a process involving low-level visual pathways less likely to be personality-linked (also see

Fetterman et al., 2011). Interpersonal hostility was assessed in the same manner as in Study 1. Higher red bias scores should covary with higher levels of hostility.

Method

Participants, Materials, and Procedures

Participants were 91 (27 female) undergraduates from NDSU who received course credit. They entered the lab in groups of 6 or less and sat at semi-private personal computers. A color perception test (described below) was administered first. Subsequently, participants' interpersonal hostility was assessed using the same IAS-R marker-based (Wiggins et al., 1988) scale of Study 1 (M = 1.86; SD = .67; alpha = .92). Other questionnaires were also administered, in part for other reasons but in part to preclude discernment of the hypothesis.

Perceptual Bias Task

The color perception task was programmed with E-Prime 2 software. Participants were told that we were interested in their ability to alternate between two very different tasks, one involving auditory perception and the other involving visual perception. They wore headphones during the task. At the beginning of each trial, a white noise blast or silence was presented over the headphones. We reported results involving the sound manipulation in Fetterman et al. (2011): White noise blasts biased people to perceive the color red with a greater subsequent frequency. This effect was orthogonal to the present focus on individual differences in hostility, which did not interact with the manipulation, $p > .60$. Accordingly, and because we reported the manipulation effects in a previous article, we collapsed across this variable for present purposes.

We used the HSB model of Adobe Photoshop to create stimuli. An HSB model characterizes color in terms of three dimensions: hue, saturation, and brightness. Prototypical red (0 degrees) and blue (240 degrees) hue values were used to generate color patch stimuli to

occupy an entire computer screen. These fully saturated (100), full brightness (100) stimuli were easily perceived as red or blue, as they should be given the prototypical hue values. To examine biases, we needed to de-saturate the stimuli. This was accomplished by reducing saturations to much lower values (e.g., 1%, 2%, 4%, etc.) while keeping the brightness at 100. Six pilot test participants categorized the latter stimuli as red or blue. On the basis of their responses, and with the goal of a color categorization accuracy rate of approximately 75%, we chose red patches that were 4% saturated and blue patches that were 2% saturated for use as stimuli in the study proper. These differential saturation values were designed to compensate for a computer-presentation artifact such that most stimuli appeared more likely to be blue than red.[5]

In the program for assessing participants, there were 120 trials, 60 involving degraded red patches and 60 involving degraded blue patches, both occupying the whole screen. Color was randomly assigned to trial number. Participants were correctly informed that the task would be difficult, that all stimuli were in fact red or blue to some degree, and that the colors could be accurately perceived to some extent. Each color patch was categorized as red or blue using the 1 and 5 keys of a response box, with mappings counterbalanced across participants. After each color categorization, there was a 500 ms blank delay before the next trial began.

Accuracy for the color categorization task was 66%, which was significantly different from chance responding on the basis of the 95% confidence interval for the accuracy rate observed, $p < .01$. Interpersonal hostility was not related to accuracy rates, $r = -12$, $p > .25$. Our hypotheses, however, pertained to a *bias* to perceive the color red, independent of the stimuli actually presented. To quantify this bias, we used signal detection methods. We calculated "hit" rates for red stimuli, "false alarm" rates for blue stimuli, *z*-scored both rates, added them together, and multiplied the resulting score by -0.5 (i.e., the *c* parameter: Swets, 1996). Such bias

scores were then reverse-scored so that higher numbers represented greater tendencies to perceive the color red, regardless of whether it was present or not.

Results and Discussion

A simple regression analysis revealed that a bias to see red was characteristic of higher levels of interpersonal hostility, $b = .23$, $t = 2.22$, $p = .03$. To additionally characterize the results, estimated hostility means were calculated at -1 and +1 *SD* along the red bias continuum (Aiken & West, 1991). Interpersonal hostility was higher for those biased to see red (estimated $M = 2.05$) than for those less biased to see red (estimated $M = 1.66$). The results of Study 2 extend those of Study 1 by revealing that a bias to see, in addition to a preference for, the color red reflects higher levels of interpersonal hostility.

Study 3

Study 2 contrasted the colors red and blue. This is a common contrast in studies of color psychology (e.g., Mehta & Zhu, 2009; Payen et al. 2011; Ten Velden et al., 2012). Furthermore, Fetterman et al. (2012) found that blue, relative to achromatic gray, neither facilitated nor inhibited categorizing stimuli as hostility-related in reaction time terms. Nonetheless, it may be desirable to conceptually replicate the results of Study 2 with a different contrast color. Green opposes red in color vision (Changizi, Zhang, & Shimojo, 2006) and is often used as a comparison color for this reason (e.g., Klinger & Gilad, in press; Maier et al., 2013; Tanaka & Tokuno, 2011). In seeking to replicate the results of Study 2, therefore, green was chosen as the contrast color. In addition, and importantly, the paradigm was changed such that the red and green colors were presented in separate blocks. In the red block, for example, red or white stimuli were presented and participants were instructed to indicate whether red was present versus not present on individual trials. We could thus compute a bias score specific to perceiving

each chromatic color separately. Variations in interpersonal hostility were hypothesized to covary with red color bias scores, but not green color bias scores.

Method

Participants, Materials, and Procedures

Participants were 72 (25 female) undergraduates from NDSU who received course credit. They entered the lab in groups of 6 or less and sat at semi-private personal computers to complete the study. The color perception test was administered first. Then, participants' interpersonal hostility was again assessed using IAS-R interpersonal markers (M = 2.24; SD = .81; alpha = .94). The Medialab program also contained other questionnaires of a non-hostile type, in part to preclude discernment of the hypothesis.

Perceptual Bias Task

The stimuli for Study 3 consisted of three full-screen color patches created by Adobe Photoshop software in a manner that paralleled the stimulus creation procedures of Study 2. One was non-chromatic white, the second was red (0 degrees), and the third was green (180 degrees). All stimuli were maximum brightness (100). Pilot testing with 8 participants had determined that 3% saturation rates for the chromatic stimuli led to a relatively equal percentage of color endorsements (relative to thinking no color was present); accordingly, 3% saturation rates for these stimuli were used in the study proper. This selection procedure was successful in the sense that the proportion of red responses in a red block (see below) was comparable to the proportion of green responses in a green block, F (1, 70) = 2.71, p = .10.

The assessment task was programmed with E-Prime 2 software. On 30 trials, red or white stimuli were presented and participants indicated whether the color patch was red or not (n = no; y = yes). On another 30 trials of the task, green or white stimuli were presented and participants

indicated whether the color patch was green or not (n = no; y = yes). The order of red versus green blocks was counterbalanced across participants. The task was intentionally difficult, but accuracy rates for both the red block (M = 56%) and the green block (M = 54%) exceeded chance, ps < .05. Interpersonal hostility was not related to these accuracy rates, |rs| < .13, ps > .25, and the findings reported below should therefore be interpreted in terms of *biases* to see a color, whether present or not. Trial procedures for the blocks were parallel. The screen went black for 300 ms to disrupt iconic memory comparisons across successive trials (Sperling, 1960). Then, a white or colored stimulus was randomly selected and presented on the entire screen. The stimulus remained until a response was made, after which the next trial began.

Bias (c) scores were computed as in Study 2, but they were computed separately for the red and green blocks. These bias scores were z-scored and then reverse-scored so that higher numbers reflected greater biases to perceive the relevant color – either red or green. The bias scores were correlated at r = .73, p < .01. Thus, there was a general tendency for people to see color or not across the two blocks, but roughly 50% of the variance in color biases was unshared across the two blocks.

Results and Discussion

As hypothesized, a simple regression found support for the idea that biases to see red were more evident at higher levels of interpersonal hostility, b = .31, t = 2.71, p = .01. This finding, however, could be due to a bias to respond yes, either in general or, in color detection tasks, independent of the color involved. We were able to rule out this generic interpretation by showing that green bias scores did not relate to interpersonal hostility in a second simple regression, b = .08, t = 0.65, p = .51. Moreover, the two regression coefficients were different from each other in magnitude, t = -2.79, p = .01. For the sake of adding a bit more detail

concerning the findings, Figure 1 uses the simple regressions to estimate interpersonal hostility means (Aiken & West, 1991) at a low (-1 SD) versus high (+1 SD) level of each of the color bias continuums. As shown there, the estimated level of interpersonal hostility was notably higher at the high relative to low level of the red bias measure. In summarizing, what we emphasize is the manner in which the Study 3 results conceptually replicate those of Study 2 in a context in which a red bias score could be computed independent of any other chromatic color.

Study 4

Studies 1-3 linked red preferences and biases to trait-related variations in hostility. In Study 4, we shifted the focus from trait reports to hostile social decision-making. Specifically, we presented participants with two scenario-based measures in which hostile decisions could be made. The first involved moral dilemmas, which permit people to choose very hostile courses of action on the basis of rational considerations. People avoid making such decisions to the extent that they are inconsistent with self-standards for how one ought to treat others (Bartels, 2008; Greene, 2011). We hypothesized that people preferring the color red relative to blue, the Study 1 color assessment reintroduced for Study 4, would find the behaviors more compatible with their dispositions and would therefore choose the hostile courses of action more frequently. The second measure was a version of the ultimatum game. In this task, people often reject unfair offers from another person out of hostility toward the other person, even at some loss to the self (Güth, Schmittberger, & Schwarze, 1982). In this case, we hypothesized that people preferring the color red would reject ultimatum offers to a greater extent than their blue-preferring counterparts, particularly when such offers were unfair and therefore somewhat provoking.

Method

Participants, Materials, and Procedures

Participants were 116 (55 female) undergraduates from NDSU who received course credit. They completed the study at semi-private computers in groups of 6 or less. The study was programmed with Medialab software. The social decision-making tasks (described below) were administered first. Then, participants completed several filler questionnaires prior to completing the red/blue preference measure administered in Study 1. In the present study, 30% of participants preferred the color red, a percentage almost identical to that of the first study.

Hostility-Related Decision-Making Tasks

Two social decision-making tasks were utilized. First, a set of 5 moral dilemma scenarios was administered. In the dilemmas, one could engage in a hostile, indeed murderous, action in the service of a utilitarian goal. This choice is rational, but very cold-blooded. Many people resist such an option because they find the idea of directly harming another person morally repugnant to the self (Greene & Haidt, 2002). One of 5 scenarios read:

> You are an inmate in a concentration camp. A sadistic guard is about to hang your son who tried to escape and wants you to pull the chair from underneath him. He says that if you don't he will not only kill your son but some other innocent inmate as well. You don't have any doubt that he means what he says. What would you do?

Options for this scenario were q = "I would NOT pull the chair" or p = "I would pull the chair". Pulling the chair represents a hostile action because the self is the agent that directly harms another person (Greene & Haidt, 2002). For all 5 scenarios, the hostile action was coded as 1 and the empathetic, non-hostile action was coded as 0. Responses to the scenarios were averaged (M = .52; SD = .25).

Second, we administered a variant of the ultimatum game inspired by economic game theory (Güth et al., 1982). In this task, participants were told to imagine that another person had

decided how to split $10 and it was the participant's prerogative to accept the offer made to him/her or to reject it. If the offer was accepted, both parties would receive the money designated in the offer. If the offer was rejected, neither party would receive any money for that trial. The motivation for rejecting offers is a reactive form of hostility: People reject offers because they perceive them to be unfair and they desire to harm the offending party (Güth et al., 1982). There were 10 trials, 2 each of 5 types ($1 offered, $2, $3, $4, or $5). Only the $5 offer is completely fair. In this case, hostility should not be felt and a preference for red might not matter. In the case of the unfair offers, on the other hand, ultimatum rejection percentages should be higher for red-preferring individuals. The 10 trials were presented in randomized order. A rejection was coded as 1 and an acceptance was coded as 0 (M = .54; SD = .25 across the various trial types).[6]

Results and Discussion

A first analysis examined responses to the moral dilemmas as a function of color preference. There was a main effect of Color Preference in this one-way ANOVA, F (1, 114) = 7.79, p = .01, partial eta square = .06. As hypothesized, red-preferring individuals were more likely to indicate that they would harm another person in the scenarios (M = .61; SD = .23) than blue-preferring individuals (M = .47; SD = .25). Such actions are hostile, but they can also be viewed as rational. In this context, results from the ultimatum game can offer further insights into the processes involved in that hostile decision-making in the second task is not rational (i.e., one loses money when rejecting unfair offers out of spite).

For the frequency of ultimatum rejections measure, we expected a main effect for color preference, as most offers were unfair. We also expected an interaction with offer type, such that color preference should matter less as offers are increasingly fair and therefore less provoking. Both hypotheses were examined simultaneously in a 2 (color preference: red versus blue) x 5

(offer type: $1 versus $2, etc.) mixed-model ANOVA. Color preference was a between-subjects factor and offer type was a within-subject factor.

The analysis revealed a main effect for Color Preference, F (1, 114) = 8.83, p = .004, partial eta square = .07. As hypothesized, those who preferred red rejected offers more frequently (M = .65; SD = .18) than those who preferred blue (M = .50; SD = .27). There was also a main effect for Offer Type, F (4, 456) = 173.94, p < .01, partial eta square = .60, such that rejections systematically increased as offers became increasingly unfair (Ms = .01, .34, .67, .79, & .87 for the $5, $4, $3, $2, & $1 conditions, respectively). Findings of the latter type are often observed in ultimatum games (Güth et al., 1982).

Finally, and as hypothesized, there was a Color Preference by Offer Type interaction, F (4, 456) = 3.41, p = .01, partial eta square = .03. Rejection frequencies for this interaction are displayed in Figure 2, as are follow-up tests for each offer condition considered separately. Red-preferring individuals rejected unfair offers with a greater frequency, but did not reject the fair ($5) offer with a greater frequency. In other words, a perceived inequity was required to activate the hostile responses of red-preferring people.

General Discussion

Color is an important feature of our perceptual environment, yet the systematic empirical investigation of color psychology is of a relatively recent origin (Elliot & Maier, 2014). The primary focus of this emerging body of work has been on whether exposure to a color, and particularly the color red, influences affect, cognition, and/or behavior, and this research has revealed a number of interesting and informative findings. For example, when people imagine themselves wearing a red (relative to a blue) sports uniform, they view themselves as more dominant and threatening than their opponent in a potential sporting contest (Feltman & Elliot,

2011). Whether color has implications for personality psychology, however, has yet to be the focus of this new wave of systematic empirical research on color psychology. The present investigation sought to rectify this oversight in the color psychology literature.

Study 1 demonstrated that people preferring the color red over the color blue were more interpersonally hostile. Study 2 demonstrated that people biased to perceive the color red, independent of their sensitivity to this color, were more interpersonally hostile. Study 3 replicated the results of Study 2 and did so with a task in which a bias to perceive the color red could be computed separately from a bias to perceive a chromatic control color. Study 4 demonstrated that a preference for the color red was linked to hostile responses on social decision-making tasks, whether such responses could be viewed as rational (Greene, 2011) or not (Güth et al., 1982). The present studies therefore establish a systematic link between a preference for, and a bias to see, the color red and individual differences in interpersonal hostility.

Preferences and Biases for the Color Red

Historically, color preferences have been assessed in a somewhat atheoretical manner (Whitfield & Wiltshire, 1990). Our assessment of color preferences, by contrast, was theoretically motivated in that we drew on a number of different sources of evidence for the idea that interpersonal hostility should be linked to a specific color – namely, red. Interpersonal hostility commonly involves anger, which is manifest on the face as red coloration (Changizi, 2009; Drummond, 1997). Hostility and aggression are often accompanied by a testosterone surge, which has been linked to enhanced red coloration in several different species, including primates (Andersson, 1994; Dixson, 1998; Setchell & Wickings, 2005), and to red self-identifications among humans (Farrelly et al., 2013). Hostile, aggressive encounters, especially in the wild but also among humans, often lead to exposed blood, whose color is red.

Given these deep connections between red and hostility, it seemed feasible to us that individuals who like the color red would have higher levels of trait-assessed interpersonal hostility (Study 1) and exhibit greater hostility in their responses to social scenarios (Study 4). Although the results are fairly novel, they make conceptual sense given previous research on redness-related associations. Nonetheless, it might be useful to build upon the present findings. For example, research might examine whether red-preferring individuals exhibit higher levels of laboratory aggression or aggression in their daily lives, hypotheses that would also build on what we know concerning the connotations of the color red (Elliot & Maier, 2014).

In prior research, we had shown that activating hostile thoughts biased individuals to perceive the color red, an experimental effect (Fetterman et al., 2011). The present findings establish a role for personality-related variations in hostility in this color-perception realm, a novel addition to the literature. The results of Studies 2 and 3 likely occurred because hostile people have hostile thoughts, hostile thoughts are implicitly associated with the color red, and therefore hostile people are biased to see this color more frequently. Other personality variables such as dimensional psychopathy might also relate to red-seeing biases, but, if so, such results would be compatible with the present findings in that a wide number of hostility-related traits are organized by the dimension of interpersonal hostility assessed in the present studies (Wiggins & Broughton, 1991). As a final point here, we suggest that bias-related tendencies toward red may reflect more basic associative processes than preferences for the color red. Nonetheless, associations often underlie preferences (Greenwald et al., 2002) and, in any case, we emphasize convergence across the two sorts of measures.

It is important to note that interpersonal hostility was linked to a bias to see the color red rather than sensitivity to this color (in the present studies, as assessed by accuracy rates). This

differential pattern is what should be expected in that sensitivity to the color red is the result of low-level processing in the color-perception system (Livingstone & Hubel, 1987). Interpersonal hostility is unlikely to be linked to such low-level processing, but would rather constitute an influence that occurs subsequently (Gegenfurtner, 2003). In other words, the results of Studies 2 and 3 are almost certainly due to top-down, conceptual influences in color perception rather than processing within low-level visual pathways.

Additional Considerations and Questions

We focused on personality-related relationships, which are necessarily correlational in nature (Kenrick & Funder, 1988). Nonetheless, it may be useful to offer speculations concerning possible causal directions. Theories of metaphor and embodied cognition contend that people recruit the perceptual domain in seeking to understand more abstract thoughts and feelings (Landau, Robinson, & Meier, in press). Translated to the present context, relatively more abstract hostile thoughts and feelings would be implicitly represented in relatively more concrete redness-related terms. Consistent with this direction of influence, Fetterman et al. (2011) found that manipulated hostile thoughts and feelings biased people to see the color red more often. Individual differences in such thoughts and feelings, by extension, might well shape perceptions and preferences in a redness-favoring direction (Robinson & Fetterman, in press).

Even so, we contend that such relationships are likely to be bi-directional. The introduction reviews multiple reasons for thinking that hostility and redness are systematically associated. Once formed, such associations would reinforce each other, much as other mental associations generally do (Landau et al., in press). Consistent with this point, the embodied cognition literature has shown that perceptual experiences can result in metaphor-consistent interpersonal feelings (e.g., Williams & Bargh, 2008). Further, a body of research has shown that

exposure to the color red can shape subsequent thoughts and behaviors (Elliot & Maier, 2014). Thus, there are reasons for thinking that biases and preferences involving the color red could, over time, contribute to one's typical level of interpersonal hostility. Our studies were of course correlational, but these speculations are useful in thinking about the processes involved.

Turning to a different question, would people preferring red also be biased to see this color? We think so (see Dunning & Balcetis, 2013), but did not examine this potential relationship. Instead, the important point is that both sorts of color-related measures systematically correlated with hostility. Might preferences for the color red relate to other individual differences aside from hostility-related ones? This seems likely. For example, Elliot and Neista (2008) found that the color red enhanced sexual attraction among strangers. Preferences for the color red might similarly relate to sexual attraction processes, a possibility yet to be explored. Further, as red is a signal of possible failure in achievement contexts (Elliot et al., 2007), it may be that biases to perceive the color red might be linked to apprehension in test-taking contexts. Just as the effects of exposure to the color red are diverse (Elliot & Maier, 2014), that is, it seems reasonable to posit that preferences for, or biases to see, the color red may have other correlates aside from those examined in the present studies. Regardless, we believe that hostility is a primary associate to the color red and our findings substantiate this point.

Finally, the studies focused on red as a prototypical color because we suspect that only prototypical red connotes hostility (Elliot & Maier, 2014; Needham, 1973). For this reason, we do not think that preferences related to purple or orange – which can be created by mixing red with other colors – would systematically vary according to how hostile a person is. In bias-related paradigms, though, the processes are likely to operate differently. One might ask participants whether an even mix of red and blue (i.e., purple) has a greater proportion of red or

blue in it. In such a paradigm, higher levels of hostility would likely be linked to perceptions biased toward red over blue. In total, then, it is our sense that the paradigm will matter in determining the scope of relations between hostility and the color-related processes focused on.

Conclusions

As a broader context for the present studies, Bruner (1951) advanced the idea that important insights into personality functioning can be found in perceptual tasks. Such "New Look" ideas foundered in part because of questionable psychodynamic ideas subsequently introduced to this literature (Bruner, 1992). With the recent revitalization of color psychology (Elliot & Maier, 2014), it is an excellent time to revisit Bruner's (1951) central interest in personality-related factors in perception. The present results suggest that preferences for, and biases to see, the color red are correlates of personality-related variations in interpersonal hostility. These findings encourage future investigations of the personality-perception interface in a manner extending Bruner's (1951) New Look ideas to the perception of other colors besides red and perhaps even to other visual and non-visual perceptual phenomena.

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Footnotes

[1]We desired approximately 80-120 participants per study, numbers that would afford reasonable power to detect medium effect sizes, as medium effect sizes were of interest. The exact number of participants per study depended on sign-up and show-up rates, which in turn depended on time of semester as well as unknown factors. No preliminary data analysis occurred; rather, data collection ended (and was not restarted) when the last scheduled session for a study was completed. Recruiting procedures were generally successful in that sample sizes for the studies ranged from 72-116.

[2]The research protocols were approved by NDSU's Institutional Review Board. The vast majority of participants completed the studies as part of a mandatory course requirement. They could sign up for other studies instead, however, or they could satisfy the course requirement without participating in experiments. The authors were not instructors for classes possessing the mandatory course requirement. The same sort of very general instructions given to participants in Study 1 were given to participants in Studies 2-4 as well.

[3]Hypotheses were of a simple regression type – i.e., people preferring red (Studies 1 & 4) and people biased to see red (Studies 2 & 3) should be higher in interpersonal hostility. Such relations remained significant (Studies 3 & 4) or marginally significant (Studies 1 & 2) when controlling for sex in multiple regression analyses. Additionally, relations between redness and interpersonal hostility did not vary by sex, as indicated in the text.

[4]Studies 1-3 administered the full IAS-R circumplex measure. In these studies, relations involving the other three dimensions of the circumplex were not significant, *p*s > .05. The red-preferring or -biased person is hostile, then, in somewhat particular terms.

[5]All 6 computer monitors were of an identical model (LG Flatron ME 20CR-BF) with identical settings (brightness = 100; contrast = 100; sharpness = 5). However, it should be noted that we did not calibrate the monitors with a spectrophotometer. For this reason, the stimulus parameters mentioned in the text must be considered approximate.

[6]Offers greater than $5 were not presented because nearly everyone would accept them. The $5 condition (representing a fair offer) is a good baseline against which to compare the other (unfair) conditions.

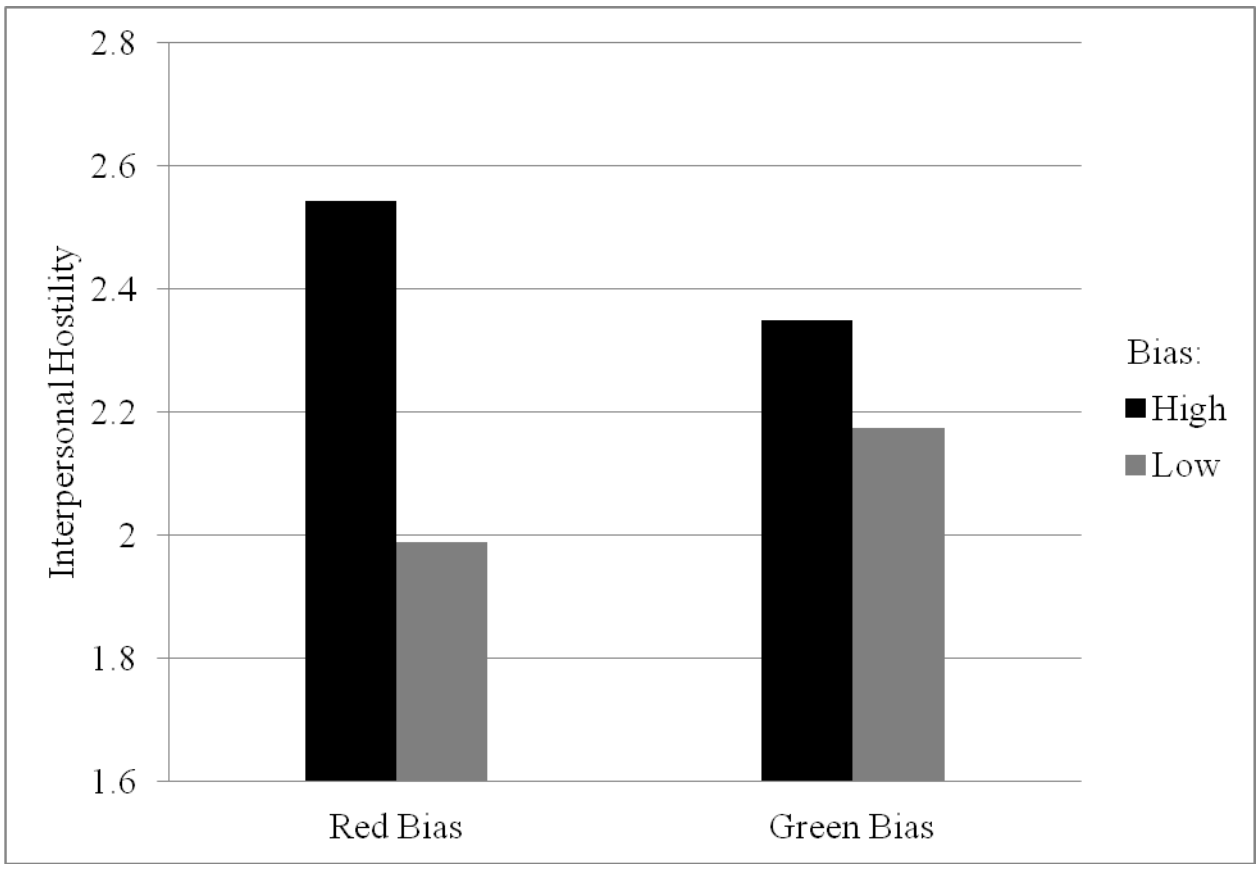
Figures

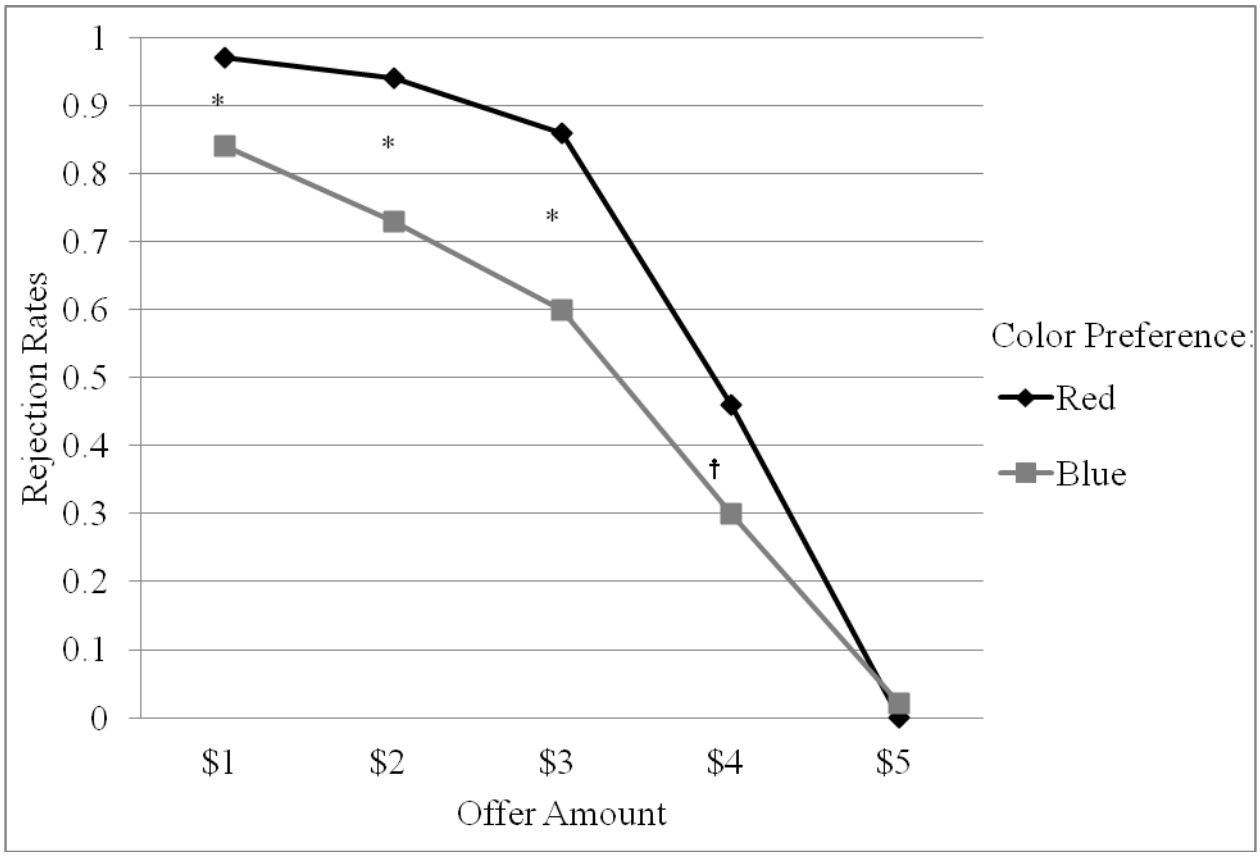
Figure 1

Estimated Means for Interpersonal Hostility at Low (-1 SD) and High (+1 SD) Levels of the Red and Green Bias Continuums, Study 3

Figure 2

Rejection Rates in an Ultimatum Game by Color Preference and Offer, Study 4


2.8
2.6
2.4
2.2
2
1.8
1.6
Interpersonal Hostility
Red Bias
Green Bias
Bias:
High
Low


1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Rejection Rates
*
*
*
†
$1
$2
$3
$4
$5
Offer Amount
Color Preference:
Red
Blue

Note: * = $p < .01$; † = $p < .10$