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Anger as "Seeing Red":

Evidence for a Perceptual Association

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Abstract

Metaphor representation theory contends that people conceptualize their non-perceptual states (e.g., emotion concepts) in perceptual terms. The present research extends this theory to color manipulations and discrete emotional representations. Two experiments (N = 265) examined whether a red font color would facilitate anger conceptions, consistent with metaphors referring to anger to “seeing red”. Evidence for an implicit anger-red association was robust and emotionally discrete in nature. Further, Experiment 2 examined the directionality of such associations and found that they were asymmetrical: Anger categorizations were faster when a red font color was involved, but redness categorizations were not faster when an anger-related word was involved. Implications for multiple literatures are discussed.

KEYWORDS: Metaphor, Anger, Discrete Emotions, Color, Reaction Time

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Evidence for a Perceptual Association

Beginning with James (1884), psychologists have sought to explain feelings in terms of more observable phenomena, whether physiological activation patterns (Ekman, Levenson, & Friesen, 1983), expressive behavior (Ekman, 1992), or action tendencies (Frijda, 1992). Such attempts have not been entirely successful. Perhaps most to the point, the multiple components of emotion do not covary with each other in a manner suggesting a coordinated innate emotion program (Barrett, 2006; Mauss & Robinson, 2009). To understand the subjective component of emotions, then, it is necessary to provide an explanatory framework that does not reduce them to its observable manifestations (Barrett, Mequita, Ochsner, & Gross, 2007).

Indeed, there is an ineffability to feelings that has long been appreciated by consciousness scholars and researchers (Chalmers, 2007; Searle, 1998). Laypeople too, we suggest, face an epistemic challenge in understanding their feelings in a manner that connects them to real-world referents (Lambie & Marcel, 2002). The feeling of anger, for example, feels like something, but what exactly does it feel like? In relation to this question, Lakoff and Johnson (1980; 1999) contend that people think metaphorically. That is, they liken their feelings to more concrete perceptual experiences that provide a potentially crucial scaffolding (Williams, Huang, & Bargh, 2009) in understanding them. According to this metaphor representation theory, for example, we think of nice people as "sweet" not because they taste sweet – because they most likely would not even if one ate them – but rather because it is similarly pleasant to interact with nice people and to eat sweet foods (Meier, Moeller, Riemer-Peltz, & Robinson, 2012).

How Do People Conceptualize Their Anger States?

Anger is a somewhat common feeling (Averill, 1983) and one that often leads to aggressive behaviors (Berkowitz, 1993). In addition, anger is disruptive to social relationships (Smith, Glazer, Ruiz, & Gallo, 2004) and perhaps a major scourge to social functioning more generally (Tavris, 1989). The manner in which individuals conceptualize their angry states is thus an important focus of research. We draw from metaphor representation theory (Lakoff & Johnson, 1999) in proposing that people use perceptual metaphors to understand anger.

Multiple cultures associate the color red with anger and danger (Kövecses, 2000; Needham, 1973). Especially angry individuals are thought to “see red” or to be “red with rage” (Lakoff, 1987). Anger’s other metaphoric links – e.g., to heat, fire, and blood – similarly suggest an implicit mapping of this type (Gibbs, 1994). It is likely not arbitrary, from this perspective, that the Devil’s skin is red (Meier, Hauser, Robinson, Friesen, & Schjeldahl, 2007) or that popular movies consistently link the color red to anger and aggression (e.g., Stephen King’s *Carrie*). Such mappings may have some basis in physiology as anger often results in facial flushing and thus a redder face (Changizi, Zhang, & Shimojo, 2006; Drummond, 1997). On the basis of such considerations, we suggest, states of anger may be understood in terms of perceptual redness. Such considerations are revisited in the General Discussion.

The feeling of anger is not red as feelings have no color. Nonetheless, and on the basis of a largely philosophic view of metaphor (Lakoff & Johnson, 1999), we hypothesized that anger conceptions would borrow from the perceptual domain and do so in a manner supporting the idea that anger is a red emotion. If so, presenting anger words in a red font color should facilitate (i.e., speed) their categorization even in the context of: (a) no systematic relationship between emotion type and font color, and, in fact (b) instructions to ignore font color.

Our predictions should be viewed in light of a tension in the emotion and emotion representation literatures. Ekman (1992) made a case for the idea that emotional states are conceptualized in a discrete manner. For example, and of particular relevance to the present experiments, anger and fear should differ in their correlates and biases, despite the fact that they are both unpleasant states of high arousal. More recently, such discrete emotion perspectives have been increasingly questioned, so much so that the pendulum now appears to favor dimensional rather than discrete perspectives on emotion (Barrett, 2006), though theorists contend that anger must be distinguished from other negative emotional states (Carver & Harmon-Jones, 2009). We sought to investigate the discreteness of the present associations and hypothesized that the color red would facilitate anger categorizations, but not fear or sadness categorizations, two other very common negative emotional states and concepts.

The metaphor representation theory guiding our predictions (Lakoff & Johnson, 1999) contends that conception borrows from perception, but perception does not borrow from conception. This asymmetry makes sense from what we know to be true concerning the temporal course of processing in the brain (Dehaene, Changeux, Naccache, Sackur, & Sergent, 2006). The cortices in the back of the brain are responsible for object identification processes of a particularly perceptual type (Storbeck, Robinson, & McCourt, 2006). Subsequently, the temporal and frontal cortices of the brain then attempt to assign meaning to stimuli *subsequent* to their perceptual recognition (Rolls, 1999). If so, and translated to the present context, two predictions can be made. First, color categorizations should be faster than emotion concept categorizations. Second, an asymmetry should be observed such that perceptually red stimuli should facilitate anger categorizations, but anger stimuli should not facilitate categorizing a font color as red. This

predicted asymmetry is examined in Experiment 2 in addition to its more crucial prediction that anger categorizations should be facilitated by a red font color.

Experiment 1

To the extent that anger is conceptualized in terms of the color red, presenting anger words in a red font color (relative to a control font color: an achromatic mid-gray) should speed their categorization. For purposes of discriminant validity, two word control conditions were also used. Some words were affectively neutral and were categorized as such. To the extent that the font color manipulation does not influence the speed with which neutral words can be categorized, such results would rule out the differential perceptibility of the two font colors. Of additional importance, some words were of a fear-related type and were categorized as such. On the basis of metaphoric associations linking the state of anger, specifically, to the color red (Gibbs, 1994; Lakoff, 1987), a unique and discrete relation of this type was hypothesized.

Method

Participants and General Procedures

Ninety-seven (56 female) undergraduate students from North Dakota State University received course credit for their participation. After general instructions, participants completed the emotion categorization task on a personal computer.

Emotion Categorization Task

Participants were instructed to categorize presented words as quickly and accurately as possible within an e-Prime program. They were also told that the words might vary in font color from trial to trial, but that such variations were irrelevant to the task at hand. Against a white background, words were randomly assigned to red versus mid-gray font colors in a 24-point font size. Gray was chosen as a control condition because it was non-chromatic in nature, yet clearly

discernible against the background. By importing e-Prime's default red and mid-gray colors into Adobe Photoshop software, we were able to confirm that the two font colors used corresponded to the hues characteristic of red (CIE angle 0) and gray (which has no CIE angle because it has no hue) and were practically equivalent in brightness values. There were 120 trials in the task.

Word stimuli were to be categorized as anger-related, fear-related, or neutral. Anger and fear words were chosen on the basis of markers from the PANAS-X (Watson & Clark, 1994), a well-validated self-report inventory of emotion, and on the basis of additional categorization norms from our lab (e.g., Wilkowski & Robinson, 2007). Neutral words were chosen such that they were neither unpleasant nor pleasant according to the word norms of Bradley and Lang (1999). Particularly in relation to the anger and fear words, it was deemed important to use only highly prototypical, representative stimuli, as the use of less prototypical stimuli (e.g., the word "contempt" for anger) would undermine accuracy rates, which we wanted to be high.

On the basis of such considerations, we presented 10 anger word stimuli (angry, annoyed, bitter, furious, hostile, infuriated, irritable, mad, outraged, & scornful), 10 fear word stimuli (afraid, fearful, frightened, jittery, jumpy, nervous, panicky, scared, shaky, & worried), and 10 neutral stimuli (author, chart, custom, dense, exposure, garment, proof, swallow, vertical, & violin). Word frequencies (based on the norms of Kucera & Francis, 1967) were equal for the three word categories, F (2, 18) = .03, p = .97, as were the number of letters for the three word categories, F (2, 18) = .16, p = .85. Admittedly, the neutral stimuli were largely nouns, whereas the emotional stimuli were all adjectives. However, our predictions were of an interactive (word category x font color) type rather than of a main effect (word category) type. Words were repeated four times each.

Word stimuli were randomly assigned to trial number and randomly assigned to one of the two font colors – red or gray. Such random assignment algorithms were different for each participant, as was true in Experiment 2 as well. Such random assignment algorithms also ensured that the same word stimulus was sometimes paired with one color and sometimes with the other across repetitions of the words, even for a particular participant, and this was also true in Experiment 2 as well. Responses were made using the arrow keys of the right, lower portion of the keyboard. Participants were instructed to place their right index fingers on the down arrow key at the start of each trial, which did not begin until they had done so. Thereafter, the trial stimulus was presented at center screen. If the stimulus was perceived to be neutral, participants were to press the up arrow key immediately above the down arrow key. Anger and fear words were categorized using the left and right response arrows of this portion of the keyboard, with these mappings counterbalanced across participants. Erroneous responses were penalized by a 1000 ms “INCORRECT” error message.

Results

Results Involving Categorization Speed

Reaction times (RTs) were handled in accordance with recommendations in the literature. Inaccurate responses (M = 9.84%) were deleted, RTs were log-transformed, and log-transformed times 2.5 *SD*s below or above the grand latency mean were replaced with these values (Robinson, 2007). A 3 (Word Type) x 2 (Font Color) repeated measures ANOVA was then conducted on the (trimmed) log latency means, though millisecond means will be reported for ease of interpretation.

There was a main effect for Word Type, F (1, 95) = 80.72, p < .01, partial eta square = .46. Neutral words were categorized faster (M = 983 ms) than anger- (M = 1128 ms) or fear-

related (*M* = 1168 ms) words. This main effect is not important in the present context, but we offer a brief interpretation of it. Studies have shown that a first stage in affective processing seems to involve whether stimuli are of an affective type or not (e.g., Murphy & Zajonc, 1993). Only with subsequent processing are discrete forms of negative affect likely distinguished (Barrett, 2006). Accordingly, the slower RTs exhibited in the negative affect conditions, relative to the neutral condition, likely involves the added processing time necessary to disambiguate the two types of negative stimuli.

Interestingly, it was also found that anger stimuli were categorized faster than fear stimuli, F (1, 95) = 9.84, $p < .01$, partial eta square = .09, despite the fact that such stimuli were equal in word frequency, number of letters, and all were adjectives. We are not aware of any precedent for this finding, but it may comport with other results showing that words suggesting a more palpable threat to the self, as should be the case for anger relative to fear stimuli (Wentura, Rothermund, & Bak, 2000), are recognized faster (Wurm & Vakoch, 2000). On the other hand, there was no main effect for Font Color, F (1, 95) = 1.51, $p = .22$. Thus, the two color conditions were well-matched in terms of their discriminability against the background.

Of most importance was the hypothesized Word Type by Font Color interaction, which was significant, F (1, 95) = 9.40, $p < .01$, partial eta square = .09. Millisecond means for this interaction are displayed in Figure 1. The means reported in Figure 1 suggest that a red font color facilitated the categorization of anger words, but not neutral or fear words. This impression was confirmed by follow-up tests examining the effect of the font color manipulation for each word type separately. Anger categorizations were faster when the font color was red rather than gray, F (1, 95) = 17.12, $p < .01$, partial eta square = .15. On the other hand, the font color manipulation was a non-significant predictor of the speed with which words could be categorized as neutral, F

(1, 95) = .01, p = .91, or fear-related, F (1, 95) = 2.95, p = .09. We are reluctant to make much of the latter marginal effect given the substantial power of the experiment. In any case, the fact that fear categorizations were slightly faster when stimuli were gray rather than red reinforces the specificity of the anger-redness association.

Results Involving Accuracy Rates

The task, stimuli, and procedures were designed to ensure high accuracy rates. Nonetheless, it might be important to examine accuracy rates in relation to potential speed-accuracy tradeoffs (Pashler, 1998). Accordingly, a 3 (Word Type) x 2 (Font Color) ANOVA was conducted to examine accuracy rates as a function of the manipulations. The Word Type manipulation was again significant, indicating that neutral words could be more easily categorized (*M*s = 95.51%, 91.91%, & 90.77% for neutral, anger, & fear words, respectively). There was no main effect for Font Color, F (1, 95) = .00, p = .96, but there was a Word Type by Font Color interaction, F (1, 95) = 4.14, p = .05, partial eta square = .12.

To understand the latter interaction, follow-up ANOVAs were performed. The font color manipulation was irrelevant in predicting the accuracy of neutral word categorizations, F (1, 95) = .88, p = .35. On the other hand, anger categorizations were directionally, though not significantly, more accurate when the font color was red (M = 92.63%) rather than gray (M = 91.20%), F (1, 95) = 2.45, p = .12. Fear categorizations, by contrast, were directionally, though not significantly, more accurate when the font color was gray (M = 91.49%) rather than red (M = 90.05%), F (1, 95) = 3.41, p = .07. In relation to accuracy data, which were not of central interest, the most important point is that there was no hint of a speed-accuracy tradeoff for anger words presented in a red font color.

Discussion

Experiment 1 examined the novel idea that people implicitly conceptualize anger in terms of perceptual redness. If so, an irrelevant manipulation of perceptual redness should facilitate anger categorizations, discretely so. Just such a pattern was observed, it was unique to anger words relative to fear or neutral words, and it was not associated with a speed-accuracy tradeoff. Given the novelty of these results, it was deemed important to conceptually replicate them.

Experiment 2

Experiment 1 had included a neutral word categorization condition, which was viewed as an important control condition in this initial experiment. As hypothesized, the font color manipulation was quite irrelevant to the speed with which neutral words could be categorized. Accordingly, we dropped the neutral word condition in Experiment 2. A benefit of doing so is that two-alternative choice tasks are more common to the social cognition literature (Fazio & Olson, 2003; Greenwald & Farnham, 2000) and the processes contributing to performance in them are better understood than are choice tasks with more than two response options (Luce, 1959; Meyer, Irwin, Osman, & Kounois, 1988).

Additionally, Experiment 1 provided important support for a discrete emotions perspective favoring the implicit association of anger and perceptual redness. In Experiment 2, we sought to provide additional support for this perspective. We did so by asking individuals to categorize emotional stimuli as anger- or sadness-related. Sadness, like fear, is a common and basic negative emotion, nonetheless thought to differ from anger in terms of its correlates (Ekman, 1992). Further support for a discrete emotions perspective would thus be found to the extent that a red font color facilitates anger word, but not sadness word, categorizations. As a color control condition, Experiment 1 used an achromatic gray. To rule out the possibility that the findings of Experiment 1 were due to the presence of color per se, regardless of that color,

Experiment 2 presented anger and sadness words in either red or blue font colors. Blue is as basic a color as red and there is a unique set of retinal cones sensitive to blue wavelengths (Goldstein, 1999).

A secondary question of Experiment 2 was whether sadness categorizations would be facilitated by a blue (relative to a red) font color. In favor of this possibility is the fact that "blue" is often used as a synonym for sadness. Disfavoring such an association are two considerations. First, cultures agree on the affective connotations of the colors white, black, and red to a far greater extent than they agree on the affective connotations of other colors such as blue, green, or yellow (Lakoff, 1987; Needham, 1973). Second, metaphoric associations are likely reinforced by repeated perception-conception pairings (Kövecses, 2000). Although it is easy to see how prior experiences gave rise to the idea that anger is red, it is difficult to discern systematic reasons for sadness being blue. For example, although angry others may exhibit facial flushing, sad others are not likely to have a blue skin tone. In addition, it is quite unlikely that people are sadder on days on which clear blue skies predominate. In point of fact, then, we were uncertain as to whether a sadness-blue association would be found in Experiment 2.

A final question of interest in Experiment 2 was the idea of Lakoff and Johnson (1999) that metaphoric associations should be asymmetric in that conception is thought to borrow from perception, but not vice versa. The brain, in fact, is structured such that perception precedes conception (Dehaene et al., 2006; Rolls, 1999) and therefore such asymmetric predictions make sense. In two sub-experiments, we presented the same stimuli – anger and sadness words presented in a red or blue font color – to all participants, but either in the context of a conceptual (i.e., anger versus sadness) or perceptual (i.e., red versus blue font color) categorization task. In comparing the results of these sub-experiments, we hypothesized a three-way interaction of an

asymmetric type: Anger words should be categorized faster when presented in a red font color, but red font categorizations should *not* be facilitated when the relevant word is an anger-related one. Further discussion of such interactive predictions is presented following the relevant results.

Method

Participants and General Procedures

Data were collected in two successive weeks. During the first week of data collection, 88 participants (33 female) were asked to categorize (red or blue) stimuli as anger- or sadness-related. During the second week of data collection, 80 participants (35 female) were asked to categorize (anger- or sadness-related) stimuli as red or blue in font color. All participants were from North Dakota State University and all received course credit by their participation.

Participants were not randomly assigned to the two categorization tasks, as we had initially considered these to be two separate experiments, albeit of a largely overlapping nature. On the other hand, our participant pool is practically identical from week to week in age, race, sex, and personality characteristics. Accordingly, and given a subset of the theoretical goals mentioned above, we combined the two data sets for present purposes. General procedures for the two sub-experiments were identical to those of Experiment 1.

Categorization Tasks

Whether categorizing stimuli by emotion or font color, the same instructions were administered. Participants were to categorize presented stimuli as quickly and accurately as possible. In the case of both tasks, the stimuli were the same. There were six anger-related words (anger, furious, irate, outrage, scornful, & violent) and six sadness-related words (depressed, gloomy, lonely, miserable, sad, & sorrowful), chosen on the basis of the prototype analysis of Storm and Storm (1987). Anger and sadness words were equal in word frequency, F (1, 5) = .00,

p = .97 and number of letters, F (1, 5) = .00, p = 1.00. Words were repeated multiple times to produce the desired number of trials.

Both tasks were programmed in e-Prime using the default red and blue font color options of the program and a mid-gray background was used. By importing stimuli into Adobe Photoshop software, we were able to confirm that the two font colors were prototypically red (CIE angle 0) and blue (CIE angle 240) and were equal in luminance (brightness) values. Stimuli were identical in size (18-point), were centrally displayed, response mappings were provided, a response box was used, and individuals were penalized with a 1500 ms visual error message in the case of inaccurate categorizations. A 150 ms blank interval followed each response and the presentation of the next stimulus to be categorized.

In the emotion-categorization task, words were categorized as anger- or sadness-related. In the color-categorization task, words were categorized in terms of whether they were red or blue in font color. In both tasks, responses were made using both index fingers by pressing the 1 or 5 keys of a response box, with response mappings counterbalanced across participants. Word stimuli and font colors were randomly assigned to trial number for both tasks. The number of trials involved did differ slightly across the tasks (192 for the emotion categorization task & 120 for the color categorization task), a design difference further considered in the Results section.

Results

Results Involving Categorization Speed

Reaction times were handled in a manner identical to Experiment 1, but separately so for the two tasks involved. Following such RT transformation procedures, response latencies were examined as a function of the 2 (Task: emotion categorizations versus font color categorizations) x 2 (Word Type: anger versus sadness) x 2 (Font Color: red versus blue) mixed-model design. It

was hypothesized that font color categorizations would be faster than emotion categorizations and this was the case, as revealed by a main effect for Task, F (1, 166) = 433.05 $p < .01$, partial eta square = .72 (*M*s = 463 ms & 809 ms, respectively). Thus, it was easier to categorize the same stimuli in perceptual rather than connotative terms, a result that comports with brain-based models of the time course of perceptual versus conceptual achievements (Rolls, 1999).

Main effects for Word Type, F (1, 166) = .71, $p = .40$, and Font Color, F (1, 166) = .18, $p = .67$, were not significant, nor were the Word Type by Font Color, F (1, 166) = 1.20, $p = .27$, the Task by Word Type, F (1, 166) = .20, $p = .65$, or the Task by Font Color, F (1, 166) = 1.00, $p = .32$, two-way interactions significant. What is particularly emphasized is that the implicit association of anger and perceptual redness (which would have involved a Word Type by Font Color interaction) was not robust across the two tasks. Instead, and as hypothesized, there was a significant Task by Word Type by Font Color interaction, F (1, 166) = 10.53, $p < .01$, partial eta square = .06.

To better understand the nature of the three-way interaction observed in Experiment 2, 2 (Word Type) x 2 (Font Color) repeated-measures ANOVAs were conducted for each task separately considered. In the emotion categorization task, main effects for Word Type, F (1, 87) = .62, $p = .43$, and Font Color, F (1, 87) = 1.11, $p = .30$, were not significant. The latter non-significant main effect establishes that the two colors manipulated were equally discernable. As hypothesized, however, there was a significant Word Type by Font Color interaction, F (1, 87) = 8.23, $p < .01$, partial eta square = .09. Means for this interaction are displayed in Figure 2. Follow-up pairwise comparisons established that anger categorizations were faster when the font color was red rather than blue, F (1, 87) = 7.25, $p < .01$, partial eta square = .08, but that font color did not have an impact on sadness categorization times, F (1, 87) = 1.04, $p = .31$.

In the follow-up ANOVA involving performance speed in the color categorization task, main effects for Word Type, F (1, 79) = .14, p = .71, and Font Color, F (1, 79) = .15, p = .70, were not significant. There was a marginal interaction of these two factors, F (1, 79) = 2.84, p = .10, but the pattern was very different than that found in the emotion categorization task. Indeed, when categorizing colors, there was some tendency for individuals to be slower to categorize stimuli as red in font color when the words were anger-related (M = 468 ms) rather than sadness-related (M = 457 ms) – a marginal interference effect rather than a facilitation effect. Means were 463 ms and 465 ms for the two remaining cells of the interaction – namely, sadness words presented in red and blue colors, respectively.

Recall that there were more trials in the emotion categorization task than in the perceptual categorization task. A supplemental analysis was thus performed in which task lengths were equated by using only the first 120 trials of the emotion categorization task. Again, there was a main effect for Task, F (1, 166) = 430.32, p < .01, partial eta square = .72, and the hypothesized three-way interaction remained significant, F (1, 166) = 9.22, p < .01, partial eta square = .05. Effects in the perceptual categorization task, which involved 120 trials, were necessarily the same as those reported above. In the emotion categorization task, main effects for Word Type, F (1, 87) = .13, p = .72, and Font Color, F (1, 87) = .68, p = .41, were not significant, but there was a significant Word Type by Font Color interaction, F (1, 87) = 6.71, p < .01, partial eta square = .07. Anger categorization times were faster when stimuli were red rather than blue, F (1, 87) = 5.72, p < .01, partial eta square = .06, but sadness categorization times did not vary by font color, F (1, 87) = 1.68, p = .20.

Results Involving Accuracy Rates

A parallel 2 (Task) x 2 (Word Type) x 2 (Font Color) ANOVA was conducted on accuracy rates. Because the tasks were designed to be sensitive to RT rather than accuracy, and because our primary interest in examining accuracy rates was to rule out potential speed-accuracy tradeoffs, lower-order effects are not reported. Of most importance, there was a significant Task by Word Type by Font Color interaction, F (1, 166) = 5.45, p = .02, partial eta square = .05. As in the case of reaction time tendencies, this three-way interaction was decomposed by performing repeated measures ANOVAs for each task condition separately considered.

In the emotion categorization task, there was a significant Word Type by Font Color interaction, F (1, 87) = 13.81, p < .01, partial eta square = .03. Anger categorizations were more accurate when the font color was red (M = 94.78%) rather than blue (M = 93.66%), F (1, 87) = 4.95, p = .03, partial eta square = .05, but sadness categorizations were more accurate when the font color was blue (M = 95.40%) rather than red (M = 93.87%), F (1, 87) = 11.75, p < .01, partial eta square = .12. Such results further reinforce the idea that anger and perceptual redness are implicitly associated, though they do suggest some association of sadness and perceptual blueness, a result further discussed below. In the color categorization task, by contrast, the Word Type by Font Type interaction was not significant, F (1, 87) = .02, p = .88.

Discussion

As in Experiment 1, anger categorizations were facilitated when such words were presented in a red font color. This implicit tendency to conceptualize anger in terms of perceptual redness appears to be a robust one as it was found across two different emotion concept control conditions (fear in Experiment 1 & sadness in Experiment 2) and two different font color control conditions (gray in Experiment 1 & blue in Experiment 2). Moreover, accuracy rates tended to

confirm an implicit anger-redness association rather than suggest a speed-accuracy tradeoff. This was especially the case in Experiment 2.

By contrast, our introduction to Experiment 2 should have made it clear that we were less certain as to whether a blue font color would facilitate sadness categorizations. Although “blue” is a synonym for sadness in the English language, we also presented reasons for doubting the generality of such implicit associations. In point of fact, the evidence for a sadness-blue mapping was mixed: Although reaction times did not favor such an association, accuracy rates did so. Further research on the possibility that sadness and the color blue are linked, then, can be advocated. In any case, all of our results are consistent with the idea that perceptual redness facilitates anger categorizations, the central hypothesis of our investigation.

Turning to a different purpose of Experiment 2, metaphoric associations are thought to be asymmetric in that conceptual representations borrow from perceptual representations but not vice versa (Lakoff & Johnson, 1999). Experiment 2 included a relatively direct test of this idea. Using the same stimuli in both conceptual and perceptual categorization tasks, it was found that anger categorizations were facilitated by a red font color, but categorizations of perceptual redness were not faster in the context of anger words. There are at least two ways of viewing such asymmetric effects and they seem compatible to us. From a metaphor representation perspective, abstract feeling states are to be explained, not perceptual experiences (Meier & Robinson, 2005). From a brain-based view, perception precedes conception and thus it is far more likely for perceptions to influence conceptions than vice versa (Dehaene et al., 2006; Rolls, 1999). Both such views assume that perception is the easier achievement and we found support for this idea in that the same stimuli were classified as red or blue much more quickly than they were emotionally categorized. In other words, it is perhaps *precisely* because color

categorizations are easier than emotion categorizations that we observed the asymmetric effects that we did. More difficult perceptual tasks might reveal that anger stimuli facilitate redness categorizations and we encourage this direction of future research, though such difficult perceptual tasks would seem somewhat unnatural to the perceptual environment.

General Discussion

Linguistically, people often refer to anger in terms of perceptual redness (e.g., "seeing red"). We pursued the idea that such linguistic expressions capture an important truth. Namely, they capture a deep mapping in which perceptual redness is recruited in understanding and conceptualizing anger even in the absence of a communication context. Specifically, we hypothesized that perceptually red stimuli would facilitate anger categorizations. This predicted effect was confirmed in two experiments involving two color control conditions (gray & blue) and two negative emotion control conditions (fear & sadness). In the General Discussion, we focus on theoretical considerations, potential reasons why anger and perceptual redness are linked, task considerations, and also highlight some brief directions for future research.

Theoretical Considerations

It is important to mention that metaphor representation theory (Lakoff & Johnson, 1999) is just that – a theory. Good theories account for important facts and make specific predictions. The metaphor representation theory fulfills such criteria. People very frequently think and talk about their experiences in metaphoric terms (Kövecses, 2000). Just how frequently they do so can be appreciated by noting that "closeness" is a surprisingly common way of conceptualizing and referring to intimate relationships (Williams & Bargh, 2008), that references to "seeing" are surprisingly common when people seek to characterize experiences of insight and understanding (Lakoff, 1987), and that the containment metaphor of "in" is remarkable for its extended use in

referring to states and relationship commitments that are not themselves based on any sort of containment within a physical space (Lakoff & Johnson, 1999).

An admirable feature of metaphor representation theory, further, is that it makes specific predictions: To the extent that linguistic metaphors are consistent (e.g., dominance being “up”, nice people being “sweet”, and so on), specific and novel predictions can be made. For example, Meier et al. (2012) were able to show that nice individuals, as defined in terms of the personality trait of agreeableness, actually did like sweet foods (e.g., chocolate cake) to a greater extent, but did not like spicy, sour, bitter, or salty foods to a greater extent. The metaphor linking niceness to sweetness, then, proved to be highly informative in generating novel empirical results. The present results should be viewed as supportive of a link between anger and perceptual redness that (a) is consistent with common linguistic metaphors, (b) had not been previously investigated, and yet (c) does not “prove” the theory that we drew from.

On the other hand, as findings consistent with this theory accumulate, the theory should be accorded more weight in future studies of affective processing and social functioning. In fact, predictions derived from metaphor representation theory (or related theories) have been supported in studies linking positive affect to perceptual lightness (Meier, Robinson, & Clore, 2004), dominance to higher vertical positions (Schubert, 2005), intimacy and perspective taking to perceptual closeness (Williams & Bargh, 2008), and morality to cleanliness (Zhong & Liljenquist, 2006). It is unlikely that such diverse results can simply be due to covariations in past experience, at least in a simplistic manner. For example, many very positive experiences (e.g., love-making or partying) occur after nightfall, a period of darkness. Such issues, though, should be discussed in a more nuanced manner, which we do next.

Why are Anger and Perceptual Redness Linked?

Of all the emotions, anger is quite likely the one that best predicts behaviors intended to physically harm another person (Berkowitz, 1993). Anger is thus an especially dangerous interpersonal emotion (Tavris, 1989). Perceptual redness signals danger in several contexts. Toxic plants and animals are often red-colored in nature. A particularly injurious portion of fire is red or orange in its coloration. Harmed individuals bleed and blood is red when it exits the body. It is not likely a coincidence, then, that red is used to signal danger in more symbolic contexts – such as red stop signs, stop lights, or fire trucks (Elliot & Maier, 2007). It is equally understandable, from this perspective, why anger metaphors frequently reference redness (e.g., “seeing red”), why red is viewed as angry in many cultures (Needham, 1973), and why the present experimental results involving anger categorizations were so robust in nature.

In addition, though, anger and redness might be linked for physiological reasons. Anger often produces facial flushing, which renders faces perceptually redder (Changizi et al., 2006; Drummond, 1997). On the other hand, facial flushing also occurs in non-angry states such as sexual excitement (Katchadourian, 1987). Perhaps, then, states considered passionate, a quality of both anger and sexual excitement, co-opt perceptual redness and this association has a possible physiological (and observable) origin. Regardless, our results supported a discrete perspective of the relevant results in that a red font color facilitated anger categorizations, but did not facilitate fear categorizations, though both states are negative/high arousal ones.

Task Considerations

The results should be viewed as quite distinct from emotional Stroop effects (for a review, see Williams, Mathews, & MacLeod, 1996). In an emotional Stroop task, emotional words (most typically threatening words) are presented in different font colors and the task is to name the font colors while ignoring the words. It is often observed that anxious individuals

exhibit slower color-naming performance when the words to be ignored are threatening in nature relative to non-threatening, a result that is not typically observed among non-anxious individuals (MacLeod, 1999). Our participants, however, were required to categorize emotional words, not name font colors. In addition, response facilitation rather than slowed reaction times were observed. Finally, results were specific to a given font color – red – that is metaphorically linked to anger, and were therefore not of the sort shown in emotional Stroop tasks, in which the actual font color is quite irrelevant to predictions (Williams et al., 1996). For all of these reasons, we suggest that emotional Stroop processes and findings are irrelevant to our results.

Similarly, our results are quite different from those reported in the color-word Stroop literature (see MacLeod, 1991, for a review). The Stroop effect is one in which individuals are slower to name font colors when the printed word in question is incongruent rather than congruent with the font color involved. By contrast, our participants were required to categorize emotional words, not to name font colors. In addition, our task did not manipulate response congruencies or incongruencies (MacLeod, 1991) in that font colors were irrelevant to the emotional categorizations to be made. Although Stroop-related facilitation effects have been observed, none of the relevant mechanisms proposed – inadvertent reading processes (Kane & Engle, 2003), convergence of sources of information (Melara & Algom, 2003), or lexicality costs (Brown, Gore, & Carr, 2002) can be viewed as relevant to our results. We manipulated font colors and reading processes are thus irrelevant. Convergence is defined in terms of a very direct overlap between irrelevant and relevant sources of information (e.g., the word red in a red font color) and our tasks did not involve such direct sources of overlap. Finally, the to-be-ignored source of information (font color) was not lexical and our results cannot therefore be understood

in terms of lexical processing costs. In sum, although our tasks involved font colors and words, results cannot be ascribed to emotional or color-word Stroop-like processes (De Houwer, 2003).

Our designs were within-subject designs, common to the cognition and affective processing literatures. The benefits of within-subject designs are several and we mention a particularly important one here. Within-subject designs control for individual differences in overall speed, which can be pronounced (Robinson & Oishi, 2006) and therefore a source of unwanted and uncontrolled noise. As to whether within-subject designs somehow reinforce associations of the present type, we do not think so. The fact is that word/color pairings were made on a randomized basis and there was thus no systematic relation between a particular emotion category (e.g., anger) and a particular perceptual color (e.g., red). It remains to be seen whether similar results might be found when manipulating color in a between-subjects manner, however, and this future direction of research might be advocated in examining boundary conditions.

Future Research Directions

We conclude by mentioning some directions for future research, albeit briefly so. It would be useful to examine whether the locus of our effects is more perception- or response-related, which can be done using electrophysiological measures and suitable paradigms (Luck, 2005). Although Lakoff (1986) suggested that metaphoric associations within a given culture are likely to be somewhat universal, we have found that such metaphoric effects vary by individuals in an informative manner (e.g., Meier & Robinson, 2006; Robinson, Zabelina, Ode, & Moeller, 2008). It would thus seem useful to determine whether individual differences in the magnitude of red-anger facilitation effects observed can be used to understand and predict individual differences in anger. A final direction of research follows from the work of Elliot and colleagues

(e.g., Elliot & Maier, 2007). It would be informative to the social psychology literature to determine whether perceptual redness cues result in higher levels of anger, social judgments related to anger, or aggression. We view individuals, as do Gibbs (1994) and Lakoff and Johnson (1999), as subtly yet profoundly trapped by their conceptual metaphors. If so, manipulations of perceptual redness are likely to influence anger-related judgments and outcomes beyond those found in the present investigation.

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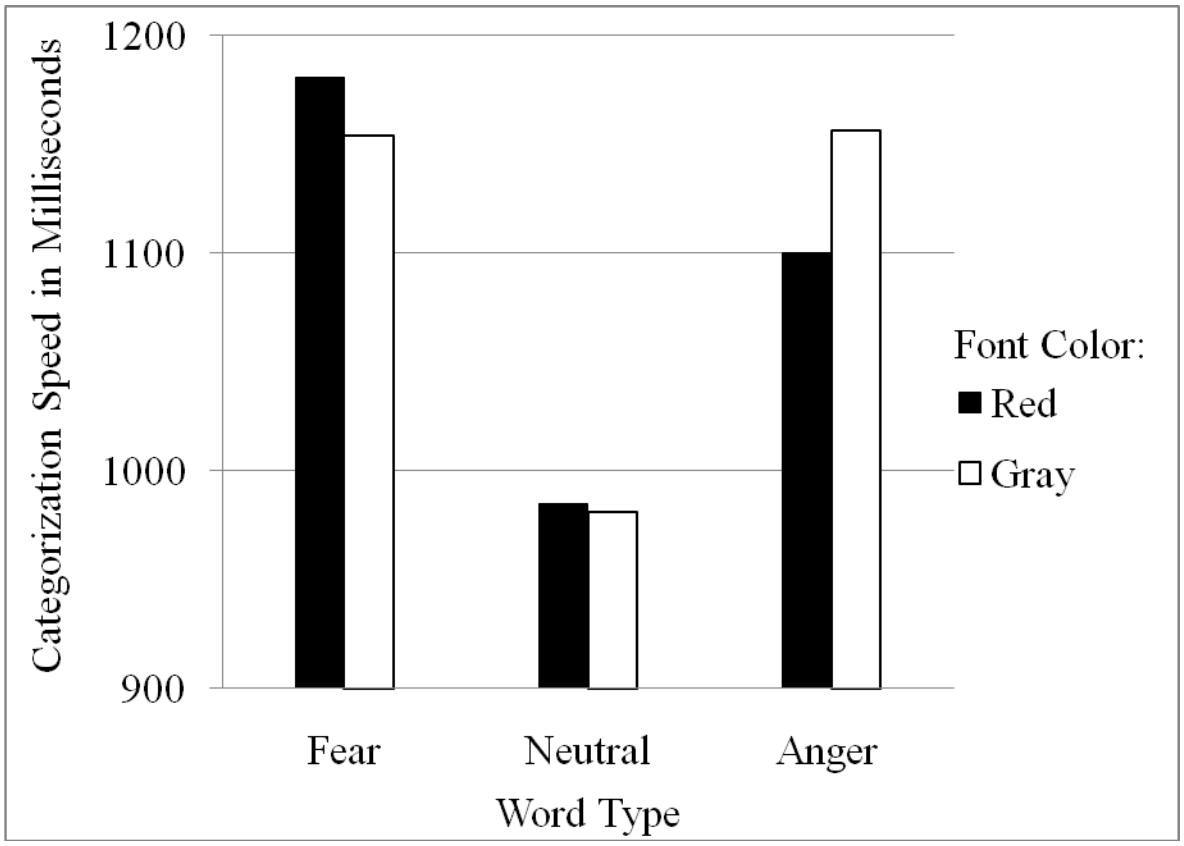
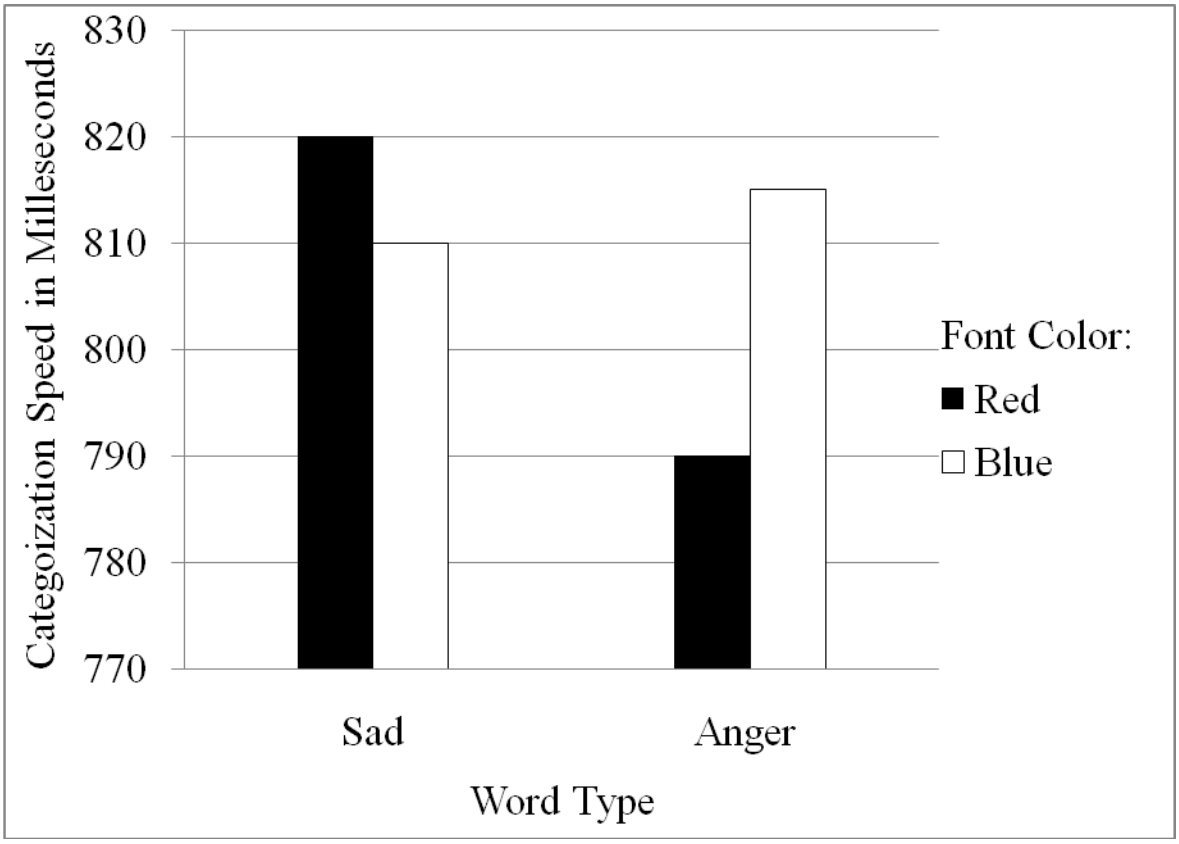
Figure Captions

Figure 1. Emotion Categorization Speed as a Function of Font Color, Experiment 1

Figure 2. Emotion Categorization Speed as a Function of Font Color, Experiment 2


Categorization Speed in Milliseconds
1200
1100
1000
900
Fear
Neutral
Anger
Word Type
Font Color:
Red
Gray


Categoization Speed in Milleseconds
830
820
810
800
790
780
770
Sad
Anger
Word Type
Font Color:
Red
Blue