I'M SEEING RED! LITERALLY:

THE EFFECT OF METAPHORIC REPRESENTATION ON PERCEPTION

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The Supervisory Committee certifies that this ***disquisition*** complies with North Dakota State University's regulations and meets the accepted standards for the degree of

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ABSTRACT

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Metaphor is often used to represent abstract concepts using concrete domains (Lakoff & Johnson, 1980). One set of metaphors that has long been of interest, but seldom studied, is the set of those linking color and emotion. Specifically, red and anger are often linked in everyday language and popular media. There is a recent body of work on metaphoric representation processes, yet none of it has focused on color perception. The present studies investigate the effects of priming anger-related concepts and experiences on the visual perception of color. It was predicted that participants would perceive degraded color screens as red following the activation of anger-related thoughts (Study 1) and when made angry (Study 2), consistent with the "seeing red" metaphor for anger. Both hypotheses were supported. Implications of the findings are discussed.

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INTRODUCTION

"When you're singled out,

The red, well it filters through.." – "Red" by Chevelle (2002)

The association of red and anger is seen in society and popular culture. People often use the phrase "I'm seeing red" or "I'm feeling blue" to refer to being angry and sad, respectively. Likewise, people are often described as "red with rage" or "red with anger". In addition, there are many songs about anger that reference this association (i.e. "Red" by Chevelle). More broadly, red seems to be associated with things that are negative, arousing, and aggressive (Lakoff, 1987). For example, warning lights and fire trucks tend to be red. In fact, a "level red" represents the highest level of security threat in the US. Thus, red appears to be commonly used to represent experiences of arousal and anger. Given these seemingly widespread associations, is it the case that people are actually subjectively "seeing red" when they are aroused with anger? The purpose of these studies was to answer this question.

Metaphor and Cognition

Metaphor is used to represent abstract concepts in terms concrete referents (Lakoff & Johnson, 1980). Abstract in this context means a concept that has no direct perceptual experience – i.e. it cannot be seen, heard, tasted, measured, or weighed. Along these lines, it has been pointed out how frequently metaphors are used to represent our emotional experiences, which are otherwise private intrapsychic events (Crawford, 2009; Meier & Robinson, 2005). The fact is that humans are not born with the ability to think in abstract ways. These abilities are developed through experience (Piaget & Inhelder, 1969). Piaget and Inhelder (1969) suggest that cognition begins with sensorimotor experiences, and the ability to think in abstract ways must necessarily build upon this earlier concrete form of thinking. For example, when a mother holds her child, the child feels good and warm. Subsequently, the child comes to represent nurturing in terms of warmth. Indeed, a "warm" person is caring and empathetic. While concrete perceptions can be used to represent abstract concepts, the opposite is not so (Gibbs, 1994). For example, we do not use expressions such as "my hand feels red!" when touching a hot stove; rather, we just say "my hand feels hot!"

While some believe that metaphors are nothing more than figures of speech (Glucksberg, Keysar, & McGlone, 1992), Lakoff and others theorize that people use metaphors to make sense of or effectively communicate abstract concepts such as emotions and affect (Lakoff, 1987; Lakoff & Johnson, 1980; Crawford, 2009; Landau & Meier, 2009). Even more dramatically, Lakoff speculates that representational metaphors are so vital to human cognition that without physical reality, we could not think. If this is so, then we might expect quite surprising effects related to the manner in which metaphor shapes cognition.

Recent studies have pursued this radical view of metaphor and have, indeed, found some surprising results (Landau & Meier, 2009). Researchers have created social cognitive paradigms that explore congruency effects in reaction time. Meier and Robinson (2004) found that people were faster to evaluate positive/negative words when presented in metaphorically consistent high/low vertical positions, consistent with "good is up/bad is down" metaphors. Likewise, Meier, Robinson, and Clore (2004) found that participants were faster to evaluate positive/negative words when presented in metaphorically consistent white/black fonts, consistent with "good is bright/bad is dark" metaphors. With respect to "bigger is better" metaphors, it has been shown that people are faster to evaluate words as positive/negative when presented in metaphorically consistent big/small font sizes (Meier, Robinson, & Caven, 2008). Following theories of implicit narcissism, individuals were faster to evaluate self/other words when presented in big/small font sizes (Fetterman, Robinson, & Gilbertson, 2010). These findings have been shown to be automatic in certain respects. However, all of these effects involved relatively subtle differences in reaction time. As such, there may or may not be any relationship between metaphor and how the world is perceived (e.g. "seeing red").

There is some research on embodied perception, most of it focusing on the attribute of perceptual size. In one direction, seemingly consistent with bigger is better metaphors, neutral words were evaluated more positively when presented in a larger font size (Meier et al., 2008). The size-evaluation association seems to work in the opposite direction as well. That is, people perceived positive things as larger. In an intriguing early study along these lines, poor children were shown to perceive coins as larger than cardboard disks that were actually the same size (Bruner & Goodman, 1947). One explanation for this phenomenon has been termed the Functional Perception Hypothesis (Bruner, 1957): People will see things as larger as their utility is increased. Consistent with this hypothesis, participants were shown to perceive a glass of water as larger when thirsty (Veltkamp, Aarts, & Custers, 2008), ball players that had a higher batting average reported that the ball was larger (Witt & Proffitt, 2005), and dart-throwing ability was correlated with the perceived size of the target (Wesp, Cichello, Gracia, & Davis, 2004).

Furthermore, there are studies suggesting that representational metaphors may influence social perceptions/behaviors. Frank and Gilovich (1988) found that athletes were perceived as more aggressive when wearing dark uniforms and actually received more penalty minutes when wearing them (consistent with negative is dark metaphors). Zhong and Liljenquist (2006) found that priming individuals with dirtiness led to harsher moralistic judgments (consistent with immoral is dirty metaphors). Finally, Meier, Hauser, Robinson, Friesen, and Shjeldahl (2007) found that pictured individuals were judged to believe in God to a greater extent when their pictures were presented higher on a computer screen (consistent with holy is up metaphors).

Emotion, Color, and Metaphor

Most of the perceptual effects reviewed above involved perceptual size, vertical position, or other environmental coordinates. The research has accordingly neglected more qualitative aspects of perception such as perceived color. The psychology of color has a long history, but of a very speculative applied/aesthetic type (Elliot & Maier, 2007). The lack of systematic research on metaphor and color is unfortunate given the richness of such metaphors and their seeming ubiquity (Lakoff & Johnson, 1980).

From our perspective, another problem with the historical treatment of emotion in color psychology is that the emotion-color links that were proposed were very specific and somewhat naïve from a modern perspective of emotion. In particular, they adopted a discrete emotions perspective, in which each emotion is seen to be an entity entirely to itself. We now know that the discrete emotions perspective does not adequately capture relationships among different feelings and their more fundamental dimensional nature (Russell, 1997). Research has demonstrated that all emotions can be conceptualized as occurrences within a two-dimensional Euclidean space (Barrett & Russell, 1999). The two dimensions are valence (positive vs. negative) and arousal (aroused vs. non-aroused) (Barrett & Russell, 1999; Mauss & Robinson, 2009). From a dimensional perspective, making fine-grained distinctions between emotions that occupy the same region in the two-dimensional space (e.g. contempt vs. disgust, shame vs. guilt, sadness vs. boredom) is likely counterproductive as a representation of how people experience their emotions.

These points are particularly apt when thinking about color psychology because many of the emotion-color links proposed were almost arbitrarily specific (e.g. "green with envy", "yellow with cowardice"). Metaphors involving black, white, and red seem to be universal, but beyond that it is difficult to discern any systematic pattern (Lakoff, 1987). There appears good evidence to link black and white to the valence dimension. Specifically, white and black (or light and dark) represent good and bad, respectively, in representational metaphors (Lakoff & Johnson, 1980), universally so (Adams & Osgood, 1973; Lakoff, 1987). Moreover, empirical evidence from social cognition studies is supportive of such an association at the implicit level of processing (McArthur & Post, 1977; Frank & Gilovich, 1988; Meier et al., 2004; Meier, Robinson, Crawford, & Ahlvers, 2007; Sherman & Clore, 2009). Of particular interest to the present studies, Meier et al. (2007) found that positive words were perceived as brighter than negative words. Thus far, color mappings for the arousal dimension have been neglected and/or more speculative. However, there may be reason to think that red and blue are used to conceptualize high and low arousal states, respectively.

The psychological significance of the color red has a recent history. Elliot and colleagues initially focused on red as representing negativity. They noted that red can be seen as a warning signal that requires a response, typically of avoidance (Elliot & Maier, 2007; Elliot, Maier, Moller, Friedman & Meinhardt, 2007). Consistent with an avoidance theory of red, stop signs, stop lights, tail lights, railroad crossing lights, and fire trucks are all red. Also consistent with an avoidance theory of red, Elliot, Maier, Binser, Friedman, and Pekrun (2009) found that people moved away from red test covers in spatial terms.

However, it appears that red may have more to do with arousal in general than negativity or avoidance. That is, people typically associate red with aggression *and* excitation (Hemphill, 1996). Maier, Barchfeld, Elliot, and Pekrun (2009), indeed, found that red can be preferable in a hospitable context, but not in a hostile context. Obviously, the former finding is problematic for a simplistic avoidance theory of red. Also problematic for an avoidance theory of red, Elliot and Niesta (2008) found that women wearing red were viewed as more sexually attractive. It may be that red symbolizes not negativity, but rather arousal. This would explain why red leads to avoidance motivation in an aversive context (Elliot et al., 2009), but seemingly high levels of approach motivation in an appetitive context (Elliot & Niesta, 2008). Of course, it would be desirable to test this arousal theory more directly, which the present studies attempted to do.

We have suggested that red is often used to reflect high levels along the arousal dimension. There are reasons for thinking that the opposite side of the dimension may be implicitly represented as blue. This would explain why the word "blue" is literally used to refer to sadness, a low arousal state (Barrett & Russell, 1999). Similarly, "the blues" is a type of music characterized by a slow tempo and disconsolate themes. Just as the red-arousal link does not seem valence-specific, though, a similar case can be made in relation to the blue-low arousal link. Blue is often used to conceptualize states of tranquility and peace (Lakoff & Johnson, 1999). The primordial root of such red-blue metaphors is likely that fire, a very active element, is red, whereas ice, a very inactive element, is blue (Lakoff, 1987).

There are some preliminary results in support of these associations. Fetterman, Robinson, and Meier (2010) presented anger and sadness words in either a red or blue font color. Their prediction was that when presented in a red font, anger words would be categorized as such faster and more accurately. This hypothesis was supported in two studies. These results provide initial evidence for the idea that there is an implicit association between red and anger. However, reaction time data are not perceptual data, the focus of the present studies.

Overview of Studies

Arousal is a fundamental dimension of experience. A case was made that people conceptualize high arousal states in terms of redness and low arousal states in terms of blueness. Among other consequences, this would explain the common phrases "seeing red" and "feeling blue". It is contended that such mappings are pre-linguistic in nature and sufficient to alter one's subjective perceptual experiences. Therefore, it was hypothesized that those primed with anger-related words (Study 1) would perceive a slightly saturated colored screen as red more often. Furthermore, those primed with anger-related words would be faster to identify the screen color when it was, in fact, red.

Some emotion scholars (Clore, Wyer, Dienes, Gasper, Gohm, & Isbell, 2001), and even some affect-metaphor scholars (Crawford, 2009), believe that emotion concepts, but not experiences, are fundamental to affective priming effects (e.g., mood dependent recall). Others disagree, instead believing that emotional experiences, themselves, activate experience-consistent thoughts and perceptions (Bower, 1981; Innes-Ker & Niedenthal, 2002). Such considerations set the stage for Study 2, in which individuals were irritated without priming affective concepts. Because Lakoff (1987) believes that metaphoric mappings are pre-linguistic in nature, it was hypothesized that the experience of anger would bias perception in a red direction without any linguistic context. Such effects were hypothesized to reflect biased responding, regardless of the color actually presented.

STUDY 1

Study 1 sought to evaluate whether people primed with anger-related words would be biased toward seeing red. It was also hypothesized that priming individuals with sadness-related words would bias them toward seeing blue. In other words, a crossover prime type (anger vs. sadness) by screen color (red vs. blue) interaction was predicted.

Method

Participants

Seventy-eight participants (47 female) were recruited through SONA internet software, primarily from an introductory psychology course at North Dakota State University. They completed the experiment for class or extra credit. Each participant was assigned to a personal computer.

Stimuli

Each trial primed a particular anger- or sadness-related word, which have been validated in previous studies (Fetterman et al., 2010; Wilkowski, Meier, Robinson, Carter, & Feltman, 2009). There were six stimuli for each emotion category (anger: anger, furious, irate, outrage, scornful, violent; sadness: depressed, gloomy, lonely, miserable, sad, sorrowful).

Color patches were created using Adobe Photoshop software. First a 4" x 4" white patch was made. Using the fill tool, the patch was saturated with red or blue 1% at a time. Once the patches were created, colleagues were run through a brief color identification task and accuracy rates were collected. At the level of 4% red saturation and 2% blue saturation, people were 75% accurate in each case. This was deemed an ideal accuracy rate, somewhat midway between chance and perfect responding. Therefore, the color patches at 4% red and 2% blue saturation were used in the study. In order to reduce contrast between the patches and the background, the patches were made large enough to fill the screen.

Procedures

Participants signed up using the online system by finding the experiment named "Categories and Colors Study". Upon entering the lab, participants were told that this study is about basic cognitive processes. After signing an informed consent form, participants were instructed to take a seat at one of six personal computers. Once the EPRIME program started, instructions appeared and read as follows:

> "We are interested in your ability to do two tasks at once. For each trial, you will be given a word to categorize and then be asked to identify a color represented in a screen. In the first part of the trial, a word will appear at the center of the screen. It is your job to say whether the word is an anger-related word -- by saying "anger" -- or a sadness-related word -- by saying "sadness" -- into the microphone. Your answers will be recorded and reviewed for accuracy. In the second part of the trial, you will be asked to do a very different type of perceptual task by categorizing a color screen as red or blue by pressing the 1 or 5 key on the button box accordingly (we will tell you which color is which response once the trials begin). It is important to emphasize that there will always be a correct answer for both tasks so please answer as quickly and accurately as possible. Please press 1 or 5 to begin."

The directions were worded in such a way that the participant should have no reason to think that the two tasks have anything to do with each other. Furthermore, the mundane nature of the tasks should give no indication of the purpose of the study.

After being seated at a private computer, the experimenter assigned the participants a subject number, asked the participants to put on pair of headphones with an attached microphone, and started the program. Using a within subject design, each participant was exposed to all conditions repeatedly and equally for a total of 120 paired trials.

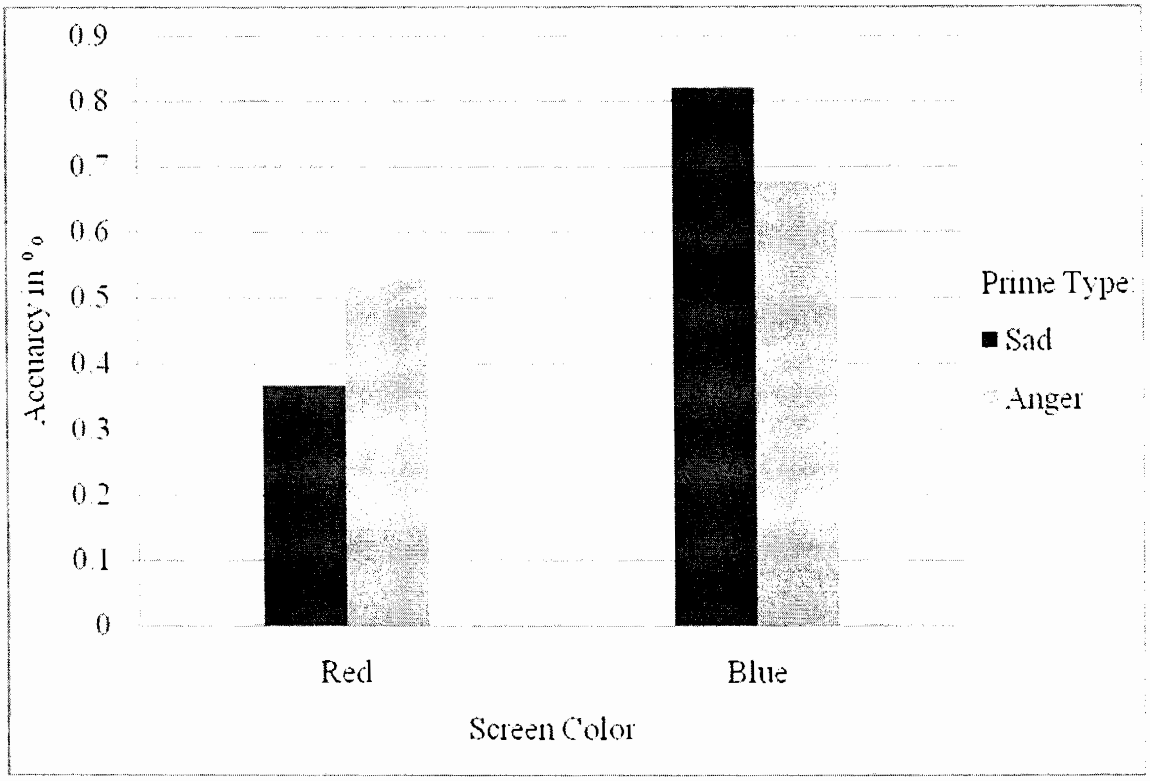
The structure of the trial was such that first a word appeared in the center of the screen. The word was either a sadness- or anger-related one described in the stimuli section. The participant categorized the word vocally, as indicated in the instructions. They were required to vocalize a response for every trial, though in fact, accuracy data was not collected. After a 200 ms delay, the screen turned one of the two saturated colors, as described in the stimuli section. The mappings were counterbalanced such that some participants made a "RED" ("BLUE") response by pressing the 1(5) key, with these mappings reversed for the other half of the sample. The mappings for each computer were labeled on the button box and the participants were required to correctly identify the button corresponding to each color response. After discerning the color of the screen for a particular trial, a 500 ms delay occurred and the next trial subsequently began. Reaction time (RT) and accuracy information was recorded for each trial.

Results

Prior to analyzing the data, average levels of RT and accuracy were scanned for each individual participant. Those responding with the same key on every trial were deleted. In addition, those with color identification accuracy rates of less than 45% were deleted. The resulting number of participants was 44 (27 female).

To test the interactive hypothesis, a repeated measures analysis was used. Specifically, accuracy rates for the color identification task were examined as a function of a 2 (prime type) x 2 (screen color) ANOVA. Although we had tried to equate the stimuli, there was a significant main effect of color, $F(1,43) = 30.05$, $p < .01$, such that accuracy rates were higher when blue screens (74.92%) relative to red screens (44.81%) were presented. There was no main effect of prime type, $F < 1$, nor was one hypothesized. Of most importance, there was a significant interaction, $F(1,43) = 10.25, p < .01$ (means presented in Figure 1). Thus emotion concepts altered perceptual processes, a remarkable phenomenon.

Figure 1: Accuracy Rates for the Prime Type by Screen Color Interaction, Study 1



To understand the nature of the interaction, pairwise comparisons were performed. As predicted, participants more accurately saw the screen as red when primed with a metaphorically consistent anger- (vs. sadness-)related word, $F(1,43) = 9.95, p < .01$. Also as predicted, participants more accurately saw the screen as blue when primed with a metaphorically consistent sadness- (vs. anger-)related word, $F(1,43) = 9.29, p < .01$. These findings are, therefore, supportive of the specific predictions.

In addition, RT results were also tested. Inaccurate (40%) responses were deleted. To curb the influence of exceptionally fast or slow responses (Robinson, 2007), we replaced log-transformed times 2.5 *SD*s below or above the grand latency mean with these values (2.7% replaced). As with accuracy rates, a 2 x 2 ANOVA was conducted. There were no main effects for either prime type, $F(1,43) = 1.56, p < .21$, or screen color, $F(1,43) = 2.55, p < .11$. However, the predicted interaction was found, $F(1,43) = 12.00, p < .01$. Participants were significantly faster to correctly identify the screen as red when primed with anger- (vs. sadness-) related words, $F(1,43) = 4.88, p < .05$ (Anger: $M = 761$ & Sadness: $M = 902$). Furthermore, participants were significantly faster to correctly identify the screen as blue when primed with sadness- (vs. anger-) related words, $F(1,43) = 10.26, p < .01$ (Anger: $M = 905$ & Sadness: $M = 687$). Again, these findings are supportive of implicit associations of anger and perceptual redness.

Sensitivity versus Bias

An important aspect to interpreting the accuracy results is whether the effects reflect bias or sensitivity. If the effects reflect sensitivity, then it would appear that something at a lower, physiological, level is being affected by the emotion primes. This seems unlikely. What is more likely is that the effects of emotion priming are creating a bias in which the participants think they are seeing red. To examine such processes, the average proportions of red responses were scored. These means were analyzed as a function of a 2 (prime type) x 2 (screen color) ANOVA. A two-way interaction would be reflective of an effect on sensitivity. Particularly, following anger (sadness) primes, a greater proportion of red responses would occur for red screens and a *lesser* proportion of red responses would occur for blue screens. This was not the case, as the prime type x screen color interaction was not significant $F < 1$.

There was a main effect of screen color, $F(1,43) = 68.46, p < .01$. This effect reveals that the red and blue stimuli were perceptually distinct, in that a higher proportion of red responses was given to red screens (61.70%) relative to blue screens (35.61%). In addition, there was a main effect of prime type, $F(1,43) = 11.46, p < .01$. The latter is a bias to see screens as red more frequently when anger primed (56.67%) than sadness primed (40.64%), irrespective of the actual screen color.

Discussion

Recall that pilot testing had revealed that a 4% saturation of red was necessary to produce accuracy comparable to a 2% saturation of blue. This difference is understandable in terms of the principles of colorimetry. Specifically, the saturation occurred within the context of a white background, which is closer in the perceptual color space to blue than red (Nimeroff, 1968). The pilot test sought to correct for such factors, but there was still a residual bias to blue relative to red. This is likely so because the pilot test involved fewer participants and therefore underestimated the size of the better discriminability of blue superimposed on a white base.

Of more importance the results provide initial support for the idea that individuals are biased to perceive red when primed with anger-related words. Moreover, being primed with sadness-related words biased individuals' perception to seeing blue. It was also shown that these effects were of a psychological type, not of a low-level sensory type. The findings may be explained by the theory that emotion concepts activate metaphorically consistent thoughts and perceptions (Clore et al., 2001; Crawford, 2009). Although the findings of Study 1 are entirely novel, it would be more impressive if the same effects were found when the emotion of anger itself was evoked, thereby bypassing semantic factors.

STUDY 2

As indicated above, there are disagreements as to whether emotional experiences themselves, in the absence of semantic labeling, activate emotion consistent thoughts and perceptions. Lakoff's (1987) theory suggests that they do. Accordingly, the manipulation in Study 2 was non-linguistic in nature. A similar interaction was hypothesized.

Method

Participants

A new sample of 97 participants (29 female) was recruited in the same fashion as in Study 1.

Stimuli

For many years now, the aggression literature has used noise blasts to provoke individuals, precisely so because of their noxiousness (see Bettencourt, Talley, Benjamin, & Valentine, 2006 for review). Thus, the manipulation seemed ideally suited for Study 2's purposes. Nevertheless, it was also deemed useful to ensure that the specific noise parameters to be used – a 4000 ms exposure of an 80 dB white noise sound – arouse levels of irritation and anger. For pilot testing purposes, a separate set of participants were presented with 20 noise blasts and 20 silent intervals of an equal duration, following each of which they reported on their current levels of "irritation" and "anger". Repeated measures ANOVAs revealed strong effects of the noise manipulation on both irritation and anger, $Fs > 190$. Therefore, 80 dB noise blasts were used to provoke anger in the current study. The same color patches from Study 1 were used to fill the screen in Study 2 as well.

Procedures

Participants signed up using the online system for a study called "Sounds and Colors Study". Upon entering the lab, participants were told that the study is about basic perceptual processes. After signing an informed consent form, participants were instructed to have a seat at one of six personal computers. Once the EPRIME program started, instruction appeared and read as follows:

> "In this study, we are interested in your ability to alternate between two different perceptual tasks. In the first part of each trial, you will listen to sounds or non-sounds over headphones. In the second part of the trial, you will be asked to do a very different type of perceptual task by categorizing a color patch as red or blue by pressing the 1 or 5 key on the button box accordingly (we will tell you which color is which response once the trials begin). It is important to emphasize that there will always be a correct answer so please answer as quickly and accurately as possible. Please press 1 or 5 to begin."

The experimenter assigned a subject number, asked the participants to put on pair of headphones with an attached microphone, and started the program. Using a within subject design, each participant was exposed to all conditions repeatedly for a total of 120 paired trials. The manipulation in Study 2 involved whether or not a 4000 ms noise blast of 80 dB was presented for the individual trial. In the case of no noise, there was a 4000 ms blank screen instead. Participants then, after a 300 ms delay, were presented with a color screen. RTs and accuracy information were recorded for each trial.

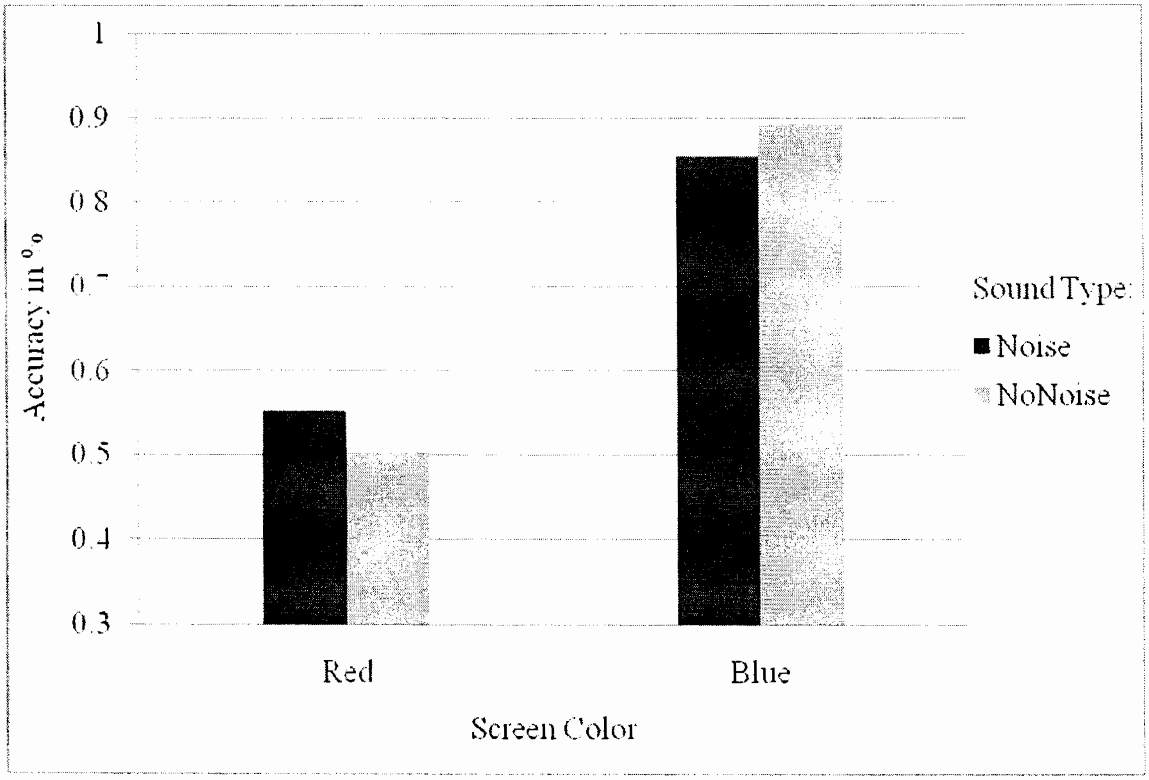
<u>Results</u>

Participants were removed if they did not exhibit different responses across trials (e.g. responding "1" for every trial). In addition, participants whose accuracy rates were below chance were deleted. This left 81 (20 female, 6 unidentified) participants total.

Accuracy was then examined as a function of a 2 (sound type) x 2 (screen color) ANOVA. Like Study 1, there was a significant main effect of screen color, $F(1,80) =$

108.85, $p < .01$, such that participants were more accurate to blue (87.34%) relative to red (52.80%) screens. There was no main effect of sound type, $F < 1$. However, there was a significant 2 (sound type) x 2 (screen color) interaction, $F(1,80) = 8.15$, $p < .01$ (means presented in Figure 2).

Figure 2. Accuracy Rates for the Sound Type by Screen Color Interaction, Study 2



As can be seen in Figure 2, noise (vs. no noise) lead individuals to perceive red screens more accurately, $F(1,80) = 6.98$, $p < .01$. Furthermore, participants were more accurate recognizing the screen as blue when they heard no noise (vs. loud noise) and this was also significant, $F(1,80) = 6.56$, $p = .01$. The latter reversal was not anticipated, but can be understood in the context of our dimensional model, in which blue represents low arousal (here, no noise).

Prior to the analysis of RT, data were cleaned. First, inaccurate (30%) responses were deleted. Second, we replaced log-transformed times 2.5 *SDs* below and above the grand latency mean with said values (2.4% replaced). Then a 2 x 2 ANOVA was performed. There were main effects of noise type, $F(1,79) = 56.40$, $p < .01$, and screen color, $F(1,79) = 32.78$, $p < .01$. The main effect of noise type indicated that participants were faster to respond in the loud noise condition ($M = 1108.68$), as opposed to the no noise condition ($M = 1291.77$). The main effect of color indicated that participants were faster overall to blue ($M = 1064.99$), as opposed to red ($M = 1335.46$). The latter results are consistent with the greater perceptibility of blue.

The noise type x screen color interaction was also significant, $F(1,79) = 6.54$, $p = .01$. As predicted, participants were significantly faster to correctly identify the screen as red when exposed to a noxious noise (vs. no noise), $F(1,79) = 30.91$, $p < .01$ (loud noise: $M = 1194.21$ & no noise: $M = 1476.71$). However, the main effect for noise also rendered participants faster to correctly identify the screen as blue when there was noise (vs. no noise), $F(1,79) = 13.57$, $p < .01$ (loud noise: $M = 1023.15$ & no noise: $M = 1106.83$).

Sensitivity versus Bias

Further analyses were conducted to understand the accuracy related results. Specifically, scores were computed to reflect the percentage of red responses as a function of noise type and color screen. These means were then entered into a repeated measures ANOVA. To the extent that the priming effects are due to low level perceptual processes, an interaction should be observed such that a greater proportion of red responses should follow noise, but a lesser proportion of red responses should follow non-noise. No such interaction was observed, $F < 1$.

We regarded it as more likely that noise biases the individual to perceive red, regardless of the actual color involved. Indeed, this was the case as the main effect of noise type was significant, $F(1,81) = 8.35, p < .01$. As hypothesized, a greater proportion of red responses occurred following noise (35.00%) than in the no noise condition (30.49%). There was also a main effect of screen color, $F(1,81) = 157.77, p < .01$, such that a greater proportion of red responses was given to red screens (52.80%) than to blue screens (12.65%).

Discussion

The main effect of screen color was particularly pronounced in Study 2. This is not a problem for the interactive hypotheses, but does suggest further fine tuning of stimuli may be useful in paradigms such as the present one. Although certainly of lesser emphasis, an interaction on reaction time was found, such that the anger induction facilitated responding to red screens over blue screens, to a greater extent than did the non anger condition. That people were faster overall following noise blasts is consistent with the behavioral activation component of anger (Carver & Harmon-Jones, 2009).

Additionally, it appears that the experience of anger itself can activate metaphoric thoughts and bias perceptions (Bower, 1981; Innes-Ker & Niedenthal, 2002). That is, when made angry (or aroused) participants were biased toward seeing red. Because this was true irrespective of lower level sensory contributions, the effects implicate higher level psychological processes instead.

GENERAL DISCUSSION

Traditional thinking on metaphor is that it constitutes colorful poetic language that is used to impress an audience (Davidson, 1979). Lakoff's (1987) more recent contention is that metaphor is about *thought* rather than language. That is, even in the absence of a communication context, people understand their experiences by likening them to physical referents. Striking support for this metaphor representation theory has recently been reported, but very little of it involves actual changes in the way in which the world is viewed (i.e. perception). This was the aim of the two studies presented here.

Overview of Results

In Study 1, participants were primed with either anger- or sadness-related words and then asked to identify a degraded screen color as either red or blue. In this study, while participants had an overall propensity to respond blue, the hypotheses were supported. That is, when primed with an anger (vs. sadness) word, they were more accurate and faster to correctly identify the screen as red. Sadness primes, on the other hand, facilitated the recognition of blue. It was further shown that these priming-effects were of a subjective sort. That is, anger did not facilitate seeing red, but did lead individuals to perceive red even when it did not exist. Because there was no communication context, the results are consistent with Lakoff's (1987) assertion that people think in metaphors. However, given the linguistic nature of the primes, the effects could be broadly semantic rather than directly implicating the use of metaphor to understand experience.

To investigate whether these effects can be found pre-linguistically, as proposed by Lakoff and Johnson (1999), Study 2 sought to investigate if the findings would replicate when emotional states were elicited. To induce emotion, participants were blasted with a loud irritating sound on some trials and not others. The results of Study 2 conceptually replicated those of Study 1, in that angry states led to more accurate and faster recognition of red screens than did non-angry states. The results were again symmetrical in that non-angry states facilitated identification of the color blue, relative to anger states. This second finding lends further support to the idea that people implicitly represent high and low arousal along a red-blue continuum. As in Study 1, the effects involved subjective perception rather than low-level visual processes.

The patterns of findings across these studies are highly informative concerning how metaphor operates. Lakoff and Johnson (1999) contend that metaphor is used by the brain to characterize the neural state involved, pre-linguistically so. On the other hand, Crawford (2009) follows earlier thinking (Clore et al., 2001) in suggesting that emotional experience itself – i.e., as an unlabeled quale – has no conceptual or representational function of any type. Given the results of Study 2, it appears that metaphor extends beyond semantics as no semantic primes occurred. Thus, the evidence presented here leads to the conclusion that Lakoff and Johnson's (1999) experiential postulate is correct.

Implications, Future Directions, & Limitations

The extent to which metaphor biases perception should be more extensively investigated. Meier et al. (2008) found that people were faster to evaluate words as positive/negative when presented in a large/small font, consistent with "bigger is better" metaphors. To the extent that actual perceptual processes are involved, one may predict that this type of metaphor should have wider implications. As an example, a preferred pen may seem larger than a non-preferred one. Moreover, if one is extremely self-centered, one may report oneself as "larger" than others, in accordance with Fetterman et al.'s (2010) findings regarding self/other categorization times. In short, the present findings open up a cornucopia of future directions.

Indeed, that emotion alters perception is consistent with a recent body of findings. In one study, fear was shown to affect how one perceives height, in that those made fearful viewed downgrades as steeper (Stefanucci, Proffitt, Clore, & Perekh, 2008). In another study, individuals with acrophobia perceived a greater distance to the ground than a control group (Stefanucci & Proffitt, 2009). In a third study, Pijpers, Oudejans, Bakker, and Beek (2006) showed that anxiety was associated with reduced perceived, and actual, capabilities to reach out for higher hand-holds. Finally, when loaded with cumbersome objects, people perceived the same distances as further away (Proffitt, Stefanucci, Banton, & Epstein, 2003). It is hoped that a rapprochement of metaphoric and resource based (Proffitt et al., 2003) views of emotion might be facilitated in the future.

Finally, an additional implication is related to false memories. The research of Elizabeth Loftus provides insight into the formation of false memories (see Loftus & Pickrell, 1995). In one instance, Loftus & Palmer (1974) provided evidence that using certain words affected how people remembered an automobile crash. From these types of findings, she has been able to provide a compelling case of the problems of eye-witness testimony (Loftus, 1979). The present findings highlight an additional potential memory bias. For example, after being assaulted, our findings would suggest a perceptual distortion in favor of red objects (e.g., "I think he wore a red shirt"). Future studies might profitably investigate metaphoric biases of this type.

There are a couple limitations of the studies and they involve the stimuli. There was a tendency for participants to default to responding blue, owing to color saturation within a white background context. In future studies, it might be better to take fully saturated colors and vary the relative proportion of red and blue hue. Furthermore, this might assuage participants that there is an actual correct answer, in turn facilitating engagement with the task.

Beyond the limitations, the hypotheses were supported. That is, the metaphor of "seeing red" when angry goes beyond a mere figure of speech. Indeed, when primed with anger or made angry, individuals did think they were perceiving red. These findings open up a new avenue for understanding the wide scope in which human cognition may be metaphoric in nature.

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