The Chill of Fear:

Can Experiencing Fear Affect both Our Judgments of Ambient Temperature and Our Physical Skin Temperature?

Danielle J. Landau

Barnard College of Columbia University

Author Note

Mentor: Joshua I. Davis, Department of Psychology, Barnard College of Columbia University; Advisor: Larry Heuer, Department of Psychology, Barnard College of Columbia University.

Abstract

"It was a *chilling* account" is one of many metaphors using cold temperature terminology to describe fearful situations. The present study sought to explore whether or not these metaphors reflect psychological (a change in the perception of one's surroundings) and/or physiological (changes in skin temperature) experiences during a fear-inducing event. In this study participants were presented with emotion inducing stimuli designed to elicit a change in their subjective ambient temperature estimates as well as their skin temperature measurements. Before stimulus presentation, participants in this study were asked to provide their initial estimate of the ambient temperature of the testing room. They then watched a video clip showing fear-inducing, neutral or safety-inducing material and were then again asked to estimate the ambient temperature of the room. Throughout the duration of each session, participants' forehead skin temperature was continuously monitored using a skin temperature probe. Across the three conditions (fear, neutral, and safety) participants' subjective estimates of ambient temperature did not change significantly from before stimulus presentation to after stimulus presentation. In the fear condition, however, there was a non-significant trend in the predicted direction. Alternatively, skin temperature measurements did change significantly from baseline measures to measures taken during stimulus presentation, but no interaction effect of the before vs. after periods by the three conditions was observed. These results suggest that more research is needed to determine whether or not metaphors relating cold and fear are simply linguistic devices or reflections of the body and mind's experiences during a fearful experience.

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"It was a *chilling* account," "that sent a *shiver* down my spine," "I was *shaking* in my boots," and "it was a *hair raising* experience" - These figures of speech consistently utilize words signifying cold temperature to describe fearful situations. In each phrase the cold temperature words specifically references one of the body's reactions to both fear and cold. Examples of responses common to fear and cold include: Blood concentrating in the vital organs, tremor, and piloerection (Cannon, 1927; Mader, 2011). There is evidently a strong linguistic connection between fear and cold, begging the question, what, if anything, do these metaphors reflect? This study sought to determine whether these metaphors reflect the subjective experience of cold, and/or a change in skin temperature in response to a fearful event.

Over the past two decades various linguists and psycholinguists have noted the regular pairing of temperature words and emotion words in metaphorical language (Kovecses, 1986, 2005; Kovecses & Benczes, 2010; Lakoff & Kovecses, 1987; Omori, 2008). They proposed possible explanations for the pattern they observed and theorized that there must be some sort of deeper process at work. Lakoff and Kovecses (1987) hypothesized that the noticeable ubiquity of temperature-emotion word pairings might be due to the proposed ability for emotion and associated temperature to lead to the same bodily or cognitive experience. This theory however, was not empirically tested in a scientific manner.

The most relevant empirical literature regarding the connection between fear and cold are animal studies investigating psychological responses to fear-inducing experiences (Antoniadis & McDonald, 1999; Delini-Stula & Morpurgo, 1970; Nakayama, Goto, Kuraoka, & Nakamura,

2005). Nakayama et al. (2005) studied the effect of a fear inducing experience on the nasal skin temperature of monkeys. These monkeys were presented with fear-inducing stimuli such as an experimenter in a lab coat (these monkeys had been previously conditioned to fear the experimenter), a suddenly dark room, and a shock apparatus (Nakayama et al., 2005). These fear inducing techniques led to a significant decrease in the monkeys' skin temperature (Nakayama et al., 2005). Alternatively, Antoniadis & McDonald (1999) and Delini-Stula & Morpurgo (1970) examined core temperature changes in rats exposed to fear inducing stimuli. In these studies fear was either induced by presenting the rat with a threatening figure or by placing the rat in an environment where the rat had been previously shocked and consequently the rats feared the environment. In both studies the core temperature of the rat increased significantly (Antoniadis & McDonald, 1999; Delini-Stula & Morpurgo, 1970; Nakayama et al., 2005) from pre-stimulus levels.

While a decrease in skin temperature is consistent with metaphors regarding fear and cold, the increase in core temperature seems to conflict. Both increases in core temperature and decreases in skin temperature can be associated with the experience of cold. When one has a fever, the core body temperature rises which typically coincides with the onset of a "*chill*" or a general experience of cold (Kliegman, Behrman, Jenson, & Stanton, 2007a, 2007b). Additionally, when one experiences extreme cold, blood moves away from the extremities, towards the vital organs, decreasing the temperature of the skin (Mader, 2011).

Though the animal studies mentioned above provide some information on the relationship of temperature and fear, these studies do not answer the question of whether or not metaphors of cold and fear reflect the subjective change in temperature perception in response to a fear-inducing stimulus. The present study is interested in the subjective experience of cold as

well as the physiological experience of cold. Provided that many metaphors relating cold and fear seem to be based on the subjective cold experience, for example, "my blood ran *cold,*" there is reason to believe that a fear-inducing event leads to an identifiable subjective experience of cold.

There is currently no research investigating the relationship between fear and the subjective experience of cold. However, evidence based on other temperature-emotion pairs - such as those relating to kind feelings, loneliness, and anger - suggests that subjective experiences of temperature can be associated with, at least, some emotional responses (e.g. Williams & Bargh (2008), Zhong & Leonardelli (2008), and Wilkowski, Meier, Robinson, Carter, & Feltman (2009).

Williams & Bargh (2008) found that participants who were primed with the concept of "warmth" by holding a hot cup of coffee were significantly more likely to rate a novel person as socially "warmer" compared to participants who were primed with "cold" by holding a cold cup of coffee. In this study, participants were never primed with any concept of social warmth or social coldness, yet participants who experienced a warmer temperatures were more likely to rate a person as socially warmer indicating that there is a cognitive connection between physical warmth and social warmth.

Additionally, Zhong & Leonardelli (2008) explored the apparent relationship between "cold" and "lonely" as is evident in metaphors such as "they left me all *cold* and alone." Results revealed that participants who were primed with loneliness by being asked to remember an instance of social exclusion were significantly more likely to rate their ambient environment as colder compared to participants who were primed with inclusion by being asked to remember an instance of social inclusion.

Finally, with respect to metaphors pairing the words “anger” and “ heat” such as in “I was so angry I was *burning* up,” Wilkowski et al., (2009) found that participants who were primed with anger words, by being asked to repeat them after they were flashed on a screen, were significantly more likely to estimate the average temperature of an unknown city as higher compared to when the same participants were asked to repeat neutral words or fear words.

In summary, existing research on the relationship between fear and cold temperature shows that fear has been associated with skin and core temperature in animals (Antoniadis & McDonald, 1999; Delini-Stula & Morpurgo, 1970; Nakayama et al., 2005), and that various other emotion-temperature pairs seem to have a cognitive basis in humans in their ability to elicit one factor (e.g. emotion feelings) from the associated temperature or vice versa (Antoniadis & McDonald, 1999; Delini-Stula & Morpurgo, 1970; Nakayama et al., 2005; Wilkowski, Meier, Robinson, Carter, & Feltman, 2009; Williams & Bargh, 2008; Zhong & Leonardelli, 2008). These findings, from the studies on other emotion-temperature word pairings, suggest that a psychological relationship between fear and cold is likely, but it has never been tested. The present study examined the relationship between the experience of fear and the subjective estimation of ambient temperature.

This study investigated what was being reflected in metaphors using cold temperature words to describe fearful experiences; the subjective (a change in temperature estimate responses) and/or the physiological (a change in the skin temperature). Participants in this study watched a fear-inducing, safety-inducing, or neutral video. The neutral stimulus acted as the control stimulus while the safety video was used as an exploratory stimulus. Fear and safety may be binary poles of a scale and interestingly, fear tends to be associated with cold temperatures in

metaphor, and safety tends to be paired with warmth, as in phrases such as "I was safe and *warm.*"

Participants in the present study rated their subjective experience of the ambient temperature both before and after the stimulus presentation. Throughout the entire session participants' skin temperature was monitored to determine if skin temperature changed from before the presentation of the stimulus to during the presentation of the stimulus. Regarding the subjective experience of temperature, participants in the fear condition were expected to rate the room as having become significantly colder after the fear-inducing stimulus as compared to before stimulus presentation. Participants in the neutral condition were expected to estimate the ambient temperature as the same from before to after stimulus presentation. Finally, participants in the safety condition were expected to rate the ambient temperature as higher after stimulus presentation as compared to before stimulus presentation. In regards to the physiological experience from baseline to the emotion-inducing video prime, participants in the fear condition were expected to show a decrease in skin temperature, participants in the neutral condition were expected to show no change in skin temperature, and participants in the safety condition were expected to show an increase in skin temperature. These results would add to the body of literature supporting that metaphors pairing temperature and emotion reflect a physiological and/or subjective change in temperature in response to the prime of the associated emotion.

Method

Participants

The participants consisted of 45 undergraduates at Columbia University (39 Female, six Male, mean age = 20.3, SD = 2.29). Participants received credit toward a course requirement or $5.00 for their participation in this study.

Stimuli

All videos presented to participants were rated R or lower by the Motion Picture Association of American. The neutral video clip was a commercial ad for "Slomin's Sheild" (32 seconds). The video clip used to induce safety feelings was a commercial ad for "Keebler Fudge Stripe Cookies" (34 seconds). The fear–inducing clip was an excerpt from the movie "A Tale of Two Sisters" (1.00 minutes) (Kim, 2003). In pilot testing (N = 20) the fear stimulus was rated, on average -2.95, the neutral was rated on average 0.20, and the safety stimulus was rated on average 2.70, on a scale from extremely safe (-4) to extremely fearful (4) with 0 as the neutral point. One sample *t*-tests revealed that both fear, $t(19) = -8.78$, $p < .01$, and safety, $t(19) = 7.58$, $p < .01$, differed significantly from the neutral 0 midpoint, while the neutral stimulus did not, $t(19) = 1.71$, $p < .10$.

Scales

Fear/safety as an emotional response was judged on a 9-point scale (-4 = *extremely fearful* and 4 = *extremely safe*) with 0 as the neutral midpoint. Emotional valence was judged on a 9-point scale (-4 = *extremely negative* and 4 = *extremely positive*) with 0 as the neutral midpoint. Emotional arousal was judged on a 9-point scale (1 = *not at all aroused* and 9 = *extremely aroused*).

Procedures

The experimenter informed participants that they would be participating in a study investigating the effect of the room environment on perception of video clips or movie clips. They were also told that they were all randomly assigned to the small, quiet room condition. The cover story was intended to help keep participants from guessing the hypothesis, while providing

a reason to ask for ambient temperature ratings among various other questions relating to the room environment, such as lighting level, chair stiffness, and the smell of the room.

The participant was then brought to the testing room and asked if he/she would consent to the experimenter taping a "physiological data monitor" to his/her head. The monitor was a Vernier Surface Temperature Probe (Vernier Software & Technology, Beaverton, OR, USA), but was referred to as "physiological data monitor" in order not to prime temperature concepts. Participants then answered questions about the testing room environment. Following the room-related questions, participants then sat until 10 minutes had passed, the latter five minutes of which were used to determine a baseline skin temperature level.

Participants then watched one of three short video clips, to which they were randomly assigned. After watching the video, participants answered the identical room environment related questions as they answered before stimulus presentation. Finally, participants answered questions about the videos themselves including questions such as: "what was your emotional response to this video," "how emotionally arousing was this video," and "how positive or negative did you feel while watching this video."

Results

Manipulation Check

A one-way analysis of variance (ANOVA) was used to analyze the emotional response – on a scale of safety to fear - of participants after the presentation of a fear-inducing, neutral, or safety-inducing stimulus. The result of the comparison between the three conditions yielded a significant effect of condition, F (2,42) = 20.5, $p < .01$. Further t-tests revealed that the fear condition produced more fear (M = -1.93), than the neutral condition (M = 0.20), t(28) = -5.20, $p < .01$, that the fear condition produced more fear than the safety condition (M = 1.80), t(28) =

-5.79, $p < .01$, and that the safety condition produced more safety than the neutral condition, $t(28) = -2.41$, $p = .02$. Additionally, the one sample *t*-tests on emotional response as rated by participants showed that the fear condition produced feelings of fear significantly different from a neutral 0 midpoint, $t(14) = -7.25$, $p < .01$, the neutral condition produced neutral feelings that were not different from the 0 midpoint, $t(14) = .642$, $p = .53$, and finally that the safety condition produced feelings of safety that were significantly different from the 0 midpoint, $t(14) = 3.07$, $p = .01$.

An analogous one-way ANOVA on the reported level of emotional arousal was used to analyze the emotional arousal of participants after the presentation of a fear-inducing, neutral, or safety-inducing stimulus. The result of the comparison between the three conditions yielded a significant effect of condition, $F(2,42) = 25.9$, $p < .01$. Further *t*-tests revealed that both the fear condition ($M = 6.00$) and safety condition ($M = 5.27$) produced significantly more emotional arousal than the neutral condition ($M = 2.13$), $t(28) = 7.13$, $p < .01$, and $t(28) = -5.65$, $p < .01$, respectively. The difference in arousal between the fear condition and the safety condition was not significant, $t(28) = 1.20$, $p = .24$. Because arousal was not a bipolar scale I did not perform one-sample *t*-tests comparing conditions to a neutral midpoint.

Finally, a one-way ANOVA was used to analyze participants' rated emotional valence after the presentation of the fear-inducing, neutral, or safety-inducing stimulus. The result of the comparison between the three conditions yielded a significant effect of condition, $F(2,42) = 23.5$, $p < .01$. Further *t*-tests revealed that the fear condition produced more negative emotional valence ($M = -2.27$), than the neutral condition ($M = .20$), $t(28) = -7.10$, $p = .01$, that the fear condition produced more negative emotional valence than the safety condition ($M = 1.33$), $t(28) = -5.62$, $p < .01$, and that the safety condition produced marginally significantly more positive

emotional valence than the neutral condition, $t(28) = 1.97$, $p = .06$. Additionally, one sample *t*-tests on emotional valence as rated by participants showed that the fear condition produced emotional valence levels that were significantly different from a neutral 0 midpoint, $t(14) = -7.18$, $p < .01$, the neutral condition produced emotional valence levels that were not different from the 0 midpoint, $t(14) = 1.38$, $p = .19$, and finally that the safety condition produced emotional valence levels that were significantly different from the 0 midpoint, $t(14) = 2.39$, $p = .03$.

Temperature Estimates

A one-way ANOVA revealed that the groups' initial ambient temperature ratings did not differ significantly, $F(2,42) = 1.92$, $p = .16$. A 2 period (before vs. after stimulus presentation) x 3 condition mixed design ANOVA with period as the repeated measure, revealed no main effect of period, $F(2,42) = 1.25$, $p = .27$, no main effect of condition, $F(2,42) = 1.26$, $p = .29$, and no interaction effect, $F(2,42) = 1.78$, $p = .18$ (see Figure 1). Follow up planned paired samples *t*-tests revealed that participants in the fear condition ($M = 71.35$, $M = 69.45$), $t(14) = 1.68$, $p = .12$, the neutral condition ($M = 68.10$, $M = 68.30$), $t(14) = -.393$, $p = .70$, and the safety condition ($M = 70.21$, $M = 70.23$), $t(14) = -.016$, $p = .99$, were not significantly more likely to estimate the ambient temperature after the stimulus as lower compared to before the stimulus presentation. A non-significant trend in the predicted direction was evident in the fear condition. The effect size was analyzed using Cohen's *d*, using Mean Square Error from the 2 x 3 ANOVA mentioned above. The effect size of the condition was, $d = .3$, which is a medium effect size. Finally, adding in the actual initial room temperature measurements as a covariate had no effect on previously found significance levels. Additionally, after removing the 13 participants (six from the fear condition, two from the neutral condition, five from the safety condition) who guessed the

hypothesis, there was no significant difference in the main effect of condition, main effect of period, or interaction effect of period by condition (all *p*s > .4).

Skin Temperature

A one-way ANOVA revealed that the groups' baseline temperature measurements did not differ significantly, F (2,42) = 1.00, p = .38. A 2 x 3 condition mixed design ANOVA with period as the repeated measure, revealed a significant main effect of period, F (1,42) = 9.02, p < .01, no main effect of condition, F (2,42) = .85, p = .44, and no interaction effect, F (2,42) = .84, p = .44 (see Figure 2). Follow up planned paired samples *t*-tests revealed that the skin temperature measurements of participants in the fear condition increased significantly from baseline when compared to during stimulus presentation (M = 92.87, M = 93.16), t(14) = -2.91, p = .01, skin temperature measurements of participants in the neutral condition did not change significantly from baseline when compared to during stimulus presentation (M = 92.12, M = 92.65), t(14) = -1.64, p = .12, skin temperature measurements of participants in the safety condition changed marginally significantly from baseline when compared to during stimulus presentation (M = 91.89, M = 92.78), t(14) = -1.94, p = .07. Finally, adding in the initial room temperature as a covariate made the main effect of period non-significant and the main effect of condition and interaction effect remained non-significant. Additionally, after removing the 13 participants (six from the fear condition, two from the neutral condition, five from the safety condition) who guessed the hypothesis, the main effect of period became significant (p = .05). There was no change, however, in the significance of either the main effect of condition or the interaction effect of before vs. after by fear, safety or neutral.

Discussion

The English language is replete with metaphors pairing fear and cold, examples of which are, "I had a *cold* feeling of dread," "it was a *chilling* fear," and "the *icy* fear gripped me." The prevalence of these metaphors begged the question, "why is this particular emotion consistently paired with this specific temperature?" The present study asked whether these metaphors reflected a physiological phenomenon and/or a psychological phenomenon; does the skin temperature change and/or does the person's subjective estimate of ambient temperature in response to fear change? An interaction effect was hypothesized: participants in the fear condition were expected to show a decrease in physiological skin temperature measurements as well as a decrease in their subjective estimates of ambient temperature. Additionally, participants in the safety condition were expected to show an increase in physiological skin temperature measurements as well as an increase in their subjective estimates of ambient temperature.

The results of the current study did not support these hypotheses. Regarding the physiological, the participants' skin temperature across all conditions increased from the baseline period to the period during stimulus presentation. There was, however, no interaction effect and when skin temperature was covaried with room temperature, the main effect of period became non-significant. Regarding the subjective, participants in the fear condition did not rate the ambient temperature as colder following the stimulus presentation as compared to before the stimulus presentation. Additionally, as previously mentioned, the safety condition was used as an exploratory measure to determine whether safety can be used as the opposite emotion of fear. Participants in the safety condition were expected to report higher ratings of ambient temperature after stimulus presentation to reflect metaphors such as "I was safe and *warm*." The results revealed that after stimulus presentation participants did not rate the ambient temperature as

significantly warmer than before stimulus presentation suggesting that safety cannot be used as an opposite emotion for fear.

One way to interpret the enumerated findings is that pairings of cold and fear reflect neither the subjective (estimated ambient temperature) nor the physiological (skin temperature measures) phenomena experienced during a fearful event. Instead such pairings might simply be manners of speech. One piece of evidence to support this claim is the lack of cultural consistency in the fear and cold metaphors (Kovecses, 2005). Various other metaphors using temperature and emotion terminology are equally prevalent cross-culturally (Kovecses, 2005), including metaphors of heat and anger, warmth and kindness, and cold and loneliness. In each of the three examples mentioned above, researchers found that there was a connection between the temperature and the emotion that enabled them to prime one factor and elicit the other (Wilkowski et al., 2009; Williams & Bargh, 2008; Zhong & Leonardelli, 2008). Additionally, these studies show that temperature and emotion are connected in two directions; the emotion produces the associated temperature perception, and the temperature produces the association perception of the emotion, which is consistent with the various metaphors.

The controversial nature of the cold and fear metaphors' lack of consistency across cultures leads linguists to argue that coldness may not be linked to fear to the same degree as some other temperature and emotion pairs (Kovecses, 2005; Kovecses & Benczes, 2010). The statement, that metaphors of cold and fear are not as universal as various other metaphors, implies that these figures of speech are not in fact a reflection of what is occurring in the body and in the mind. According to Kovecses (2005), if the metaphors were universal than this would indicate that all human beings experience these conceptual metaphors in the same way both psychologically (subjectively) and physiologically. Consequently, this implies that metaphors

that are not cross-culturally consistent are not at all or are not accurately reflecting the body and mind's responses to the temperature and emotion concepts.

Another way to explain the non-significant results of the present study is to state that there was simply not enough power in the study to yield significant results. A closer analysis of the participants in the fear condition who reported non-significant changes in subjective ambient temperature estimates from before to after stimulus presentation revealed a non-significant trend in the predicted direction. Participants tended to report a lower temperature after stimulus presentation, but the results did not turn out to be significant. Upon the analysis of effect size, using Cohen's *d,* it became evident that the effect size was medium, (d = .3) implying that with a larger sample size, or more power, the fear group might have revealed significant results in the predicted direction.

If power were increased in this study in future iterations, and significant results were found, this would hypothetically imply that even though metaphors using fear and cold do not seem to be culturally consistent, the body and mind (the physiological and the subjective) respond the same way to the emotion and temperature concepts. The presence of responses to cold and fear, both subjectively and physiologically that are consistent with the metaphors lend support to a hypothetical claim of directionality in the development of these metaphors. If it were the case that future studies yielded significant results, then this might indicate that the body and mind's responses to fear and cold were similar even before the metaphor was developed.

While it is possible that non-significant results were a product of small sample size or metaphors that are cross-culturally inconsistent and therefore do not reflect the body and mind's responses to the concepts, it is also likely that methodological limitations contributed to the outcome of non-significant results. The methodological limitations of this study include use of a

video stimulus to elicit emotion, inadvertently priming temperature concepts, and the choice of location for the skin temperature probe.

During pilot testing participants rated the fear-inducing video as significantly more fear inducing than participants in the present study, $p = .04$. These results imply that the fear stimulus may not have elicited strong enough emotions, thereby reducing the effectiveness of the manipulation and subsequently leading to weaker changes in subjective ambient temperature estimates. In the same vein, using a video stimulus of any kind to try to elicit fear was less than ideal due to the difficulty of evoking the emotion in general (Philippot, 1993).

Regarding the priming of temperature concepts, it is possible that the computer screen collecting the physiological data was visible to participants even though participants were explicitly instructed not to look at the computer screen. If some of the participants did see the skin temperature being collected, it would defeat the purpose of referring to the probe as a physiological data monitor to avoid priming the concept of temperature. Additionally, priming temperature concepts might cause temperature to be too salient, possibly mitigating the effects of the manipulation. It is likely that if participants become attuned to temperature measures that they would be less likely to report major changes in subjective temperature estimates because they are paying more attention to the temperature of the testing room.

Finally, in the present study the skin temperature probe was placed on participants' foreheads because research suggests that the forehead is sensitive to changes in skin temperature directly related to emotional change (McIntosh, Zajonc, Vig, & Emerick, 1997). The reason, however, that the forehead is sensitive to emotional changes is because the temperature change is due to brain activity during emotional responses (McIntosh et al., 1997). Skin temperature change is the measure of interest in the present study, not brain activity in response to emotional

stimuli, which is assumed due to the process of priming emotion. In order to measure skin temperature changes in response to emotions alone, other skin surfaces, such as the nose, limbs, and the hands might provide a more accurate surface from which to measure temperature change (Abramson & Ferris, 1940; Boudewyms, 1976; Hertzman & Dillon, 1939; Mittelmann & Wolff, 1943; Nakayama et al., 2005).

Though overall the results of this study do not support the underlying hypothesis that metaphors of fear and cold reflect the body and mind's responses to experiences of fear, the non-significant trend in the predicted direction in the fear condition for the subjective ambient temperature measure provides some encouragement for continuing to research this particular metaphor. The medium effect size of the non-significant trend (d = .3) suggests that the manipulation might lead to significant effects given more power. Future studies accounting for the limitations addressed above and increasing power might yield significant results in both the subjective and the physiological aspects of the study. Provided that these metaphors do not exist cross-culturally, any results that show that cold and fear metaphors lead to the experience of cold both subjectively and physiologically imply that the concepts of cold and fear are strongly linked even without the presence of the metaphors suggesting a basis for a directionality argument.

References

Abramson, D., & Ferris, E. (1940). Responses of blood vessels in the resting hand and forearm to various stimuli. *American Heart Journal, 19* 541-553.

Antoniadis, E., & McDonald, R. (1999). Discriminative fear conditioning to context expressed by multiple measures of fear in the rat. *Behavioural Brain Research, 101*(1), 1-13.

Boudewyms, P. A. (1976). A comparison of the effects of stress vs. relaxation instruction on the finger temperature response. *Behavior Therapy, 7*, 54-67.

Cannon, W. B. (1927). *Bodily Changes in Pain, Hunger, Fear and Rage: an Account of Recent Researches into the Function of Emotional Excitement*. New York: D. Appleton.

Delini-Stula, A., & Morpurgo, C. (1970). The influence of a fear evoking-situation on the rectal temperature of rats. *International Journal of Psychobiology, 1*(1), 71-75.

Hertzman, A. B., & Dillon, J. B. (1939). Selective vascular reaction pattersn in the nasal septum and skin of the extremeties and head. *American Journal of Physiology* 127; 671-684.

Kim, J.-w. (Writer). (2003). A Tale of Two Sisters. In J.-W. Choi, J.-w. Oh, J.-w. Oh & K.-m. Oh (Producer). South Korea.

Kliegman, R., Behrman, R., Jenson, H., & Stanton, B. (2007a). *Nelson Textbook of Pediatrics* (18 ed.). Philidelphia: Saunders Elseiver.

Kliegman, R., Behrman, R., Jenson, H., & Stanton, B. (2007b). *Nelson Textbook of Pediatrics* (18 ed.). Philadelphia: Saunders Elseivier.

Kovecses, Z. (1986). *Metaphors of Anger, Pride, and Love: a Lexical Approach to the Structure of Concepts.* . Amsterdam: J. Benjamins Pub. .

Kovecses, Z. (2005). *Metaphor in culture: Universality and variation*. New York, NY: Cambridge University Press; US.

Kovecses, Z., & Benczes, R. (2010). *Metaphor: a Practical Introduction*. New York: Oxford UP.

Lakoff, G., & Kovecses, Z. (1987). The cognitive model of anger inherent in American English *Cultural models in language and thought* (pp. 195-221). New York, NY: Cambridge University Press; US.

Mader, S. S. (2011). *Inquiry into Life*. Dubuque, IA: McGraw-Hill.

McIntosh, D. N., Zajonc, R., Vig, P. S., & Emerick, S. W. (1997). Facial movement, breathing, temperature, and affect: Implications of the vascular theory of emotional efference. *Cognition and Emotion, 11*(2), 171-195.

Mittelmann, B., & Wolff, H. (1943). Emotions and skin temperature: observations on patients during psychotherapeutic (psychoanalytic) interviews. *Psychosomatic Medicine, 5*, 211-231.

Nakayama, K., Goto, S., Kuraoka, K., & Nakamura, K. (2005). Decrease in nasal temperature of rhesus monkeys (Macaca mulatta) in negative emotional state. *Physiology & Behavior, 84*(5), 783-790.

Omori, A. (2008). Emotion as a huge mass of moving water. *Metaphor and Symbol, 23*(2), 130-146.

Philippot, P. (1993). Inducing and assessing differentiated emotion-feeling states in the laboratory. *Cognition and Emotion, 7*(2), 171-193.

Wilkowski, B. M., Meier, B. P., Robinson, M. D., Carter, M. S., & Feltman, R. (2009). "Hot-headed" is more than an expression: The embodied representation of anger in terms of heat. *Emotion, 9*(4), 464-477.

Williams, L. E., & Bargh, J. A. (2008). Experiencing physical warmth promotes interpersonal warmth. *Science, 322*(5901), 606-607.

Zhong, C.-B., & Leonardelli, G. J. (2008). Cold and lonely: Does social exclusion literally feel cold? *Psychological Science, 19*(9), 838-842.

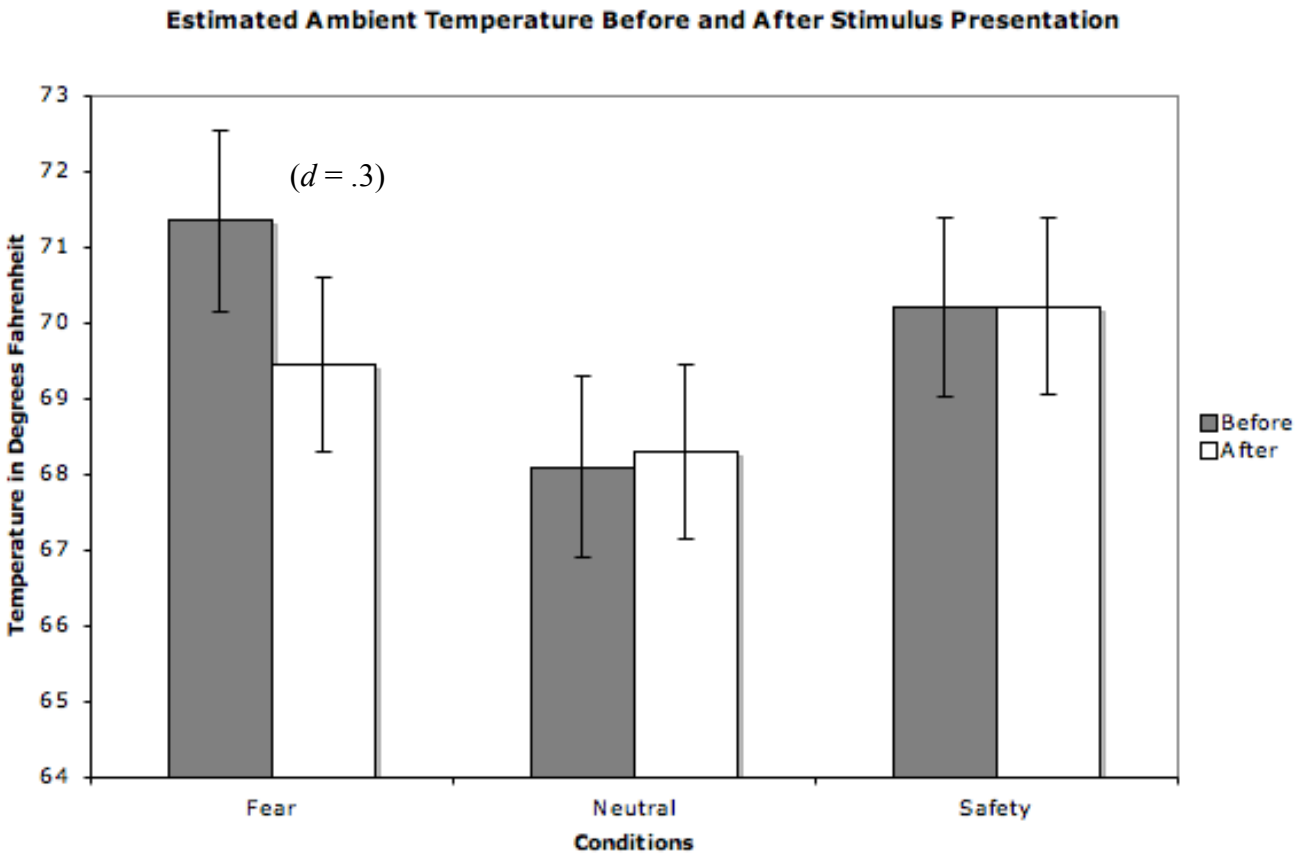

Figure 1: The figure describes participants' ambient temperature estimates before and after the presentation of a video stimulus in three different conditions (fear, neutral, and safety).

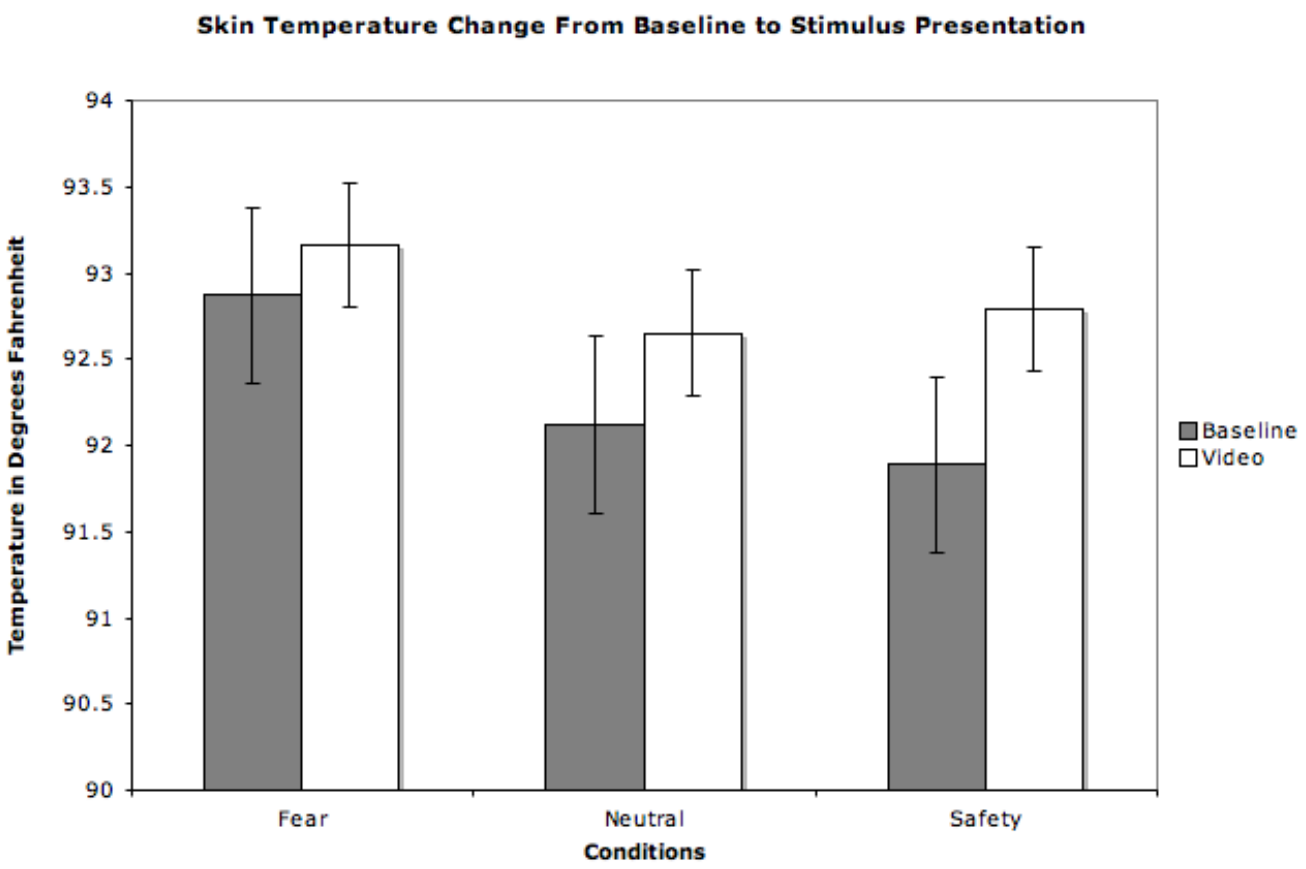

Figure 2: The figure describes participants' skin temperature measurements before and after the presentation of a video stimulus in three different conditions (fear, neutral, and safety). Note: the standard error bars represent standard error as produced by the ANOVA. The paired *t*-tests were conducted independently for each condition and did not use the pooled error from the ANOVA.