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ScienceDirect

Journal of Consumer Psychology 24, 2 (2014) 207–216

JCP JOURNAL OF CONSUMER PSYCHOLOGY

Research Article

Incandescent affect: Turning on the hot emotional system with bright light☆

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Received 26 February 2013; received in revised form 1 December 2013; accepted 23 December 2013
Available online 31 December 2013

Abstract

We propose that turning on the light can turn on the hot emotional system. Across six studies we show that ambient brightness makes people feel warmer, which increases the intensity of their affective response, including sensation seeking from spicy-hot foods, perception of aggression and sexiness ("hotness") in others, and generating more extreme affective reactions toward positive and negative words and drinks. We suggest that these effects arise because light underlies perception of heat, and perception of heat can trigger the hot emotional system. Thus, turning down the light, effortless and unassuming as it may seem, can reduce emotionality in everyday decisions, most of which take place under bright light.

Keywords: Light; Emotions; Affective response; Ambient effects; Decision making

A light without shadow generates an emotion without reserve.
[~Roland Barthes]

Introduction

Bright sunny days are known to fill the heart with joy (Schwarz & Clore, 1983); they are also associated with heartbreak (Kevan, 1980). On the one hand, on sunny days, people are more optimistic about the stock market, report higher wellbeing, and are more helpful (Cunningham, 1979; Hirshleifer & Shumway, 2003; Kamstra, Kramer, & Levi, 2003; Schwarz & Clore, 1983, 2003), while extended exposure to gloomy winter days can result in seasonal affective disorder (Rosenthal et al., 1984; Workman and Nelson, 2011). Thus, brighter days correspond with outcomes associated with feeling good (Cunningham, Steinberg, & Grev, 1980; Grable & Roszkowski, 2008). Positive feelings also enhance perceived brightness—for example, smiling faces or positive words are` perceived as brighter than frowning faces or negative words (Meier, Robinson, Crawford, & Ahlvers, 2007; Song, Vonasch, Meier, & Bargh, 2011). On the other hand, on sunny days, depression-prone people also become more depressed. For instance, suicides peak in late spring and summer when sunshine is abundant, while fewest suicides occur in the winter months (for a review, see Kevan, 1980). This seasonal trend of suicide is supported in more than sixty of eighty studies reviewed by Kevan (1980). Lab studies also found that the level of illumination increases unpleasant feelings with noises (Biner, 1991). In sum, bright light is found to amplify positive affect sometimes, but to amplify negative affect at other times. To reconcile these seemingly inconsistent findings, we suggest that bright light amplifies a person's initial affective response.

In particular, we propose that bright light can increase perception of heat and perception of heat turns on the emotional system, intensifying a person's initial emotional reaction, positive or negative, to any stimulus. Natural sciences establish that light is fundamental to the perception of heat (MacIsaac, Kanner, & Anderson, 1999); in fact, luminance of an object is the key attribute used by astronomers and scientists to estimate its heat (Rodgers, 1976). Because people often experience light along with heat, this connection between light and heat may be deeply rooted psychologically, and the perception of bright light may create an illusionary experience of heat. This psychological experience of

☆ This research was supported in part by a standard research grant from the Social Sciences and Humanities Research Council of Canada (no. 491127) to A.J. Xu.
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1057-7408/$ -see front matter
http://dx.doi.org/10.1016/j.jcps.2013.12.007

heat turns on the hot emotional system, intensifying a person's emotional reactions to any stimulus. Thus, in bright light, good feels better and bad feels worse. We test these propositions in six studies.

Theoretical background

Light as warmth trigger

Basic physics states that incandescence is heat made visible. All objects with a temperature greater than absolute zero emit thermal radiation or electromagnetic waves as temperature rises, making very hot objects appear as if they are emitting white light (MacIsaac et al., 1999). As a result, in the natural sciences, bright light is believed to be a sufficient input for the estimation of warmth. Astronomers use luminance of an object to estimate its temperature (Rodgers, 1976). Accordingly, bright luminous stars are usually estimated as being hotter (Conti & Alschuler, 1971). Because of the omnipresence and necessity of both light and warmth for human survival, this fundamental connection is deeply ingrained in the human psyche. For example, "Darkness is associated with blindness, death, cold…Light is the antidote to the above…in the light one is safe and warm" (Borg & Wright, 2000). In sum, objects that are visually brighter usually are warmer and are perceived as warmer. Even when light is dissociated from warmth, people perceive brighter to be warmer. Anecdotally, after a cold front hits, the sun usually comes out but the temperature drops; yet people expect it is warm outside. Warmth without brightness also is perceived cooler. For example, hot but dim flame from a Bunsen burner is perceived cooler. We propose that if brightness serves as an input to the perception of warmth, then bright light by itself, regardless of whether it is accompanied by warmth or not, may induce a perception or psychological experience of warmth.[1]

Warmth and emotional intensity

From researchers who describe the emotional system as hot (Loewenstein, 2000; Metcalfe & Mischel, 1999), to poets who describe passion and anger, love and shame as burning, and pain and sorrow as searing, emotional intensity and heat are inscribed together. Warmer locales are populated by emotionally more expressive residents (Pennebaker, Rimé, & Blankenship, 1996), and hot temperature stimulates emotionally intense actions such as aggression and riots (Carlsmith & Anderson, 1979; United States Riot Commission, 1968), serious and deadly assault (Anderson, 2001; Anderson, Bushman, & Groom, 1997), domestic violence (Rotton & Frey, 1985), and rape (Michael & Zumpe, 1983). While these field observations suggest a correlation between emotional intensity and warmth, lab studies directly show that ambient warmth intensifies emotional responses—positive and negative—ranging from positive affiliation to potentially negative impulsivity and aggression. On the positive side, holding a warm cup of coffee leads people to perceive greater warmth and affection in others' characters (Williams & Bargh, 2008), and a lack of physical warmth motivates people to seek psychological warmth by watching affect-rich romantic movies (Hong & Sun, 2012). People in a hot spa room have higher willingness to pay for hedonic products offering emotional appeal and express a stronger preference for immediate rewards than those in a cold spa room do (Ahn, Mazar, & Soman, 2010). On the negative side, people in a warmer room also deliver more intense electric shocks to others, implying that warmth intensifies aggression (Baron & Bell, 1976). Thus, warmth is associated more intense emotional response, positive and negative.

Light intensifies emotional response

If bright light enhances perception of warmth, as we suggest, and if warmth amplifies emotional response, then from the preceding analysis, it follows that bright light may intensify emotional response. Supporting evidence for this possibility is found in Watson (2000). Watson (2000) collected diary reports from students in Texas (N = 478) between 1985 and 1993 during either the fall or the spring and investigated the influence of amount of sunshine and rain on mood. The analysis revealed no consistent effect of amount of sunshine on any of the daily mood variables; however, he found that sunshine influenced the overall intensity of participants' mood reports when comparing days with 0% sunshine with days with 100% sunshine. Moreover, because mildly positive feelings are the "usual" feelings for most people most of the time (e.g., Matlin & Stang, 1979; Schwarz & Clore, 2003), our proposition that bright light intensifies initial emotional reactions is consistent with the findings that most of the time sunlight intensifies mild positive feelings making people upbeat and optimistic (Schwarz & Clore, 1983). Similarly, according to our analysis, for people with a negative mood, sunlight instead should intensify their negative feeling making them more depressed and pessimistic than otherwise, which may account for why suicides also increase on bright days (Kevan, 1980). Consistent with this interpretation, Kommer, Schwarz, Strack, and Bechtel (1986) found that non-depressives reported higher well-being on sunny than on rainy days, whereas depressives tended to report higher well-being on rainy than on sunny days. Kommer et al. (1986) reasoned that depressives can attribute their negative feelings to the bad weather on rainy days but to themselves on sunny days, which can result in their lower wellbeing on sunny days. While rainy vs. sunny days can indeed allow people to make different attributions for their feelings, it is additionally possible that bright light intensifies people's default affective reactions towards other people or external stimuli, which in turn, influences their judgment and decision making in that situation. Gal, Wheeler, and Shiv (2007) reported that people who like strong coffee tended to drink more coffee under bright (vs. dim) light, but that people who dislike

[1] It is important to distinguish between luminance and hue of light in the current context. Depending on the light's wavelength, it may be perceived as having a warm color (e.g., red or orange) or having a cold color (e.g., blue or light purple). Thus, the color of the light, rather than luminance could potentially influence people's perception of warmth. Because our focus is on luminance or brightness, we eliminate this potential confound and controls for a potential influence of people's beliefs of what hue might imply with respect to temperature. To do so, we used white light (such as white light from a fluorescent light or computer screen). Because white is not a warm color, this manipulation of brightness is conservative and controls for any influence of color of the light on judgments.

strong coffee strong tend to drink less under bright (vs. dim) light. Gal et al. (2007) findings cannot be accounted for by an attribution account and they instead proposed that bright is perceptually sharp and this non-conscious reminder of sharpness resulted in cross-modal priming and participants perceiving the taste of coffee as sharper. While it is possible that bright is perceptually sharp and it primed sharp taste in Gal et al.'s (2007) studies, we propose that bright light may intensify a person's initial affective response, which consequently influences people's judgments and decision making in various contexts even unrelated to sharpness.

We conducted six experiments to test our hypothesis. In experiment 1 we show that bright light increased people's feeling warmth, even though the physical temperature was kept constant. In experiment 2 we show that ambient brightness increased people's desire for spicier foods. In line with the idea that consumption of spicy foods is associated with thrill seeking, bright light increased perceived warmth, which further increased anticipated thrill of eating chili. In experiments 3, we show that bright light also polarizes judgments of both positive (i.e., perceptions of sexiness) and negative affective stimuli (e.g., perceptions of aggression). In experiment 4, we show that brightness polarizes people's affective reactions towards affect-laden objects (i.e., positive or negative words) that have no semantic/metaphorical associations with the concept of "hot". Moreover, brightness does not influence feelings towards affectively-neutral stimuli. From these findings, it appears the link between light and affect may indeed be deep rooted in the fundamental physiology and psychology of light and heat, as we posit, rather than an outcome of metaphorical or perceptual priming (Gal et al., 2007), and the link is specific to emotional response. In experiment 5 we measured brightness as a continuous variable, to establish that increased brightness increases whereas reduced brightness decreases intensity of emotional response. Moreover, calling people's attention to potential influence of brightness on their affect did not lead to correction and attenuation of the proposed intensification effect, indicating that the effect of brightness on affect we observe does not rely on people's naïve theories or attributions that are observed in previous research on the influence of weather (Kommer et al., 1986). Finally, in experiment 6, in line with our emotional-amplification hypothesis, we showed that bright light increased consumption of favorable drinks and reduced consumption of unfavorable drinks, and the influence of brightness on consumption behavior was mediated by more intense affective reactions towards the drinks.

Experiment 1: feeling warmer in bright light

Experiment 1 tested whether bright light increases perceived warmth. Forty-three undergraduate students from University of Toronto (12 men, 31 women) were compensated to participate in this experiment. Upon arrival at the lab, the participants were assigned to either a *bright-light* or *dimmed-light* condition. In the *bright-light* condition, fluorescent ceiling lights in the lab were turned on during the experiment. In the *dimmed-light* condition, fluorescent lights were turned off, and the room was dimly lighted by light from computer monitors. The bright-light condition and the dimmed-light condition were administered alternatively, and the objective temperature of the room was constant.

Participants were run in groups of up to eight students. Each participant completed the study individually on a computer and was informed in advance of the experiment that the lighting had been adjusted to maximize performance. Once seated at a work station, the participant evaluated how warm they felt (1 = cold, 7 = hot), brightness of the room (1 = dim, 7 =bright), and a number of control dimensions pertaining to the room, such as cleanliness, distinctiveness, and spaciousness [all scales: 1 = lowest, 7 = highest], to ensure that warmth but not all judgments are more extreme in bright light. All the dimensions were presented in a random order. As additional control, participants also indicated the extent to which they felt aroused (1 = Not at all; 7 = Very much). They were then thanked and debriefed—no participant correctly guessed the true purpose of the study.

Results and discussion

The participants reported that the room was brighter when the ceiling lights were on rather than dimmed (M_{bright} = 5.74, M_{dimmed} = 1.42, $F(1, 41) = 115.71$, $p < .001$, $\eta^2 = .74$), implying that our manipulation of ambient brightness was successful. Importantly, they also reported that the room was warmer (M_{bright} = 4.58, M_{dimmed} = 3.79, $F(1, 41) = 6.37$, $p < .02$, $\eta^2 = .13$), when the lights were on rather than dimmed (see Table 1). We observed no differences based on lighting on any of the other dimensions (all $ps > .20$). Therefore, although ambient brightness enhanced perceptions of brightness and warmth, it did not have a general amplification effect on other assessments of the room. Participants also reported similar levels of arousal across the two conditions (M_{bright} = 2.21, M_{dimmed} = 2.37, $F < 1$), suggesting that ambient brightness does not amplify arousal.[2]

[2] This result indicates that the manipulations of ambient brightness in our experiment did not influence subjective (self-reported) arousal. Two reasons prompted us to seek additional physiological evidence to validate our findings. First, one previous study showed that bright light could increase systolic blood pressure, whereas dimmed light could decrease systolic blood pressure (Biner, 1991, experiment 3). Second, bright light may increase arousal but participants may not able to consciously detect the change. Therefore, using an additional method to measure physiological arousal would be desirable (Anderson, 1989). We recruited forty-eight participants to take part in an ostensibly electronic blood pressure monitor evaluation study either in a bright room or in a dimmed room. The participants were asked to help the experimenters test a blood pressure and pulse monitor. We recorded systolic pressure (SYS), diastolic pressure (DIA), and pulse rate at the start of the session and then after 15 min. Finally, the participants evaluated their usage experience. Recorded SYSs were submitted to repeated measure GLM and analyzed as a function of ambient brightness and test–retest. The results showed that the participants had lower SYSs in the retest than in the initial test (M_{sys1} = 109.72, M_{sys2} = 105.21, $F(1, 46) = 10.21$, $p < .005$, $\eta^2 = 0.18$), suggesting that the participants calmed down after spending 15 min in the lab. And this was true in both the bright-light condition (M_{sys1} = 108.58, M_{sys2} = 104.00) and the dimmed-light condition (M_{sys1} = 110.86, M_{sys2} = 106.41). Ambient brightness had neither a main effect nor an interactive effect with repeated-tests on SYS. Based on both measured physiological arousal and subjective arousal, we conclude that in the current research settings, ambient brightness does not influence arousal. However, these results do not preclude the possibility that unusually bright conditions may change arousal (e.g. turn on four 300 W bulbs in the bright-light condition, see Biner, 1991).

Table 1
Summary of results—experiments 1,2,3,4,6.

	Dependent variable	Conditions	
		Bright mean (SD)	Dimmed mean (SD)
Experiment 1	Judgment of brightness	5.74 (1.42)	1.42 (1.12)
	Judgment of warmth	4.58 (1.02)	3.79 (1.03)
	Arousal	2.21 (1.22)	2.37 (1.38)
Experiment 2	Choice of spice level	7.78 (4.48)	5.59 (4.32)
	Anticipated affective reactions to spice consumption	6.05 (2.12)	5.14 (2.53)
	Judgment of warmth	3.58(.93)	3.11(1.17)
Experiment 3	Judgment of aggressiveness	7.48 (1.27)	6.87 (1.69)
	Judgment of non-aggressiveness	4.78 (1.62)	4.71 (1.71)
	Judgment of sexiness	5.09 (1.14)	4.59 (1.23)
	Perception of being active	3.87 (1.29)	3.78 (.90)
	Perception of being inactive	4.18 (1.42)	4.32 (1.21)
Experiment 4	Affective reaction to positive words	8.71 (.82)	7.93 (1.02)
	Affective reaction to negative words	4.82 (1.13)	5.49 (1.23)
	Affective reaction to neutral words	6.64 (1.20)	6.34 (1.23)
Experiment 6	Consumption of favorable juice	85.23 (53.61)	49.30 (44.84)
	Consumption of unfavorable juice	15.43 (15.47)	32.88 (32.87)
	Affective reaction to favorable juice	6.75 (2.31)	5.35 (2.85)
	Affective reaction to unfavorable juice	2.77 (2.22)	5.29 (3.04)

Experiment 1 thus showed that brighter light makes people feel warmer, without altering control judgments and without impacting arousal level. If bright light intensifies affective reactions, then it should influence likeability of extreme affective outcomes. Experiment 2 tested this possibility by investigating whether bright light intensifies positive affective response to spicy foods. Indeed, cursory observation suggests that people who live in warmer areas in the world also consume spicier foods (e.g., southern vs. northern US or Europe, or South Asia as opposed to northern regions). Part of the reason is that eating spices provides health benefits to people in warmer countries, by helping lower blood pressure and stimulating sweating to cool down the body. However, most people consume spices for the positive thrill of the burning sensation on the tongue (Wright, 2005; known as benign masochism). If environmental brightness activates the hot emotional system, it should intensify the positive affective responses associated with the anticipated thrill of eating chili, and as a result increase preference for spicier food. We also tested the mediating role of perceived warmth on people's affective response toward eating chili.

Experiment 2: spicing it up

Method

One hundred twenty-eight participants (60 men, 68 women) were recruited for a taste-test and randomly assigned to a bright-light or dimmed-light condition as in experiment 1. They participated for extra course credit and were run in groups of up to twelve participants. At the beginning of the experiment, the participants reported demographic information such as age, gender, and whether they are vegetarians. Four participants were vegetarians, and as our taste test involved non-vegetarian foods, they were screened out from the study.

Participants were informed that they would taste chicken wings on behalf of Buffalo Wild Wings® which is a restaurant chain in North America. The restaurant can customize the flavor of chicken wings for individual customers. Because the restaurant plans to expand its business into the local market next year and would like to know local consumers' taste preference. Based on this cover story, participants read a complete list of 16 sauces that Buffalo Wild Wings® can use to flavor the wings (see menu at http://www.buffalowildwings.com; see Appendix A). The sauces are listed from the mildest to the hottest, and the spiciness levels are also indicated by the number of chilies attached to each option. Participants were asked to read the descriptions of the different flavors and choose one flavor of sauce that they want to eat most now. They were informed that they would have the opportunity to taste the chosen flavor of wings. The level of spiciness that participants chose served as the main dependent variable. After that, participants rated how spicy they anticipated the chosen sauce would be (0 = Not at all; 10 = Very), and their affective reactions to eating spicy food were measured. Specifically, the participants rated the extent to which they agreed with the following statements: "In general, I like spicy food," "When my tongue burns from spicy food, I find the sensation thrilling," and "In general, more spicy food is thrilling" [all scales: 0 = strongly disagree, 10 = strongly agree]. Finally, similar to experiment 1, participants rated the room on different dimensions such as brightness, felt warmth, cleanliness, etc. [all scales: 1 = lowest, 7 = highest].

Though participants believed that they would actually taste chicken wings with the sauce flavor they chose, they were not made to taste the chicken wings. Instead, they were thanked and debriefed. No participant guessed the purpose of the study correctly.

Results

Choice of spice level

We coded the 16 different flavors of sauces from 1 (least hot) to 16 (hottest). The participants' choices were analyzed as a function of room brightness. The results revealed a main effect of room brightness, indicating that the participants chose spicier sauces if they were in a bright-light room than if they were in a dimmed-light room (M_{bright} = 7.78, M_{dimmed} = 5.59, $F(1, 122) = 7.66$, $p < .01$, $\eta^2 = .06$). The former group of participants also judged their chosen options to be spicier (M_{bright} = 5.82, M_{dimmed} = 4.08, $F(1, 122) = 11.63$, $p < .001$, $\eta^2 = .09$). This finding excludes the possibility that brightness promotes choice of spicier food because it changes (reduces) the perceived spiciness of food options. We next tested the mediating role of affective reactions.

The participants' responses to three affective reaction measures were averaged to form a single index ($\alpha = .70$). As expected, room brightness enhanced the participants' positive affective reactions to eating spicy food (M_{bright} = 6.05, M_{dimmed} = 5.14, $F(1, 122) = 4.72$, $p < .04$, $\eta^2 = .04$.).

A mediation analysis was conducted to test the mediating role of affective reactions in the influence of room brightness on choice of spiciness level. Room brightness influenced both affective reactions to spicy food (b = .91, SE = .42, t = 2.17, p < .04) and choice of spice levels (b = 2.19, SE = .79, t = 2.77, p < .01). Affective reactions towards eating spice also affected the choice of spiciness (b = .73, SE = .16, t = 4.65, p < .001). The influence of room brightness on spiciness choice was reduced when including affective reactions into the model (b = 1.52, SE = .75, t = 2.04, p < .05). A bootstrap test confirmed the mediating role of extremity of affective reactions to eating spicy food (Confidence-Interval: .0795 to 1.4204; Preacher & Hayes, 2004, 2008; Zhao, Lynch, & Chen, 2010). Thus, room brightness increased affective reaction toward spicy food and resulted in participants choosing spicier food.

Our theory is that ambient brightness increases feelings of warmth which enhances affective reactions. Thus, we additionally checked whether ambient brightness increased feelings of warmth, and whether feelings of warmth underlie the intensified hot emotional (affective) reactions, as we propose.

Feeling warm

Replicating experiment 1, the participants reported feeling warmer if they were in the bright room than if they were in the dimmed room, (M_{bright} = 3.58, M_{dimmed} = 3.11, F(1, 122) = 6.20, p < .02, η^2 = .05).

To investigate process, we tested for the mediating effect of felt warmth on the influence of brightness on affective reactions towards eating spicy food. Room brightness influenced both felt warmth (b = .47, SE = .19, t = 2.49, p < .02) and affective reactions to spicy food (b = .91, SE = .42, t = 2.17, p < .04). Felt warmth also had an impact on the extremity of affective reactions towards eating spice (b = .38, SE = .20, t = 1.89, p = .06). The influence of room brightness on affective reactions to spicy food was reduced when felt warmth was taken into account (b = .74, SE = .43, t = 1.73, p < .09). A bootstrap test confirmed the mediating role of extremity of affective reactions to eating spicy food (CI: .0141 to .5315; Preacher & Hayes, 2004, 2008; Zhao et al., 2010).

In sum, experiment 2 showed that (a) ambient brightness increases felt warmth, similar to experiment 1, and additionally that (b) felt warmth increases positive affective response, and (c) positive affective response impacts choice. The goal of experiment 3 was to extend the investigation to effect of brightness on judgments of both positive and negative affect-laden stimuli.

Experiment 3: hot-headed and hot-and-sexy

Participants (N = 98, 34 men and 64 women) were randomly assigned to a bright- or dimmed-light condition, as in experiments 1–2. The cover story indicated that the study was interested in collecting consumers' reaction to potential advertising plots and models. Under this pretense, the participants were presented with what was described as a script for a television commercial in which the target person, Alex, engaged in a series of potentially aggressive behaviors because he was late to work (adapted from Srull & Wyer, 1979; see Appendix B). They then rated Alex on each of several characteristics: three related to aggression (aggressive, hot-tempered, hostile, 1 = not at all, 9 = very) and the remaining five unrelated to aggression (e.g., powerful, strong, and adventurous). Then, the participants proceeded to a subsequent task in which they judged the sexiness of three Caucasian women models for print ads (1 = not hot, 7 = very hot). We presented pictures of these women models on the computer, individually, in random order. Finally, to ensure that ambient brightness does not impact how tired or sleepy a person might feel, participants reported their activity and inactivity levels by indicating whether they felt energetic, active, tired, and inactive (all scales: 1 = strongly disagree, 7 = strongly agree). They also reported demographic information such as gender and age. No participant correctly guessed the true purpose of the study.

Results and discussion

Is Alex hot-headed?

Judgments on eight characteristics were submitted to a principal component factor analysis with varimax rotation. When loadings less than 0.30 were excluded, the analysis yielded a two-factor solution with a simple structure. Judgments of aggressive, hot-tempered and hostile loaded on one factor, and the rest loaded on the second factor. We analyzed attribute judgments of Alex as a function of room brightness and participants' gender, because men are, on average, more aggressive than women (Eagly & Steffen, 1986), and personal aggression could have impacted perceived aggression of others' actions. Gender did not impact judgment either directly or interactively with room brightness, Fs < 1. As expected, however, participants in a bright room—relative to those in a dimmed room—rated Alex as more aggressive (α = .86; M_{bright} = 7.48, M_{dimmed} = 6.87, F(1, 94) = 4.12, p < .05, η^2 = .04). Room brightness did not impact aggression-unrelated dimensions (M_{bright} = 4.78, M_{dimmed} = 4.71, F < 1). In sum, room brightness intensified perceived aggression in others' potentially aggressive actions.

Hot or not?

We analyzed the judgments of three women as a function of conceptual replication (within-participant), room brightness (between-participant), and gender (between-participant). One woman was judged to be less hot (M_{woman1} = 4.58) than the other two (M_{woman2} = 4.91, M_{woman3} = 5.03, F(2, 188) = 4.18, p < .02, η^2 = .04). The participants' gender had neither a main nor interactive effect on hotness judgments (p > .20 in both cases). Importantly, the participants seated in a bright rather than dimmed room judged all three women to be hotter (M_{bright} = 5.09, M_{dimmed} = 4.59, F(1, 94) = 3.81, p = .05, η^2 = .04), as we predicted.

Brighter is not more active

Ambient brightness did not differentially impact how active participants felt (α = .85; M_{bright} = 3.87, M_{dimmed} = 3.78, F < 1) nor how inactive they felt (α = .83; M_{bright} =

4.18, M_{dimmed} = 4.32, $F < 1$). Therefore, the alternative explanation that a bright environment makes people feel more awake or active than a dimmed environment is unlikely.

Experiment 3 showed that participants judged ambiguously aggressive behavior as more aggressive and potentially sexy women as sexier in bright than in dimmed light. Therefore, bright light polarizes judgments of both positive and negative stimuli. One limitation of these findings is that although we assume that participants' positive/negative feelings are important input for judging sexiness and aggressiveness, we did not measure participants' affective reactions directly. The other limitation is that both aggression and sexiness are metaphorically associated with the concept of "hotness." Thus, although these data do show that bright light polarizes judgments of both positive and negative stimuli, they do not show that these effects can arise independently of any metaphorical links (Barsalou, 2008; Lakoff and Johnson, 1999; Landau et al., 2010; Meier et al., 2012) between a stimulus and hotness. Our theory suggests that there is a link between brightness and emotional intensity that is independent of any metaphorical links. Therefore, the proposed effect should occur even when the affect-laden stimuli are not metaphorically or semantically associated with the concept of "hotness." In experiment 4, participants reported their feelings towards positive, negative, and neutral stimuli that are not metaphorically or semantically related to the concept of "hotness." If ambient brightness intensifies affective responses, then ambient brightness should polarize participants' reported feelings about both positive and negative targets, but should not influence their feelings towards affectively-neutral targets.

Experiment 4: good gets better and bad gets worse

We randomly assigned participants (N = 60, 21 men, 38 women, and 1 unreported) to a bright- or dimmed-light condition, as in experiments 1–3. Once seated, participants completed a word-assessment task and reported their feelings towards each of five positive words (e.g., flower, smile, etc.), five negative words (e.g., medicine, dentist, etc.) and five neutral words (e.g., chimney, paper, etc.), presented randomly (1 = very negative, 10 = very positive, adapted from Fishbach & Labroo, 2007). They were then thanked and debriefed. No participant correctly guessed the true purpose of the study.

Results and discussion

We analyzed averaged feelings towards the five positive, five negative, and five neutral words (within-participant) as a function of room brightness (between-participant). The analysis revealed a main effect of target-item valence ($F(2, 116) = 131.93$, $p < .001$, $\eta^2 = .67$), qualified by a two-way interaction between brightness and item valence ($F(2,116) = 6.99$, $p < .002$, $\eta^2 = .04$). As expected, brightness enhanced positive feelings towards positive items ($M_{bright} = 8.71$, $M_{dimmed} = 7.93$, $F(1,58) = 10.73$, $p < .002$, $\eta^2 = .16$), decreased positive feelings towards negative items ($M_{bright} = 4.82$, $M_{dimmed} = 5.49$, $F(1, 58) = 4.67$, $p < .04$, $\eta^2 = .07$), and did not impact feelings towards neutral items ($M_{bright} = 6.64$, $M_{dimmed} = 6.34$, $F < 1$). Experiment 4 thus provided evidence that brightness polarized affective reactions, making feelings towards positive words more positive but making feelings towards negative words more negative, suggesting that bright light intensified experienced affect, even without any semantic associations of a stimulus to hotness.

In sum, brightness increases felt warmth (experiment 1), intensifies positive affective reactions towards hot experiences (eating chili, experiment 2), increases perceptions of others as affectively hot (aggressiveness, a negative affect-laden judgment, and sexiness, a positive affect-laden judgment, experiment 3), and intensifies feelings towards non-metaphoric but affect laden stimuli (experiment 4). In all these experiments, we manipulated two levels of ambient brightness because it is unclear what a control brightness condition would be. However, to test whether bright light intensifies affective reactions, dimmed light dilutes affective reactions, or both, in experiment 5 we collected a continuous measure of ambient brightness. We expect that brightness and dimness are the two ends of a continuum and because brighter is warmer (MacIsaac et al., 1999), the brighter the environment is, the more intense the affective reactions will be. In addition, we investigate whether people have a naïve theory about the intensification effect of ambient brightness. Following the misattribution research paradigm (Schwarz & Clore, 1983; Strack, Schwarz, Bless, Kübler, & Wänke, 1993; Wilson & Brekke, 1994), we manipulated the participants' awareness about the potential influence of ambient brightness. If participants hold a naïve theory concerning the intensification effect of ambient brightness, calling their attention to the source influence of should result in a correction effect. If participants hold no naïve theory about the intensification effect, as suggested by our theory, calling their attention to the source will not attenuate this effect.

Experiment 5: the fundamentality of brightness-affect link

One-hundred two participants (56 men and 46 women) from a U.S. online panel participated for compensation. The participants were randomly assigned to one of two conditions, either a control condition where they proceeded directly to the word-assessment task as in experiment 4 or an awareness condition in which they were informed that the brightness of their environment might influence their feelings and they should avoid being influenced by how bright or dimmed the environment was. All the participants then provided their feelings toward each of the five positive, five neutral, and five negative words, and presented randomly (1 = very negative, 10 = very positive). After that, the participants responded to several questions about the room in which they were seated, including its brightness (all scales: 1 = lowest, 7 = highest, item counterbalanced), embedded within some demographic measures. Finally, they were thanked for completing the survey.

Results and discussion

We analyzed averaged feelings towards the five positive, five negative, and five neutral items (within-participant) as a function of self-reported (mean-centered) brightness, awareness, and all

interactions. The analysis revealed a main effect of target-item valence ($M_{positive}$ = 8.29, $M_{neutral}$ = 6.16, $M_{negative}$ = 3.99; $F(2, 196) = 423.27$, $p < .001$, $\eta^2 = .80$), qualified by a two-way interaction of brightness and item valence ($F(2, 196) = 6.56$, $p < .005$, $\eta^2 = .01$), and a two-way interaction of awareness and item valence ($F(2, 196) = 3.70$, $p < .03$, $\eta^2 = .007$). The three-way interaction of brightness, item valence, and awareness was not significant ($F < 1$).

Further investigation into the source of the brightness × valence two-way interaction revealed that ambient brightness positively predicted affective reactions to positive items (b = 0.21, SE = 0.07, $t = 2.98$, $p < .005$, $\eta^2 = 0.08$), negatively predicted affective reactions to negative items (b = −0.14, SE =0.07, $t = -2.02$, $p < .05$, $\eta^2 = 0.04$), and did not predict affective reactions to neutral items (b = 0.028, SE = 0.07 $t = 0.38$, $p > .70$). This result replicated the findings of experiment 4.

Further investigation to decompose the awareness × valence interaction showed, interestingly, that awareness reduced affective reactions to positive items (M_{aware} = 7.86; $M_{no\text{-}aware}$ = 8.69, $F(1, 100) = 11.45$, $p < .001$), but did not influence affective reactions to negative (M_{aware} = 4.08; $M_{no\text{-}aware}$ = 3.92, $F < 1$) or neutral items (M_{aware} = 6.12; $M_{no\text{-}aware}$ = 6.23; $F < 1$). These results imply that when the participants were informed that their affect might be influenced by extraneous factors such as the brightness levels, they reported their positive affect more conservatively. However, this effect was independent of the brightness levels. Awareness did not interact with brightness in either two-way or three-way interactions (Fs < 1), therefore, it did not attenuate the intensification effect, which implies that people are unaware of the role brightness may play in amplifying their emotional reactions. This finding is therefore more consistent with our position that the link between brightness and emotional response is more fundamental and probably rooted at the physiological/psychological level and not the result of any naïve theories, or experimenter demand effects.

In sum, the results of experiment 5 show that higher levels of brightness intensify both positive and negative affective reactions but not reactions to neutral items. Moreover, calling the participants' attention to ambient brightness does not attenuate the intensification effect, implying that people are unaware of how ambient brightness may be impacting their affective responses and that the link between brightness and affective response may be operating at a basic, non-conscious level, as we propose. In a final experiment, we demonstrate the influence of ambient brightness on real consumption behaviors.

Experiment 6: consuming yummy or yucky juice

Eighty four participants (22 men, 52 women, 10 unreported) took part in a blind taste-test. They were randomly assigned into one of four conditions in a 2 (lighting: bright vs. dimmed) × 2 (drink: favorable vs. unfavorable) between-participant design. The lighting manipulation was identical to that in experiments 1–4. Once seated, the participants were invited to participate in a taste test of a brand of soft drinks. They were asked to taste the drink and answer some questions while consuming it. They could drink as much as they wanted. Then the participants were served either a 155 gram cup of orange juice (favorable drink) or vegetable juice (unfavorable drink). Pretesting (N = 24) confirmed that the favorable juice is indeed favorable (M = 8.33, different from midpoint, $t(23) = 10.72$, $p < .001$; 0 = dislike very much, 10 = like very much) while the unfavorable juice is unfavorable (M = 3.92, different from midpoint, $t(23) = -2.09$, $p < .05$). Participants tasted the drink and reported their feelings when tasting the drink (Right now, I feel: 0 = bad; 10 = good). They also verbally described the taste of the drink, guessed the type of drink they tasted, and indicated their thoughts on how to improve the taste of the drink. These verbal protocols were fillers and were not analyzed. In the main study, after participants completed the task, research assistants surreptitiously recorded the amount of drink left. No participant correctly guessed the true purpose of the study.

Results and discussion

Amount of juice consumed

The amount of juice consumed (grams) was analyzed as a function of brightness and juice favorableness. The analysis revealed a main effect of juice favorableness. As may be expected, the participants consumed more of the favorable juice than the unfavorable juice ($M_{favorable}$ = 67.27, $M_{unfavorable}$ = 24.16; $F(1, 80) = 23.09$, $p < .001$, $\eta^2 = .20$). This main effect was qualified by the predicted two-way interaction between brightness and juice favorableness ($F(1, 80) = 8.85$, $p < .005$, $\eta^2 = .08$). The participants consumed more of the favorable juice in bright rather than dimmed light (M_{bright} = 85.23, M_{dimmed} = 49.30; $F(1,44) = 5.83$, $p < .02$, $\eta^2 = .12$), but less of the unfavorable juice (M_{bright} = 15.43, M_{dimmed} = 32.88; $F(1, 36) = 4.67$, $p < .04$, $\eta^2 = .11$).

Affective reaction

Ten participants failed to provide a response on the affect measure. The remaining data were used to analyze affective reaction as a function of brightness and drink favorableness. There was a main effect of drink favorableness on affect ($M_{favorable}$ = 6.05, $M_{unfavorable}$ = 4.03; $F(1, 70) = 10.88$, $p < .005$, $\eta^2 = .12$), qualified by the two-way interaction between brightness and drink favorableness ($F(1, 70) = 10.28$, $p < .005$, $\eta^2 = .11$). Bright-light compared to dim light enhanced positive feelings toward the favorable drink (M_{bright} = 6.75, M_{dimmed} = 5.35; $F(1, 38) = 2.91$, $p < .10$, $\eta^2 = .07$) and enhanced negative feelings toward the unfavorable drink (M_{bright} = 2.77, M_{dimmed} = 5.29; $F(1, 32) = 7.68$, $p < .01$, $\eta^2 = .19$).

Mediated moderation

We tested the mediation role of affective reactions in explaining the interactive effective of room brightness and drink favorableness on consumption. Per Hayes (2013), two regression models were used to assess the indirect effects. The mediator model is: $M_e = \alpha_0 + \alpha_1^* X + \alpha_2^* M_o + \alpha_3^* X^* M_o + r$ and the dependent variable model is: $Y = b_0 + c_1'^* X + c_2'^* M_o + c_3'^* X^* M_o + b_1^* M_e + r$, where M_e is the mediator (i.e., affective reactions), X is the independent variable (i.e., brightness: bright vs. dimmed), M_o is the moderator (i.e., drink favorableness: favorable vs. unfavorable), and Y is the amount of drink consumption.

In the mediator model, the interactive effect of brightness and drink favorableness on affect was significant (α_3 = 0.98, SE = 0.31, t = 3.21, p < .005). In the dependent variable model, the direct interactive effect of brightness and drink favorableness on consumption became insignificant (c_3' = 7.70, SE = 5.05, t = 1.52, p > .10), whereas the effect of the affect was marginally significant (b_1 = 3.57, SE = 1.84, t = 1.94, p < .06). Bootstrap tests showed that the interactive effect of brightness and drink favorableness on consumption was mediated by affect (95% bias corrected confidence-interval using 5000 bootstrap samples: 0.633 to 9.099). Thus, this experiment showed that ambient brightness amplifies affective reaction which impacts consumption. People consume more of favorable drinks and less of unfavorable drinks in bright light.

General discussion

Though people see with their eyes, being in light can influence their heart. Across six experiments, we found that light increases people's perception of ambient warmth, which in turn activates their hot emotional system, leading to intensified affective reactions—positive and negative—to different kinds of stimuli. Across different domains, ranging from feelings towards words to judgments of ad scripts and ad models for aggressiveness and sexiness, and to choice of food spiciness levels and consumptions of drinks, we found that light intensified both experienced and anticipated affective reactions, and consequently, influenced judgment and choice in a variety of contexts. Importantly, the awareness of a potential influence of ambient brightness on affective response did not result in a correction of its influence. The reality, based on our data, however, is that bright light intensifies positive and negative affective responses. The fact that people are unable to correct intensification of their affective responses when directed to consider a potential influence of bright light on their affective system implies, in line with our theorizing, that the connection between bright light and emotional intensification is fundamental and perhaps deeply rooted in physiological experiences that have resulted in connections between light, warmth, and emotion.

These findings are important for several reasons. First, by suggesting that bright light intensifies the initial affective response to any stimulus, they provide a theoretical lens with which to reconcile the inconsistent findings in literature regarding the influence of bright light on people's affect, some showing that sunshine (ambient brightness) enhances positive affect and others showing that it amplifies negative affect. Second, equally importantly, they show that one format of sensory input (light) can influence a wide range of judgments that are not obviously or directly related to it. The results thus imply that different sensory inputs combine to influence each other. The sensation of light increases the feeling of warmth, and influences judgments just as warmth does. Future research should investigate whether the feeling of warmth also increases the perception of light, or whether these effects are unidirectional. As warmth is not a fundamental dimension for estimation of light, we expect that these effects will be unidirectional. A third substantial contribution is that these data show that visual input of ambient brightness can impact judgments and decision making by activating the hot emotional system. Thus, this aspect of visual perception is an important input to emotional response. Research on mood and emotions has not considered until now how light can trigger the emotional system. Future research should further investigate other ways the visual system and the emotional system may be linked and how and when visual input is a precursor to activation of the emotional system.

These findings also go beyond past research arguing that good is metaphorically associated with light and evil with darkness and therefore light is good. For example, in other research, participants who recalled evil actions judged the experiment room to be darker (Banergee, Chatterjee, & Sinha, 2012); professional sports teams wearing black uniforms were judged more malevolent than those wearing nonblack uniforms (Frank & Gilovich, 1988). Those findings are seemingly incompatible with the polarization effects we found in experiments 3–6. It should be noted that in those studies, semantic activation of evil-related concepts played the critical mediating role and the findings are limited to when judgments of good and evil are directly evoked and made obvious by a context, experimenter or among people who are chronically predisposed to thoughts about good and evil. Based on our data, brightness seems to be insufficient to activate good or evil related concepts on its own when good and evil have not been made accessible by the experimental task (Banergee et al., 2012) or decision context (Frank & Gilovich, 1988). Thus, it seems that brightness does not directly cue good or evil on its own but instead is a trigger to the emotional system.

The current finding also provides a new way of interpreting previous research demonstrating how ambient darkness changes people's cognitive processing and influences their behavior. For example, Zhong, Bohns, and Gino (2010) showed that darkness can induce an illusion of anonymity that disinhibits self-interested and unethical behaviors. This effect occurs because darkness increases people's cognitive inference regarding others' ability to see or identify them. The current findings offer another potential explanation—darkness may reduce emotional connection with others, and/or may reduce people's negative reactions toward their own immoral actions, and this reduced emotionality disinhibits immoral behavior. Separating the cognitive and emotional consequences of ambient brightness/darkness will be fruitful for future research.

A majority of everyday decisions are made under bright light, and as a result are likely to be impacted emotionally in this manner. The emotional bias is likely to be stronger on brighter days, around noon, when the sun is brightest, and in geographic regions with sunnier rather than cloudier days. From a policy perspective, these findings suggest a simple way to nudge people into being less emotional—by simply turning the lights down. On the other hand, for those wanting to sway opinions with passionate claims, or those desiring swift action to overcome procrastination, turning on the lights may be best.

Appendix A. Sixteen Flavors of Buffalo Wings*—Experiment 2

Sweet BBQ™ Traditional BBQ sauce: Satisfyingly sweet.
Teriyaki™ Terrifically tasty teriyaki sauce.

Mild™ Classic wing sauce: High flavor, low heat.
Parmesan Garlic™ Roasted garlic and Parmesan sauce with Italian herbs.
Medium™ Classic wing sauce: Comfortably hot.
Honey BBQ™ A sweet, sassy sauce: Savor the flavor.
Spicy Garlic™ A tasty, spicy, garlicky good sauce.
Jammin' Jalapeno™ Spicy jalapenos, blended with a touch of tequila and hint of lime.
Asian Zing® Sweet meets heat: A chili pepper, soy and ginger sauce.
Caribbean Jerk™ Red peppers you love, island spices you crave: An exotic, delicious sauce.
Thai Curry™ Herbs and spices combined with sweet chilies and a touch of curry flavor.
Hot BBQ™ Rich BBQ sauce with a touch of heat.
Hot™ Classic wing sauce: Delicious flavor, exhilarating heat.
Mango Habanero™ Feel the burn, savor the sweet: Two sensations, one sauce.
Wild® Classic wing sauce: Big flavor, blisterin' heat.
Blazin'® Keep away from eyes, pets, children: The hottest sauce we got.

*The flavors appear in the menu from the lowest level of spiciness to the highest. In the experiment, the spiciness levels are also indicated by the number of chilies attached to each option.

Appendix B. Alex Ad script—experiment 3

Alex is late to work and is speeding. A car cuts in front of him and Alex honks loudly. When he arrives at his garage his parking spot is taken. He curses loudly and leaves his car with flashers as he goes to find the valet. When he finds the valet he chucks his keys at the valet and loudly tells the valet that he should have not been missing. The valet goes to attend to Alex's car. As Alex rushes upstairs to his office, he nearly pushes an older gentleman out of the way. A woman with a baby is waiting to go inside but Alex does not hold the door open for her. His receptionist wishes him good morning but Alex rushes by without answering.

References

Ahn, H. K., Mazar, N., & Soman, D. (2010). Being hot or being cold: The influence of temperature on judgment and choice. In M. C. Campbell, J. Inman, & R. Pieters (Eds.), *Advances of consumer research* (pp. 86–87) (Duluth, MN, 2010).

Anderson, C. A. (1989). Temperature and aggression. Ubiquitous effect of heat on occurrence of human violence. *Psychological Bulletin*, *106*, 74–76.

Anderson, C. A. (2001). Heat and violence. *Current Directions in Psychological Science*, *10*, 33–38.

Anderson, C. A., Bushman, B. J., & Groom, R. W. (1997). Hot years and serious and deadly assault: Empirical tests of the heat hypothesis. *Journal of Personality and Social Psychology*, *73*, 1213–1223.

Banergee, P., Chatterjee, P., & Sinha, J. (2012). Is it light or dark? Recalling moral behavior changes perception of brightness. *Psychological Science*, *23*, 407–409.

Baron, R. A., & Bell, P. A. (1976). Aggression and heat: The influence of ambient temperature, negative affect, and a cooling drink on physical aggression. *Journal of Personality and Social Psychology*, *33*, 245–255.

Barsalou, L. W. (2008). Grounded cognition. *Annual Review of Psychology*, *59*, 617–645.

Biner, P. M. (1991). Effects of lighting-induced arousal on the magnitude of goal valence. *Personality and Social Psychology Bulletin*, *17*, 214–226.

Borg, M. J., & Wright, N. T. (2000). *The meaning of Jesus: Two visions.* NY: Harper Collins.

Carlsmith, J. M., & Anderson, C. A. (1979). Ambient temperature and the occurrence of collective violence: A new analysis. *Journal of Personality and Social Psychology*, *37*, 337–344.

Conti, P. S., & Alschuler, W. R. (1971). Spectroscopic studies of O-type stars. I. Classification and absolute magnitudes. *The Astrophysical Journal*, *170*, 325–344.

Cunningham, M. R. (1979). Weather, mood, and helping behavior: Quasi experiments with the sunshine Samaritan. *Journal of Personality and Social Psychology*, *37*, 1947–1956.

Cunningham, M. R., Steinberg, J., & Grev, R. (1980). Wanting to and having to help: Separate motivations for positive mood and guilt-induced helping. *Journal of Personality and Social Psychology*, *38*, 181–192.

Eagly, A. H., & Steffen, V. J. (1986). Gender and aggressive behavior: A meta-analytic review of the social psychological literature. *Psychological Bulletin*, *100*, 309–330.

Fishbach, A., & Labroo, A. A. (2007). Be better or be merry: How mood affects self-control. *Journal of Personality and Social Psychology*, *93*, 158–173.

Frank, M. G., & Gilovich, T. (1988). The dark side of self-and social perception: Black uniforms and aggression in professional sports. *Journal of Personality and Social Psychology*, *54*, 74–85.

Gal, D., Wheeler, S. C., & Shiv, B. (2007). *Cross-modal influences on gustatory perception.* (Doctoral Dissertation). : Stanford University.

Grable, J. E., & Roszkowski, M. J. (2008). The influence of mood on the willingness to take financial risks. *Journal of Risk Research*, *11*, 905–923.

Hayes, A. F. (2013). *Introduction to mediation, moderation, and conditional process analysis.* NY: The Guilford Press.

Hirshleifer, D., & Shumway, T. (2003). Good day sunshine: Stock returns and the weather. *Journal of Finance*, *58*, 1009–1032.

Hong, J., & Sun, Y. (2012). Warm it up with love: The effect of physical coldness and liking of romance movies. *Journal of Consumer Research*, *39*, 293–306.

Kamstra, M., Kramer, L., & Levi, M. (2003). Winter blues: A SAD stock market cycle. *American Economic Review*, *93*, 324–343.

Kevan, S. M. (1980). Perspectives on season of suicide: A review. *Social Science and Medicine Part D: Medical Geography*, *14*, 369–378.

Kommer, D., Schwarz, N., Strack, F., & Bechtel, G. (1986). Stimmung und Informationsverarbeitung bei depressiven Störungen [Mood and information processing in depressives]. *Zeitschrift für Klinische Psychologie Psychopathologie und Psychotherapie*, *34*, 97–112.

Lakoff, G., & Johnson, M. (1999). *Philosophy in the flesh: The embodied mind and its challenge to western thought.* NY: Basic Books.

Landau, M. J., Meier, B., & Keefer, L. (2010). A metaphor-enriched social cognition. *Psychological Bulletin*, *136*, 1045–1067.

Loewenstein, G. (2000). Emotions in economic theory and economic behavior. *The American Economic Review*, *90*, 426–432.

MacIsaac, D., Kanner, G., & Anderson, G. (1999). Basic physics of the incandescent lamp. *The Physics Teacher*, *37*, 520–525.

Matlin, M. W., & Stang, D. (1979). *The Pollyanna principle: Selectivity in language, memory, and thought.* Cambridge, MA: Shenkman.

Meier, B. P., Robinson, M. D., Crawford, L. E., & Ahlvers, W. J. (2007). When "light" and "dark" thoughts become light and dark responses: Affect biases brightness judgments. *Emotion*, *7*, 366–376.

Meier, B. P., Schnall, S., Schwarz, N., & Bargh, J. A. (2012). Embodiment in social psychology. *Topics in Cognitive Science*, *4*, 705–716.

Metcalfe, J., & Mischel, W. (1999). A hot/cool-system analysis of delay of gratification: Dynamics of willpower. *Psychological Review*, *106*, 3–19.

Michael, R. P., & Zumpe, D. (1983). Annual rhythms in human violence and sexual aggression in the United States and the role of temperature. *Social Biology*, *30*, 263–278.

Pennebaker, J. W., Rimé, B., & Blankenship, V. E. (1996). Stereotypes of emotional expressiveness of northerners and southerners: A cross-cultural test of Montesquieu's hypotheses. *Journal of Personality and Social Psychology*, *70*, 372–380.

Preacher, K. J., & Hayes, A. F. (2004). SPSS and SAS procedures for estimating indirect effects in simple mediation models. *Behavior Research Methods, Instruments, and Computers*, *36*, 717–731.

Preacher, K. J., & Hayes, A. F. (2008). Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behavior Research Methods*, *40*, 879–891.

Rodgers, C. D. (1976). Retrieval of atmospheric temperature and composition from remote measurements of thermal radiation. *Reviews of Geophysics*, *14*, 609–624.

Rosenthal, N. E., Sack, D. A., Gillin, J. C., Lewy, A. J., Goodwin, F. K., Davenport, Y., et al. (1984). Seasonal affective disorder: A description of the syndrome and preliminary findings with light therapy. *Archives of General Psychiatry*, *41*, 72–80.

Rotton, J., & Frey, J. (1985). Air pollution, weather, and violent crimes: Concomitant time-series analysis of archival data. *Journal of Personality and Social Psychology*, *49*, 1207–1220.

Schwarz, N., & Clore, G. L. (1983). Mood, misattribution, and judgments of well-being: Informative and directive functions of affective states. *Journal of Personality and Social Psychology*, *45*, 513–523.

Schwarz, N., & Clore, G. L. (2003). Mood as information: 20 Years later. *Psychological Inquiry: An International Journal for the Advancement of Psychological Theory*, *14*, 296–303.

Song, H., Vonasch, A. J., Meier, B. P., & Bargh, J. A. (2011). Brighten up: Smiles facilitate perceptual judgment of facial lightness. *Journal of Experimental Social Psychology*, *48*, 450–452.

Srull, T. K., & Wyer, R. S. (1979). The role of category accessibility in the interpretation of information about persons: Some determinants and implications. *Journal of Personality and Social Psychology*, *37*, 1660–1672.

Strack, F., Schwarz, N., Bless, H., Kübler, A., & Wänke, M. (1993). Awareness of the influence as a determinant of assimilation versus contrast. *European Journal of Social Psychology*, *23*, 53–62.

United States Riot Commission (1968). *Report of the National Advisory Commission on Civil Disorders.* NY: Bantam.

Watson, D. (2000). *Mood and temperament.* NY: Guilford Press.

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

Wilson, T. D., & Brekke, N. (1994). Mental contamination and mental correction: Unwanted influences on judgments and evaluations. *Psychological Bulletin*, *116*, 117–142.

Workman, J. L., & Nelson, R. J. (2011). Potential animal models of seasonal affective disorder. *Neuroscience and Biobehavioral Reviews*, *35*, 669–679.

Wright, C. (2005). *Some like it hot: Spicy favorites from the world's hot zones.* Boston: The Harvard Common Press.

Zhao, X., Lynch, J. G., & Chen, Q. (2010). Reconsidering Baron and Kenny: Myths and truth about mediation analysis. *Journal of Consumer Research*, *37*, 197–206.

Zhong, C. B., Bohns, V. K., & Gino, F. (2010). A good lamp is the best police: Darkness increases dishonesty and self-interested behavior. *Psychological science*, *21*, 311–314.