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Homeostasis-Driven Responses to Consumer Sensations

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HOMEOSTASIS-DRIVEN RESPONSES TO CONSUMER SENSATIONS

by

RHONDA HADI

A dissertation submitted to the Graduate Faculty in Business in partial fulfillment of the requirements for the degree of Doctor of Philosophy, The City University of New York

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This manuscript has been read and accepted for the Graduate Faculty in Business in satisfaction of the dissertation requirement for the degree of Doctor of Philosophy.

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THE CITY UNIVERSITY OF NEW YORK
Abstract

HOMEOSTASIS-DRIVEN RESPONSES TO CONSUMER SENSATIONS

by

Rhonda Hadi

Advisor: Lauren Block, PhD

This research examines the effect of experienced physical temperature on an individual’s decision-making process. Reliance on emotions can function as a warming process and reliance on cognitions can function as a cooling process, hence individuals are nonconsciously induced to alter their decision-making style according to their thermoregulatory objectives. My first two studies support a thermoregulatory account by demonstrating that the mere use of cognitive versus affective processing leads to both self-reported and objective changes in body temperature, and that the adoption of a compensatory pathway can indeed aid in providing temperature-related comfort. My last three studies demonstrate that individuals adopt these compensatory pathways on their own accord, and accordingly we document the effects of both physical and simulated temperature on choice, willingness to pay, and donation likelihood, and support the role of reliance on emotions as a mediator.
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Introduction

Consumers are constantly exposed to fluctuations in physical temperature. Some of these fluctuations happen gradually (e.g. changing seasons), while other changes happen much more suddenly (stepping inside an air-conditioned store, or taking a sip of a hot drink at a café). In response to such variations, our bodies physiologically respond to ensure that we maintain a specific internal body temperature—a process known as thermoregulation (Alberts and Brunjes 1978; Kirkes 1899). In this research, we suggest that autonomic physiological responses may not be the only way in which humans thermoregulate. We propose that humans can engage in thermoregulation via non-physiological means, a process we term “mental thermoregulation.” Specifically, we suggest that reliance on affect can function as a warming agent, reliance on cognitions can function as a cooling agent, and thus the adoption of a particular decision-making process can operate as a thermoregulatory mechanism.

How might mental processes serve as a direct vehicle for thermoregulation, an ostensibly physiological phenomenon? In the behavioral sciences, the term “cool” processing typically refers to those processes which involve calculative cognitions, linear if-then logical progression, and critical analysis, while “warm” processing alludes to associative systems involving feelings, desires, and emotions (Metcalfe and Mischel 1999). This terminology suggests that at least semantically, each of these processes encompasses a distinct thermoregulatory tone. A number of research programs, including Barsalou’s (1999) framework on perceptual symbol systems, posit that semantic expressions are underpinned by sensory perception, hence semantic expressions that suggest sensory dimensions may in fact have physiological bases. If semantic expressions are usually underpinned by sensory bases, then it may be fruitful to investigate whether those sensory pathways exist, and why. In this research, we suggest that reliance on emotions can
function as a warming process whereas reliance on cognitions functions as a cooling process, and therefore individuals may alter their decision-making style to move toward their thermoregulatory objectives.

Specifically, we propose that experienced temperatures beyond an organism’s homeostatic levels may lead them to compensate by adopting a decision making style with an opposite thermoregulatory tone. In other words, when exposed to cooler than homeostatic temperature conditions, we expect individuals to respond with a “warm” decision-making process (taking an affective pathway) in an effort to warm up, whereas in warmer than homeostatic conditions, we expect individuals to apply a “cool” decision making process (taking a cognitive pathway) in an effort to cool down.

This research makes several meaningful theoretical contributions. We suggest that an individual may choose to embody a decision-making process that is semantically consistent with his or her thermoregulatory objectives (and thus inconsistent with his or her thermoregulatory state). As far as the authors are aware, no research has examined whether an individual’s decision-making process can function to change perceived or actual temperature, nor whether an attempt to do so may be part of an individual’s nonconsciously activated regulatory strategy.

Thus, unlike much of the literature based on embodied cognition, this research provides an example and explanation of why individuals may respond to physical sensations in an oppositional, compensatory fashion (not in a manner congruent with the experienced sensation). Instead of merely reacting to the physical temperature in a metaphorically assimilative manner (i.e. relying on emotions more when warm), physical sensations might instead activate a thermoregulatory goal, thus motivating individuals to employ a process with a contrasting
thermoregulatory tone. To support these predictions, we will briefly review the relevant literatures.
Conceptual Framework

Human Responses to Temperature

*Responses to temperatures within the comfort zone.* Previous research has documented that consumers’ physical surroundings significantly impact their judgments and decisions (Belk 1975). However, temperature has remained a relatively understudied atmospheric variable, despite the fact that it is ever-present, and consumers seem to be quite conscious of it (Cheema and Patrick 2012). Recently, researchers have documented some important consequences of modest ambient temperatures on consumer behavior. One noteworthy example is work by Cheema and Patrick (2012), which examines the effect of a subtle range of temperatures (67 - 77°F) on task performance. Building on a thermal stress paradigm, they find that relatively warm temperatures (around 77°F) increase thermal load, leading to increased reliance on System 1 (heuristic) processing, and thus hampering performance on complex tasks. Along the same vein, Tong and colleagues (2013) find that within a comfortable range of temperatures (61 – 79°F), cool temperatures encourage primarily systematic processing and thus enhance performance on simple tasks, while warm temperatures prompt primarily heuristic processing, and thus lead to better performance on complex tasks.

Importantly, the work above examined temperatures within a modest range (61 – 79°F). According to Hancock and Warm’s Maximal Adaptability Model (MAM; 1989), all these temperatures fall within the so-called “comfort zone” (i.e. 60.8–84.2°F), but only the cold temperature conditions fell within the more narrowly-defined “normative zone” (i.e. 62.6–73.4°F). According to MAM, temperatures within the comfort zone but outside the normative zone will leave people with limited cognitive resources to focus on tasks. Thus in the work by
Cheema and Patrick (2012) and Tong and colleagues (2013), participants only experienced thermal-stress in the warm conditions, but all participants were “comfortable” temperature-wise.

But what happens when temperatures move outside the limited “comfort zone” range? In the present research, we examine consumer responses to temperature that are outside this “comfort” zone. In other words, we explore how consumers behave in temperatures that may feel “too cold” (hypostress) or “too warm” (hyperstress, Hancock and Warm 1989). This distinction is crucial, because we would expect such temperatures to elicit goal-directed responses, while we would not expect such motivated behavior if consumers feel thermally comfortable. To explore how such excessively high or low temperatures impact consumers’ behavior, we next turn to literature on thermoregulation.

**Physical Thermoregulation.** Individuals often face fluctuations in their external environment (e.g. changing weather). In response to such variations, our bodies have a tendency to physiologically regulate our internal environment to ensure stability---a dynamic, iterative process known as homeostasis (Jäning 2008; Marieb and Hoehn 2007). One homeostatic process that is vital to our survival is thermoregulation: our body must maintain a specific internal body temperature, thus we regulate our internal environment to achieve and maintain a stable and balanced condition via autonomic responses (Alberts and Brunjes 1978; Kirkes 1899).

Accordingly, many physiological responses to heat and cold (e.g. sweating, shivering) are tied to our need to keep our core body temperature stable (Bell and Greene 1982). Many organs function to promote thermoregulation, including our brains. One method our brains use to help encourage behavioral thermoregulation is via state-dependent alterations of hedonic perception: our brains generate pleasure or aversion towards stimuli depending on our internal state and corresponding homeostatic needs (Cabanac 1971; Rolls 2005). Specifically, the brain generates
pleasure toward warm stimuli when our core temperature is colder than basal requirements, and pleasure toward cool stimuli when we are warmer than homeostatic temperature requirements (Panksepp 1998). This suggests that experienced temperatures can create different thermoregulatory objectives, and one route to fulfill those objectives is via attraction to physically warm or cold stimuli (King and Janiszewski 2011).

Compensatory Behaviors in Response to Temperature. However, purely physiological thermoregulation may not be the only way in which humans respond to overly hot or cold temperatures. A growing body of literature seems to suggest that people may compensate for suboptimal temperature conditions via alternative behavioral responses. For example, Parker and Tavassoli (2000) accumulated correlational data suggesting that the per capita consumption of stimulating products like alcohol, cocoa, coffee, tea and tobacco is higher in high latitudes, even when controlling for income. In a follow-up paper, it is argued that people in colder climates are below their optimal stimulation level, and thus may be more likely to seek sensation and arousal (Tavassoli 2009). This is supported by research that suggests that cold (vs. warm) weather leads to increases in aggressiveness and risk-taking, resulting in higher stock market returns (Cao and Wei 2005). Further, other research streams seem to suggest that people may try to counteract for excess cold through other compensatory behaviors. For example, findings suggest that individuals are more motivated to watch romantic movies and engage in interpersonal activities when they feel physically cold, to reduce the feeling of coldness (Hong and Sun 2011; Zhang and Risen 2010). More recent research has also suggested that consumers associate abundance with physical warmth, and thus physical cold drives increased purchase intention and purchase quantities (Wang and Zhou 2012). Thus the existing literature has suggested that consuming stimulating products, partaking in interpersonal activities, and increasing purchase quantity all
seem to function as “warming” agents.

Collectively then, extant research indicates that individuals often respond to physical temperatures in a manner that seems to be compensatory in nature. We suggest that this is indeed the case, and further propose that humans may compensate for high or low physical temperatures via largely mental means, a process we term “mental thermoregulation.” Specifically, we propose that the use of a particular decision-making style (using either an affective or cognitive pathway) can serve as a thermoregulatory mechanism by making individuals feel either hot or cold, respectively. But why might one’s reliance on emotions vs. cognitions affect how they feel thermally? To explore this question, we turn to support from literature on perceived temperature.

**Antecedents of Perceived Temperature**

Ample research has demonstrated that experienced thoughts and feelings are not independent of physical and somatic perception (Barsalou 2008; Varela, Thompson, and Rosch 1991), and accordingly, cognitions and feelings can illicit perceptual stimulation and somatic responses (Barsalou 1999; Schubert 2005). Accordingly, the notion that psychological behaviors can lead to physiological temperatures responses is not startling. In fact, research in social perception suggests that affective feelings can have distinct thermoregulatory tones (Ax 1953). Recent research in neuroscience has suggested that the same part of the brain (the insular cortex) is involved in processing both psychological and physical warmth information (Kang et al. 2010).

Several researchers have documented the ability of non-physiological factors to impact an individual’s perceived thermal state. Color cues (Szocs and Biswas 2013), anger-related thoughts (Wilkowski et al. 2009), communion traits (Szymkow et al. 2013), and feelings of
loneliness (Zhong and Leonardelli 2008) have all been shown to impact temperature perceptions. In the last body of work, for example, participants felt colder and evaluated warm food more highly when a social exclusion experience was either primed (asking participants to recall a past experience) or induced (via a virtual interaction) (Zhong and Leonardelli 2008). Together, these studies demonstrate that psychological concepts can in fact impact how warm or cold an individual feels.

However, such research represents particular concepts deliberately primed or induced by the experimenter. But might an individual, on his or her own accord, choose to adopt a particular decision-making process?

**Present Research: Mental Thermoregulation**

In this research, we suggest that an individual may choose to adopt a decision-making process that is metaphorically consistent with his or her thermoregulatory *objective* (and thus inconsistent with his or her thermoregulatory *state*). As far as the authors are aware, no research has examined whether an individual’s decision-making process can function to change perceived or actual temperature, nor whether an attempt to do so may be part of an individual’s regulatory strategy.

Importantly, we argue that these effects will manifest when experienced temperatures shift above or below homeostatic levels. Such temperature changes activate thermoregulatory objectives, which are what ultimately lead to differences in decision-making style. This distinguishes the current research from previous work that examines the important effects of temperature at modest, comfortable ranges (Cheema and Patrick 2012, Tong et al. 2013).
My motivational regulatory account, which focuses on the processing pathways activated by experienced temperatures, is distinct from the extant research on metaphor-consistent behavior in response to physical sensations (Ackerman, Nocera, and Bargh 2010; Williams and Bargh 2008). In the latter research, metaphor-consistent behavior arises because of established associative links between two concepts in memory (Ackerman, Nocera, and Bargh 2010; Williams and Bargh 2008). For example, warm cups make us think the person who gave it to us has a “warmer” personality (Williams and Bargh 2008). This “haptic mindset” triggers a transfer of the activated metaphor (e.g., warm) from the original touched object to the target object (Ackerman, Nocera and Bargh 2010). Importantly, the transfer is limited to the specific concept and not generalized beyond that; for example, touching hard (vs. soft) objects led participants to rate a target person as more rigid and strict, but not more or less positive overall (Ackerman, Nocera and Bargh 2010). Such literature seems to demonstrate metaphor-consistent behavior in response to physical sensations, while the current research documents an opposite pattern of causal direction. This shift in directionality stems from two important distinctions. First, as noted above, my mental thermoregulation framework represents a goal-driven explanation for behavioral responses to physical sensations. If physical sensations are within comfortable, homeostatic levels, there is no reason to expect a motivated response. The second distinction involves the dependent variables being examined. For example, previous research has shown that experienced temperatures can lead to metaphorically-consistent incidental judgments (e.g. warm cups make us think the person who gave it to us has a “warmer” personality; Williams and Bargh 2008). However, my account suggests that temperature can also change the way we make decisions, given that the adopted process allows us to thermally compensate. While there is no reason to believe the specific content of our judgments will impact our resulting temperature
(e.g. judging a person to have a warmer personality should not necessarily make us feel warmer, and we can come up with such judgments via cognitive or affective means), we suggest and demonstrate that the decision-making style an individual adopts (i.e. cognitive vs. affective pathway) will indeed have an impact. Thus, by exploring responses to physical sensations via a regulatory framework, this work addresses the call to more critically examine processes by which physical sensations exert their effects (Krisha 2012; Zhang and Li 2012).

Thus, we contribute to literature on thermoregulation, atmospherics, and the role of affect in decision-making by suggesting that reliance on emotions (cognitions) can function as a warming (cooling) process, and individuals may accordingly alter their decision-making style to fulfill thermoregulatory objectives in response to experienced physical temperatures that are cooler or warmer than homeostatic levels in their internal milieu. Assuming that individuals start off at a relatively homeostatic base level temperature, exposure to excess physical warmth (coolness) will activate a desire to cool down (warm up), and thus the individual will attempt to fulfill this objective by adopting a cognitive (affective) decision making style. My proposed framework, along with a pictorial representation of the mental thermoregulation process, is depicted in Appendix A.

Mental thermoregulation represents a unique framework for the study of behavioral response to physical sensation—therefore, I conducted a series of studies that collectively provide compelling empirical support for my theorizing, but individually provide support for each element of my theorizing replicated across different domains and dependent variables. My first two studies support the mental thermoregulation explanation by providing evidence that the mere use of cognitive versus affective pathways can indeed alter an individual’s perceived and actual temperature (Study 1), and the adoption of a compensatory pathway can indeed aid in providing
temperature-related comfort (Study 2). In my last three studies, I test the hypothesis that cold (warm) temperature leads individuals to spontaneously rely more on affect (cognitions) when making decisions. Specifically, I examine the effect of temperature willingness to pay (Study 3), donation likelihood (Study 4), and choice (Study 5), and support the role of reliance on emotions as a mediator. Thus taken as a set, these five studies provide converging support for my mental thermoregulation framework (Appendix A).
Study 1: Temperature Responses

My proposed mental thermoregulation framework hinges on the key prerequisite that affective and cognitive pathways can function as warming and cooling mechanisms respectively. However, as far as the author is aware, this has never been empirically tested in the existing literature. Thus, the purpose of Study 1 was to support the validity of my thermoregulation account by demonstrating objective, physical temperature fluctuations as a result of affective vs. cognitive decision-making.

The study was a 2 level (task instructions: affective vs. cognitive) between subjects design. Upon entering the lab, subjects were equipped with wireless iButtons to measure their temperature over the duration of the experiment. After a filler task, participants were given explicit instructions to describe either their feelings (affective condition) or evaluative thoughts (cognitive condition) in assessing a series of scenarios and I examined the changes in their physical temperature as a result. I expected that affective processing (as compared to cognitive processing) would result in objectively warmer (vs. cooler) physical temperature, suggesting that the ability of affective/cognitive pathways to produce physiological temperature responses.

Method

Upon entering the lab, fifty-eight undergraduate students were asked to indicate which hand was their non-dominant hand. The experimenter then proceeded to affix an iButton, a wireless temperature monitor, to the index finger of the participant’s non-dominant hand using medical tape. I chose to capture temperature at the fingertip because previous research suggests skin-temperature readings at the fingertip are a convenient and accurate measure for the assessment of psychophysiological responses and thermoregulatory vasoconstriction (Kistler,
iButtons contain a semiconductor temperature sensor and a computer chip with a real time clock and memory enclosed in a $16 \times 6 \text{ mm}^2$ stainless steel can. Thus, the iButton functions as both a thermometer (constantly measuring participants’ temperature) and a data logger (recording the observed temperature at specified intervals, as frequently as every 8 seconds). This provided the experimenters with continuous time-stamped temperature data for each participant. Manufacturing specifications indicate precision of $+/-.125^\circ \text{C} (+/-.225^\circ \text{F})$, and previous studies have validated the use of iButtons on human skin for clinical and field measurements (Hasselberg, McMahon, and Parker 2013; Marken Lichtenbelt et al. 2006).

After being outfitted with an iButton, participants started off with a neutral filler task that lasted approximately ten minutes. The purpose of the filler task was two-fold: first, it served as a calibration period to allow the iButton time to acclimate to the individual’s skin temperature, and second, it allowed me to obtain temperature estimates for participants in a neutral state (neither explicitly cognitive nor affective). After participants completed the filler task, the experimenter took note of the exact time (in order to match it up with the real-time temperature data later) before getting the participants started on the second task.

The second task involved the manipulation. Participants were given explicit instructions to describe either their feelings or evaluative thoughts in assessing a series of scenarios (“Going to a rock concert” “Taking a test at school,” “Spending Thanksgiving with your family,” and “Watching your favorite TV show at home.”). In one condition (which I refer to as “affective instructions”), respondents were instructed to focus and describe their feelings and emotions in relation to each scenario. In the other condition (which I refer to as “cognitive instructions”), respondents were told to focus on their objective assessments in describing each scenario (see
Appendix B, the instructions were adapted from Pham et al. 2001).

After each participant completed this task, the experimenter again noted the exact time. Participants were then asked to indicate the basis of their assessments in an attempt to ascertain whether the manipulation did indeed succeed to elicit participants’ use of affective vs. cognitive pathways. This was measured via a four-item scale adapted from Shiv and Fedorikhin 1999 (all seven-point items; “My decision of how much to pay for insurance was driven by: "my thoughts (1)/my feelings (7)," "my prudent self (1)/my impulsive self (7)," "my rational side (1)/my emotional side (7)," and "my head (1)/my heart (7)," $\alpha = .76$). Lastly, participants indicated their gender and ethnicity. After participants completed the survey, the experimenter detached the iButton from the participant, and downloaded the logged temperature data.

**Results and Discussion**

Four students entered the laboratory with food or drink (i.e. coffee and frozen yogurt) that they consumed throughout the duration the experiment. Because such consumption can clearly impact body temperature, these individuals were excluded from the remaining analysis. In addition, three students were interrupted during the duration of the experiment (i.e. for a bathroom break and to answer a phone call). Because of the time-stamped nature of the temperature data, these individuals were also excluded, resulting in 51 active observations for analysis.

*Manipulation check.* As predicted, results did indeed demonstrate a significant main effect of processing instructions on respondents’ reliance on affect, ($M_{\text{Cognitive}} = 2.80$ vs. $M_{\text{Affective}} = 4.34$, $F(1, 49) = 27.89, p < .01$). However, a stem-and-leaf plot indicated that in the cognitive condition, there were two participants who scored high enough in reliance on affect to be
considered “extreme” cases. This demonstrates that these participants are outliers, and also suggests that the two subjects failed to follow the processing instructions (i.e., they used affect instead of cognition in their processing). Thus, these two participants were removed from further analysis.

*Time Spent on Task.* Because task time was not fixed, some participants took longer to complete the designated task than others. I expected that individuals with the affective instructions would spend a shorter amount of time on the task than individuals with the cognitive instructions, since previous literature has repeatedly documented that judgments based on affective assessments are reached faster than those based on reason-based assessments (Pham 2007; Pham et al. 2001; Verplanken, Hofstee, and Janssen 1998; Zajonc 1980). Results from an analysis of variance confirmed this expected difference, with a significant main effect of processing instructions on respondents’ time spent on the task ($M_{\text{Cognitive}} = 18.90$ minutes vs. $M_{\text{Affective}} = 15.34$ minutes, $F(1, 49) = 4.04, p < .05$).

*Hierarchical Linear Model.* By matching the time-stamped temperature data with the recorded task times, the experimenter was able to attain a base temperature estimate for each participant upon starting the designated affective/cognitive task, along with the participants’ temperature every 8 seconds while performing the given task (see figure 1 for visual representations of data from two sample participants). As previously mentioned, some participants took longer to complete the designated task than others, which resulted in a different number of data points for each participant. I thus applied a longitudinal hierarchical linear model (HLM) to analyze the data (Khare and Inman 2006; Lam et al. 2013; Raudenbush and Bryk 2002; Snijders 1996). The purpose of this analysis was to assess the impact of the manipulation (task instructions) on how participants’ temperature changed over time. An important advantage
of using HLM is that it allows for differences across subjects in the number of measurement occasions, without needing to discard any data (Snijders 1996). In this model, the Level 1 regression captures within-individual changes in temperature as a function of time. I clocked time such that the first temperature estimate upon starting the designated task represented the start of the task (Time 0). Level 2 equations in the model express the Level 1 intercept and slopes as a function of the between-group predictor (task instructions). Thus, the Level 2 equations allow us to assess the impact of affective vs. cognitive instructions on an individual’s physical temperature changes over time. The model specification was as follows:

Level 1:

\[
TEMP_{ti} = \pi_{0i} + \pi_{1i}(TIME_{t}) + e_{ti}
\]

Level 2:

\[
\pi_{0i} = \beta_{00} + \beta_{01}(TASK_{i}) + r_{0i}
\]

\[
\pi_{1i} = \beta_{10} + \beta_{11}(TASK_{i}) + r_{1i}
\]

where \( TEMP = \) recorded temperature, \( TIME = \) time elapsed, and \( TASK = \) task instructions (cognitive or affective). Analysis results indicate that both the overall intercept and the task-specific intercept were significant (\( \beta_{00} = 87.21, t = 90.42, p < .001 \); and, \( \beta_{01} = 2.46, t = 1.71, p = .09 \) respectively). The overall slope was not significant (\( \beta_{10} = -0.01, t = -1.64, p > .1 \)), suggesting that on average, time has no significant effect on temperature. However, and most importantly to my hypotheses, the coefficient for task-specific slope was indeed significant (\( \beta_{11} = 0.02, t = 2.65, p = .009 \).
This suggests that task instructions did indeed impact the effect of time on temperature. Importantly, the coefficient is positive, which suggests that affective instructions led to increases in temperatures compared to cognitive instructions.

Figure 1

Visual Representation of Data from Two Sample Subjects- Study 1
Simple Slopes Analysis. The HLM results suggest that the task instructions led to differences in individuals’ temperature over time. However, I also wanted analyze the data within-conditions, to more closely examine directionality of how cognitive and affective instructions each impacted individuals’ temperature. To do so, I ran a simple slopes analysis, using a calculator allowing for differences in the number of measurement occasions across subjects (Bauer and Curran 2005; Preacher, Curran, and Bauer 2006). Results indicated that for affective subjects, the slope was positive and significant ($\beta = 0.0093, t = 2.08, p = .04$), while for cognitive subjects, the slope was negative and marginally significant ($\beta = -0.0038, t = -1.71, p = .09$). These results suggest that overall, those individuals who completed the affective instructions showed increases in temperature on average, while those individuals who completed the cognitive instructions showed decreases in temperature on average.

Analysis of Variance. Lastly, I conducted a mixed analysis of variance procedure to assess the impact of the two different processing instructions (cognitive vs. affective) on participants’ physical temperature across two points in time (before and after the cognitive or affective task). This additional analysis adds value above the previous analysis because it allows me to examine the difference in individuals’ temperature across conditions at the end of the task (because individuals had unique task times, this contrast could not be calculated in the previous analysis). Results demonstrated a significant interaction between instruction type and time ($F(1, 47) = 8.09, p < .01$). Before starting the cognitive/affective task, there was no significant difference between the physical temperature of participants in the two conditions ($M_{\text{Cognitive}} = 86.87$ vs. $M_{\text{Affective}} = 87.93, F(1, 47) < .1$). However, after the designated task, results did indeed demonstrate a significant difference between instruction conditions: as predicted, participants who completed the task via affective instructions produced a higher temperature than individuals
who completed the task via cognitive instructions ($M_{Cognitive} = 85.83$ vs. $M_{Affective} = 89.29$, $F(1, 47) = 5.24, p < .05$; see figure 2 for a visual representation of contrasts).

Figure 2
Mean Temperature by Condition - Study 1

A second set of planned contrasts examined how individuals’ temperatures changed within each condition. Results from these contrasts support the pattern of results found in the simple slopes analysis. In the cognitive instructions condition, individuals’ temperature were marginally significantly lower after the task, as compared to before the task ($M_{Before} = 86.87$ vs. $M_{After} = 85.83$, $F(1, 47) = 3.36, p < .08$). Participants in the affective conditions displayed an opposite pattern: their temperature were significantly higher after the task, as compared to before the task ($M_{Before} = 87.93$ vs. $M_{After} = 89.29$, $F(1, 47) = 4.74, p < .05$).

Taken together, results from this study support the thermoregulation explanation by suggesting that the mere use of cognitive versus affective pathways can indeed alter an individual’s physical temperature via a physiological warming (vs. cooling) process.
Study 2: Forced Pathways

The purpose of the second study was two-fold: first, to add additional support for the thermoregulation explanation by suggesting that the mere use of cognitive versus affective pathways can alter how warm or cold an individual feels (not just objective measures), and more importantly, to demonstrate that the adoption of a compensatory pathway can aid in providing temperature-related comfort. In other words, I examined whether individuals feeling too hot or too cold could at least partially thermoregulate by adopting a compensatory decision-making process. Further, previous research has suggested that temperature changes may impact arousal levels (Poulton 1976), although the literature documents that uncomfortable temperatures in either direction (hot or cold) are both arousing and sedative (Anderson 1989). Nevertheless, I added a measure to assess and control for any differences in perceived arousal as a result of the temperature manipulations.

The study took the form of a 2 (temperature: cold vs. warm) x 2 (task instructions: affective vs. cognitive) between subjects design. After the temperature manipulation, participants were given explicit instructions to describe either their feelings (affective condition) or evaluative thoughts (cognitive condition) in assessing a series of scenarios (as in Study 1), and I examined the degree to which individuals felt a difference in physical temperature as a result. I expected that emotional processing (as compared to cognitive processing) would result in warmer (vs. cooler) perceived temperature. Thus, when comparing all four conditions resulting from the 2 x 2 design, I expected that those in the cold-cognitive condition would be the coldest, those in the warm-affective would be the warmest, and those in the cold-affective and warm-cognitive conditions would be somewhere in between (but I made no predictions of which of these two conditions would be warmer, since I make no predictions about the comparative
warming/cooling power of the temperature vs. instructions manipulations). Importantly, to support my thermoregulatory process explanation, I expected that in the cold temperature conditions, those in the affective condition would be more comfortable in terms of temperature that those in the cognitive condition, but that in the warm temperature condition, the reverse would be true.

**Method**

One hundred and seventeen undergraduate students were assigned to one of two temperature conditions. Temperature was manipulated by asking participants to hold onto a cup throughout the duration of the experiment. As a cover story, respondents were told that the experimenters were interested in their ability to multi-task. Depending on condition, the cup was filled with either cold water or warm water before participants entered the lab (manipulation used in Williams and Bargh 2008). Cold water was obtained from an ice-filled cooler, while the warm water was poured from an electric kettle (cup surface temperature ranged from approximately 45–60°F in the cold condition, and 110–125°F in the warm condition). After the temperature manipulation, I measured mood and arousal. Mood was measured using five 7-point Likert scale items (Good Mood, Content, Cheerful, Unhappy (reverse coded), Bored (reverse coded); α = .80), and perceived arousal was measured using a 24-item scale (ex. “alert,” “excited,” “drowsy,” taken from Anderson, Deuser and DeNeve 1995, α = .92).

Next, participants were given explicit task instructions to describe either their feelings or evaluative thoughts in assessing a series of scenarios (as in Study 1). In this experiment, I was interested in whether the affective versus cognitive pathway instructions would lead to differences in perceived physical temperature. Thus, afterwards, I asked participants to indicate
their perceived temperature (“Please indicate how warm or cold you currently feel in terms of temperature” on a 9-point Likert scale anchored by “extremely cold” and “extremely warm.”) However, to support my thermoregulation process, I was most interested in how well each process allowed individuals to “mentally thermoregulate.” Thus, participants were asked to indicate their comfort temperature-wise (“Please indicate how comfortable you currently feel, in terms of temperature”) on a 9-point Likert scale anchored by “very uncomfortable” and “very comfortable.” Afterwards, participants indicated gender and age.

**Results and Discussion**

*Covariates and Control Measures.* Neither gender nor age significantly interacted with the independent variable (affective vs. cognitive instructions) nor covaried significantly with the dependent measures in the study (perceived temperature and thermal comfort), and were thus excluded from the remaining analysis. In addition, the temperature manipulation did not have a significant impact on perceived arousal ($F(1, 115) = 1.13, p > .1$) or mood ($F(1, 115) < 1$), and were thus excluded from the remaining analysis as well.

*Perceived Temperature.* According to my proposed framework, I expected that emotional processing (as compared to cognitive processing) would result in warmer (vs. cooler) perceived temperatures regardless of whether participants were exposed to the warm or cold temperature manipulation (a main effect). As predicted, the results did indeed demonstrate a significant main effect of processing instructions on respondents’ perceived temperature ($M_{\text{Affective}} = 5.98$ vs. $M_{\text{Cognitive}} = 5.13$, $F(1, 113) = 9.34, p < .01$). Thus, respondents’ self-reported temperature in the affective conditions was significantly higher than in the cognitive condition. Temperature and instruction manipulations did not have an interactive effect on perceived temperature ($p > .6$),
nor did I expect them to. However, as I predicted, a planned linear contrast confirmed that perceived temperatures from the four conditions resulting from our temperature x instructions design followed a linear pattern (the order hypothesized was, in order of cold to warm: matched: cold-cognitive; mixed: warm-cognitive/cold-affective; and matched: warm-affective ($F(1, 113) = 4.49, p < .05$). Additional analyses of planned contrasts indicated that the perceived temperature for those participants in the cold-affective condition was significantly warmer than for those in the cold-cognitive condition ($M_{\text{Cold-Affective}} = 5.93$ vs. $M_{\text{Cold-Cognitive}} = 4.97, F(1, 113) = 6.30, p < .05$), and those in the warm-affective condition displayed marginally significantly warmer perceived temperature than those in the warm-cognitive condition ($M_{\text{Warm-Affective}} = 6.04$ vs. $M_{\text{Warm-Cognitive}} = 5.33, F(1, 113) = 3.00, p < .09$), see figure 3 for a visual representation of the contrasts). These results demonstrate a perceived warming (vs. cooling) impact of employing an affective (vs. cognitive) pathway, regardless of the initial physical temperature manipulation. Hence, this study supports the thermoregulation explanation by suggesting that the mere use of cognitive versus affective pathways can indeed alter an individual’s perception of physical temperature.

Figure 3
Mean Perceived Temperature by Condition- Study 2
Thermal Comfort. Because my theorizing suggests that both cognitive and affective pathways can function as regulatory mechanisms, I expected an interactive effect on thermal comfort, depending on the initially experienced temperature. Indeed, an ANOVA revealed a significant temperature x instructions interaction on respondent’s thermal comfort ($F(1, 113) = 7.47; p < .01$). In the cold condition, affective respondents were more comfortable in terms of temperature than cognitive respondents ($M_{Affective} = 6.55$ vs. $M_{Cognitive} = 5.61$, $F(1, 113) = 4.43, p < .05$), but the reverse was true in the warm condition ($M_{Affective} = 5.79$ vs. $M_{Cognitive} = 6.63$, $F(1, 113) = 3.14, p < .08$, see figure 4 for a visual representation of the interaction and contrasts). In other words, participants whose instructions had a thermoregulatory tone that contrasted with their initial experienced physical temperature (cold-affective and warm-cognitive respondents) were the most comfortable, suggesting that they were better able to thermoregulate compared to individuals whose instructions matched their initial physical temperature manipulation (cold-cognitive and warm-affective respondents).

Figure 4

Mean thermal comfort by Condition- Study 2
Study 3: Clocks

While my first two studies support the thermoregulatory power of affective and cognitive decision-making, the purpose of study 3 was to examine whether individuals spontaneously apply this regulatory strategy when exposed to temperatures above or below homeostatic levels. In other words, this study sought to examine the impact of physical temperature exposure on individuals’ reliance on affect in decision-making, and thus support the front-end of my proposed mental thermoregulation framework (Appendix A). Specifically, I examined the degree to which individuals were relying on affect by measuring the maximum amount they would be willing to pay for insurance for an object (an antique clock; adapted from Hsee and Kunreuther 2000). Depending on condition, the clock had either a high sentiment description (indicating high affective value) or a low sentiment description (indicating low affective value). If one is not relying on affect (which I propose should be the case in the warm temperature condition), then there should be no difference between the maximum amount an individual is willing to pay under the two object description conditions. However, if an individual is in fact relying on his or her emotions (which I propose should be the case in the cold temperature condition), then we would expect participants to be willing to pay more to insure the object with a high sentiment description than for the object with a low sentiment description.

Method

One hundred and twelve undergraduate students were randomly assigned to one of four conditions according to the 2 (temperature: cold vs. warm) x 2 (object description: low sentiment vs. high sentiment) design. Temperature was manipulated using the same cup-holding procedure as in Study 2. After the temperature manipulation, all participants were presented with a
hypothetical scenario in which they would have the opportunity to purchase insurance for an antique clock (Hsee and Kunreuther 2000). Participants read a description of the clock which differed depending on condition: the clock was described in either a low sentiment or high sentiment fashion (see Appendix B). In the low sentiment condition the object description implied no sentimental value to the subject, while in the high sentiment condition the object description did imply sentimental value to the subject.

After reading the scenario and object description, respondents indicated the maximum amount they would be willing to pay for insurance of the clock, which was the main dependent variable of interest. After making the decision, participants were asked to indicate the basis of their decision (again using the scale adapted from Shiv and Fedorikhin 1999). Lastly, participants indicated their gender and ethnicity.

Results and Discussion

Covariates and Control Measures. Neither gender nor ethnicity significantly interacted with the independent variable (temperature) nor covaried significantly with the dependent measures in the study, and were thus excluded from the remaining analysis.

Willingness to Pay. As predicted, an ANOVA revealed a significant interaction between temperature and object description on willingness to pay ($F(1, 108) = 4.46, p < .05$). This indicates that the difference between the two object description conditions was significantly different in the two temperature conditions. As expected, in the cold temperature condition, the difference between the low sentiment and high sentiment conditions was significant ($M_{\text{Low Sent.}} = $8.71, $M_{\text{High Sent.}} = $52.12; $F(1, 108) = 17.04 p < .01$), and in the hypothesized direction (participants were willing to pay significantly more for the clock when it had a highly
sentimental description). In the warm temperature condition however, as expected, the difference between the two object description conditions was not significantly different ($M_{\text{Low Sent.}} = $19.71, $M_{\text{High Sent.}} = $32.22; $F(1, 108) = 1.52, p > .1$). Furthermore, the contrast between the cold and warm conditions was not significant in the low sentiment condition ($M_{\text{Cold}} = $8.71, $M_{\text{Warm}} = $19.71; $F(1, 108) = 1.19 p > 1$), but was marginally significant in the high sentiment condition ($M_{\text{Cold}} = $52.12, $M_{\text{Warm}} = $32.22; $F(1, 108) = 3.52 p < .07$). See figure 5 for a visual representation of the interaction and planned contrasts.

Figure 5
Mean Willingness to Pay by Condition- Study 3

**Willingness to Pay for Object Insurance**

- Cold: $8.71
- Warm: $19.71
- Low Sentiment: $52.12
- High Sentiment: $32.22

*Decision Basis.* Again, the four-item decision basis scale measured whether decisions across different conditions were based on respondents' affective reactions or cognitions. To determine the extent to which reliance on emotions mediated the effect of temperature on willingness to pay, I applied a moderated mediation bootstrap procedure (Model 8 in the macro
suggested by Hayes, 2012). I expected that the indirect effect of temperature on willingness to pay through decision basis would be significant in the high sentiment condition (where there is an opportunity for an affective response), but not significant in the low sentiment condition (where there is little opportunity for an affective response). Upon specifying a confidence interval of 95% with 5000 bootstrap resamples, the analysis confirmed a conditional indirect effect: in the low sentiment description condition, the indirect effect of temperature on willingness to pay through decision basis was not significant, with a confidence interval including zero (-9.4192 to 4.9247), but in the high sentiment description condition, the indirect effect of temperature on willingness to pay through decision basis was significant, with a confidence interval excluding zero (-19.0283 to -1.3141). These results suggest that when there is an opportunity for an affective response (ex. via a sentimental description), reliance on emotions mediates the effect of temperature on willingness to pay.
Study 4: Pandas

The purpose of this study was to expand the boundaries of the thermoregulation process examined in Study 3. Particularly, I wished to demonstrate that the extent to which an individual relies on his or her emotions in decision-making is influenced not only by actual physical temperature, but can also be impacted by changes in perceived temperature. Specifically, I investigated whether mere simulated temperature influences reliance on emotions in decision-making. Thus, I manipulated temperature (cold vs. warm) via mental simulation. I adapted a procedure from Hsee and Rottenstreich (2004). Hsee and Rottenstreich argue that when individuals rely on affect in making decisions, they become insensitive to scale differences (i.e., differences in magnitude). Thus, individuals relying on their emotions are willing to donate as much money to save one panda as to save four pandas, but those using cognitive processing are willing to donate more to save more pandas. The study took the form of a 2 (temperature simulation: cold vs. warm) x 2 (scope: one vs. four) between subjects design, and examined the degree to which individuals were relying on affect by measuring their likelihood of donating toward an effort to save the endangered panda/pandas. For those individuals in the cold temperature simulation (who we predicted would rely on affect), I expected to find no difference between donation likelihood in the one panda vs. four panda conditions. However, in the warm temperature simulation condition, one would expect participants to be more willing to donate in efforts to save the four pandas than in efforts to save just one.

Method

For this study, responses were collected from ninety-eight participants via Amazon’s Mechanical Turk system. Respondents were presented with temperature simulation instructions
depending on condition. Simulated temperature was manipulated by asking participants to read, imagine, and retype a scenario in which they were consuming either a cold or warm beverage. Participants in the cold condition read the following:

“Imagine that you are sitting at a cafe, and you are given a **glass of iced tea**. Visualize yourself accepting the glass. As you hold the glass, you can feel the **coolness** of the glass against the palms of your hands. You continue holding the glass, until you have finished your iced tea.”

Participants in the warm condition read the following:

“Imagine that you are sitting at a cafe, and you are given a **mug of warm tea**. Visualize yourself accepting the mug. As you hold the mug, you can feel the **warmth** of the mug against the palms of your hands. You continue holding the mug, until you have finished your warm tea.”

As a manipulation check after the temperature simulation, respondents were asked to indicate how warm or cold they felt on a 7-point scale anchored by “extremely cold” and “extremely warm.”

Afterwards, respondents read a hypothetical scenario that described rescue efforts to save either one or four endangered pandas. In the one-panda condition, participants read a scenario about a rescue effort for one panda, and only one panda was pictured. In the four-panda condition, participants read a scenario about a rescue effort for four pandas, and four pictures of the panda were presented (see Appendix D). The main dependent variable of interest was donation likelihood (“How likely would you be to donate money towards the rescue effort?”), measured on a 7-point scale anchored by “very unlikely” and “very likely.” After indicating their donation likelihood, participants were then asked to indicate the basis of their decision, again in
an attempt to ascertain whether decisions across different conditions were based on respondents' affective reactions or cognitions. These decision basis items were the same that were used in study 1 ($\alpha = .90$). In addition, participants completed a Likert-scaled item measuring their general concern for endangered animals to be used as potential covariate. Lastly, participants evaluated their current mood state (measured with four Likert-scaled items: “I am in a cheerful mood right now;” “I am in a good mood right now;” “I am unhappy right now; and “I am bored right now,” $\alpha = .80$), and indicated their gender and age.

**Results and Discussion**

*Manipulation Check.* An ANOVA revealed that the temperature simulation did indeed lead to differences in perceived temperature in the desired direction ($M_{\text{cold}} = 3.67$, $M_{\text{warm}} = 5.15$, $F(1, 96) = 42.24$, $p < .01$).

*Covariates and Control Measures.* An ANOVA revealed that temperature did not lead to any differences in mood across the conditions. Neither gender nor age significantly interacted with the independent variable (simulated temperature) nor covaried significantly with the dependent measure in the study (donation likelihood), and were thus excluded from the remaining analysis. However, general concern for endangered species did covary with the dependent variable, and was thus included as a covariate in the remaining analysis (greater general concern for endangered species led to greater donation likelihood; $F(1, 97) = 64.76$, $p < .001$).

*Donation Likelihood.* As predicted, an ANOVA revealed a significant simulated temperature by scope interaction ($F(1, 93) = 5.08$, $p < .05$). Specifically, in the warm temperature simulation condition, I predicted that respondents would be using a cognitive process and thus be
sensitive to scale. Results confirm that participants were more likely to donate more when there were four pandas ($M_{\text{Four Pandas}} = 4.30$) than when there was only one panda in the scenario ($M_{\text{One Panda}} = 3.44$; $F(1, 93) = 4.76, p < .05$). In the cold temperature condition however, where I predicted respondents would rely on emotion and thus be insensitive to scale, the difference between the one-panda and four-pandas conditions was, as expected, not significant ($M_{\text{One Panda}} = 4.33, M_{\text{Four Pandas}} = 3.96; F(1, 93) < 1$). Thus, individuals were scale insensitive only in the cold temperature condition. Further, the contrast between the cold and warm conditions was, as expected, significant in the one panda condition ($M_{\text{Cold}} = 4.33, M_{\text{Warm}} = 3.44; F(1, 93) = 5.20, p < .05$), but was not significant in the four pandas condition ($M_{\text{Cold}} = 3.96, M_{\text{Warm}} = 4.30; F(1, 93) < 1$). See figure 6 for a visual representation of the interaction and planned contrasts.

Figure 6

Mean Donation Likelihood to Pay by Condition- Study 4

![Bar chart showing donation likelihood by condition](image-url)
**Decision Basis.** Again, the 4-item decision basis scale measured whether decisions across different conditions were based on respondents' affective reactions or cognitions. To determine the extent to which reliance on affect mediated the effect of temperature on willingness to pay, I applied a mediated moderation bootstrap procedure (Model 8 in the macro suggested by Hayes, 2012). Upon specifying a confidence interval of 95% with 5000 bootstrap resamples, the analysis confirmed an indirect effect: the indirect effect of temperature x scope on donation likelihood through decision basis was significant, with a confidence interval excluding zero (0.0848 to 0.8407). These results suggest that reliance on affect mediates the effect of temperature by scope on donation likelihood.
Study 5: Cake

The purpose of study 5 was to provide more robust evidence for my theorizing in a different decision making context (i.e. one related to indulgence) and different dependent variables (choice and product evaluation). Thus, this study once again investigated the role of physical temperature on reliance on emotions in decision-making. The study examined the degree to which individuals were relying on affect in two temperature conditions by subjecting participants to a binary choice task, in which one alternative, chocolate cake, was superior on the affective dimension but inferior on the cognitive dimension compared to the other alternative: fruit salad (procedure borrowed from Shiv and Fedorikhin 1999). According to the literature, if people are relying on affect, they will be more likely to choose the chocolate cake, but if they are relying on their cognitions, they will be more likely to choose the fruit salad (Shiv and Fedorikhin 1999).

Pretest

A pretest was conducted to ensure that there were no differences in the perceived physical temperature of the two snack options. Fifty-nine undergraduate students from the same population as the main study were administered the pretest. Participants were shown a picture of either the chocolate cake or the fruit salad, and were asked, “How cold/warm would you expect the cake (fruit salad) pictured above to be?” and were provided with a seven point scale anchored by “extremely cold” (1) and “extremely warm” (7). An ANOVA did not detect any significant difference in perceived temperature between the two snack options ($M_{\text{cake}} = 3.67$, $M_{\text{fruit salad}} = 3.55$; $F(1, 58) < .1$).
Method

One hundred and eighteen undergraduate students from an undergraduate subject pool were assigned to one of two temperature conditions: cold or warm. Temperature was manipulated using the same cup-holding procedure as in Study 3.

After being assigned to a manipulation, all participants were presented with a hypothetical binary choice task (see Appendix C for experimental stimuli), in which they had to choose an afternoon snack to purchase. Between the two options, one alternative, chocolate cake, was superior on the affective dimension but inferior on the cognitive dimension compared to the other alternative, fruit salad (procedure borrowed from Shiv and Fedorikhin 1999). The main dependent variable of interest in this study was the participant’s choice in the binary choice task (either chocolate cake or fruit salad). As an additional dependent measure, participants were asked to assess their likelihood of purchasing the chocolate cake if not forced to choose (“If you were not forced to choose any one option, how likely would you be to purchase the chocolate cake?”). To ascertain whether decisions were based on respondents' affective reactions or cognitions, participants were then asked to indicate the basis of their choice on the same scale used in Study 1a. In addition, participants completed 3 Likert-scaled items to be used as potential covariates: health consciousness (“I consider myself a health conscious individual”), general preference for chocolate cake (“I am a chocolate cake fanatic”) and general preference for fruit salad (“I am a fruit salad fanatic”). Lastly, participants indicated their gender and ethnicity.
Results and Discussion

Covariates and Control Measures. Checks were also made to ensure that none of the covariates significantly interacted with the independent variable (temperature). Of the potential covariates, only two (general preference for chocolate cake and general preference for fruit salad) covaried significantly with both dependent measures in the study and were thus included in the remaining analyses (greater general preference for cake led to increased purchase likelihood of cake ($F(1, 117) = 10.32, p < .001$), and greater general preference for fruit salad led to reduced purchase likelihood of cake ($F(1, 117) = 2.00, p < .08$).

Choice and Purchase Likelihood. As predicted, a binary logistic regression analysis confirmed a significant main effect of temperature on choice ($\chi^2 = 8.46, p < .01$). In the cold temperature condition, 57% of participants chose the chocolate cake, while in the warm temperature condition, only 30% of respondents made that choice. Thus, choice probabilities differed in the hypothesized direction, suggesting that the affectively superior option dominated in the cold condition, but the cognitively superior option dominated in the warm condition. In addition, an ANOVA revealed significant main effect of temperature on purchase likelihood of cake (“If you were not forced to choose any one option, how likely would you be to purchase the chocolate cake”) ($F(1, 117) = 4.62, p < .05$). Again, results were in the hypothesized direction ($M_{\text{cold}} = 4.60, M_{\text{warm}} = 3.75$).

Decision Basis. As previously mentioned, the four-item decision basis scale ($\alpha = .84$) measured whether decisions across different conditions were based on respondents' affective reactions or cognitions (higher values indicated more reliance on affect). An ANOVA revealed a significant effect of temperature on reliance on affect in the hypothesized direction ($M_{\text{cold}} = 4.02$, $M_{\text{warm}} = 3.27; F(1, 117) = 5.98, p < .05$). To determine the extent to which reliance on affect
mediated the effect of temperature on choice and purchase likelihood, I applied the bootstrap procedure (Model 4 in the macro suggested by Hayes, 2012). Specifying a confidence interval of 95% with 5000 bootstrap resamples, the indirect effect of temperature on choice through decision basis was significant, with a confidence interval excluding zero (-0.9781 to -0.0323). In addition, the indirect effect of temperature on purchase likelihood through decision basis was also significant, again with a confidence interval excluding zero (-0.5761 to -0.0483). Thus, these results suggest that reliance on affect does indeed mediate the relationship of temperature on choice and purchase likelihood of cake.
General Discussion

Using a thermoregulatory framework in which organisms use various bodily organs to adjust their temperature (Kirkes 1899; Romanovsky 2007), I explored whether a mere mental process relying on emotions (cognitions) can function as a warming (cooling) mechanism, and whether individuals might be induced to alter their decision-making style to fulfill thermoregulatory objectives in response to experienced physical temperatures. I document the ability of affective and cognitive pathways to function as warming and cooling mechanisms, leading to both self-reported and objective increases and decreases in recorded temperature. Further, I demonstrate that the adoption of a compensatory pathway can indeed aid in providing temperature-related comfort. Lastly, but crucially, I document the effect of physical temperature on choice, willingness to pay, and donation likelihood, and support the role of reliance on emotions, a mental but ultimately brain-based pathway, as a mediator. Thus, taken as a set, these five studies provide converging support for my proposed mental thermoregulation framework (Appendix A).

This research makes several meaningful theoretical contributions. As previously mentioned, the current research supports the proposition that reliance on emotions (cognitions) can function as a warming (cooling) process, and individuals may accordingly (and perhaps nonconsciously) alter their decision-making style to fulfill thermoregulatory objectives in response to experienced physical temperatures. Specifically, I suggest that an individual may choose to adopt a decision-making process that is semantically consistent with his or her thermoregulatory objective (and thus inconsistent with his or her thermoregulatory state). As far as the author is aware, no research has examined whether an individual’s decision-making process can function to change perceived or actual temperature, nor whether an attempt to do so
may be part of an individual’s regulatory strategy. Further, I additionally contribute by documenting the ability of affective and cognitive pathways to function as warming and cooling mechanisms, suggesting that autonomic physiological responses (ex. sweating, shivering) are not the only way in which we programmatically regulate our temperature.

Hence, unlike most previous and emerging literature on embodiment (Williams and Bargh 2008), this research provides an example and explanation of why individuals may respond to physical sensations in a compensatory fashion. Instead of merely assimilating to the physical temperature in a semantically consistent manner (i.e. relying on emotions more when warm), physical sensations might instead activate a thermoregulatory goal, thus motivating individuals to embody a process with a semantically-opposite thermoregulatory tone. Hence, this manuscript paves the way for research to explore other instances in which physical sensations may lead to goal-driven behavior in a pattern that is metaphorically inconsistent with an experienced physical state. Such new research streams might explore how other atmospheric dimensions aside from temperature can lead to changes in mental processes. Lighting, for example, is one such dimension. Retailers such as Abercrombie and Fitch use dim illumination in their stores with the objective of projecting a particular brand image. However, emerging research suggests the use of dim illumination may have unintended consequences, creating a goal of increasing cognitive illumination, operationalized as feelings of decision certainty (King 2013). Illumination and temperature, then, appear to be two perceptual dimensions of atmospherics that may influence higher order, executive processes that influence the relative use of mental processes. Beyond illumination and temperature, it would be important to identify additional perceptual dimensions that can have an influence on cognitive and affective processing.
There has been a recent call for research that explores antecedents to affective processing, or “affective engineering” (Cohen, Pham, and Andrade 2008; Pham 2012). This research represents a step in this direction by proposing a precursor to increased use of affective information in consumer decisions, and contributes to the literature on atmospherics by assessing the role of temperature on consumer judgment. Further, by exploring the impact of physical temperature via a thermoregulatory framework, I address the call to more critically examine processes by which sensory cues exert their effects (Krishna 2012).

Finally, from a broader, more structural perspective, the results of the experiments are also consistent with Damasio, Tranel, and Damasio’s (1991) *Somatic Marker Hypothesis*, which posits that the organism’s brain and body generates some aspects of the anticipated stimulus to help guide decision making, with temperature being one aspect that carries information for the organism. The nature of information carried by temperature for the organism is a promising avenue for further research.

Several practical implications stem from these research findings as well. Physical temperature can be manipulated in retail environments via thermostat control, or providing patrons with a warm or cool drink. A retailer selling hedonic goods would likely benefit a consumer’s reliance on affect, and thus may profit by lowering the environmental temperature in the retail space. Interestingly, a New York Times article titled, “Shivering of Luxury,” suggests external validity to this finding by reporting a strong negative correlation between a retailer’s prices and store temperature- the ritzier the establishment, the lower the thermostat setting (Salkin 2005). The current research suggests that this may be an effective strategy for luxury retailers, since low temperatures may induce patrons to adopt a more affective mind-set, in which
they are more likely to legitimize hedonic and indulgent purchases. A restaurant hoping to entice patrons with its indulgent dessert selections might similarly benefit from lowered temperatures.

This research also provides marketing applications for advertising and promotions. Aside from temperature manipulation via store-based thermostat control, companies can impact individuals’ experienced temperature via non-traditional promotional campaigns. For example, Columbia Sportswear recently set up a mobile walk-in freezer in Manhattan’s Bryant Park, where consumers were encouraged sing karaoke while testing the brand’s new heated apparel. Kraft Foods, on the other hand, built and maintained heated bus shelters in an attempt to convey the warmth consumers would feel from eating stuffing (Elliott 2008). While these promotional campaigns are meant to highlight product benefits, companies should be cognizant of the unintentional consequences on a consumer’s decision-making style. Further, because this research also showed that such processing differences can stem from simulated temperature, advertisers should also consider the impact of inducing temperature sensations via ad copy, images, and color usage.

Future research in this area might test a few potential moderators of the thermoregulation process. These might include a measure of self-monitoring and/or temperature tolerance, for example. A less intuitive, conceptually interesting moderator could be individual propensities to gain weight or become obese, if temperature regulation is ultimately underpinned by energy regulation. If warm temperatures induce relatively more cognitive processing, exposure to warmth may be an important intervention for people with obesity. Indeed, there is some correlational evidence that lower temperatures lead to lower rates of obesity (Bo 2011). If such measures do indeed moderate the process, they might help establish boundary conditions for the
psychologically mediated thermoregulation process, and build a functional account for when and why temperatures influence mental processes in organisms.
Appendix A: Illustration of Proposed Model

Mental Thermoregulation

Physical Cold → Reliance on Affect → Dependent Variables:
- Choice
- WTP
- Purchase Likelihood
- Donation Likelihood
- Evaluation

Physical Warmth → Reliance on Cognition

Exposure to warm temperature → Warmth creates cooling objective → “Cool” Decision Making (cognitive pathway)

Base Temperature

Exposure to cold temperature → Cold creates warming objective → “Warm” Decision Making (affective pathway)

Base Temperature
Appendix B: Instructions for Studies 1 and 2

Participants in the Affective Instructions condition read the following:

“For each of the following scenarios, please describe in detail the emotional experience that comes to mind. In other words, we are interested in your feelings towards each scenario. Would the scenario make you feel pleasant or “positive” (e.g., happy, joyful, pleased, proud) or would it make you feel unpleasant or “negative” (e.g., sad, angry, disgusted, scared)? Please focus on your emotions when responding.”

Participants in the Cognitive Instructions condition read the following:

“For each of the following scenarios, please describe in detail the advantages and disadvantages of each experience. In other words are interested in your objective evaluation of each scenario. By evaluation, we mean a judgment of the pros and cons of scenario. Please focus on your objective judgments when responding.”
Appendix C: Stimuli used in Study 3

All participants read the following:

“Suppose that you are about to move to a new city. Your company will pay for all the moving expenses. Among the things you ask the moving company to ship is an antique clock. There is some chance that the clock may get lost in shipment. The moving company does not provide insurance, but you can purchase insurance from an independent company yourself. Buying insurance will not affect the chance of loss, but if you buy insurance and the clock is lost, you will receive $100 in compensation.”

In addition, those in the “low sentiment” condition read the following:

“The clock no longer works and cannot be repaired. It has literally no market value. It does not have much sentimental value to you. It was a gift from a remote relative on your 5th birthday. You didn't like it very much then, and you still don't have any special feeling for it now.”

Those in the “high sentiment” condition read the following:

“The clock no longer works and cannot be repaired. It has literally no market value. However, it has a lot of sentimental value to you. It was a gift from your grandparents on your 5th birthday. You grew up with it. You learned how to read time from it. You have always loved it very much.”
Appendix D: Stimuli Used in Study 4

Participants in the One-Panda condition read the following:

READ THE FOLLOWING SCENARIO CAREFULLY BEFORE PROCEEDING:

Please imagine that a team of zoology students has discovered a panda in a remote Asian region. Their university's wildlife foundation intends to save the endangered animal, and is soliciting donations for the rescue effort.

[Image of a panda]

Participants in the Four-Pandas condition read the following:

READ THE FOLLOWING SCENARIO CAREFULLY BEFORE PROCEEDING:

Please imagine that a team of zoology students has discovered four pandas in a remote Asian region. Their university's wildlife foundation intends to save the endangered animals, and is soliciting donations for the rescue effort.

[Images of four pandas]
Appendix E: Stimuli Used in Study 5

Imagine that it is about 3pm. You had an early lunch, and you are feeling hungry. It is too early for dinner, so you decide to buy a snack at a snack counter. There are two options, a chocolate cake, or a fruit salad (pictured below). Each costs $2.00.

Chocolate Cake:  
Fruit Salad:

Which item would you choose to buy?  
(please circle your choice below)

the chocolate cake  the fruit salad
References


Poulton, E. C. (1976), “Arousing environmental stresses can improve performance, whatever people say,” Aviation, Space, and Environmental Medicine, 47, 1193-204.


