THE EFFECT OF TEMPERATURE PRIMES ON IMPULSIVITY

By

HEE KYUNG AHN

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Abstract: Temperature-related words such as “hot” and “cold” are often used to describe impulsive and calculated behaviors, respectively. These metaphoric connotations of thermal concepts raise the question as to whether temperature, psychological states and decision making are related to each other, and if so, how. The current research examines these questions and finds support for a relationship. Across four laboratory experiments and two field studies, I demonstrate that both hot temperature primes (e.g., pictures, words, therapeutic packs) and hot ambient temperature trigger decision outcomes in line with the metaphoric association between hot temperature and impulsivity. I suggest that the theory of embodied cognition provides an explanation for these findings.
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INTRODUCTION

Most people, at some time or another, engage in impulsive behaviors in their judgments and choices. For example, we confront situations where we end up with extra purchases while shopping due to sudden impulses. As dieters, we sometimes yield to temptations (desires) for more chocolates without thinking of negative consequences. Similarly, a student may decide to go to a party tonight even if he/she has to prepare for an exam scheduled in a few days. Such unreflective behavioral tendencies or a lack of self control due to a sudden desire or urge could result in impulsive behaviors in various domains.

Impulsivity has been widely studied in a variety of disciplines including cognitive, clinical, social, developmental, and consumer psychology, economics, and judgment and decision making in general. While psychologists have focused more on the general human trait of impulsivity and impulse control (Eysenck and Eysenck 1978; Puri 1996; Rook and Fisher 1995), economists and decision researchers have often assumed that impulsivity can be best captured by the inability to delay gratification or hyperbolic discounting, which has been widely used to model impulsive choices (Monterosso and Ainslie 1999).

Although previous research has covered a wide range of impulsive behaviors (Eysenck and Eysenck 1978; Monterosso and Ainslie 1999; Puri 1996; Rook and Fisher 1995), it is rather surprising that there is limited research that identifies specific conditions under which impulsive behavioral tendencies are stronger or weaker. Some researchers have shown that visceral stimuli (e.g., exposed rewards, sexual and appetitive cues) increase desire and engender impatience
(Baumeister 2002; Bergh, Dewitte, and Warlop 2008; Hoch and Loewenstein 1991; Li 2008) by demonstrating individuals’ preference for immediate (vs. delayed) rewards triggered by those external cues.

In our daily lives, temperature-related words such as “hot” and “heat” are often used to describe such impulsive behaviors (e.g., hot headed). In these expressions, “hot” is interpreted as a metaphor rather than as a literal thermal concept. In addition, marketers often use different temperature associations to build up their brands in various marketing contexts such as advertising, packaging and retailing. For example, consumers are exposed to different gum brands which can evoke distinct temperature associations (e.g., Excel Inferno, Excel Polar Ice). Can these temperature related words influence subsequent choices and judgments? Particularly, it might be an interesting question whether marketing stimuli that suggest hot temperatures can actually induce impulsive behaviors.

Although there has been relatively little research that systematically examines the relationship between temperature and decision making, psychologists and behavioral decision researchers often use the thermal concept “hot” (vs. “cold”) to describe impulsive behaviors metaphorically (Loewenstein 1996; Metcalfe and Mischel 1999; Peters et al. 2006). These metaphoric associations of thermal concepts and impulsivity raise the question as to whether temperature concepts, psychological states, and decision making are related to each other, and if so, how.

While previous research on impulsive behaviors used external stimuli that can directly change people’s visceral states (e.g., appetitive cues), the current research investigates whether priming hot temperature related concepts can trigger impulsive behaviors and if so, how. By
examining the effects of priming merely the concept of temperature on impulsivity, I attempt to build upon prior research which has demonstrated the direct effects of visceral cues on impulsivity. Specifically, I demonstrate that the association between the thermal concept ‘hot’ and impulsivity is not simply metaphorical, but that activating the concept of hot can actually cause impulsive behaviors. By using different priming manipulations of the concept of temperature as well as various dependent measures to operationalize the concept of impulsivity, I provide a controlled demonstration of the causal effects of priming temperature on behavior. This is consistent with my proposition that the mere priming of ‘hot’ can activate its metaphorically linked concepts such as desire, urge or drive, which in turn, lead to impulsive behaviors.

The remainder of the thesis is organized as follows. In chapter 1, I provide a review on the varieties of impulsivity. In chapter 2, I delineate a cognitive perspective on metaphors, including the theories of embodied cognition perspectives, and the impact of such metaphoric links on judgment and decision making as well as the relationship between ‘hot’ and impulsivity. Based on this literature review on impulsivity and metaphoric associations, I build my own conceptual framework to explore the effects of priming hot temperature on impulsivity. In chapter 3, I address potential alternate models. In chapters 4 through 7, I report the results of a series of laboratory experiments conducted to test my hypotheses. In chapter 8, I discuss the further exploration of the effect of ambient temperature on impulsivity beyond mere priming effects. Finally, in chapter 9, I conclude with a discussion on theoretical contributions and practical implications of this work.
CHAPTER 1

VARIETIES OF IMPULSIVITY

Impulsivity has been widely researched in various disciplines including, clinical, social, and consumer psychology, as well as judgment and decision making (Eysenck and Eysenck 1978; Monterosso and Ainslie 1999; Puri 1996; Rook and Fisher 1995). While several researchers have addressed impulsivity by using related constructs and phenomena, their conclusions are poorly agreed upon. What is clear, based on this previous literature, is that there is more than one type of impulsive behavior (Evenden 1999).

Various Manifestations of Impulsivity

Individuals often act without considering the full consequences of their actions. These actions, based on feelings, focus on immediate pleasures rather than on long-term consequences, which often result in complications. For instance, people often succumb to the temptation of dessert, alcohol, cigarettes or drugs, opting for immediate gratification without thoughtful consideration of the associated long term risks (Hofmann, Friese, and Wiers 2008). Previous research demonstrated that many consumption behaviors can be framed in terms of a conflict
between immediate impulses on one hand and reasoned attitudes and standards to restrain behavior on the other (e.g., Baumeister and Heatherton 1996; Carver 2005).

Although it is easy to identify examples of impulsive behavior in both the literature and in our everyday lives, it is difficult to rigorously define what constitutes impulsive behavior, especially in the context of different cultures and ages, leading to a great amount of disagreement regarding the definition of the term (Evenden 1999). As a lexical definition, however, the word ‘impulsive’ is described as “inclined to act on impulse rather than thought” (The American Heritage Dictionary of the English Language 2000) or “characterized by actions based on sudden desires, whims, or inclinations rather than careful thought” (Collins English Dictionary-Complete and Unabridged Sixth Edition 2003).

Evenden (1999) specifically pointed out, “There is not one unitary ‘impulsivity’ or only one type of impulsive behavior. Instead, there are several related phenomena which are usually classified together as impulsivity, which I would like to term ‘varieties of impulsivity,’ and which leads to different forms of impulsive behavior” (p. 348). The term impulsivity has been used in the literature to represent a number of different behaviors. In studying it, however, it is important to recognize that impulsivity is multidimensional and does not manifest itself as a single trait or construct (Romer 2010). Some researchers in psychology define impulsivity as the inability to delay gratification or the inverse of self-control (Ainslie 1975; Metcalfe and Mischel 1999; Monterosso and Ainslie 1999), while others define impulsivity as “short decision time” or “lack of persistence” (Buss and Plomin 1975), “unconscious risk taking” (Eysenck 1993), and “sensation seeking” (Zukerman 1994). Barratt (1985) characterized impulsivity as the inability to plan ahead, acting without thinking, fast speed of response, and risk taking (Langewisch and
Frisch 1998). Particularly Frederick (2005) argued that the prevalence of an erroneous but intuitive answer (i.e., “10 cents”) to the ‘bat and baseball problem’ is due to impulsivity characterized by immediacy of responses and short decision times, suggesting that impulsivity causes people to respond with the first thing that comes to mind.

Many consumer researchers have incorporated the concept of impulsivity into buying or spending situations. Impulsive buying can be defined as a spontaneous and unreflective desire to buy, without careful consideration of why and for what reason a consumer should buy the product (Rook 1987; Rook and Fisher 1995; Vohs and Faber 2007). Some earlier research argued that impulsive buying is mainly due to individual difference (Rook and Fisher 1995), while others have investigated occasional factors (e.g., incidental moods) in the context of purchase situations (Elliott 1994; Rook and Gardner 1993). For example, a recent study by Vohs and Faber (2007) demonstrated that participants who were temporarily robbed of their self-regulatory resources during an earlier task were later willing to pay higher prices for a variety of products. In other words, they used the willingness to pay measure as a representation of impulse spending (buying). Table 1.1 outlines various constructs and manifestations of impulsivity in prior research.
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Conceptualization of Impulsivity

A comprehensive review of the impact of the hot-impulsivity link on judgment and decision making requires that we rigorously define the concept of impulsivity. Therefore, in this section, I conceptualize the construct of impulsivity as used in the current research, and discuss the focal manifestations of impulsivity that will be dealt with in the empirical part of the thesis.

Although impulsivity influences many different domains of behaviors, four general categories are of special relevance to consumer behavior, based on the current conceptualization of impulsivity: 1) reward behaviors in intertemporal choice settings, 2) spending (buying) behaviors, 3) decision making under risk, and 4) intuitive judgment in problem solving. Thus, in this section, I review relevant previous research to conceptualize impulsivity as used in the current research. In reviewing these various manifestations of impulsivity, it is important to recognize that impulsivity is multidimensional and does not manifest itself as a single trait.

First, impulsivity is characterized by the tendency to exhibit impatience when given a choice between an immediate but small reward versus a larger but delayed reward. That is, impulsivity can account for the inability to delay gratification (Ainslie 1975; Metcalfe and Mischel 1999), and it is often assessed using a delay discounting paradigm that can measure differences in preference for delayed rewards (Ainslie 1975; Rachlin 2000). People have a tendency to choose the more immediate gratification, and in so doing, decrease the reward they receive due to impulsivity. Ainslie (1975) posed the following question in his seminal paper: “why do organisms, particularly human beings, often freely choose the poorer, smaller, or more disastrous of two alternative rewards even when they seem to be entirely familiar with the
alternatives?” (p. 463). He classified this choice of a smaller, sooner reward, in the face of a larger, later reward as an impulsive behavior. To function effectively, one has to voluntarily postpone urges or desires for immediate gratification and focus on goal-oriented behaviors to achieve positive consequences in his/her future (Zimbardo and Boyd 1999).

Second, many consumer researchers have dealt with the concept of impulsivity in buying or spending situations. Impulsive buying behavior can be interpreted by the core elements of impulsivity. For example, Kacen and Lee (2002) stated, “impulsive buying behavior is a sudden, compelling, hedonically complex purchasing behavior in which the rapidity of the impulse purchase decision process precludes thoughtful, deliberate consideration of all information and choice alternatives.” In addition, impulsive buying can be viewed as involving spontaneous and unreflective desires to buy, without carefully considering the reason for the purchase (Rook 1987; Rook and Fisher 1995; Vohs and Faber 2007).

Rook and Hoch (1985) explain impulsive purchasing as being accompanied by a “sudden and spontaneous desire to act” (p. 23) “without regard to the consequences” (p. 24), which implies that impulse purchases can be understood as a consumer’s pursuit of immediate gratification. In particular, a recent study by Vohs and Faber (2007) demonstrates that depleted self-regulatory resources during buying situations lead to a higher willingness to pay (WTP) for potential purchases. The findings suggest that when a consumer’s desire to buy is intensified by exerting regulatory resources in an initial self-control task (i.e., temporal depletion of self-regulatory resource), he/she may be less able to resist the impulse to buy, and hence induce higher willingness to pay for products/services. In other words, consumers are willing to pay more for target products or services caused by their increased desire without thoughtful
consideration. Impulse buying or spending situations with higher willingness to pay for products or services is due to a lack of self control (Vohs and Faber 2007), which is often caused by a lack of deliberation.

Third, impulsivity can manifest itself in risk taking behaviors (Evenden, 1999; Langewisch and Frisch 1998). Previous research in psychology has presumed that risk taking is a personality trait (Plax and Rosenfeld 1976). In particular, researchers in personality psychology have consistently found that impulsivity is highly correlated with risky behavior (Cloninger, Przybeck, and Svrakic 1991; Cloninger, Svrakic, and Przybeck 1993; Miller et al. 2003). Another stream of research on risk taking has focused on the fact that risk taking tendencies may interact with situational factors (Slovic 1972; Schoemaker 1993). Results from decision making experiments demonstrate that individuals generally avoid risk when they have to choose between options associated with probable versus certain desirable outcomes. Particularly, in the gain domain, people tend to choose a sure thing over probabilistic outcomes even when the expected value of the probabilistic outcome exceeds that of the sure thing (Kahneman and Tversky 1979). For example, participants almost unanimously chose $1 with (near) certainty over $4 with a probability of 5/18 (Rachlin and Raineri 1992). Although people generally have intrinsic attitudes towards risk (e.g., a risk avoiding tendency in the gain domain), their evaluations of risks often diverge from their impulsive reactions to such risks due to decision frames, tasks, and different information processing strategies (see Schoemaker 1993).

In my thesis, I focus on risky decisions under uncertainty, rather than adopting various types of ‘risk-taking’ behaviors that have been examined in social and clinical psychology for two reasons. First, I assume that the underlying construct of risk in decision making under
uncertainty is structurally identical to those in other risk taking domains (e.g., substance abuse) in that people are willing to take the chance of getting less desirable outcomes in their decisions. Second, many other risk taking behaviors are presumed to be based more on an individual’s predisposition rather than situational factors. Thus, the risk taking tendencies in other domains (e.g., addiction to gambling and drugs) are less likely to be influenced by situational factors in experimental settings such as decision frames and tasks. That is—individuals’ predispositions toward risky behaviors in other domains might be less sensitive to mere priming the concept of hot temperature.

In order to understand risk taking tendencies in the context of decision making under uncertainty as a manifestation of impulsivity, it is useful to make a distinction between the two kinds of risk taking (i.e., instrumental risk taking and stimulating risk taking). According to Zaleskiewics (2001), instrumental risk taking is related to risk preference resulting from reflective decision making in the investment domain, and is determined by personality traits connected with orientation toward the future. Some people might be willing to take risks after a thoughtful deliberation. For example, investors in the stock market are often willing to take risks after a thorough calculation of risks and potential returns. In such cases, instrumental risk taking behaviors may not be a good representation of impulsive behaviors.

On the other hand, stimulating risk taking is an example of a more rapid, effortless and even automatic behavior, and is characterized by impulsive decision making. This is often found to be associated with gambling. Thus, stimulating risk taking behavior can be thought of as a manifestation of impulsivity. For this reason, I make a distinction between the two types of risk taking focusing on stimulating risk taking which properly reflects impulsivity.
Finally, in numerous research papers, the concept of impulsivity is characterized by short decision times (Buss and Plomin 1975) or fast responses (Barratt 1985) mainly due to a lack of thoughtful consideration. According to another measure of impulsivity by Porteus (1965), a scoring system was based on the participant’s lack of attention to detail, carelessness and lack of planning, depicted by errors in solving mazes. Extending these process-based explanations, a large body of literature has addressed the distinction between two types of cognitive processes: quick, less deliberative processes and slower, more reflective processes (Epstein 1994; Kahneman and Frederick 2002; Stanovich and West 2002). With this in mind, consider the following problem:

A bat and a baseball cost $1.10 in total. The bat costs $1 more than the ball. How much does the ball cost?

Here, an intuitive and impulsive response (e.g., 10 cents) can spring to mind when answering the bat and baseball problem based on the quick, less deliberative processes. Frederick (2005) argued that the prevalence of an erroneous but intuitive answer to the bat and baseball problem (i.e., ‘10 cents’ instead of the correct answer, ‘5 cents’) is due to immediate impulses (see also Kahneman 2003). Kahneman (2003) explained that this erroneous answer is due to the fact that the sum $1.10 simply separates into $1 and 10 cents. Although the simple mathematical calculation may require a minimum level of cognitive effort, this apparently fast and automatic response based on the simple calculation (i.e., system 1) can be attributed to impulsivity (Kahneman 2003).

However, not all problem solving tasks engender such an immediate and impulsive reaction. As Frederick (2005) exemplifies, finding the square root of 19163 to two decimal
places without a calculator involves slower, reflective mental operations requiring effort, motivation, concentration, and the execution of learned rules. In addition, quick, less deliberative processes are less likely to play a role in yielding incorrect answers in a domain of purely knowledge based problems (e.g., quizzes for historical facts). It is important to note that for the bat and baseball problem, individuals who are mathematically sophisticated are likely to answer correctly. In addition, individuals who are highly motivated may reflect upon the structure of the question carefully, and are therefore more likely to respond correctly. However, individual differences in terms of ability and motivation are outside of the focus of the current research, and random assignment of participants should balance highly motivated and mathematically sophisticated participants across conditions.

With regard to the short decision times and fast responses associated with impulsivity, one might question whether strategic uses of quick decision processes, such as the deliberate use of heuristics, can be regarded as an impulsive behavior. According to Dickman (1990), the answer seems to be yes. He proposed that impulsivity can have positive as well as negative consequences, differentiating between functional and dysfunctional impulsivity. He argued that dysfunctional impulsivity is associated with a tendency to act without premeditated thinking, defining it as “a tendency to engage in rapid, error prone information processing because of an inability to use a slower, more methodical approach under certain circumstances” (p. 101).

In contrast, functional impulsivity is associated with the ability “to engage in rapid error prone information processing when such a strategy is rendered optimal by the individual’s other personality traits” (p. 101). This distinction implies that both immediate and deliberate (or strategic) use of quick, error prone information processing strategies involve impulsivity. Thus,
the inability to use deliberate information processing, as well as the strategic use of heuristics can be viewed as an impulsive tendency since impulsivity can cause a rapid and error prone information processing in both cases.

However, it is important to note that short decision times and fast responses do not always represent impulsivity. Sometimes fast and frugal heuristics may cause (sub)optimal decision outcomes rather than cause erroneous outcomes (Gigerenzer and Todd 1999). Furthermore, experts often only require short decision times in their responses without making errors (Simon 1996). In these cases, the apparent behaviors based on intuition (see Frederick’s argument above) are similar to behaviors based on impulsivity. Both intuitive and impulsive behavioral tendencies can carry seemingly fast (in terms of speed of reaction) and frugal (in terms of amount of processing effort) characteristics. However, fast and frugal heuristics based on intuition can often yield suboptimal yet desirable decision outcomes instead of causing negative outcomes. Thus, the operationalization of impulsivity with short decision times in the current thesis mainly relates to short and unreflective decisions that result in negative or undesirable consequences.

In my theoretical development of the impulsivity construct, it is worth noting how the construct of impulsivity is related to dual processing accounts (e.g., heuristic processing vs. analytical processing). This is because such dual processing accounts can explain the four general categories that are of special relevance to consumer behavior within the conceptualization of impulsivity. Most dual processing accounts have in common a distinction between cognitive processes that are fast, automatic, and unconscious and those that are slow, deliberative, and conscious (Epstein 2004; Evans 2008). These dual processing theories are
applied in different domains including impression formation and stereotyping (Chaiken 1980), and judgment and decision making (Kahneman, Slovic and Tversky 1982).

According to Evans (2006), System 1 (heuristic) processes intuitive judgment, whereas System 2 (analytic) processes high-effort deliberative reasoning, which can inhibit biased responses. In a similar vein, Kahneman and Frederick (2002) have suggested a dual process theory of probability judgment. Heuristic judgments generally lead to biases, which are endorsed by System 1, while analytical reasoning, which is governed by System 2, may override these heuristic judgments (Kahneman and Frederick 2002). I think that impulsive behaviors can be represented by heuristic processing associated with System 1. Strack and Deutsch (2004) adopted the terms “impulsive” and “reflective” to make a distinction between System 1 and System 2 respectively. Evans (2008) suggested that this dual processing account is implicated when we contrast intuitive judgment with reflective decision making. A large number of decisions (e.g., gambling, overeating or overspending) appear to involve rapid, intuitive, and impulsive judgments that require little effort (Evans 2008).

In summary, although impulsivity is not a simple, unidimensional construct, it seems that the concept needs to be broadly defined as a behavioral tendency characterized by several elements. In the current research, I take into consideration a variety of manifestations of impulsivity adopted by researchers across disciplines, and I conceptualize impulsivity as an unreflective behavioral tendency or a lack of self-control due to a sudden desire or urge that could result in undesirable (negative) outcomes. Based on this conceptualization of impulsivity, I operationalize impulsive behaviors as 1) an unpremeditated decision for immediate gratification,
2) a higher willingness to pay due to an unconsidered valuation, 3) a risk seeking tendency due to a lack of deliberation, and 4) an erroneous response to the bat and baseball problem.

Given this operational definition of impulsivity, the next step is to examine whether and how the concept of impulsivity could be related to temperature. As previously discussed, I argue that the concept of impulsivity and temperature are related to each other in a metaphorical fashion, and understanding this metaphorical relationship plays an important role in investigating the impact of priming temperature on impulsivity. In the next chapter, I review relevant literature on (1) metaphors from cognitive perspectives, (2) embodied cognition perspectives, (3) how metaphoric links affect judgment and decision making, and (4) the metaphoric link between ‘hot’ and impulsivity.
CHAPTER 2

CONCEPTUAL FRAMEWORK

Cognitive Perspectives on Metaphor

In traditional language theories, a metaphor was regarded as an issue of language rather than thought. Although they enabled thoughts to be expressed meaningfully, metaphors were considered essentially ornamental and poetic and therefore distinct from the realm of everyday speaking (Lakoff and Johnson 1980). Over the past thirty years, however, the cognitive perspective on metaphor usage has altered dramatically, and metaphors are now recognized as a regular component of commonplace speech (Bowdle and Gentner 2005; Emanatian 1995; Glucksberg 1998). The notion that metaphors create links between concepts from separate spheres of knowledge has been a central premise of psychological research on metaphors (Bowdle and Gentner 2005).

Earlier research indicates that metaphorical associations are not merely isolated concepts. Rather, whole collections of ideas and experiences are formed through interfaces with the natural and social environment. These collections facilitate the comprehension of more complicated interactions (Bargh 2006; Lakoff and Johnson 1980). An increasing amount of linguistic proof points to the significant role played by metaphors in connecting abstract concepts and emotions.
with reasoning and communication (Lakoff and Johnson 1980). This mounting appreciation of the significance of metaphors in language and thought has led in turn to a substantial amount of research on the cognitive processes occurring in metaphor comprehension (Bowdle and Gentner 2005). Two conceptual domains, the ‘source’ domain and the ‘target’ domain, are connected by metaphors. The ‘source’ domain is usually comprised of literal, concrete things. The ‘target’ domain is made up of abstract concepts such as impulsivity which are difficult to describe. Because metaphors function at the level of thought rather than merely language, it is believed that the target domain mirrors the source domain’s pre-existing associations of entities and characteristics (Katz and Taylor 2008). Metaphorical relationships are comprised of correspondences between concepts from discrete domains. These relationships facilitate the comprehension of a more intricate interplay among the concepts (Bowdel and Gentner 2005). This, in brief, has been the consensus of most cognitive research on metaphors.

Embodied Cognition Perspective

Traditional views of cognitive psychology have characterized the mind as an abstract information processor that is independent of the body and the environment (Beilock and Holt 2007). However, recent theories of embodied cognition suggest that cognitive representations and operations are fundamentally grounded in their physical context and perception (Barsalou 1999; Gallese and Lakoff 2005; Glenberg 1997; Lakoff and Johnson 1999). Researchers who have examined metaphors have found that some metaphoric associations can be understood with the theory of embodied cognition (for an overview, see Barsalou 2008). This theory postulates
that cognitive representations are rooted in the brain’s sensorimotor systems. Perceptual representations of abstract concepts (i.e. target domains) are developed through the individual’s mapping of experienced bodily states (i.e. source domains). The actuation of these bodily states can affect abstract thinking and mental stimulation.

Abstract concepts are learned through the repetition of physical experiences in childhood. According to one of the recent findings in embodied cognition (Jostmann, Lakens, and Schubert 2009), when people hold a heavy object (i.e., physical weight) this bodily experience influences their judgment of the importance of an issue in an unrelated domain. Particularly, in one experiment, participants were asked to estimate the value of foreign currencies while holding a heavy or a light clipboard. Participants who were holding a heavy clipboard placed a higher value on these foreign currencies than those who were holding a light clipboard. According to the author, value is a crucial index of a currency’s importance. That more strength or strategizing is needed to handle weighty objects than light ones, for instance, is learned by handling objects physically (Jostmann et al. 2009). Therefore, people link the experience of heaviness with a heightened degree of physical and intellectual exertion. In this instance, the separate domains of physical heaviness and significance share the same relational structure, and therefore, such a cross-domain mapping can occur.

Similarly, previous research in social psychology has provided growing evidence supporting the notion that the body is closely tied to the processing of social and emotional information (Niedenthal et al. 2005). For example, Wells and Petty (1980) observed that nodding the head (as in agreement) while listening to persuasive messages led to more positive attitudes toward the message’s content than shaking the head (as in disagreement). Cacioppo, Priester, and
Berntson (1993) found that participants evaluated novel Chinese ideographs more favorably when the Chinese ideographs were presented during arm flexion (i.e., an approach-related action) than when they were presented during arm extension (i.e., an avoidance-associated action). Another study demonstrated that participants who had been primed with the stereotype of being old subsequently walked down a hallway more slowly than participants who had not been primed (Bargh, Chen, and Burrows 1996). Building on this notion of embodied cognition, I examine in the next section how metaphorical relationships can be used to either inhibit or facilitate judgment and decision making.

The Impact of Metaphoric Links on Judgment and Decision Making

According to Nelson and Simmons (2009), people’s judgments of travel time, ease, and cost are affected by the metaphoric relationship between cardinal direction (i.e., north and south) and vertical position (i.e., up and down). Thoughts of cardinal direction may summon visual pictures associated with this connection: ‘north’ can evoke mental illustrations that are compatible with it being above ‘south’ as in traditional Western maps. Accordingly, people may judge northbound travel as going uphill and southbound travel as going downhill. Since gravity makes uphill travel more onerous, people usually think going uphill is more difficult than going downhill. In addition, they expected that doing difficult things is more effortful, and hence more expensive than doing easier things. Thus, Nelson and Simmons (2009) demonstrated that people actually think northbound travel as more effortful, more difficult, and costlier than southbound travel (Nelson and Simmons 2009). Furthermore, Zwan and Yaxley (2003) also demonstrated
that people are faster at identifying the relationship between two words (e.g., basement and attic) when the word presentation is consistent with their spatial relationship (e.g., when “attic” is written above “basement”).

Likewise, Schubert (2005) found that thoughts of power induce mental simulations of vertical spatial positions. People naturally associate authority or power with a position at the top. In his experiment, he presented participants with pairs of occupations (e.g., professor and student), and found that individuals are faster to identify related words when the high-powered or authority role is physically above the low-powered role. Moreover, a psychological association between bodily cleanliness and moral purity was found by Zhong and Liljenquist (2006). Participants remembering immoral actions produced more cleansing-related concepts. This signified that the urge to cleanse physically could be triggered by the menace of moral impurity.

In a study of the metaphorical linkages between temperature and other abstract concepts, Zhong and Leonardelli (2008) found that the lexical pairing of coldness and social isolation may mirror people’s habit of using ideas rooted in bodily experience to convey complex abstractions like ostracism (see also Lakoff 1987). Furthermore, in addition to illustrating interpersonal relationships with the intentional use of temperature concepts, people also interpret social interactions differently according to temperature concepts that are triggered by chance. Zhong and Leonardelli (2008) found that social rejection actually makes people feel cold in the literal sense of the word. In another study of embodied cognition associated with temperature (Williams and Bargh 2008), researchers found that when subjects held cups of hot coffee, they judged other individuals as being warmer than when the subjects were holding cups of cold coffee. The evaluation of personality trait such as “warm” was affected by physical warmth (i.e., mere
touching a cup of hot coffee). These two studies directly relate to the current thesis in that the research focus is on the metaphoric link between temperature concepts and other abstract domains (i.e., social isolation and personality trait).

Embodied cognition theories such as the Perceptual Symbol Systems Theory (henceforth, PSS; Barsalou 1999) provide the main basis for all of these observations. According to PSS theory, knowledge is frequently represented by perceptual symbols (i.e., modality-specific or modal representations) as opposed to feature lists or amodal propositions (Barsalou 1999, 2008). Perceptual symbols are defined as schematized perceptual experiences comprised of information from introspection, the senses, and the sensorimotor program. Cognitive processes such as perception, categorization, and judgment all draw these perceptual symbols (Barsalou 1999; Schubert 2005).

Standard theories of cognition have assumed that knowledge resides in a semantic memory system separate from the brain’s modal systems for perception (e.g., vision, audition), action (e.g., movement states, affect), and introspection (e.g., mental states, affect) (Barsalou 2008). Furthermore, cognition is defined as a computation on amodal symbols in a modular system, independent of the brain’s modal systems for perception, action and introspection. However, theories of embodied cognition reject the standard view that amodal symbols represent knowledge in semantic memory. Instead, embodied cognition proposes that modal simulations, bodily states, and situated action underlie cognition. Some accounts of embodied cognition focus on roles of the body in cognition, based on widespread findings that bodily states can cause cognitive states and be affected by them (Barsalou et al. 2003; Lakoff and Johnson 1980). However, most accounts of embodied cognition focus on the roles of simulation in cognition...
Simulation is the reenactment of perceptual, motor, and introspective states acquired during experiences with the world, body and mind.

In PSS theory, mental delineations of concepts are anchored in perceptual bases. How knowledge is perceived determines the way in which it is encoded, stored, and retrieved; concepts perceived as co-varying are encoded, stored, and retrieved as such. Therefore, activating the concept of ‘hot’ may elicit the corresponding notion of impulsivity. This association may subsequently affect the individual’s choices and judgments. Hot temperature concepts may ignite abstract correlations (e.g. impulsivity) if non-concrete concepts are grounded in the perceptual stimulation of the senses. As a result, my conceptual model suggests that priming the concept of hot can induce impulsive behaviors. In the next section, I explore the possibility that the priming of ‘hot’ directly activates behavioral tendencies to act impulsively.

Metaphoric Link between ‘Hot’ and Impulsivity

Most people are acquainted with the concept of temperature. In addition to denoting a physical phenomenon, temperature has also generated a large number of metaphors. The terms “hot” or “cold” are applied to a wide variety of things, including ideas, individuals and commodities. Calculated conduct is frequently termed “cold,” just as impulsive behavior is regularly labeled “hot.” Metaphors linking hotness and impulsivity are especially common in everyday life (e.g., ‘hot-headed, impulsive murder’; see Bushman and Anderson 2001). “Hot” is understood metaphorically rather than physically in these expressions. For instance, the terms
‘hot-headed’ and ‘impulsive’ are regarded as interchangeable and lexically synonymous. Moreover, different mental states have been depicted metaphorically with temperature-related words in academic research. For example, the hot-impulsive system has been contrasted with the cold-reflective system. That ‘hot’ has an impulsive characteristic has also been shown by earlier research based on the hot-cool framework (Metcalfe and Mischel 1999). However, rather than treating ‘hot’ as a physical concept that genuinely motivates impulsive conduct, researchers have merely deployed the word ‘hot’ as a metaphor for impulsive traits such as hasty information processing.

In addition to psychologists, many behavioral decision researchers have utilized the thermal concept of ‘hot’ to portray impulsivity (Loewenstein 1996; Peters et al. 2006) by contrasting the thermal concept of hot with cold. They often use the thermal concepts of hot and cold to describe human beings’ distinct mental processing systems such as emotion and cognition respectively. Their efforts have been in keeping with the theory that individuals typically use metaphors to think of abstract concepts in physical ways (Amorim, Isableu, and Jarraya 2006; Lakoff and Johnson 1980). As remarked by Lakoff and colleagues, metaphors signify abstract domains for people. Hence, terms related to temperature, which is a concrete domain, are used to depict impulsivity, a more abstract domain.

Figure 2.1 illustrates the hypothesized effect of priming hot temperature on impulsive behaviors, and the dotted line shows the assumed underlying process. Consistent with this observation, the thermal concept of ‘hot’ has shared attributes (e.g., desire, urge) with the concept of impulsivity, and therefore, those core elements of impulsivity can be tethered to the thermal concept of hot as a metaphoric linkage in long-term memory.
FIGURE 2.1 HYPOTHESED EFFECTS OF TEMPERATURE PRIMES

Note: The dotted line depicts an assumed process of the causal relationship between priming hot and observed impulsive behaviors.

The concepts of hot and impulsivity share attributes that are acquired through an individual’s interaction with his or her natural and social environment as is the case with other metaphorical associations which are formed through learned experiences (Bargh 2006). For example, people may have some images associated with fire or heat and a person who shows impulsive behavioral tendencies. Once the main characteristics of impulsivity are triggered by hot temperature primes, those features can perform a function in human motivation. Put differently, “action tendencies” are embedded in the core components of impulsivity (Frijda 1986). Action tendencies can be delivered by drive states (e.g., desire and other motivations), according to Loewenstein and O’Donoghue (2004). Therefore, exposure to the thermal concept of ‘hot’ may lead people to engage in impulsive conduct. I expected that a priming stimulus such as hot temperature could increase the likelihood of an impulsive behavior under relevant circumstances, such as spending situations (see Bargh 2006).

Overall, I suggest that the conceptualization of impulsivity can be embodied by the priming of hot temperature as a simulation of the bodily state. In other words, embodied
cognition states that the simulation of a concrete concept (i.e., hot) can be associated with an abstract concept (i.e., impulsivity), which is in line with the cross mapping of two disparate domains in metaphors. The term “embodied” cognition can create some confusion. A common misunderstanding related to “embodied cognition” is that bodily states are necessary for cognition, and as a result, researchers focus heavily on bodily states in conducting research. However, according to Barsalou (2008), “cognition often proceeds independently of the body, and many researchers address other forms of grounding. Grounded cognition reflects the assumption that cognition is typically grounded in multiple ways including simulations, situated action, and on occasion, bodily states (p. 619).”

In my thesis, I adopt a broader meaning of embodied cognition, or grounded cognition as Barsalou suggested. Thus, I focus more on the simulation of the bodily sensation (i.e., primed temperature concept), which can be also explained by embodied (or grounded) cognition. Although I mainly focus on testing the effect of priming temperature concepts on impulsivity, in the current framework I take a view that the experience of actual hot temperature can cause an activation of the concept of hot. For this reason, I included experiment 3 (therapeutic pack study) using a physical prime. Furthermore, through the investigation of the causal relationship between the concept of hot and impulsive behaviors, I examine if participants’ actual feeling of hot mediates this causal relationship.

In sum, while there has been a widespread acceptance of viewing metaphors as cross-domain mappings (i.e., correspondences between two separate domains), there is little consensus on how these mappings occur (Bowdle and Gentner 2005, p. 193). Furthermore, the actual causal relationship of the proposed metaphoric associations (i.e., hot–impulsivity) remains an open and
Empirical question. Thus, in this research, I focus on whether and how the metaphorical link between hot and impulsivity actually influences judgments and choices, by testing the causal relationship between the priming of hot temperature and the incidence of impulsive behaviors.

Experimental Hypotheses

Building on the theories of metaphors and embodied cognition that explain the link between temperature-related concepts and impulsivity, I argue that merely priming hot temperature affects decision outcomes by activating the core elements of impulsivity. In particular, I propose that priming hot (vs. cold) temperature is likely to trigger impulsivity, resulting in impulsive behavioral tendencies in choices and judgments. Throughout experiments 1 and 2, the primed cold temperature condition is used as a control group to test whether the priming of hot temperature concepts can induce different decision outcomes caused by the metaphoric association between hot and impulsivity. I initially thought that the cold-calculated link may be a good comparison since we actually relate hot and cold with impulsive and calculated respectively. Thus, the comparison between the two conditions may be worth testing. In addition, I include a neutral temperature control condition in the last two experiments. In hindsight, the cold priming condition was not significantly different from the control condition. That is, the comparison between the hot and cold priming conditions in experiments 1 and 2 can be supportive evidence for the hot-impulsivity link.

I present my general propositions more formally as follows:
**H1:** Individuals are more likely to be impulsive in a primed hot temperature condition than in a primed cold temperature condition, resulting in greater impulsivity across behavioral domains. As a result, individuals in the hot prime condition will:

a) choose a smaller-sooner reward over a larger-later reward

b) indicate higher willingness to pay for desirable products

c) choose a risky gamble over a less risky gamble with identical expected values

d) choose an erroneous answer to the bat and baseball problem
CHAPTER 3

ALTERNATE MODELS

Although I conceptualize impulsivity by adopting four different manifestations in this thesis, it is worth noting that there might be alternate models (paths) in understanding the cause-effect relationship between hot and impulsive behaviors. The word “hot” has many different associations, and hence, there is a possibility that another association can induce seemingly identical consequences as the proposed hot-impulsivity association. I address two possible alternate models of the effect of priming ‘hot’ on impulsive behaviors in this chapter. In particular, I introduce hot-anger association and hot-sunny weather association as potential pathways that can result in identical effects of hot-impulsivity link.

Metaphoric Association between ‘Hot’ and Anger

Our languages are replete with expressions such as “he has a hot temper,” or “she is burning up.” These expressions are conceptual metaphors describing the specific emotion of anger by using the word ‘hot’, or similar words (e.g., burning or heat). If people have metaphoric associations between hot and anger in their long term memory, priming hot may induce the concept of ‘anger’ rather than impulsivity.
As a result, the activation of anger triggers a certain set of actions toward implicit goals, which Frijda (1986, 2005) refers to as “action tendencies.” According to the investigations of action tendencies, anger is related to the desire to change the situation and to move against another person or obstacles (Frijda, Kuipers, and ter Schure 1989). The desire to change the situation where delaying immediate gratification is needed to maximize long-term utility may lead people to choose a smaller-sooner reward. That is, people may choose a short term reward over a larger-later reward.

Similarly, people are more likely to seek immediate gratification by indicating higher willingness to pay. In addition, previous research demonstrated that relative to other negative (e.g. fear or sadness) or neutral emotions, induced anger activated optimistic perceptions toward risk (Lerner and Keltner 2001; Lerner et al. 2003). If this is the case, priming hot may induce risk seeking behaviors via the hot-anger association. With regard to the effect of anger on judgment and decision making, researchers also found that anger activates heuristic processing (e.g., more stereotypic judgments, less attention to the quality of the arguments, and more attention to the superficial cues of the message, for a review, see Lerner and Tiedens 2006). Thus, priming hot and activating anger can result in erroneous responses mainly due to heuristic processing. Figure 3.1 summarizes the alternative hypotheses based on a hot-anger link.

Although I address the alternative explanation based on the hot-anger link, it is not transparent whether the activated anger concept actually triggers participants’ feelings of anger. In prior research, anger is defined as a syndrome of relatively specific feelings, cognitions, and physiological reactions linked associatively with an urge to injure some target (Berkowitz and Harmon-Jones 2004; Spielberger, Reheiser, and Sydeman 1995). This view is compatible with
other formulations of emotional states as constellations or networks of particular physiological patterns, behavioral tendencies, and cognitions (e.g., Bradley and Lang 2000; Izard 1991; Lang 1979; see also Herald and Tomaka 2002).

More precisely, anger is a specific kind of emotion, which presumably arises from appraisals of specific actual or contemplated states of the world (Smith and Lazarus 1990), while the term ‘mood’ is used to refer to diffuse affective states often having antecedents or referents that are unclear to the person experiencing the mood (Bodenhausen, Sheppard, and Kramer 1994). From this perspective, a primed anger concept may not be a sufficient driving force for the ‘feeling of anger’ as a specific and intensified affective state.

Rather, the primed concept of ‘anger’ is more likely to globally influence participants’ incidental moods. Regardless of whether participants actually experience anger as a specific emotion or just generally feel bad, the hot-anger association can be a potential alternative explanation to the hot-impulsivity hypothesis that I focus on in this thesis. In addition, strong negative affect is the fundamental determinant of arousal, and arousal often facilitates (or intensifies) anger generation, but is not necessary for this emotion to arise (Berkowitz and Harmon-Jones 2004).

In sum, if priming with hot temperatures influences individuals to feel angry or be in a negative mood, it may also lead individuals to high arousal states. In order to test whether the alternate hot-anger pathway can result in behaviors similar to those based on the hot-impulsivity pathway; I measure participants’ mood and arousal. Although it is not clear whether participants actually feel anger in the hot priming condition, I propose that if participants’ mood and arousal levels are not significantly different in the hot priming vs. cold priming conditions, and I still
observe impulsive behaviors in the hot priming condition, this alternative argument is less persuasive.

**FIGURE 3.1 METAPHORIC ASSOCIATIVE NETWORK OF HOT-ANGER**

![Diagram](image)

**Priming Hot vs. Priming Good Weather**

There is a possibility that hot primes are more likely to be associated with sunny and warm days as opposed to cold primes. In figure 3.2, participants’ associations with ‘hot’ actually represent this possibility by showing responses such as ‘sun’, ‘warm’, or ‘weather’.” Past research demonstrated that ambient temperature and weather variables (e.g., amount of daylight) can affect mood (Cunningham 1979; Goldstein 1972; Howarth and Hoffman 1984; Schwarz and Clore 1983) and cognition (Keller et al. 2005; Sinclair, Mark, and Clore 1994). For example, high levels of sunlight (Cunningham 1979; Schwarz and Clore 1983) and high temperature have
been shown to be associated with positive mood (Cunningham 1979; Howarth and Hoffman 1984).

Previous findings on investment behaviors demonstrated that investors’ moods were upbeat or optimistic on sunny days, which in turn induced risk seeking behaviors (Kamstra, Kramer, and Levi 2003; Saunders 1993). In addition, Sinclair et al. (1994) found that sunny and warm days were associated with more positive moods that resulted in more heuristic and less systematic processing than on cloudy and cool days. Several studies demonstrated the effect of mood on impulsive buying behavior. These findings have shown that consumers with positive moods are more conducive to impulsive buying than consumers with negative moods (Beatty and Ferrell 1998; Rook and Gardner 1993). Consumers in a positive mood usually process product information holistically and more impulsively, rather than systematically, which can lead to increased unplanned spending. Priming ‘hot’ which in turn activates sunny and warm weather may induce seemingly similar results as the hot-impulsivity link via individuals’ positive mood states. To examine the validity of this alternative explanation, I compare participants’ mood states between the hot and cold priming conditions since this alternate pathway can only occur if participants’ moods are more positive in the hot priming condition than in the cold priming condition.

**FIGURE 3.2 PRIMING SUNNY AND WARM WEATHER**
In the following chapters, I present four laboratory experiments. Each experiment tests the main hypothesis (H1) using a different operationalization of impulsivity (H1a - H1d respectively). I provide evidence that a hot prime activates impulsive behavioral tendencies, most likely due to a hot-impulsivity metaphoric association rather than due to one of the other alternate pathways (i.e. hot-anger link or hot-warm weather link). I suggest these two pathways as alternative explanations of my conceptual framework since both alternate pathways have demonstrated apparently similar results to what I expect based on the hot-impulsivity link. Interestingly, the discussed alternate pathways have similar consequences despite being mediated by opposing feeling states (negative vs. positive) as presented in figure 3.1 and figure 3.2 respectively. It is not entirely clear why priming anger as a negative affective state and priming good weather via positive mood can result in similar predictions with regard to impulsive behaviors. Although this issue is outside of my current research focus, it remains an interesting question that should be addressed in the future.

I will test the validity of the alternate ‘hot-anger’ and ‘hot-weather’ pathways by measuring participants’ mood and arousal states in response to the hot and cold primes. Specifically, if participants’ mood and arousal states in the hot priming condition are significantly more negative than in the cold priming condition, this indicates that the hot-anger pathway may also be causing the observed behavioral tendencies. If mood and arousal states are more positive in the hot vs. cold priming conditions, then the observed behaviors can potentially be explained by the ‘hot-weather’ pathway. Finally, if mood and arousal do not differ between the hot and cold conditions but I still observe the influence of temperature prime on impulsive
behaviors, then this may be interpreted as supporting evidence that the hot-impulsive pathway is indeed more likely to be responsible for the observed behavioral tendencies than the hot-anger and hot-weather links.

In sum, the major purpose of the current thesis is to demonstrate the effect of priming hot temperature on impulsive behaviors. I examine whether merely priming the concept of hot temperature can induce impulsive behaviors. Furthermore, to explain this causal relationship, I test several hypothesized mediators (or alternative explanations), such as individuals’ actual feeling of hot, their mood, or state of arousal. I also consider whether experiencing heat with therapeutic packs can be a prime. According to Williams and Bargh (2008), touching a hot cup of coffee can prime hot concepts.
CHAPTER 4

EXPERIMENT 1: THE EFFECT OF WORD PRIMES ON IMPULSIVITY

The purpose of experiment 1 is to test whether temperature primes (i.e., hot temperature related words) can influence judgments and decision making with regard to impulsive behaviors. By exposing participants to either a hot or a cold prime, I test two hypotheses. In hypothesis 1a, it is expected that individuals in the hot priming condition are more likely to choose a smaller, sooner option vs. a larger, later option, compared to the cold priming condition. In hypothesis 1b, it is expected that in the hot priming condition, participants will indicate higher willingness to pay for the target product categories.

Experimental Design

Participants. A total of 52 undergraduate students at a large Korean university were paid for their participation in this study. They were randomly assigned to one of two priming conditions: hot related words and cold related words.

Stimuli and Procedure. Upon arrival, participants were led to the behavioral lab and were told that the study consisted of two unrelated tasks: a language ability test —the scrambled sentence test (Srull and Wyer 1979) and a consumer preference survey.
The scrambled sentence test consisted of 24 sets of five scrambled words (e.g., “people water cold clothes drink”), each of which participants had to re-construct into a grammatically correct four-word sentence as quickly as possible (participants had to use four out of the five provided words). There were two versions of the scrambled sentence test. One version was intended to prime the construct “hot” and the other primed the construct “cold.” For both the hot and cold priming conditions, 12 out of the 24 sentences contained an adjective, a noun, or a verb semantically related to the concept in question (e.g., hot prime: burn, sizzling, boiling, thirsty, sunny; cold prime: freeze, snowy, icy, windy) and the remaining 12 were temperature-neutral sentences.

After completing the scrambled sentence test, participants were asked to choose between two options of bank term deposits, each with the same monthly installment (i.e., the smaller-sooner one-year option vs. the larger-longer three-year option). It was presented simply as a choice between a 1 year bank term deposit and a 3 year bank term deposit assuming that interest rates are constant during the term. Participants were also asked to indicate their willingness to pay for each of two products (i.e., a travel package and birthday dinner) on a seven-point scale anchored by amounts in Korean currency, 10,000won (KRW), which is approximately equivalent to 10 Canadian dollars (CAD). The seven-point scale ranged from low to high prices, (travel package: KRW 40–100; dinner: KRW 2–8).

The travel package was simply described as a trip to Tokyo for three nights and four days. Since Experiment 1 was conducted in Korea, Tokyo was a suitable place to travel for Korean students. Moreover, this destination is associated with all four seasons rather than being associated with a specific temperature. Similarly, for the descriptions of the dinner, I simply
asked the willingness to pay for a birthday dinner, avoiding the potential temperature specific associations with a certain type of meal. For example, depending on the type of dishes involved (e.g., sushi or steak), a birthday dinner could also produce some feelings of cold or warm. To avoid this possibility, I did not describe a specific meal type and simply asked “How much are you willing to pay for your birthday dinner per person?” However, I acknowledge that the social connotation of a birthday dinner may induce a feeling of warmth. I included exact questions or descriptions of stimuli as an appendix.

Results and Discussion

Participants in the hot priming condition were more likely to choose the more impulsive, one-year bank term deposit option (18 out of 26, 69.2 %) than the three-year bank term deposit (8 out of 26, 30.8%). In contrast, in the cold priming condition, more participants chose the three-year bank term deposit (14 out of 26, 53.8%) than the one-year bank term deposit (12 out of 26, 46.2%). The difference between the proportions of participants who chose the impulsive option (i.e., one-year bank term deposit) in the hot and cold conditions was marginally significant ($\chi^2(1) = 2.84, p < .10$).

Participants in the hot priming condition were willing to pay significantly more for the dinner ($M = 5.23, SD = 1.63$) than those in the cold priming condition ($M = 4.31, SD = 1.38$), ($t(50) = 2.20, p < .05$). The results for the travel package were in the same direction but were not statistically significant ($M_{hot} = 83.08, SD = 17.15$ vs. $M_{cold} = 77.69, SD = 17.51$), ($t(50) = 1.12, p > .20$). To summarize, the results from experiment 1 lend marginally significant support to
For testing hypothesis 1b, there is a partial support in that the result was statistically significant only for the birthday dinner example.

Although the results from experiment 1 do lend partial support for my hypothesis, the experiment has several limitations in terms of design. First, I demonstrate only a simple main effect of hot temperature primes on impulsive behaviors without testing for potential moderating effects. Second, I did not adopt an appropriate control condition using temperature-neutral words. Instead, I used a cold priming condition as a comparison group. Finally, there were no direct measures of possible mediators, impulsivity related concepts such as desire, or urge, and participants’ actual feeling of hot, and other potential associations with hot, such as the hot-anger link and hot-weather link. More specifically, in experiment 1, I did not measure participants’ mood levels, and hence, I was not able to rule out the possibility that the results can be explained by alternative explanations that I mentioned in the previous section.

In the following experiments, I test the validity of the two alternate pathways discussed in chapter 3 by measuring participants’ mood states, since ‘hot-anger’ and ‘hot-weather’ links are presumably mediated by negative and positive moods, respectively. If the participants’ moods are identical between the hot and cold priming conditions and I still observe the influence of temperature primes on behavioral tendencies, the validity of these alternative explanations will be significantly weakened.
CHAPTER 5

EXPERIMENT 2: THE EFFECT OF PICTURE PRIMES ON IMPULSIVITY

The main purpose of this experiment is to examine whether visual temperature primes can influence judgments and decision making through the metaphoric association between temperature and impulsivity. Consumers are often exposed to marketing environments with various visual marketing stimuli associated with temperature (e.g., advertisements with seasonal pictures or retail stores with temperature-associated colors). Thus, it is worth testing whether visual primes induce impulsive behaviors.

In addition to hypothesis 1a and 1b, I test hypothesis 1c in this experiment. In hypothesis 1c, it is expected that individuals in the hot priming condition are more likely to choose a risky gamble (vs. a less risky gamble) than in the cold priming condition. In my laboratory setting, I use two different gambles with the same expected value (i.e., low probability and high payoff gamble vs. high probability and low payoff gamble), and ask participants to choose between the two. In particular, in a presumably stimulating risk taking situation, individuals in the hot priming condition may be immediately or unreflectively longing for the high payoff rather than paying attention to the probability, unlike in a typical gain situation where they generally tend to avoid risk.
I also test the validity of alternate models that operate via changes in mood and arousal (such as the two alternative pathways mentioned above: the hot-anger link and the hot-warm weather link) by measuring participants’ levels of mood and arousal. I assume that if participants’ mood and arousal levels are not different between the hot and cold priming conditions, the two alternative explanations are less likely to be valid.

Experimental Design

Participants. Sixty-four students at the University of Toronto participated in the experiment in exchange for course credit. They were randomly assigned to two between-participants conditions (summer picture priming vs. winter picture priming).

Stimuli and Procedure. Participants were told they would take part in two unrelated tasks. The experimenter explained that the first task was about consumer memory and the participants should try and remember the details of a series of photographs as best they could. Participants were randomly assigned to one of two between-participant conditions—in one condition they watched a slideshow that consisted of different scenes of winter whereas in the other condition they viewed scenes of summer. In each condition, the slideshow consisted of 16 photographs—each photograph was flashed on the screen for seven seconds.
Next, participants were told that they were to complete a questionnaire. First they chose between a bank term deposit for one-year (smaller-sooner reward) and a bank term deposit for three-years (larger-later reward), each with the same monthly installment as I used in experiment 1. Second, they were asked to pick a gamble that they would rather play choosing between two options of equal expected value; a high probability [0.8]–low payoff [$50] gamble (less risky/less impulsive option) and a low probability [0.2]–high payoff [$200] gamble (riskier/more impulsive option). I selected these two gambles to demonstrate the impact of temperature on risk taking behavior, which can be best operationalized by the use of gambles as stimuli.

<table>
<thead>
<tr>
<th>Gamble A ( )</th>
<th>Gamble B ( )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chance of winning 0.8</td>
<td>Chance of winning 0.2</td>
</tr>
<tr>
<td>$50</td>
<td>$200</td>
</tr>
</tbody>
</table>

e.g., If you were to pick one gamble between the two, which one is more attractive to you?

Third, participants were asked to respond to willingness to pay questions in Canadian dollars for three products (travel package, dinner, and cell phone). Consistent with experiment 1, I selected a destination (New York City) where individuals do not have any strong associations with a specific temperature. We can observe impulsive decisions in many product and service categories. With the exception of gambles, the selection of product categories in the experiments was not related to my conceptualization of impulsivity per se. I included an appendix for the detailed description of the questions used in the experiment.

Participants were asked to indicate their willingness to pay on a seven-point scale anchored by amounts in Canadian dollars. The seven-point scale ranged from low to high prices, (travel package: $400–$1000; dinner: $20–$80; cell phone: $200–$500). For example, for the
travel package, the willingness to pay question presented participants with a seven-point scale (Nelson and Simmons 2009) anchored at $400 on the low end, and then increasing in increments of $100 to $1000. In addition to the questions listed above, participants rated their mood and arousal (bad–good, nervous–relaxed) as well as felt temperature (cold–hot) on seven-point scales. Finally, participants had to answer questions about the slideshow of winter or summer scenes they had seen earlier. None of the participants reported any suspicion of the priming task being related to the choice or willingness to pay tasks.

Results and Discussion

The results of the impulsivity measures revealed that the choice between a more impulsive option (e.g., one-year bank term deposit, low probability–high payoff gamble) and a less impulsive option (e.g., three-year bank term deposit, high probability–low payoff gamble) was dependent on the type of slideshow the participants were exposed to. Of 32 participants who watched the summer scenic slideshow, 21 (65.6%) chose the one-year bank term deposit whereas 11 (34.4%) chose three-year bank term deposit. By contrast, more participants in the winter scenic slideshow condition (20 out of 32, 62.5%) chose the three-year bank term deposit, while 12 (37.5%) chose the one-year bank term deposit ($\chi^2(1) = 5.07, p < .05$).
In the case of the gamble choice, 29 out of 32 participants (90.6%) in the cold priming condition chose the high probability–low payoff option, and only three participants (9.4%) selected the low probability–high payoff option. Interestingly, this difference decreased in the hot priming condition, where a relatively large number of participants (9 out of 32, 28.1%) chose the gamble with the low probability–high payoff over the high probability–low payoff gamble. The difference between the proportions of participants who chose the riskier option in the hot and cold priming conditions was marginally significant ($\chi^2(1) = 3.69, p = .055$).
For willingness to pay measures, the willingness to pay for dinner was significantly higher in the hot priming condition ($M = 53.75, SD = 19.30$) than in the cold priming condition ($M = 44.06, SD = 11.03$) [$t(62) = 2.47, p < .05$]. Also, participants who watched the summer scenic slideshow indicated a higher willingness to pay for the same cell phone ($M = 339.06, SD = 111.97$) than those who watched the winter scenic slideshow ($M = 279.69, SD = 89.68$) [$t(62) = 2.34, p < .05$]. The pattern for the travel package was in the same direction but was non-significant ($M_{hot} = 706.25, SD = 164.49$ vs. $M_{cold} = 671.88, SD = 154.99$; $t(62) = .86, p > .30$).

In order to check whether hot temperature primes induced participants to actually feel hot, I compared participants’ felt temperature on a seven-point scale across the two conditions.
Participants in the hot priming condition reported significantly higher thermal conditions than in the cold priming condition \([M_{\text{hot}} = 4.97, \text{SD} = 1.06 \text{ vs. } M_{\text{cold}} = 3.22, \text{SD} = 1.31; t(62) = 5.86, p < .01]\). I tested whether felt temperature plays a role as a mediator for each product category (i.e., dinner and cellular phone). I was not able to conduct a mediation analysis for the travel package since the main effect of temperature primes on willingness to pay of travel package was not significant. I found that participants actually feeling hot mediated the observed effects in neither of the two product categories (see also figure 5.3).

**FIGURE 5.3 INFLUENCE OF FELT TEMPERATURE ON WTP FOR DINNER: EXPERIMENT 2**

![Diagram illustrating the influence of felt temperature on WTP for dinner](image)

Finally, I checked for the potential confounding effects of mood and arousal. Participants’ level of mood and arousal were not significantly different between the two conditions (mood: \(M_{\text{cold}} = 5.13, \text{SD} = 1.07 \text{ vs. } M_{\text{hot}} = 5.31, \text{SD} = 1.09; t(62) = .69, p > .40\); arousal: \(M_{\text{cold}} = 5.28, \text{SD} = 1.42 \text{ vs. } M_{\text{hot}} = 5.47, \text{SD} = 1.22; t(62) = .57, p > .50\)). Given the fact
that there were no significant differences in terms of mood or arousal levels between the hot and cold priming conditions, the results of experiment 2 are not likely due to either the hot-anger path or the hot-weather path. These results do support the notion that visual hot temperature primes can induce impulsive behaviors consistent with the temperature–impulsivity link.

These results show that visual hot temperature primes can induce impulsive behaviors in some cases. For the choice measure, I found a significant result with the bank term deposits, and a marginally significant result with gambles. For the willingness to pay measure, participants showed a significantly higher willingness to pay for the dinner and cellular phone in the hot priming condition than in the cold priming condition. However, there was no significant difference in willingness to pay for the travel package. One may argue that the $400 to $1000 anchor was too low to produce a significant result for the travel package. However, the range ($400 - $1000) was based on real market prices for the category, and $1000 was an above average price for low-priced package deals, which students tend to look for. The result of the mediation analysis demonstrated that participants actually feeling hot did not play a role as a mediator of the observed effect.

Although I replicated some of the results from experiment 1 (i.e., the main effect of temperature primes on willingness to pay for dinner, the higher choice share of a short term bank term deposit in the hot priming condition), others are not significant (i.e., the main effect of temperature primes on willingness to pay for the travel package) or just marginally significant (i.e., the relatively higher choice share of risky gamble in the hot priming condition). In addition, this experiment has two flaws. First, this experiment lacks an appropriate control condition that uses temperature-neutral images. Instead, I introduced the cold condition for comparison
purposes assuming that the cold condition can be used as a control condition. In experiment 3, I include a control condition to make sure that the cold condition was not significantly different from the control condition.

Second, it is not clear whether the participants actually feeling hot after viewing pictures is due to a possible demand artifact. To measure felt temperatures, I asked participants to rate their feelings of hot or cold on a 7-point scale. Measuring felt temperature after priming the concept of temperature may have resulted in being affected by demand artifacts. Thus, in the next experiment, I asked participants to estimate the room temperature for the building manager’s use. Therefore, in experiment 3, I was able to measure participants’ perceived temperature minimizing the influence of demand artifacts without participants being aware of a relationship between temperature priming and estimated temperature,
CHAPTER 6

EXPERIMENT 3: THE EFFECT OF PHYSICAL TEMPERATURE ON IMPULSIVITY

Experiment 3 is designed to test the link between hot temperature primes and impulsivity by adopting a different dependent variable (i.e., the error rate for the “bat and baseball” problem in Kahneman and Frederick 2002; Frederick 2005). Previous research on impulsive behavior conceptualizes impulsivity as involving short decision times (Buss and Plomin 1975) or fast responses (Barratt 1985). Note that not all cases with fast response times are recognized as examples of impulsivity (e.g., experts’ skilled decisions or ‘fast and frugal’ heuristics). However, impulsivity can be represented by short response times accompanied by negative decision outcomes with absence of thoughtful consideration. For example, individuals have a tendency to state the first thing that comes to mind when answering questions in an impulsive state (Frederick 2005). Thus, I hypothesize that in the hot (vs. cold) temperature condition the error rate will increase for answers to the bat and baseball question, which tends to trigger incorrect, intuitive solutions. Originally, Frederick’s CRT (Cognitive Reflection Test) problems are as follows:

1. A bat and baseball cost $1.10 in total. The bat cost $1.00 more than the ball. How much does the ball cost? (       ) cents
2. If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets? ( ) minutes

3. In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half of the lake? ( ) days

Regarding these three questions, 10, 100, and 24 might be the intuitive answers to the questions respectively. Although Frederick (2005) introduced three different cognitive reflection test problems, I used only one of them (i.e., bat and baseball problem). First of all, I thought that the priming effect would not persist for all three questions. Second, although I did not conduct a pretest, I thought that the moderate level of simplicity of the bat and baseball problem would lead people to respond more impulsively relative to the other two problems. I thought that in the other two problems participants might engage in mathematical calculations after perceiving them to be trick questions. Finally, I thought there may be a potential learning effect after responding to the first question: while people might respond to the first CRT question without thoughtful deliberation, they may realize the nature of the questions (“trick questions”) when exposed to the remaining CRT questions.

In addition, in experiment 3, I will examine whether the metaphoric associations between hot temperature primes and impulsivity are inhibited when experiencing both hot and cold temperatures at the same time. When people are exposed to both hot and cold temperatures, I predict that neither the hot association nor the cold association can be dominant since the opposite concepts (i.e., hot vs. cold) can play a role as a distracter or interference to each other in
the occurrence of an impact of a specific association. Thus, the hot-impulsivity association is not likely to influence decisions. Finally, I add a control condition, where I do not manipulate hot or cold associations. In my previous experiments, it was unclear whether the results are due to a hot-impulsivity link or a cold-calculated link. By adding this control condition and comparing it with the hot, cold, and hot-cold mixed conditions, I attempt to identify which link is the cause of the effects. In doing so, I further examine whether the results in my previous experiments are actually due to the hot-impulsivity link by also comparing the hot and cold conditions to a baseline condition.

Thus, I propose hypothesis 2 as follows:

**H2:** The probability of choosing an erroneous answer is higher in the hot priming condition than in the ‘cold’, ‘hot and cold’ and control conditions.

In addition to the aforementioned changes, experiment 3 attempts to prime the concepts of hot and cold by asking participants to wear either hot and/or cold therapeutic packs rather than exposing participants to pictures or words. Experiencing physical temperatures through therapeutic packs can also play a role as a temperature prime. Williams and Bargh (2008) explained that “mere tactile experiences of physical warmth should activate concepts or feelings of interpersonal warmth.” They did not make a clear distinction between activating the concept of physical warmth and feeling physical warmth when participants were holding a hot cup of coffee. Instead, they seem to suggest that the mere tactile experience of physical warmth
(regardless of whether participants actually feel hot or cold) can activate other concepts (i.e., interpersonal warmth).

Experimental Design

Participants. One hundred and sixty-three participants at the University of Toronto participated in this experiment in exchange for course credit. They were randomly assigned to four different conditions: hot, cold, hot/cold, and control.

Stimuli and Procedure. In three experimental conditions (i.e., hot, cold, and hot/cold), participants were told that they would be asked to complete two separate tasks: a product evaluation study, followed by a quiz on geography and math. Participants in the control condition were only asked to participate in the quiz on geography and math. In other words, participants in the control condition did not wear any therapeutic packs, and did not perform the product evaluation. In the other three experimental conditions, participants answered questions regarding main dependent variables and other relevant measures first, and at the end of the questionnaire, they were asked several product evaluation questions.

For the product evaluation task, participants were asked to wear two therapeutic packs on their arms (one pack on each arm)—two hot packs in the hot condition, two cold packs in the cold condition, and one hot pack and one cold pack in the hot/cold condition—for two minutes. In the mixed-pack condition, the hot and the cold pack were randomly placed, one on the left
arm and one on the right arm. Participants were informed that at the end of the experimental session they would have to evaluate the therapeutic packs.

After two minutes of wearing the packs, participants in the three experimental conditions were asked to answer a quiz comprising of 10 “true or false” questions on geography and math. The target question was the bat and baseball problem (i.e., “A bat and baseball cost $1.10 in total. The bat costs $1 more than the ball. So, the ball cost 10 cents.”—True or False?), and was placed as the second question in a series of 10 questions. The remaining nine questions were filler questions such as “Conakry is the capital of French Guinea,” “The largest freshwater lake in the US is Lake Michigan,” and “0.04% = 0.004.” Table 6.1 shows all 10 questions that I used as stimuli in this experiment.

### TABLE 6.1 QUESTIONS ON GEOGRAPHY AND MATH: EXPERIMENT 3

<table>
<thead>
<tr>
<th>Questions</th>
<th>True</th>
<th>False</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The capital of Illinois is Chicago</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>2. A bat and baseball cost $1.10 in total. The bat costs $1 more than the ball. So, the ball cost 10 cents.</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>3. A day of the week is chosen at random. The probability of choosing a Monday and Friday is 2/7</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>4. The largest freshwater lake in the US is the lake Michigan</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>5. Conakry is the capital of French Guinea</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>6. The capital of Massachusetts is Boston</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>7. 0.04% = 0.004</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>8. The second largest continent in the world is Africa</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>9. The capital of Australia is Sydney</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>10. The smallest country in the Mid-East is United Arab Emirates</td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>
A critical difference between the “bat and ball” question and the other nine filler questions is the role that spontaneous (less effortful) processing is playing in the likelihood to answer these questions correctly. According to Frederick (2005), the intuitive and impulsive answer to the target question would be 10 cents, which is false, and the correct answer is 5 cents. The filler questions, on the other hand, were selected such that they were mainly based on participants’ knowledge. These questions did not have an intuitive or impulsive answer, and the amount of effortful processing should not have any impact on participants’ error rates. As Frederick (2005) argued, the “bat and baseball” question may cause people to answer impulsively, providing an incorrect response without a deep thought.

Consequently, impulsivity contingent upon a temperature manipulation would lead to a higher error rate. As for the filler questions, their error rates are not expected to be affected by impulsivity because the speed of completion is not a diagnostic factor in solving those questions correctly. Based on this reasoning, I predict that participants in the hot temperature condition will show a higher error rate on the bat and baseball question, in comparison to the remaining conditions. There should also be no difference between ‘hot’ and the remaining conditions in terms of the error rate for the filler questions. The main dependent variable was the percentage of incorrect responses on each of the questions. This was determined by counting the number of incorrect answers provided by participants for each question.

Next, in order to check whether priming temperatures by using packs actually can induce participants’ distinct perception of the room temperature (e.g., feeling hot), participants were asked to estimate the perceived room temperature (in degrees Celsius). Finally, participants rated their mood (bad–good, disappointed–satisfied, sad–happy, and displeased–pleased) and level of
arousal (calm–excited, down–elated, tired–energetic, and sedated–aroused) on 17-point scales anchored at -8 and 8 (Salovey and Birnbaum 1989) to test alternate pathways that operate via mood and arousal (see previous discussions and experiment 2).

Results and Discussion

Binary logistic regression analysis showed that temperature influenced the error rate of the bat and baseball question ($\chi^2(3) = 8.03, p < .05$). As can be seen in figure 6.1, compared to the other three conditions there were significantly more participants in the hot pack condition who answered “True,” thereby implying a higher tendency to offer an impulsive and incorrect answer. Specifically, in the hot pack condition, 46.3% (19 out of 41) of participants answered incorrectly, whereas only 19% (8 out of 42) of participants in the cold pack condition offered the incorrect answer ($\chi^2(1) = 7.04, p < .01$). This supports hypothesis 1d.

Furthermore, the error rate in the hot condition (46.3%) was higher than in the control condition with marginal statistical significance (11 out of 40; 27.5%; $\chi^2(1) = 3.08, p = .079$) and significantly higher than in the hot-cold condition (10 out of 40; 25%; $\chi^2(1) = 4.01, p < .05$), partially supporting hypothesis 2. There was no statistically significant difference ($\chi^2(1) = .82, p > .30$) between the cold (8 out of 42; 19%) and the control condition (11 out of 40; 27.5%), implying that the hot-impulsivity association may be stronger than a cold-calculated association.

Since I compared hot and cold priming conditions in experiments 1 and 2, it was unclear what drove the observed effects (e.g., higher WTP and higher choice share of SS option in the hot
priming condition). For this reason, I included in this experiment a control condition, which is a baseline condition. This result showed that the hot-impulsivity link (vs. cold-calculation link) is likely to have driven the observed effects. Finally, there was no statistically significant difference between the hot/cold condition (10 out of 40; 25%) and the control condition (11 out of 40; 27.5%; $\chi^2(1) = .07, p > .70$).

**FIGURE 6.1 INFLUENCE OF PHYSICAL TEMPERATURE ON ERROR RATE OF THE BAT AND BASEBALL PROBLEM: EXPERIMENT 3**

This result supports the notion that when participants experience both temperatures simultaneously, neither hot nor cold associations can be salient; therefore, the hot–impulsivity association can be mitigated. This is because the association with the concept of cold
temperature such as ‘calculated’ can play a role as interference or a distracter of the strength of the hot-impulsivity link.

It is worth noting that a tendency to answer randomly might play a role in the problem solving task, which could potentially induce erroneous answers. However, if participants’ answers are mainly due to the randomness, it is highly unlikely that only the hot priming condition would yield a higher probability of erroneous answers to the target question. In line with this reasoning, a binary logistic regression analysis predicting errors as a function of the type of question (target – coded as “1” vs. filler – coded as “0”), the therapeutic pack condition (i.e., hot, cold, hot/cold, control), and their interactions revealed a significant interaction effect. Specifically, there were no statistically significant differences in the percentage of incorrect answers to the filler questions between the hot pack and cold pack conditions, whereas the target question induced more erroneous answers in the hot pack than in the cold pack condition (Wald(1) = 6.07, p < .05).

### TABLE 6.2 ERROR RATES OF ALL QUESTIONS: EXPERIMENT 3

<table>
<thead>
<tr>
<th>Questions</th>
<th>Cold</th>
<th>Hot</th>
<th>Control</th>
<th>Hot &amp; Cold</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Chicago</td>
<td>40.5</td>
<td>48.8</td>
<td>47.5</td>
<td>77.5</td>
</tr>
<tr>
<td>3. Probability</td>
<td>35.7</td>
<td>41.5</td>
<td>50</td>
<td>42.5</td>
</tr>
<tr>
<td>4. Lake Michigan</td>
<td>28.6</td>
<td>41.5</td>
<td>22.5</td>
<td>45</td>
</tr>
<tr>
<td>5. Conakry</td>
<td>78.6</td>
<td>65.9</td>
<td>67.5</td>
<td>52.5</td>
</tr>
<tr>
<td>6. Boston</td>
<td>33.3</td>
<td>43.9</td>
<td>37.5</td>
<td>25</td>
</tr>
<tr>
<td>7. 0.04%=0.004</td>
<td>9.5</td>
<td>2.4</td>
<td>12.5</td>
<td>0</td>
</tr>
<tr>
<td>8. Africa</td>
<td>54.8</td>
<td>61</td>
<td>72.5</td>
<td>62.5</td>
</tr>
<tr>
<td>9. Sydney</td>
<td>50</td>
<td>53.7</td>
<td>60</td>
<td>47.5</td>
</tr>
<tr>
<td>10. United Arab Emirates</td>
<td>45.2</td>
<td>41.5</td>
<td>47.5</td>
<td>42.5</td>
</tr>
<tr>
<td>Average filler questions</td>
<td>41.8</td>
<td>44.5</td>
<td>46.4</td>
<td>43.9</td>
</tr>
<tr>
<td>2. Bat and baseball</td>
<td>19</td>
<td>46.3</td>
<td>27.5</td>
<td>25</td>
</tr>
</tbody>
</table>
Moreover, there was a marginally significant percentage difference in erroneous answers to the target question between the hot pack and control conditions, while I did not find such differences for the filler questions (Wald(1) = 3.61, $p = .058$).

The average mood (Cronbach’s $\alpha = .92$) as well as the arousal (Cronbach’s $\alpha = .75$) scores were not significantly different across the hot, cold, hot/cold, and control conditions (mood: $M_{hot} = 3.01$, SD = 2.77; $M_{cold} = 3.42$, SD = 3.16; $M_{hot/cold} = 3.24$, SD = 2.87; $M_{control} = 2.49$, SD = 2.91; $F(3, 155) = .73$, $p > .50$; arousal: $M_{hot} = -.49$, SD = 2.56; $M_{cold} = -.47$, SD = 2.40; $M_{hot/cold} = -.29$, SD = 2.96; $M_{control} = -.36$, SD = 2.79; $F(3, 158) = .05$, $p > .90$). Finally, participants’ estimates of the room temperature were not significantly different across the four conditions ($M_{hot} = 21.6 ^\circ C$, SD = 4.21; $M_{cold} = 22.1 ^\circ C$, SD = 3.76; $M_{hot/cold} = 20.8 ^\circ C$, SD = 3.12; $M_{control} = 21.3 ^\circ C$, SD = 4.78; $F(3, 159) = .80$, $p > .40$). These results showed supporting evidence that using therapeutic packs to prime temperature concepts did not induce different mood and arousal states, once again supporting the hot-impulsivity pathway. Since the effects of temperature primes on potential mediators such as mood, arousal or the estimates of room temperature (actual feeling of being hot) did not emerge, I did not conduct a mediation analysis.

Although ambient room temperatures were held constant during the experiment, participants were asked to estimate room temperature to provide a perceived temperature measure. Estimates of the ambient room temperature did not differ between the four therapeutic pack conditions; in particular the hot pack condition estimates were not significantly higher than in the remaining three conditions. This was in contrast to results from experiment 2, where
participants in the hot priming condition (i.e., summer pictures) reported feeling hotter than those in the cold priming condition (i.e., winter pictures).

One possible reason for the contrast between experiments 2 and 3 seems to be the different methods that I used to measure participants’ felt temperature in the two experiments. In experiment 2, I directly asked how they felt about the temperature. In contrast, I asked participants to estimate the room temperature in experiment 3 to minimize the influence of demand artifacts (i.e., asking the felt temperature after showing temperature-related stimuli). Another possible reason for the contrast between experiments 2 and 3 is that I used different methods to prime hot temperature (i.e., pictures vs. actual packs on arms). Since participants were exposed to either hot or cold temperature through only a small portion of their bodies in experiment 3, there seems to be no reason why felt temperatures should be different depending on different primed temperature conditions. In experiment 3, the observed effects seem to have been driven by priming the temperature concepts, not by participants actually feeling hot or cold.

Although the results of experiment 3 show that priming the temperature concepts can trigger impulsivity without affecting the level of felt temperature, it seems that it would be worth systematically investigating whether participants’ actual perception of temperature can be a crucial mediator for the effect of hot temperature primes on impulsive behaviors. Thus, in the following experiment, I test for the mediating role of feeling hot.
CHAPTER 7

EXPERIMENT 4: TESTING THE MEDIATING ROLE OF ‘FEELING HOT’ IN THE HOT-IMPULSIVITY PATHWAY

So far, I have demonstrated that priming hot temperatures triggers impulsive behaviors under various priming methods and dependent variables. However, these findings alone do not fully explain the underlying processes per se. In this chapter, I will investigate whether feeling hot mediates the effect of priming hot on impulsive behaviors. The priming methods (i.e., words, pictures and experiences of physical temperature) that I used in my previous experiments were all supraliminal in nature. In the supraliminal priming conditions, participants may have been consciously aware of the concept ‘hot’, and this awareness may have resulted in them actually feeling hot. Indeed in experiment 2, participants reported that they were feeling hotter in the summer pictures condition than in the winter pictures condition.

In order to examine the underlying processes of the hot-impulsivity pathway, it is important to clarify the validity of the self-reporting of higher temperatures. It is possible that participants were actually physically feeling hot after viewing summer scenic pictures. If this was the case, feeling hot may have been an important mediator in the ‘hot-impulsivity’ pathway, playing a critical role in producing the findings reported in previous experiments. However, there is a possibility that participants’ self-reporting of felt temperature on a seven-point scale (e.g., how do you feel? 1-cold, 7-hot), measured immediately after watching seasonal scenic pictures,
can be simply attributed to demand artifacts, and participants in the summer pictures condition did not actually feel hotter. It is worth noting that seasonal pictures (vs. a scrambled sentence test) are more likely to trigger demand artifacts when participants are asked about felt temperature. In these cases, I assume that visual primes are more vivid than word primes in inducing demand artifacts. Because of this, I decided to use a scrambled sentence test instead of seasonal pictures to minimize the possibility of demand artifacts in the supraliminal priming condition. Thus, if participants report that they are feeling hotter in this hot priming condition and I observe the effect of hot temperature primes on impulsivity, it is less likely due to demand artifacts, and this may indicate the mediating role of feeling hot in the hot-impulsivity pathway. If there is no difference in felt or perceived temperature across conditions and I still observe the effect of hot temperature primes on impulsivity, then feeling hot is not likely a mediator of the hot-impulsivity pathway.

Additionally, to further test the possible mediating role of ‘feeling hot’; I will use a subliminal priming method employing a lexical decision task (Dijksterhuis, Preston, Wegner, and Aarts 2008; Strahan, Spencer, and Zanna 2002). Participants who are primed subliminally are not aware of the target concepts (hot, cold and neutral temperatures), thus completely eliminating the possibility of demand artifacts. By then measuring participants’ perceived or felt temperatures, I can examine the possible mediating effects of feeling hot. I expect that if participants report that they are feeling hotter in the hot priming condition and I observe the effect of hot temperature primes on impulsivity, this may again indicate the mediating role of feeling hot in the hot-impulsivity pathway. Similar to the supraliminal priming condition, if there is no difference in perceived or felt temperature across conditions and I still observe the effect of
hot temperature primes on impulsivity, then feeling hot is not likely a mediator of the hot-impulsivity pathway.

In my previous experiments, I did not systematically test under what condition the observed effect of hot temperature primes on willingness to pay is moderated. Rather, I adopted various product categories such as birthday dinners and cellular phones, and found the effects of hot temperature primes on impulsivity in these categories. In experiment 4, I examine whether there is a moderating role of product type (pleasure vs. necessity) in the effect of hot temperature primes on impulsivity.

Consumers’ impulsive behavioral tendencies may be weak or strong depending on the nature of the target product categories. Individuals purchase goods or services for two basic reasons: (1) consummatory affective (or hedonic) gratification from sensory attributes, and (2) instrumental, utilitarian reasons concerned with “expectations of consequences” from functional and non-sensory attributes (see Holbrook and Hirschman 1982). Hedonic goods are more likely to influence the sensory, imagery, and affective senses of the individual. For instance, Hsee and Rottenstreich (2004) describe hedonic goods as “affect-rich” goods, and utilitarian goods as “affect-poor” goods. Furthermore, Mischel and Metcalfe (1999) have argued that impulsivity is related to affective senses, which exist only for affect-rich hedonic goods, and not for affect-poor utilitarian goods.

A question worth addressing is whether the effect of hot temperature primes on willingness to pay will hold for necessary household products for which the primary reason of purchase is not mainly based on hedonic pleasure. I test whether product type (e.g., pleasure vs. necessity) can moderate the effect of hot temperature primes on willingness to pay and expect
that participants’ willingness to pay for necessary household goods will not be significantly higher in the hot priming condition than in the other conditions (i.e., cold and neutral).

Experimental Design

Participants. One hundred and sixty two participants at the University of Toronto participated in this experiment in exchange for 5 Canadian dollars. In experiment 4, I adopted three primes (hot, cold, and neutral) using two priming methods (supraliminal vs. subliminal) in a between-participants design. All participants were randomly assigned to one of the six conditions.

Stimuli and Procedure. In all six experimental conditions, participants were told that they would be asked to complete two separate tasks: a language ability test followed by a general consumer preference survey. Participants in the supraliminal priming conditions were asked to do a scrambled sentence test similar to the one I used in experiment 1. The scrambled sentence test consisted of 26 sets of five scrambled words (e.g., “people water cold clothes drink”), each of which, participants had to re-construct into a grammatically correct four-word sentence as quickly as possible (participants had to use four out of the five provided words). I designed three versions of the scrambled sentence test. One version was intended to prime the construct “hot”, another primed the construct “cold”, and the third version was intended to prime neither concept (temperature-neutral). In all three versions, 13 out of the 26 sentences contained an adjective, a noun, or a verb semantically related to the concept in question (e.g., hot prime:
hot, sizzling, boiling, sunny; cold prime: freezing, snow, ice, cold; neutral prime: student, car, plan, responsibility) and the remaining 13 filler sentences contained only temperature-neutral words (e.g., philanthropist, performing, does).

For the participants assigned to the subliminal priming conditions, I adopted a computerized lexical decision task for priming target words. Identical prime (i.e., hot, cold, and neutral) and filler (masking) words were used in both the scrambled sentence test and the lexical decision task. All masking words were temperature-neutral (e.g., philanthropist, performing, does). In the lexical decision task, the 13 prime words were presented for 20ms (e.g., hot prime: hot, sizzling, boiling, sunny; cold prime: freezing, snow, ice, cold; neutral prime: student, car, plan, responsibility). Participants were asked to indicate whether a series of letter strings were a real word or a non-word by pressing the ‘Z’ or ‘M’ key, respectively. In each computerized session, 13 prime words and 13 mask words were presented alternately; however, due to the subliminal 20ms presentation time of the prime words, participants only saw 13 mask words, and their task was to indicate whether each one was a word or not.

After completing the scrambled sentence test (i.e., supraliminal priming) or the lexical decision task (i.e., subliminal priming), participants were told that they had to complete a consumer survey questionnaire. First, they had to choose between a $50 gift certificate now (smaller-sooner reward) and a $75 gift certificate in a year (larger later reward). Second, they were asked to pick a gamble that they preferred to play, and had to choose between two options of equal expected value; a high probability [0.8]–low payoff [$50] gamble (less risky/less impulsive option) and a low probability [0.2]–high payoff [$200] gamble (riskier/more impulsive option). Third, participants were told to indicate whether two statements were true or false. In
In this section, I used two questions from experiment 3. While the target question was the ‘bat and baseball problem’, the other one was a filler question (i.e., “Conakry is the capital of French Guinea,’). The filler question was always followed by the target question. Fourth, I asked participants to write down their willingness to pay for a home theater system and a vacuum cleaner. Fifth, I included an additional question regarding willingness to pay. Participants were asked to indicate whether they would be willing to spend less, same as, or more than usual (by using a seven-point scale, anchored by 1 being less than usual, 4 being same as usual and 7 for more than usual) on pleasure/entertainment goods and necessary household goods in the current month (e.g., April).

Next, participants were asked to indicate the felt temperature by answering how they feel on a seven point scale, anchored from 1 (cold) to 7 (hot); the same measure as the one used in experiment 2. In addition, I asked participants to estimate the ambient room temperature (in degrees Celsius). Finally, they were asked to indicate the pleasantness of the room temperature on a seven-point scale anchored from 1 (not pleasant at all) to 7 (very pleasant).

Participants also rated their mood (bad–good, disappointed–satisfied, sad–happy, displeased–pleased) and level of arousal (calm–excited, down–elated, tired–energetic, sedated–aroused) on 17-point scales anchored at -8 and 8 (Salovey and Birnbaum 1989). The mood and arousal measures were to be used in the analysis intended to rule out alternative pathways that operate via mood and arousal (see previous discussions and experiment 1).
Results and Discussion

Choice of an Impulsive Option. I analyzed the choice data by using binary logistic regression models predicting each choice as a function of priming type (supraliminal vs. subliminal), temperature (hot, cold, and neutral), and their interactions. Binary logistic regression analyses showed that overall, priming type, temperature, and their interactions do not predict impulsive behaviors. [gift certificate: $\chi^2(5) = 3.55, p > .60$; gamble: $\chi^2(5) = 4.41, p > .40$; bat and baseball: $\chi^2(5) = 6.84, p > .20$]. Since I did not find any statistically significant interaction between temperature and priming type, and the focus of analysis was the differential impact in the three thermal conditions, I first used a one-factor (i.e., temperature) binary logistic regression model for each of the three problems by collapsing the data across the two priming type conditions (i.e., supraliminal and subliminal). One marginally significant result emerged regarding the bat and baseball question, to which participants were more likely to choose an erroneous answer in the hot priming condition than in the neutral priming condition ($\beta = .76, p = .059$). Specifically, 48.1% (26 out of 54) of participants answered incorrectly in the hot priming condition, whereas 30.2% (16 out of 53) of participants in the neutral priming condition chose the incorrect answer ($\chi^2(1) = 3.62, p = .057$). This is consistent with the findings in experiment 3 (hot pack vs. control). However, the error rate in the hot priming condition (48.1%) is not significantly higher than in the cold priming condition [41.8%; 23 out of 55, ($\chi^2(1) = .44, p > .50$)]. Also, the error rate in the cold priming condition (41.8%) was not significantly different from that in the neutral priming condition [30.2%; ($\chi^2(1) = 1.58, p > .20$). This result is also
consistent with the finding in experiment 3 which implied that the observed impulsive behaviours are due to the hot-impulsivity link but there is no impact of the cold-calculated link.

Next, I examine the difference between the supraliminal and subliminal conditions for the bat and baseball problem in detail. Although there was neither a significant main effect nor a significant interaction effect involving priming type, a binary comparison between the hot and neutral conditions revealed an interesting result. As figure 7.1 shows, the higher error rate in the hot (vs. neutral) priming condition is mainly driven by the difference in the subliminal priming condition. In the subliminal/hot priming condition, 55.2% (16 out of 29) of participants gave incorrect answers to the bat and baseball question, whereas only 31.0% (9 out of 29) of participants in the neutral priming condition offered the incorrect answer. The difference is marginally significant ($\chi^2(1) = 3.45, p = .063$). For the supraliminal priming condition, however, the error rate in the hot priming condition (40.0%; 10 out of 25) is not significantly higher than in the neutral priming condition [29.2%; 7 out of 24, ($\chi^2(1) = .63, p > .40$)].
Willingness to Pay Measure. I conducted a two-way (priming type by temperature) ANOVA with willingness to pay for the target products (i.e., home theatre and vacuum cleaner) as a dependent variable. One unexpected main effect of priming type on willingness to pay was found. This was for the home theater system which had a marginally higher willingness to pay in the subliminal priming condition ($M = 1,760, SD = 2,801$) compared to the supraliminal priming condition ($M = 1,149, SD = 1,375$; $F(1, 156) = 2.90, p = .091$).

The ANOVA revealed that there were no significant interaction effects between priming type and temperature on willingness to pay (home theater: $F(2, 156) = .34, p > .70$; vacuum cleaner: $F(2, 156) = .52, p > .50$). Furthermore, the main effect of temperature on participants’ willingness to pay did not replicate (home theater: $M_{hot} = 1,071, SD = 1,166$: $M_{neutral} = 2,000$,
SD = 3.062; $M_{\text{cold}} = 1.384$, SD = 2.160; $F(2, 156) = 2.23, p > .10$; vacuum cleaner: $M_{\text{hot}}=180$, SD = 303; $M_{\text{neutral}} = 167$, SD = 168; $M_{\text{cold}} = 149$, SD = 200; $F(2, 156) = .29, p > .70$. Thus, participants’ willingness to pay for the target products were not significantly higher in the hot priming condition than in the other two priming conditions (i.e., neutral and cold). This unexpected failure to replicate the results on the first three studies will be discussed below (see limitations).

In this experiment, I included additional questions to measure participants’ willingness to pay. Participants were asked to indicate whether they would spend less, same as, or more than usual (a seven-point scale, anchored by 1 being less than usual, 4 being same as usual and 7 for more than usual) on pleasure/entertainment goods and necessary/household goods. I expected that the effect of priming hot on willingness to pay may be qualified by the product type (i.e., pleasure vs. necessity). To examine the answers to this question, I conducted a mixed design ANOVA. Product type was a within-participants variable and temperature (i.e., cold vs. neutral vs. hot) and priming type (i.e., supraliminal vs. subliminal) were between-participants variables.

For the test of within-participants effects, I did not find a significant interaction among product type, temperature and priming type ($F(2, 155) = 1.97, p > .10$). In addition, the interaction between product type and priming type was not statistically significant ($F(1, 155) = 2.30, p > .10$). As I expected, there was a significant interaction between product type and temperature ($F(2, 155) = 3.76, p < .05$). Specifically, for the pleasure and entertainment goods, participants reported that they were going to spend significantly more than usual in the hot priming condition than in the other two priming conditions [$M_{\text{hot}} = 4.41$, SD = 1.31; $M_{\text{neutral}} = 3.66$, SD = 1.74; $M_{\text{cold}} = 3.78$, SD = 1.45; $F(2, 156) = 4.22, p < .05$], while there were no
significant differences in the scores across all three priming conditions for the necessity goods

\[ M_{hot} = 3.93, \text{ SD } = 1.03; M_{neutral} = 3.96, \text{ SD } = 1.02; M_{cold} = 4.06, \text{ SD } = 1.02; F(2, 155) = .39, \ p > .60 \]. Figure 7.2 shows the two-way interaction between product type and temperature.

**FIGURE 7.2 INFLUENCE OF TEMPERATURE PRIMES ON WTP FOR PLEASURE AND NECESSITY: EXPERIMENT 4**

![Graph showing WTP for pleasure and necessity](image)

For the tests of between-participants effects, there was a marginally significant main effect of priming type on willingness to pay \[ M_{subliminal} = 3.85, \text{ SD } = 1.29; M_{supraliminal} = 4.10, \text{ SD } = 1.23; F(1, 155) = 2.90, \ p = .09 \] and a marginally significant main effect of temperature on willingness to pay \[ M_{hot} = 4.17, \text{ SD } = 1.17; M_{neutral} = 3.81, \text{ SD } = 1.38; M_{cold} = 3.92, \text{ SD } = 1.23; F(2, 155) = 2.37, \ p = .097 \]. For the main effect of priming type on willingness to pay, I speculate
that there was an unexpected stronger priming effect. Although I tried to use the same words in both priming conditions, participants in the supraliminal condition were exposed to target words with no time limit (i.e., they were allowed to spend time as much they wanted). The differential exposure time between the supraliminal and subliminal priming conditions may have driven this effect.

Post-hoc analyses confirmed that this main effect of temperature on willingness to pay is driven by the difference between hot and neutral priming conditions [least significant difference (LSD), \( p < .05 \)].

_Felt Temperature and Temperature Estimates._ Next, I conducted a two-way (priming type by temperature) ANOVA with felt temperature and temperature estimates as a dependent variable respectively. There were no significant interactions between priming type and temperature across two measures [felt temperature: \( F(2, 156) = .15, \ p > .80 \); temperature estimates: \( F(2, 156) = .76, \ p > .40 \)]. Although there was a marginally significant main effect of priming type on felt temperature \([M_{\text{subliminal}} = 4.42, SD = .73; M_{\text{supraliminal}} = 4.19, SD = .82; F(1, 156) = 3.30, p = .071] \), participants’ estimates of the room temperature were not significantly different between two priming conditions \([M_{\text{subliminal}} = 20.3^\circ C, SD = 4.35; M_{\text{supraliminal}} = 21.3^\circ C, SD = 6.30; F(1, 156) = 1.41, p > .20] \).

Finally, I found that felt temperatures across three temperature conditions were not significantly different \((M_{\text{cold}} = 4.24, SD = .77; M_{\text{neutral}} = 4.36, SD = .86; M_{\text{hot}} = 4.35, SD = .80; F(2, 156) = .42, p > .60) \). Also, participants’ estimates of the room temperature were not significantly different across the temperature conditions \((M_{\text{cold}} = 19.9^\circ C, SD = 7.43; M_{\text{neutral}} = \)
21.3 °C, SD = 3.37; $M_{hot} = 21.1$ °C, SD = 4.25; $F(2, 156) = .84, p > .40$). The results regarding both measures of felt temperature and temperature estimate showed that participants in the hot priming condition were not feeling hotter than the other two conditions, which indicates that participants’ actual feeling hot is not necessary to engage in impulsive behavior as manifested in higher willingness to pay for pleasure/entertainment goods in the hot priming condition. I thought felt temperature was a relatively more subjective judgment than a temperature estimate, although I admit that the temperature estimate may also be based on participants’ subjective perception about the room temperature. In addition, as mentioned, measuring felt temperature after priming the concept of temperature can result in demand artifacts. In this experiment, however, participants were asked to estimate the room temperature for the building manager’s use. Therefore, without participants’ awareness of a relationship between temperature priming and estimated temperature, I was able to measure their perceived temperature while minimizing the influence of demand artifacts.

*Mood, Arousal, and Pleasantness of Room Temperature.* I conducted 3 two-way (priming type by temperature) ANOVAs with mood, arousal and pleasantness of the room temperature as the dependent variables, respectively. There were no significant interactions between priming type and temperature [mood: $F(2, 156) = 1.58, p > .20$; arousal: $F(2, 156) = .69, p > .50$; pleasantness of the room temperature: $F(2, 156) = .44, p > .60$].

As I expected, both the average mood score (Cronbach’s α = .92) and the average arousal score (Cronbach’s α = .71) were not significantly different across the hot, neutral, and cold priming conditions (mood: $M_{cold} = 2.85$, SD = 2.62; $M_{neutral} = 2.76$, SD = 3.43; $M_{hot} = 3.44$, SD =
2.67; \( F(2, 156) = 1.02, p > .30 \); arousal: \( M_{\text{cold}} = -.40, \ SD = 2.43; M_{\text{neutral}} = .11, \ SD = 2.45; M_{\text{hot}} = -.02, \ SD = 2.21; F(2, 156) = .68, p > .5 \). Thus, the significantly higher willingness to pay for the pleasure/entertainment goods in the hot priming condition compared to the other priming conditions cannot be explained by participants’ mood and arousal. Consistent with the mood data, the measure of pleasantness of the room temperature were not different across three temperature conditions (\( M_{\text{cold}} = 5.15, \ SD = 1.46; M_{\text{neutral}} = 5.00, \ SD = 1.47; M_{\text{hot}} = 5.17, \ SD = 1.13; F(2, 156) = .29, p > .70 \).

Finally, there were no main effects of priming type on mood [\( M_{\text{subliminal}} = 3.19, \ SD = 2.92; M_{\text{supraliminal}} = 2.82, \ SD = 2.94; F(1, 156) = .70, p > .40 \)] and arousal [\( M_{\text{subliminal}} = -.07, \ SD = 2.36; M_{\text{supraliminal}} = -.15, \ SD = 2.38; F(1, 156) = .05, p > .80 \)]. Also, pleasantness of the room temperature was identical regardless of priming type (\( M_{\text{subliminal}} = 5.11, \ SD = 1.30; M_{\text{supraliminal}} = 5.09, \ SD = 1.43; F(1, 156) = .01, p > .90 \)).

Limitations

In this experiment, some of the findings from previous experiments were not replicated. One reason for the unexpected findings could be that most of the participants in Experiment 4 were non-native speakers of the language in which the stimuli were constructed. This could have mitigated the effects of word priming in Experiment 4.

First, participants’ probability of choosing a small sooner reward over a larger later reward was not significantly higher in the hot priming condition than in the cold and neutral.
conditions. Specifically, I observed that most participants chose a smaller-sooner reward (i.e., $50 gift certificate, now) over a larger-later reward (i.e., $75 gift certificate, in a year) regardless of the temperature conditions. In hindsight, it is possible that a $25-difference between rewards would not have been enough to offset the disadvantage of waiting for one year. In other words, the overall attractiveness of the smaller-sooner reward might have overridden the more subtle effect of hot temperature primes.

Second, willingness to pay for a home theater system and a vacuum cleaner were not significantly higher in the hot priming condition. For the willingness to pay measures, I previously used 7 point scales, anchored from lowest to highest price. Therefore, participants were restricted to a certain range when they were indicating their willingness to pay for a target product. Using a rating method (vs. open-ended questions) to measure willingness to pay seems more likely to result in significant results. In contrast, participants were able to indicate their willingness to pay in an open-ended fashion in the current experiment. Therefore, the variance in participants’ answers was smaller in the previous experiments than in the open-ended type measure that I used in this experiment. This may have reduced the likelihood of finding significant results in the current experiment.

Third, as for the significant interactive effect of product type (pleasure vs. necessity goods) and temperature on willingness to pay, there may have been a confounding variable such as the frequency of purchases. In other words, participants may purchase pleasure goods (e.g., movies) more frequently than necessity goods (e.g., detergents). As a result, the observed effects of temperature primes on willingness to pay for pleasure (vs. necessity) goods may have been influenced by other factors, rather than the focal experimental variables.
To conduct a mediation analysis that tests whether participants actually feeling hot mediates the effect of temperature primes on impulsive behaviors, the main effect of temperature primes on felt (and perceive) temperature should be significant. However, with the exception of experiment 2 (visual primes), participants’ felt (or perceived) temperature is not significantly different across the three conditions. Thus, I was not able to conduct further analyses regarding the mediation. Nonetheless, I did not find any evidence that feeling ‘hot’ mediates the effect of priming hot temperature on impulsive behaviors. In both the subliminal and supraliminal priming conditions, there were no reported differences in perceived or felt temperature across hot, cold and neutral conditions.

Furthermore, in at least two cases (i.e., the error rate of answering the bat and baseball question in the subliminal priming condition and the willingness to pay for pleasure/entertainment products regardless of the type of priming), priming hot temperatures triggered impulsive judgment/choice without the mediating influence of participants’ actual feeling hot. All in all, these results seem to lend support to the proposition that the effect of priming hot temperature on impulsive behaviors is not mediated by participants’ actual feeling ‘hot’. It seems important to note that the impact of priming hot temperature on impulsive behaviors was demonstrated in the subliminal priming condition as well.
CHAPTER 8

FURTHER EXPLORATIONS: THE EFFECT OF AMBIENT TEMPERATURE ON IMPULSIVITY

Although I have demonstrated the link between priming temperature and impulsive behaviors in the previous chapters of this thesis, there remains an important and interesting issue regarding the hot temperature and impulsivity link—whether and how ambient temperature levels affect impulsive behaviors. According to the embodied cognition perspectives, bodily experiences are closely related to, and influence how people think. In addition to the fact that simulating a thermal concept such as ‘hot’ simply by priming can influence processing an abstract concept such as impulsivity, experiencing ambient temperature is more directly related to the notion of embodied cognition, in that the bodily experience itself can influence what people think. Thus, when people are exposed to different ambient temperature conditions, this may also activate associated concepts such as impulsivity.

It may not be easy to design a study to investigate the impact of ambient temperatures on decision making because of numerous potentially confounding factors, however, it seems worth testing the effect of ambient temperature on impulsive behaviors. This chapter addresses this issue on an exploratory basis. Thus, in the following sections, I first discuss potential alternative explanations of the effect of ambient temperature on impulsive behaviors. Next, I report the
results of field studies that I conducted to investigate the impact of ambient temperature on impulsive behaviors.

An Alternative Explanation of Arousal

Physical arousal can offer an alternative explanation to the cognitive association effect of ambient temperature on impulsive behavior. Previous research has addressed that hot ambient temperatures can lead to increases in arousal. Furthermore, this induced high arousal is unlikely to be attributed to hot temperatures; that is, hot temperatures are not a salient cause of arousal, and they are not seen by people as the inducing condition (Anderson 1989). High levels of arousal have been shown to decrease an individual’s capacity to process a persuasive message (Sanbonmatsu and Kardes 1988).

The term arousal is used in Sanbonmatsu and Kardes’ research to refer to a state involving nonspecific physiological activation and a nondirectional component of alertness. According to Sanbonmatsu and Kardes (1988), physiological arousal can range from sleep at the extreme low end, up to great excitement or panic. More specifically, they use the term arousal to denote a hypothetical construct representing the net result of a variety of processes that mediate activation, alertness and wakefulness. For the purpose of the current study, this physiologically activated state due to hot ambient temperatures may induce different decision outcomes.

There is mounting evidence that impulsivity is related to arousal (e.g., Bowyer, Humphreys, and Revelle 1983; Campbell 1992; Frcka and Martin 1987; Loo 1980; O’Gorman
and Lloyd 1987; Revelle et al. 1980; Stenberg 1992). In order to minimize the effect of arousal on processing capacity and impulsive behavioral tendencies, arousal levels must be maintained constant across temperature conditions.

An Alternative Explanation of Physiological Thermoregulation Responses

Does high ambient temperature trigger impulsive behaviors due to physiological responses caused by thermoregulation processes in human beings? To answer this question clearly, we have to measure the participants’ body temperatures before and after exposure to the manipulated temperature, and demonstrate that the post-exposure body temperature significantly deviates from normal body temperature (e.g., 36.5 degrees Celsius).

One prominent characteristic of thermoregulation is the capability of body to regulate its temperature at different levels, as in situations of fever, hibernation and exercise. In other words, although external thermal factors (i.e., ambient temperature) may influence thermoregulation in human beings, the homeostatic tendency of our body system can prevent our body temperature from deviating away from its normal temperature (Parker and Tavassoli 2000).

However, perceived temperature itself may not be the same as our actual body temperature. Note that being aware of, or perceiving a certain temperature level as hot or cold is not always accompanied by changes in body temperature, which might result in certain physiological responses.
The ideas put forth here relating temperature to impulsivity via neural and hormonal systems must be viewed as tentative. Thermoregulatory theory is far too complex to be able to clearly explain the relationship between temperature and impulsivity, and understanding testable predictions concerning the shape of temperature-impulsivity effects is outside the scope of this research. In addition, it is hard to prove or disprove this alternative explanation based on physiological perspectives in a given experimental setting. Therefore, the purpose of this section is only to suggest that there may be important physiological-thermoregulatory effects underlying ambient temperature effects on impulsive behavior.

First, consider the basic effects of hot and cold on a variety of physiological systems. Exposure to hot temperatures generally produces the following effects: increased heart and respiration rates, deeper respiration, increased blood circulation, slight decrease in heart stroke volume, skin blood vessel dilation, sweating, decrease in thyroid-stimulating hormone and consequent decrease in basal metabolic rate, and increase in galvanic skin response (GSR) and skin conductance (Anderson 1989).

Exposure to cold produces a considerably shorter list of known effects: increase in heart stroke volume and consequent increase in circulation rate, shivering, vasoconstriction, increased blood pressure, increase in thyroid-stimulating hormone and cortisone (via pituitary control over the thyroid and adrenal cortex), and increase in epinephrine and norepinephrine (via the adrenal medulla). These last three hormones are all controlled to some extent by the hypothalamus, which is central in thermoregulation and serves to increase basal metabolism.

While the critical locus of thermoregulation is the hypothalamus (Mekjavic and Eiken 2006), temperature-sensitive systems are found elsewhere (Anderson 1989), especially in the
upper spinal cord (Bligh 1973). Temperature-sensitive cells are connected both directly (i.e., neurally) and indirectly (i.e., hormonally) to a variety of systems that control a range of bodily and emotional functions.

The primary neurotransmitters involved in thermoregulation are norepinephrine, epinephrine, serotonin, and acetylcholine. When the first two are released in the hypothalamus (especially the preoptic region), a variety of events occur that lead to decreases in core body temperature. In contrast, when serotonin and acetylcholine are released in the hypothalamus, they trigger events yielding increases in body temperature. Notably, the role of the serotonergic system in modulating premature and impulsive responses is recognized in both clinical (Linnoila et al. 1983) and preclinical literature (Soubrié 1986). It is possible that temperature effects on impulsive behaviors can be explained as a result of such linkages. Although these links may be related to the temperature-impulsivity hypothesis given that many of the same neural and hormonal systems that regulate body temperature are also related to impulsivity, the linkages are not simple and transparent.

In sum, it may be worth examining the neural interconnectedness of a variety of structures linked to thermoregulation and impulsive behaviors, including hypothalamus, amygdala and hippocampus. These human body systems are complex and there is currently a limited amount of research on relevant psychological processes. One of the limitations of the current research is that it does not further explore this alternative explanation. As long as the ambient temperature is used as a main independent variable, we should consider its complex interactions with biological mechanisms of the human body. However, given the limitation of
these field studies, I was not able to investigate other possible effects of ambient temperature on human body systems.

The above discussion suggests that there can be several alternative explanations regarding the impact of ambient temperature on impulsivity. I conducted two field studies on an exploratory basis, in order to examine the relationship between ambient temperature and impulsivity. The following field studies demonstrate that hot ambient temperature can trigger impulsive behaviors. Furthermore, I found that this effect is not driven by arousal or mood.

Field Study 1

In order to explore the link between ambient temperature and impulsive behaviors, I conducted a field study at a spa in Seoul, South Korea. Forty-four participants were recruited at the spa, and were compensated with souvenir gifts. The spa had rooms varying in temperature, and two rooms were selected; one hot and one cold. As explained in the earlier laboratory experiments, the cold condition was employed for comparison purposes. The reason that I did not include the neutral temperature condition in my field studies was because there was no temperature-neutral room at the spas. Also, in my field studies, I was not able to randomly assign the participants, which is a potential threat to the validity of the study especially when I interpret the observed effects.

The temperatures of the hot and cold rooms were 40°C – 50°C and 10°C, respectively. For three product categories (travel package, birthday dinner, and cell phone), participants in each
room were asked to indicate their willingness to pay on a seven-point scale anchored by amounts in the Korean currency, Won (KRW), divided by 10,000. The seven-point scale ranged from low to high prices, (travel package: KRW 40–100; dinner: KRW 2–8; cell phone: KRW 20–50). For example, for the travel package, the willingness to pay question presented participants with a seven-point scale (Nelson and Simmons 2009) anchored at 40 on the low end, and then increasing in increments of 10 to 100.

Next, participants were asked to fill out a questionnaire regarding their spa usage habits (frequency of visit, average hours per visit, and preference for room temperature). All participants in each room had spent at least 10 minutes in it before answering the questions. This was to ensure that they had adapted to the particular room temperature (i.e., hot or cold).

The willingness to pay for the three products was consistently higher in the hot room ($M_{travel\ package} = 88.57$, SD = 11.53; $M_{dinner} = 6.00$, SD = 1.41; $M_{cellular\ phone} = 43.33$, SD = 8.42) than in the cold room ($M_{travel\ package} = 70.43$, SD = 11.47; $M_{dinner} = 3.96$, SD = 1.02; $M_{cellular\ phone} = 37.39$, SD = 7.05). These differences were statistically significant [travel package, $t(42) = 5.23$, $p < .001$; dinner, $t(42) = 5.53$, $p < .001$; cellular phone, $t(42) = 2.55$, $p < .05$]. The results of the pilot study support my prediction that consumers exposed to hot ambient temperature as opposed to cold temperature might behave more impulsively.
Field study 2

The purpose of field study 2 is three-fold: (1) to demonstrate the link between hot–impulsivity more thoroughly by adding choice tasks, (2) to rule out mood or arousal as an alternative explanation for the temperature effects on judgment and choice, and (3) to test whether or not the temperature-impulsivity relationship shows a monotonically increasing pattern. In order to test this relationship, I added an extremely hot temperature condition, in which the mental associations between concepts (hot and impulsivity) could be suppressed by the unpleasantness of the extreme temperature.

Although I did not measure comfort, I measured the pleasantness of temperature. I expect that unpleasant room temperatures will result in discomfort. I therefore test whether the pleasantness of the room temperatures will be significantly lower in the “extremely hot” room than in the other two rooms (i.e. cold and hot). With the exception of the “extremely hot” condition in field study 2, there was no significant difference in terms of the pleasantness of room temperatures between the hot and cold conditions in any of the experiments. With this in mind, I test whether an extremely hot temperature can mitigate the effects of temperature associations, reducing the degree of impulsivity associated with hot temperature. The related hypothesis is as follows:

\[ H_3: \] Individuals are more likely to be impulsive in a hot temperature condition than in a cold temperature condition, resulting in a greater impulsivity across behavioral
domains. However, impulsivity will not monotonically increase as a function of temperature when the given temperature is not pleasant, thus will show an inverted U-shaped curve.

**Participants, Design, Stimuli, and Procedure.** I conducted this field study at a similar spa to that in field study 1, also in Seoul, South Korea. Ninety-seven participants were recruited at the spa, and were compensated with souvenir gifts. The spa had rooms varying in temperature, and three different rooms were selected—cold, hot, and extremely hot. As in field study 1, there was no random assignment of participants to the conditions. I was not able to add an “extremely cold” condition, simply because there was no such room in the spa. The temperature of the cold room was around 10°C, and the hot room’s temperature was 40°C – 50°C. The temperature in the extremely hot room was 80°C.

The stimuli and procedure for field study 2 were similar to those of field study 1. First, I asked participants to make a choice between a more impulsive, smaller-sooner (SS) reward of a KRW 50,000 gift certificate now and a less impulsive, larger-later (LL) reward of a KRW 100,000 gift certificate in six months. Afterwards, participants were asked to freely indicate their willingness to pay for a home theater system.

Finally, I asked participants to 1) estimate the perceived room temperature (in degrees Celsius), 2) indicate the pleasantness of the room temperature on a seven-point scale anchored at 1 (not pleasant at all) to 7 (very pleasant), and 3) indicate their mood (bad–good, disappointed–satisfied, sad–happy) and 4) level of arousal (calm–excited, tired–energetic, sedated–aroused) on a 17-point scale ranging from -8 to 8 (Salovey and Birnbaum 1989).
Results and Discussion. The eventual sample size was 90 participants, as seven were removed for not adequately following instructions. Particularly, I eliminated observations from participants who answered less than half of the questions, assuming that their minimum involvement level for answering the questions was not adequate. Participants’ estimations of the room temperature in the three rooms were significantly different ($M_{\text{cold}} = 14.6^\circ\text{C}, \text{SD} = 8.40$; $M_{\text{hot}} = 33.4^\circ\text{C}, \text{SD} = 9.34$; $M_{\text{extremely hot}} = 43.1^\circ\text{C}, \text{SD} = 9.24$; $F(2, 87) = 79.15$, $p < .01$).

However, there was a significant main effect of temperature on the pleasantness of the room temperature ($F(2, 84) = 7.43$, $p < .01$). Participants who were in the hot room and the cold room indicated similar pleasantness of room temperatures ($M_{\text{hot}} = 4.31$, $\text{SD} = 1.29$ vs. $M_{\text{cold}} = 4.65$, $\text{SD} = 1.45$; LSD, $p > .30$), while the pleasantness of the room temperature in the extremely hot room ($M_{\text{extremely hot}} = 3.37$, $\text{SD} = 1.25$) was significantly lower than in both the hot (LSD, $p < .01$) and cold rooms (LSD, $p < .01$).

Regarding choice data, binary logistic regression analysis showed that temperature influenced the choice between SS reward and LL reward ($\chi^2(2) = 8.51$, $p < .05$). As predicted, participants in the hot room were more likely to choose the SS reward (21 out of 29, 72.4%) than the LL reward (8 out of 29, 27.6%). In contrast, in the cold condition, more participants chose the LL reward (20 out of 31, 64.5%) than the SS reward (11 out of 31, 35.5%) [$\chi^2(1) = 8.21$, $p < .01$]. Next, I analyzed the other two pairs (i.e., hot vs. extremely hot: $\chi^2(1) = 1.60$, $p > .20$, and cold vs. extremely hot: $\chi^2(1) = 2.76$, $p < .10$). Although temperature (actual and perceived) was significantly higher in the extreme hot condition compared to the hot condition, participants were not more likely to choose the SS reward over the LL reward. However, the
choice probability of the SS reward over the LL reward was marginally higher ($p = .097$) in the extreme hot condition than the cold condition. These findings lend support to the notion that impulsive choice tendency does not monotonically increase as actual temperature increases from hot to extreme hot.

I found a significant main effect of temperature on willingness to pay for the home theater system ($F(2, 87) = 3.93, p < .05$). To conduct this analysis, participants' willingness to pay were divided by 1,000 to make them roughly equivalent to the amount of (Canadian) dollars. Specifically, participants reported a higher willingness to pay in the hot room ($M = 1,555, SD = 204$) than in the cold room ($M = 899, SD = 197$; LSD, $p < .05$). In addition, the willingness to pay in the hot room ($M = 1,555, SD = 204$) was significantly higher than in the extremely hot room ($M = 827, SD = 201$) (LSD, $p < .05$), which is consistent with hypothesis 3. There was no statistically significant difference between the cold room ($M = 899, SD = 197$) and the extremely hot room ($M = 827, SD = 201$) in terms of willingness to pay (LSD, $p > .8$). For this willingness to pay measure, the temperature-impulsivity relationship did not reveal a monotonically increasing pattern but showed an inverted U-shaped pattern.

To analyze differences in mood and arousal, I compared the average score of the three mood items (Cronbach $\alpha = .90$) and arousal items (Cronbach $\alpha = .56$) across the three conditions. I found a significant main effect of temperature on mood ($F(2, 86) = 3.74, p < .05$). Consistent with the results of the pleasantness measure, participants indicated a more positive mood in the hot and cold rooms ($M_{hot} = 2.05, SD = 2.87$ vs. $M_{cold} = 1.91, SD = 2.44$) than in the extremely hot room ($M = .32, SD = 2.80$). The mood scores between the hot and cold rooms were not significantly different (LSD, $p > .80$) while the differences between the hot and extremely hot
rooms (LSD, $p < .05$), and the cold and extremely hot rooms (LSD, $p < .05$), were significantly different. There was no significant difference of temperature on arousal ($M_{hot} = -1.02$, SD = 3.05; $M_{cold} = -1.1$, SD = 2.59; $M_{extremely hot} = -.96$, SD =2.18; $F(2, 86) = .01, p > .90$). The concept of hot (vs. cold) is more likely to activate concepts such as sunny and warm. In a spa environment, however, participants may not have activated other associations of hot because the ambient room temperatures are directly manipulated. This indifferent mood effect between the hot and cold rooms is not consistent with the research that has demonstrated that sunny weather is associated with positive moods (Schwartz and Clore 1983).

These findings about willingness to pay and mood are consistent with previous research. According to Griffitt (1970), very high ambient temperature is associated with negative assessments of mood and with less favorable ratings of anonymous others. If these findings can be generalized to product evaluations, they suggest that comfortable settings may enhance merchandise evaluations (Gardner 1985). In the extremely hot room, participants felt that the room temperature was not pleasant and indicated that they were in a relatively poorer mood, which may explain why the willingness to pay for the target product was significantly lower than in the hot room. The unpleasantness experienced in an extremely hot spa room could be related to discomfort. As discussed, participants reported that the room temperature was significantly unpleasant in the extremely hot spa room. This unpleasantness of the room temperature can cause discomfort. In other words, pleasant temperature is a prerequisite for comfort. This suggests that in extreme and unpleasantly hot temperatures, the metaphoric association between the concept of hot and impulsivity may disappear.
Finally, I tested the validity of an alternative explanation that mood or arousal can covary with the effect of actual temperature on choice and judgment. I conducted an ANCOVA using the mood score as a covariate, and mood did not turn out to be affecting willingness to pay \( F(1, 85) = .55, p > .40 \). Moreover, arousal did not turn out to be a significant covariate either \( F(1, 85) = .24, p > .60 \). These results show that the effect of ambient temperatures (cold vs. hot) on impulsive behaviors was not due to the change in mood or arousal level. My ANCOVA results showed that mood or arousal did not play a role as covariates across the three conditions. The null effect seems to be due to the indifference between cold and hot in terms of mood or arousal level. When I compared mood, arousal and pleasantness of the room temperatures across the three conditions, only the extremely hot condition was significantly less pleasant than the other two rooms.

In conclusion, these findings indicate that incidental mood and arousal triggered by changes in temperature (hot and cold) are not likely to induce the observed differences in impulsive behaviors. Furthermore, impulsivity does not seem to monotonically increase as ambient temperature increases from hot to extremely hot. Rather, impulsive behavioral tendencies may be mitigated by the unpleasant feelings experienced in an extremely hot room. In this case, impulsivity shows an inverted U-shaped curve as temperature increases from cold to extremely hot.
CHAPTER 9

GENERAL DISCUSSION AND CONCLUSIONS

Summary of Findings

The current thesis examines the influence of priming temperature on judgment and decision making. Specifically, I found that temperature primes may or may not have an influence on decision outcomes, possibly due to the link between temperature concepts and impulsivity. Second, the simultaneous experience (activation) of hot and cold temperature concepts negate the effects of temperature primes. This is in line with the current conceptual framework: if the cognitive association between hot and impulsivity is not strong enough due to distraction or interference by other associations (i.e., cold-calculated link), the activation of the concept of hot would not yield impulsive behaviors. Third, the effect of hot temperature primes is not mediated by individuals actually feeling hot, their moods or states of arousal. I actually conducted all possible mediation analyses with potential mediators; however, none of them mediated the effect of temperature primes on impulsive behaviors (i.e., felt and perceived temperatures, mood, and arousal). In every experiment, with the exception of experiment 2, none of the preconditions (the effect of the independent variable on hypothesized mediators) were satisfied. I proposed that the theories of embodied cognition offer a conceptual framework to explain the results obtained in the four experiments reported in this research. The common misunderstanding about “embodied
cognition” is that bodily states are necessary for cognition and that researchers focus heavily on bodily states in conducting research. However, according to Barsalou (2008), “cognition often proceeds independently of the body, and many researchers address other forms of grounding. Grounded cognition reflects the assumption that cognition is typically grounded in multiple ways, including simulations, situated action, and on occasion, and bodily states.” (p. 619). In my thesis, I take a broader meaning of embodied cognition, or grounded cognition as Barsalou suggested. Thus, in the current thesis, I focus more on the simulation of the bodily sensation (i.e., primed temperature concept), which can be also explained by embodied (or grounded) cognition.

Table 9.1 shows an overview of the four laboratory experiments. Some supporting evidence was found for the effects of temperature primes on impulsivity using 1) scrambled sentence tasks (experiments 1 and 4), 2) slideshows of seasonal pictures (experiment 2), 3) therapeutic packs as physical primes (experiment 3), and 4) a lexical decision task to prime temperature concepts subliminally (experiment 4). I tested the metaphoric link between heat and impulsivity using various concepts of impulsivity, including willingness to pay (experiments 1, 2 and 4), impatience (experiments 1, 2, and 4), risk taking (experiment 2 and 4), and errors made in questions designed to identify an impulsive problem solving process (experiments 3 and 4).

Furthermore, I tested whether individuals’ actual feeling of hot can be a plausible mediator of the causal relationship between the concept of hot and impulsive behaviors (experiment 4). However, I did not find any evidence that the actual feeling of hot mediates the observed effects. I have evidence that hot temperature primes can induce impulsive behaviors as opposed to cold temperature primes or neutral primes. In other words, the results suggested that mere priming of ‘hot’ can induce impulsive behaviors without participants’ actually feeling hot.
This provided evidence consistent with the existence of a cognitive association between the concept of hot and impulsivity yield decision outcomes in line with the association. In sum, participants in the hot (vs. cold or neutral) condition indicated a higher willingness to pay for some target products and sometimes were more likely to choose relatively impulsive options such as a smaller–sooner (SS) reward, a risky gamble, or an incorrect answer to the target problem.

### TABLE 9.1 AN OVERVIEW OF EMPIRICAL TESTS

<table>
<thead>
<tr>
<th>Study</th>
<th>Temperature manipulation</th>
<th>Design (between-subjects)</th>
<th>DV</th>
<th>Products (Stimuli)</th>
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<tbody>
<tr>
<td>1</td>
<td>Scrambled sentence task</td>
<td>Two temperature conditions (hot/cold)</td>
<td>WTP/Choice</td>
<td>Dinner/Bank term deposits</td>
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<td>2</td>
<td>Photographs taken in summer and winter</td>
<td>Two temperature conditions (hot/cold)</td>
<td>WTP/Choice</td>
<td>Dinner, cellular phone/Bank term deposits/Gambles</td>
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<td>3</td>
<td>Therapeutic packs on participants’ arms</td>
<td>Four temperature conditions (hot/cold/hot &amp; cold/control)</td>
<td>% Errors</td>
<td>Bat-and-Baseball problem</td>
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<tr>
<td>4</td>
<td>Scrambled sentence task Lexical decision task</td>
<td>3 temperature conditions (hot/cold/neutral) X 2 Priming type (subliminal/supraliminal)</td>
<td>WTP/% Errors</td>
<td>Pleasure vs. Necessity/Bat-and-Baseball problem</td>
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<tr>
<td>Field 1</td>
<td>Room temperature in a spa</td>
<td>Two temperature conditions (hot vs. cold)</td>
<td>WTP</td>
<td>Travel package, dinner, cellular phone</td>
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<tr>
<td>Field 2</td>
<td>Room temperature in a spa</td>
<td>Three temperature conditions (hot/cold/extremely hot)</td>
<td>WTP/Choice</td>
<td>Home theater/Gift certificates (SS vs. LL)</td>
</tr>
</tbody>
</table>
As I discussed in the earlier chapters, I was not able to replicate some of results with different product categories and dependent variables (e.g., WTP for the travel package in experiments 1 and 2; WTP for the home theater and the vacuum cleaner in experiment 4). Furthermore, some findings were of marginal significance rather than robust findings. Although the findings in the current thesis did not always consistently support my hypothesis, this research nonetheless demonstrates that the priming of hot temperature concepts can induce impulsive behaviors, which can be another example of the notion of embodied cognition. However, the unexpected results clearly deserve further investigation.

Temperature, Judgments, and Choice

The current research contributes to the understanding of the influence of priming temperature concepts on judgment and choice. First, recent work on the effect of temperature and weather has focused on actual temperature and its direct consequences (mood, cognition, and behaviors). The findings in this research take this insight a step further by demonstrating a link between temperature concepts and impulsivity.

Second, my findings complement studies on the relationship between physical temperature and personality evaluation (Williams and Bargh 2008). Williams and Bargh (2008) demonstrated that incidentally touching warm or cold objects (i.e., actual experience of temperature) influences the assessment of traits in other people. I demonstrate that both actual experiences of temperature and temperature primes (simulations of physical temperature
experience) can influence subsequent choices and judgments outside of the social domain. These findings are consistent with the theories of embodied cognition—processing of abstract concepts involves embodiment, where embodiment refers both to actual bodily states and simulations of experience in the brain’s modality-specific systems for perception, action, and introspection (Neidenthal et al. 2005). Although I found supporting evidence that can be explained by the notion of embodied cognition, I acknowledge that not all my findings are consistent with the theories of embodied cognition.

Third, the current research contributes to the understanding of the concepts of impulsivity. While previous studies on consumer impulsivity have largely focused on the dispositional factors of consumers (Rook and Fisher 1995), episodic experiences (Hirschman 1992; Rook 1987), and underlying motivational states (Li 2008), the present research highlights the temperature–impulsivity association as a driver for consumers’ impulsive behaviors. By doing so, the current research proposes a new route through which consumers’ impulsivity can be activated.

Finally, I incorporate various operationalizations and their measures of impulsivity across different disciplines to provide support for the hot–impulsivity association. Existing literature on impulsivity has almost exclusively focused on its behavioral consequences with regard to intertemporal choices, and therefore mostly dealt with the inability to delay gratification (Ainslie 1975; Metcalfe and Mischel 1999; Rachlin and Green 1972). The current research, however, implies that impulsivity may be related to a broader range of consumer behaviors (e.g., higher willingness to pay, risk taking, and reliance on intuition, etc.) than just the inability to delay gratification.
Practical Implications

The results have practical implications for packaging, advertising, merchandising, and pricing of goods and services, as well as for public policy and awareness. Many forms of marketing communication such as packaging, advertisements, and promotions can be presented to consumers with different associations of temperature. For instance, pictures of summer or hot-temperature related content (e.g., beach, sunshine, red color) in ads or on packaging might prompt a consumer to choose a more expensive brand or product.

In addition, the type of product or service that companies provide would result in different marketing strategies. If the product or service is more hedonic or pleasure oriented, as the findings of experiment 4 suggest, hot temperature associations are more effective in inducing consumers’ impulsive buying intentions. In real world settings, however, there may be other factors that interact with primed temperature to influence impulse purchase. Field studies employing stimuli with temperature associations seem warranted before we can draw conclusions regarding the effectiveness of the temperature primes as marketing stimuli.

Finally, the findings from the current research have important implications for public policy. Public advertising intended to reduce the usage level of illegal drugs or cigarettes, to give warning signals, often use colors (e.g., red) or words (e.g., ‘could burn your head’) that may activate the hot temperature association. These advertisements may have unintended consequences, such as promoting rather than preventing the use of illegal or dangerous substance because the temperature-related association might induce impulsivity which in turn would make consumers engage in undesirable behaviors with perceived immediate benefits. Thus, it may be
important to reconsider pictures or words that are related to hot temperatures in such
advertisements, in order to avoid undesirable consequences.

Limitations and Future Research Directions

First, I did not include a control condition in several experiments. For example, in
Experiments 1 and 2, I introduced the cold priming condition for comparison purposes instead of
adopting a temperature neutral priming condition, because the focus of my research was to
investigate the hot-impulsivity link. In Experiment 3, I included a control condition to determine
that the cold condition is not significantly different from the control condition. People were more
impulsive in the hot than in the control condition, while no difference was found between the
cold and control conditions or between the mixed (i.e., hot-cold) and control conditions. Also
note that the control condition of experiment 3 is flawed in that participants should have
experienced room temperature packs.

Second, with regard to the choice data, participants’ laziness or low involvement in the
task could be an alternative explanation to that of impulsivity. In binary choice tasks (e.g., one-
year vs. three-year, and SS vs. LL) from the experiment 1 to 3, except for the gamble choice,
impulsivity-related options were presented on the left side. Assuming that participants are likely
to see the option on the left side first, one might argue that the higher choice probability of the
impulsive options in the hot condition might be due to laziness or low involvement. Although I
did not counterbalance the questionnaires in experiment 4, I always presented the impulsive
option on the right side. This is a more conservative test by ruling out the possibility that the higher choice share of the impulsive option in each pair is due to participants’ laziness. Laziness may cause participants to choose the left-sided option without considering the right-sided one. In future research, counterbalancing the order of choice options is needed to rule out this alternative explanation.

Third, although I found that the psychological response of arousal did not affect willingness to pay and choices, one might argue that such a self-reported measure of arousal could not capture the sensitive change in participants’ arousal states. Previous research also supports this concern, stating that a change in arousal states is normally unaccountable by a person’s conscious awareness, and hence self-reported measures do not correlate with physiological measures (Li 2008). To test the physiological response, future research may need to include a more reliable measure such as skin conductance responses (Khalfa et al. 2002; Lang et al. 1993).

Fourth, in this research, I did not directly test the effect of cognitive association between temperature and impulsivity on impulsive behaviors. One way to directly test for the effect would be to strengthen the association through the rehearsal of word pairs such as hot/desire or hot/urge and see if the effect gets stronger. The enhanced cognitive association may result in more impulsive behavior tendencies.

Fifth, metaphors have been typically considered unidirectional (Bargh 2006; Lakoff and Johnson 1980): concepts learned earlier in life, such as heat, should prime more abstract concepts such as impulsivity. However, recent research suggests that abstract concepts (e.g., social isolation and moral purity) can activate concrete concepts (coldness of room temperature and
bodily purity) (Zhong and Leonardelli 2008; Zhong and Liljenquist 2006), in contrast to earlier research. Given the fact that some metaphor relationships are bidirectional, the results of the current thesis can be extended by testing the existence of an ‘impulsivity-hot’ link. In other words, it is worth testing whether individuals’ impulsive behaviors can cause them to feel hot.

In conclusion, given that temperature is such a pervasive part of our daily lives, the temperature effects reported in this research are operative in a variety of consumer contexts. At the same time, this thesis raises several important questions for future research. The answers to these questions are crucial in gaining a more comprehensive understanding of the effects of temperature and related concepts on consumer behavior and marketing in general.
APPENDIX 1. QUESTIONS: EXPERIMENT 1

If you were now going to open a bank term deposit, which would you choose
1-year term (  ) 3-year term (  )
(* Assume that interest rates are constant during the term)

Suppose that you are planning on a short trip (3 nights and 4 days) to Tokyo. How much are you willing to pay for it including a round-trip flight ticket?
40-------50-------60-------70-------80-------90-------100 (unit: 10,000KRW=10 CAD)

Suppose that you are planning on going out to have a dinner on your birthday. How much are you willing to pay per person?
2-------3-------4-------5-------6-------7-------8 (unit: 10,000KRW=10 CAD)
APPENDIX 2. QUESTIONS: EXPERIMENT 2

If you were now going to open a bank term deposit, which would you choose
1-year term ( )       3-year term ( )
(* Assume that interest rates are constant during the term)

If you were to pick one gamble between the two, which one is more attractive to you?

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<th>Gamble A ( )</th>
<th>Gamble B ( )</th>
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<td>Chance of winning 0.8</td>
<td>Chance of winning 0.2</td>
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Suppose that you are planning on buying a new cell phone. How much are you willing to pay for it?
$200--------$250--------$300--------$350--------$400--------$450--------$500

Suppose that you are planning on going out to have a dinner on your birthday. How much are you willing to pay per person?
$20--------$30--------$40--------$50--------$60--------$70--------$80

Suppose that you are planning on a short trip (3 nights and 4 days) to New York City. How much are you willing to pay for it including a round-trip flight ticket?
$400--------$500--------$600--------$700--------$800--------$900--------$1000

After you saw the slideshow of scenic pictures, now you feel (Please check the following items)

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APPENDIX 3. QUESTIONS: EXPERIMENT 3

- What do you think is the temperature in this room? ______ degrees Celsius
- How pleasant do you find this temperature on a scale from 1 (very unpleasant) to 7 (very pleasant)?

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How do you feel right now? (Please check the following items)

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APPENDIX 4. QUESTIONS: EXPERIMENT 4

Please answer each of the following questions.

1. Please choose between the following two gift certificates.  
   (Please √ your selected option)
   
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<thead>
<tr>
<th>Option 1 (     )</th>
<th>Option 2 (     )</th>
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<tbody>
<tr>
<td>You can get an Amazon.com $75 Gift Card in a year</td>
<td></td>
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<tr>
<td>You can get an Amazon.com $50 Gift Card now</td>
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2. Which gamble would you prefer playing?  
   (Please √ the gamble of your choice)
   
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<tr>
<th>Gamble A (     )</th>
<th>Gamble B (     )</th>
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<tbody>
<tr>
<td>80% of winning $50</td>
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<tr>
<td>20% of winning $0</td>
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<tr>
<td>20% of winning $200</td>
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<tr>
<td>80% of winning $0</td>
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3. Conakry is the capital of French Guinea. True or False?  
   (Please indicate your answer by √ either “True” or “False”)
   (     ) True (     ) False

4. A bat and baseball cost $1.10 in total. The bat costs $1 more than the ball.  
   So, the ball costs 10 cents. True or False?  
   (Please indicate your answer by √ either “True” or “False”)
   (     ) True (     ) False

5. Please imagine that you are going to buy a home theater system.  
   What is the maximum amount that you are willing to spend on it? $________

6. Please imagine that you are going to buy a vacuum cleaner.  
   What is the maximum amount that you are willing to spend on it? $________

7. How much are you willing to spend on **pleasure and entertainment** (like going to concerts, movies, sports games, buying CDs, DVDs, Video Games, going to clubs, etc.) in April?  
   (     ) (     ) (     ) (     ) (     ) (     ) (     )

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8. How much are you willing to spend on **necessary household goods** (like paper towels, toilet paper, cleaning detergents, garbage bags, etc.) in April?  
   (     ) (     ) (     ) (     ) (     ) (     ) (     )

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**Information for the Building Manager**

- How do you feel right now? (Please circle a number)

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- How pleasant do you find the current temperature? (Please circle a number)

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<td>Very unpleasant</td>
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- Please estimate the current temperature in this room (and indicate the scale by circling Celsius or Fahrenheit)?

_______ Degrees Celsius / Fahrenheit
REFERENCES


*American Psychologist*, 49 (8), 709-24.


and Treatment*, eds., William G. McCown, Judith L. Johnson, and Myrna B. Shure

Position in a Dimensional System of Personality Description,” *Psychological Reports*, 43
(3), 1247-255.

Frcka, Gertrude and Irene Martin (1987), “Is There—or Is There Not—An Influence of
Impulsiveness on Classical Eyelid Conditioning?” *Personality and Individual Differences*,
8 (2), 241-52.


Miller, Joshua, Kate Flory, Donald Lynam, and Carl Leukerfeld (2003), “A Test of Four-Factor Model of Impulsivity-Related Traits,” *Personality and Individual Differences*, 34 (8), 1403-418.


The American Heritage Dictionary of the English Language, 2000