THE WARMTH OF YOU, THE WARMTH IN ME: THE EFFECT OF PARTNER PRESENCE AND ABSENCE ON THE PERCEPTION OF PHYSICAL WARMTH

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THE WARMTH OF YOU, THE WARMTH IN ME: THE EFFECT OF PARTNER PRESENCE AND ABSENCE ON THE PERCEPTION OF PHYSICAL WARMTH

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An important construct that has long been associated with feelings of social connectedness, interpersonal closeness, and security is warmth. In everyday language, phrases such as "warm embrace" are often utilized in situations where social connections are of interest, and words of similar nature are also used to describe personality traits. Although a growing body of empirical research has consistently demonstrated that physical warmth is closely linked to social intimacy and proximity, extant research has not examined whether the presence of romantic partners is similarly associated with physical warmth. The studies presented in this dissertation were the first ones to investigate the link between romantic partner presence and perception of physical warmth and reveal that imagining romantic partner presence or absence altered thermal perceptions. Across five studies, it was consistently found that simply imagining being together with the partner was associated with feelings of warmth, whereas imagining being separated from the partner was associated with feelings of coldness. Moreover, thinking about partner absence (vs. partner presence or a control scenario) was associated with a greater desire for warm activities potentially to compensate for the feelings of coldness. Together, these findings extend the consistent findings on the link between social and physical warmth to romantic relationships and provide further evidence for the regulatory role of romantic relationships and the robust link between physical warmth and interpersonal affection.

BIOGRAPHICAL SKETCH

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DEDICATION

To Durul, Defne, and Muzaffer

Thank you for being my endless source of warmth.

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INTRODUCTION: An Overview

"The presence of my girl; the noises and the smells and the warmth of her in the room." -- A participant describing what he would miss while being separated from his partner.

Human beings are inherently driven by a desire to build and maintain interpersonal relationships (Bowlby, 1969, 1973). In addition to being critical for survival early in life, interpersonal relationships also make individuals feel and function better. As such, it is important to identify factors that encourage, enhance, or disrupt interpersonal relationships. One such factor that has long been associated with interpersonal affection is warmth. A growing number of empirical studies indicate that the bidirectional link between physical warmth and social affiliation is quite robust. While cues of physical warmth motivate people to socially connect (e.g., Fay & Maner, 2012), the availability of social connections makes individuals feel warmer (e.g., Inagaki & Eisenberger, 2013). Conversely, cues of physical coldness enhance feelings of loneliness (Bargh & Shalev, 2012), whereas the unavailability of social connections (e.g., being excluded) causes individuals to estimate the ambient temperature to be colder.

Moreover, research conducted with animals and human newborns has shown that physical warmth has an important regulatory function in attachment bonds (e.g., Gray, Lang, & Porges, 2012; Gray ,Watt, & Blass, 2000; Harlow, 1958; Hofer, 1987). Social thermoregulation theory suggests that proximity to close others (both in infancy and adulthood) help individuals maintain thermoneutrality (i.e., temperature-specific homeostasis) and thus contribute to health and well-being of one another by reducing energy consumption and achieving metabolic efficiency (Beckes, IJzerman, & Tops, 2014; IJzerman et al., 2015). It is recently suggested that the repeated association between physical warmth and affection, necessitated by the critical need for thermoregulation in infancy, forms an initial mental template of the link between physical

warmth and interpersonal relationships, onto which later knowledge structures are scaffolded and used as an embodied model for monitoring and making sense of social connections (IJzerman et al., 2015; IJzerman & Koole, 2011; Williams, Huang, & Bargh, 2009). That is, the availability of momentary social resources - derived from social connections - might affect how individual perceive their environments thermally and their corresponding cognitive, psychological, and physiological responses.

The aim of the present dissertation was to examine the link between romantic partner presence and perception of physical warmth. Despite the overwhelming evidence pointing to the link between social connections, affection, and physical warmth, there is surprisingly little research investigating the association between romantic partners and physical warmth. To date, it has not been explored whether romantic partners are perceived as a source of warmth and whether their presence (or absence) could regulate warmth-related perceptions and behaviors. The studies presented here were designed to close this gap by seeking answers to these questions. Chapter 1 outlines in detail the theories and empirical findings that guide the present research. Chapter 2 covers Studies 1-3, which sought to examine whether romantic partners are perceived as a source of warmth by looking at the variations in thermal perceptions as a response to imagining romantic partner presence or absence. Chapter 3 includes Studies 4 and 5, which examined whether individuals' interest in warm activities changes as a response to the imagined presence or absence of their romantic partners. Finally, Chapter 4 provides a general discussion of the findings reported in Chapters 2 and 3 and outlines some directions for future research.

CHAPTER ONE

"I imagined being curled up with him. I thought about how much I enjoyed his scent. We probably would be laughing at something ridiculous, because it seems that we always are. Thinking about it brings feelings of warmth and contentment." -- A participant describing her thoughts as she was imagining her partner's presence

The concept of warmth has long been associated with social connections and interpersonal affection. In everyday language, words used to describe social connections often include references to warmth (e.g., warm embrace, cold shoulder). Similarly, warmth is often used in person perception (Asch, 1946) and considered to be a universal dimension of social judgment (Fiske, Cuddy, & Glicke, 2007). For instance, when a person is described as warm, it is immediately understood that this person is social, friendly, and generous.

This overlap could be an indication of how people make sense of more abstract constructs and conceptualize their internal worlds by making analogies to the physical world (see Barsalou, 2008; Landau, Meier, & Keefer, 2010; Williams, Huang, & Bargh, 2009, for reviews). According to the embodiment theory, concepts that are related to the physical world such as size, distance, or temperature are formed in early childhood based on direct concrete experience and are later used to understand more complex interactions. Therefore, it is suggested that the notions of affection and warmth become conflated through repeated concurrent experiences of physical warmth and affection in early childhood (Lakoff & Johnson, 1980). Later knowledge structures are scaffolded onto this initial knowledge about relationships and used as an embodied model for monitoring and making sense of social connections (IJzerman & Koole, 2011; Williams et al., 2009).

1.1. The significance of warmth

Physical warmth is essential for human survival. As homeotherms, human beings need thermal comfort to exist (Van de Vliert, 2013). Panksepp (1998) describes bodily warmth as one of the most essential social stimuli that fosters social bonding. Indeed, findings from Harlow's (1958) experiments on rhesus monkeys provide support for this suggestion. The studies demonstrated that young rhesus monkeys preferred cuddling with a terry-clothed surrogate mother over a wire mother, even when the food was provided by the wire mother. When frightened, rhesus monkeys consistently sought comfort and security in the presence of the terry-clothed mother over the wire mother. Young rhesus monkeys not only preferred terry-clothed surrogate mothers over a wire mother, but also experienced fewer physiological and psychological problems if raised with the soft surrogate mother. Moreover, Harlow and Suomi (1970) observed that infant rhesus monkeys were remarkably less explorative and affiliative with a physically cold surrogate mother, but they returned back to normal when the physically cold mother was switched with a physically warm mother that was heated by a 100 W light bulb. Based on his experiments, Harlow (1958) concluded that warm contact comfort was essential for the healthy social development of infant monkeys.

In line with these ideas, Bowlby (1969/1982) postulated in his seminal attachment theory that infants have an inborn behavior system that fosters survival of the infant and the main function of this behavior system is to regulate *proximity* to the primary caregivers who are able to provide protection, warmth, and comfort. According to Beckes and colleagues (2015), body temperature is one of the prime indicators of a desired level of proximity. Being in close proximity to the caregiver ensures that infants maintain thermoneutrality (i.e., temperature-

specific homeostasis), which is required for normal development in infants (Fransson, Karlsson, & Nilsson, 2005).

It is argued that thermoregulation, as one of the more ancient mechanisms along with the establishment of place-attachment, may be involved in monitoring social presence (Panksepp, Nelson, & Bekkedal, 1997) . That is, physical warmth is associated with feelings of security and social connectedness, whereas physical coldness is linked to loss of these feelings. For this reason, feelings of coldness should foster alertness and motivate individuals to seek out social connections and restore warmth.

1.2. Exploring the link between physical and social warmth

Despite these early conceptualizations pointing to the strong connection between physical and social warmth, empirical studies have only been conducted in recent years to explore this link in depth. The existing research on the connection between physical and social warmth could be classified into two main groups: One group of studies consistently reported assimilative effects (i.e., prime resulting in an effect that is congruent with the original prime), while the other group demonstrated compensatory effects (i.e., prime resulting in an effect that is compensatory, rather than matching, to the original prime)[1]. Below, both assimilative and compensatory effects will be reviewed in further detail:

1.2.1. Assimilative embodiment effects

Assimilative embodiment effects can be described as congruent effects, with the prime facilitating responses that are matching (or congruent with) the prime. In line with this idea, one group of studies demonstrated that physical warmth activates concepts of social warmth. For

[1] Some researchers have preferred to refer to these effects as *complementary* effects (e.g., Van Acker, Kerselaers, Pantophlet, & IJzerman, 2016; Zhang & Risen, 2014).

instance, in their pioneering study, Williams and Bargh (2008) found that participants who held a cup of hot (vs. cold) coffee perceived a target person as friendlier and more caring (Study 1). Moreover, participants who held a hot (vs. cold) therapeutic pad were more likely to engage in prosocial behavior such as choosing a gift for a friend over a gift for themselves (Williams & Bargh, Study 2; but also see Lynott et al., 2014). In another study, participants who sat on a heated (vs. unheated) chair reported a greater level of social affiliative motivation (Fay & Maner, 2012; also see Fay & Maner, 2015). Conversely, holding a cold therapeutic pad was linked to an increase in feelings of loneliness (Bargh & Shalev, 2012).

Using two daily diary studies, Fetterman and colleagues (2017) provided further evidence that the link between physical and social warmth is at work in one's daily life. They found that on the days participants felt physically warmer, they also reported perceiving themselves to be more agreeable and caring towards others. Similarly, a controlled laboratory study has revealed that oral temperature was positively correlated with feelings of social connection even after controlling for factors such as sex, BMI, or ethnicity, which are known to affect oral temperature (Inagaki, Irwin, Moieni, Jevtic, & Eisenberger, 2016).

Physical warmth was also found to induce feelings of interpersonal closeness and similarity (IJzerman & Semin, 2009) and enhance perceptions of similarity and spatial proximity of objects (Fay & Maner, 2012; Steinmetz & Mussweiler, 2011). Individuals primed with cues of physical warmth were shown to be more socially connected (Inagaki & Eisenberger, 2013), trusting (Kang, Williams, Clark, Gray, & Bargh, 2010), and conforming (Huang, Zhang, Hui, & Wyer, 2014). Similarly, actual or imagined physical warmth was linked to an increase in affirmative response behavior, particularly when individuals were primed with affiliation cues (Steinmetz & Posten, 2017).

Another group of studies focusing on assimilative effects demonstrated that social warmth (or coldness) can trigger feelings of physical warmth (or coldness). For instance, participants reported feeling warmer after reading socially warm (vs. neutral) messages from loved ones (Inagaki & Eisenberger, 2013). Social proximity and perceived similarity - even with strangers - resulted in perceiving the ambient temperature to be higher (IJzerman & Semin, 2010). Social interaction has also been found to increase facial temperatures (Hahn, Whitehead, Albrecht, Lefevre, & Perrett, 2012; Ioannou et al., 2014) In fact, just thinking about communality, especially sociability, has been associated with higher estimates of ambient temperature (Szymkow, Chandler, IJzerman, Parzuchowski, & Wojciszke, 2013; but see Ebersole et al., 2016 for skepticism, and see IJzerman, Szymkow, & Parzuchowski, 2016 for a rebuttal). In a related vein, researchers found that when individuals were primed with communal brands that were associated with positivity (vs. negativity), they perceived the room to be warmer. (IJzerman, Janssen, & Coan, 2015). Similarly, individuals who were exposed to emotionally warm (vs. cold) stimuli perceived the room to be warmer (vs. colder) (Bruno, Melnyk, & Völckner, 2017). In the same study, participants were also found to associate emotionally warm stimuli with social proximity (i.e., feeling close to other people). Finally, social coldness has also been shown to trigger feelings of physical coldness. For instance, socially excluded participants reported feeling colder (Zhang & Risen, 2014), estimated the ambient temperature to be lower (Zhong & Leonardelli, 2008), and actually had colder skin temperatures (IJzerman et al., 2012). In fact, even a simple act like dining alone (vs. with a partner) was associated with lower estimates of ambient temperature (Lee, Rotman, & Perkins, 2014).

1.2.1. Compensatory embodiment effects

Compensatory embodiment effects are observed when individuals report a greater interest in activities that would compensate for the effects of a prime. In relation to the research on social and physical warmth, these effects typically refer to an increase in individuals' desire to experience physical or social warmth in response to being primed with physical or social coldness (for exceptions, see Bruno et al., 2017 and Lee et al., 2013).

Extant research has shown that experiencing physical coldness motivated people to engage in either physically or socially warming activities to compensate for coldness. For instance, imagined or real physical coldness fostered a greater interest in physically and socially warming activities (Steinmetz, Tausen, & Risen, 2018; Zhang & Risen, 2014). In another study, participants expressed a greater interest in warm beverages when they were physically cold, particularly after being also exposed to emotionally cold stimuli (Bruno et al., 2017). Lower ambient temperatures were found to be associated with higher levels of self-reported hope for affiliation (Kolb, Gockel, & Werth, 2012) and a greater desire to experience a social (vs. solitary) activity (Lee et al., 2013). Moreover, drinking an iced (vs. hot) beverage enhanced individuals' self-reported liking of and willingness to pay for romantic movies, but only if they associated romantic movies with social warmth (Hong & Sun, 2012).

Variations in ambient temperature was also linked to variations in preferences for independence and intimacy (Vigil, Swartz, & Rowell, 2013). Using the estimates of room temperature as their main predictor, researchers found that lower estimates of room temperature was associated with a greater desire for comfort (rather than independence) from others when experiencing distress and a greater preference to form smaller, but more intimate (rather than larger, but less intimate) social networks. Lower ambient temperatures were also linked to

finding a house more communal (i.e., safe, warm, homely) (Van Acker et al., 2016) and feeling more nostalgic, which has been highly associated with psychological comfort and warmth (Zhou, Wildschut, Sedikides, Chen, & Vingerhoets, 2012).

Compensatory effects are also observed when individuals experience social coldness. For instance, socially excluded (vs. included) individuals reported a greater interest in consuming warmer food and beverages (Zhang & Risen, 2014; Zhong & Leonardelli, 2008). In a similar vein, one study, despite its small sample size, has found that when participants with PTSD were primed with loneliness, they strongly preferred having hot soup over room-temperature food and drinks (Li & Liao, 2013). Another study showed that individuals who scored higher on the loneliness scale took longer and more frequent baths or showers (Bargh & Shalev, 2012; but see Donnellan, Lucas, & Cesario, 2015; Wortman, Donnellan, & Lucas, 2014 for skepticism, and see Shalev & Bargh, 2014, for a rebuttal). Interestingly, although individuals were not explicitly aware of the connection between physical and social warmth (Bargh & Shalev, 2012), they still implicitly associated physical warmth with positivity (Bergman, Ho, Koizumi, Tajadura-Jiménez, & Kitagawa, 2015).

Thus, it seems that physical warmth is used as a regulatory response to reverse the perceived coldness following the lack of social resources. These findings combined with the recent neurological evidence pointing to the overlapping neural activity between physical and social warmth (Craig, Chen, Bandy, & Reiman, 2000; Inagaki & Eisenberger, 2013) in addition to the shared neurochemical mechanisms (Inagaki, Irwin, & Eisenberger, 2015) suggest that physical warmth could be used as a proxy for social warmth and temporarily satisfy the need for closeness (see Blumberg, Efimova, & Alberts, 1992; Stone, Bonnet, & Hofer, 1976 for a similar discussion in animal research).

1.3. Social Thermoregulation Theory

The regulation of body temperature is essential for the survival of species. However, keeping body temperature in optimal limits is very costly if maintained alone. In species like birds or rats, thermoregulation is achieved through physical contact (e.g. huddling in birds). In humans, too, social touch has been linked to elevated facial temperature (Hahn et al., 2012). Indeed, the secretion of oxytocin, which is so closely related to social touch, has been shown to contribute to increased skin temperature through vasodilation, a state in which the blood flows to the periphery (for a review, see Beckes, IJzerman, & Tops, 2015).

Interestingly, although warm physical touch between partners has been associated with intimacy, affection, and security in addition to reduced stress reaction and enhanced well-being (for a review, see Jakubiak & Feeney, 2016), the thermoregulatory role of physical touch in adulthood has yet to be explored. Thus, evidence for social thermoregulation in humans comes from studies conducted with infants and their attachment figures. For instance, newborns who engaged in minimally interrupted skin-to-skin contact for the first 24 hours of their lives achieved thermal control more rapidly compared to the control group who received conventional care (Nimbalkar et al., 2014). Another study found that skin-to-skin contact with the mother resulted in higher rectal and peripheral skin temperatures in newborns compared to being monitored in a thermoneutral incubator (Bauer et al., 1997). A recent meta-analysis of physiological effects of skin-to-skin contact for newborns revealed strong evidence for increased body temperature during skin-to-skin contact relative to the body temperature prior to the contact (Mori, Khanna, Pledge, & Nakayama, 2010).

In addition to these findings, researchers also investigated the effect of brief "separations" from the mother right after the birth. For instance, Christensson and colleagues

(1992) found that healthy, full-term infants that were placed in a cot cried significantly more than those kept skin-to-skin with the mother. Furthermore, the skin temperatures as well as blood glucose levels were significantly higher in infants, who were in the skin-to-skin condition. The researchers concluded that maintaining skin-to-skin contact with the mother not only preserved energy and accelerated metabolic adaptation, but also increased the well-being of the newborn (Christensson et al., 1992). Lower body temperatures as a result of maternal separation were also observed in monkey infants (Reite, Short, Seiler, & Pauley, 1981; Reite, Short, Kaufman, Stynes, & Pauley, 1978) and rat pups (Hofer, 1973, 1976).

Hofer (1987) suggested that physical warmth was an important component of the mother-pup interaction and that its absence could result in disruptions in behavioral and physiological systems. Recently, physical warmth, either provided by skin-to-skin contact or an external warmer, has been shown to work as an analgesic in human newborns (Gray, Watt, & Blass, 2000; Gray, Lang, & Porges, 2012). It is speculated that the mechanism through which the pain is reduced is likely to be related to infant's reduced metabolic expenditure thanks to the thermoregulatory benefits of warm contact (Gray et al., 2012). In line with this speculation, social thermoregulation theory suggests that proximity to close others (both in infancy and adulthood) helps individuals maintain thermoneutrality (i.e., temperature-specific homeostasis) and thus contribute to health and well-being of one another by reducing energy consumption and achieving metabolic efficiency (Beckes et al., 2015; IJzerman et al., 2015b). In fact, IJzerman and Hogerzeil (2017) took this idea one step further and argued that social thermoregulation might be the main force behind the need to belong.

One of the key assumptions of social thermoregulation is that the repeated association between physical warmth and affection, necessitated by the critical need for thermoregulation in

infancy, forms an initial mental template of the link between physical warmth and interpersonal relationships, onto which later knowledge structures are scaffolded and used as an embodied model for monitoring and making sense of social connections (IJzerman & Koole, 2011; Williams et al., 2009). Accordingly, the perception of temperature could be used as a prediction system to decide whether individuals could rely on their social connections at the moment or not (Ijzerman et al., 2015b). This temperature prediction system is believed to help individuals navigate their social environment by becoming an integral part of the high-order prediction systems (IJzerman & Hogerzeil, 2017). Accordingly, the availability of social connections might affect how individual perceive their environments thermally and their corresponding cognitive, psychological, and physiological responses. But, what do individuals gain from the availability or proximity of their social connections?

1.4. Social Baseline Theory

As outlined above, one of the main propositions of social thermoregulation theory is that since keeping body temperature in optimal limits is bioenergetically costly, regulating body temperature through physical touch provides a cost effective option (Beckes et al., 2015; IJzerman et al., 2015b). Ultimately, this proposition is an extension of Social Baseline Theory (SBT; Coan, 2008; Beckes & Coan, 2011), which outlines why proximity to social connections is crucial.

SBT proposes that because humans have adopted social proximity and interaction as a way to reduce energy expenditure, the human brain assumes proximity to conspecifics and expects access to relationships that would provide social resources. The availability of social resources might alter the perception of embodied bioenergetic resources as well as environmental demands (Gross & Proffitt, 2013; Sbarra & Coan, 2018). The real and perceived costs of

responding to environmental demands increase if access to social resources is limited (e.g., when the individual is alone). Conversely, environment is perceived to be easier to manage if social resources are high and accessible. Indeed, empirical evidence provides support for this proposed scaling. For instance, people estimate the slant of a hill to be steeper when they are alone (vs. when they stood next to a friend) (Schnall, Harber, Stefanucci, & Proffitt, 2008). Similarly, participants who were about to lift a box with another person perceived the box to be lighter than participants who expected to do the same task alone (Doerrfeld, Sebanz, & Shiffrar, 2012).

Two main strategies that are used to utilize the presence of conspecifics with the aim of reducing energy consumption are risk distribution and load sharing. As the name suggests, risk distribution strategy provide the benefit of simple distribution of risk in the environment. The risk of a personal danger for a given individual is substantially smaller when group size increases. Therefore, social proximity leads to diminished vigilance as the environment is considered to be more predictable and social resources more available.

Load sharing, on the other hand, is more related to the distribution of effort applied to shared goals (Coan & Sbarra, 2015). Coan (2008) proposes that individuals would count on a trusted and interdependent partner to engage in several beneficial activities, such as procuring and sharing resources, providing comfort and security in the face of threats, tending to one's needs, and helping with the protection and nurturing of the offspring. Thanks to these allegiances, the cost of many metabolically expensive activities including maintaining physiological and emotional homeostasis is distributed. Consequently, cognitive and physiological resources could be used towards exploration and affiliation (see Zeifman & Hazan, 2008).

1.5. Regulatory function of romantic relationships

It has been consistently shown that romantic relationships, just like infant-caregiver bonds, serve a regulatory function so that individuals can respond to environmental demands in a less effortful way (Sbarra & Coan, 2018). As partners' psychological and physiological systems become interwoven, the relationship itself becomes a primary source of regulation for each partner. In other words, partners become *connected* and *embedded* in each other's biological rhythms (Pipp & Harmon, 1987). Also known as coregulation, synchrony or attunement, this comingled state is what maintains and regulates psychological and physiological homeostasis for each partner in the relationship (Sbarra & Hazan, 2008).

Coregulation is a dynamic and enduring mechanism that occurs without conscious effort or even awareness (Butner, Diamond, & Hicks, 2007; Field, 1985; Hofer, 1984, 1994; Saxbe & Repetti, 2010). It is considered to be a defining feature of normative attachment (Beckes & Coan, 2015; Hazan, Gur-Yaish, & Campa, 2004).

Coregulation enables dyads to dynamically organize and influence each others' behaviors within an optimal range, a psychological and physiological homeostatic set-point from which they can function effectively (Butler & Randall, 2013; Sbarra & Hazan, 2008). It also contributes to health and well-being of romantic partners by providing metabolic efficiency through optimizing performance and minimizing costs (Diamond, Hicks, & Otter-Henderson, 2008; Sbarra & Hazan, 2008; Selcuk, Zayas, & Hazan, 2010; Troxel, 2013).

According to Butler and Randall (2013), coregulation provides a rich context where the load sharing strategy of SBT is utilized. Put differently, coregulation implies the presence of a load sharing relationship whereas the opposite is not true. As a result of consistent support, care and resources provided by the attachment figure, individuals could reduce their energy

consumption and achieve metabolic efficiency. Coan (2008) agrees that relying on close others for support provides the most efficient and metabolically cost-effective means of regulating affect. This could explain why coregulation contributes to healthy functioning and effective self-regulation (Beckes & Coan, 2015; Sbarra & Hazan, 2008; Selcuk et al., 2010).

Although the extent of SBT is not limited to romantic relationships, it provides a useful framework to understand how romantic partners get "in the head and under the skin". By getting in each other's head and under each other's skin, romantic partners become an essential source of regulation for each other. Moreover, once partners are moved to this stage, even their imagined presence become a source of regulation. In the following sections, findings from the growing body of research that demonstrates how relationship partners can contribute to the regulation of physiology, behavior, affect, and cognition will be reviewed:

1.5.1. Regulation at the level of physiology

Recent years have witnessed a rapid increase in the number of studies that explored the regulatory role of romantic relationships on physiology. The availability of new techniques allowed researchers to come up with clever experimental designs to examine the effect of relationships.

Hidden regulators. One of the first studies in this area was conducted by Hofer (1987) on distress responses in rat pups when they were separated from their mothers. After observing that his initial manipulations did not eliminate the slow-developing behavioral and physiological changes in rat pups, Hofer speculated that the slow-developing changes could, in fact, be an assemblage of separate independent processes operating in different pathways and getting activated simultaneously when the mother's regulatory function was withdrawn. He tested this idea by introducing specific features of the absent mother, one at a time, and then measuring

what kind of an effect that feature had on the pup's distress. These specific features included mother's odor, touch, warmth, movements and even her feeding of the pups.

These studies revealed that each slow-developing distress symptom observed in rat pups was actually tied to a specific maternal feature. For example, heart rate of pups was linked to the milk injected into their stomachs while activity levels were tied to mother's warmth. The major finding was that although each maternal feature alleviated a single distress symptom, it had no effect at all on the others. Hofer concluded that the mother regulated her pups in multiple ways that are hidden within the ordinary mother-pup interactions. The dysregulation observed when pups are separated from their mothers is the result of the removal of these "hidden regulators."

Hofer (1984, 1996) also pointed out to the similarity between the responses of adults to bereavements and those of infants to maternal separation. Both responses included the initial acute phase in which infants and adults felt agitated and aimless, and also cried a lot. In the chronic phase, both infants and adults experienced loss of appetite, decreased social interaction and sleep disturbances as well as going through cardiovascular, endocrinological and immunologic changes.

Regular contact with an attachment figure would increase the availability of the social provisions. One mechanism underlying this process could be the interactions between partners becoming *social zeitgebers*, the environmental, or external, events (or cues) that can synchronize or entrain circadian rhythms. Because psychophysiological systems in humans are open to external regulators, physical zeitgebers such as light can regulate the circadian systems. It is also proposed that social contact with other individuals can work as social zeitgebers and contribute to the stability of an individual's daily routine or constitute their social rhythm (Ehlers, Frank, & Kupfer, 1988; for a review, see Grandin, Alloy, & Abramson, 2006). According to Hofer (1984),

seemingly minor aspects of social interactions such as "nonverbal signals, mannerisms, tones of voices, gestures, facial expressions, brief touches, and even the timing of events and pauses between words may have physiologic consequences—often outside the awareness of the participants" (p. 194). Therefore, it is not surprising that romantic relationships play an important role in everyday regulation of physiology in partners.

Neurophysiology. Neuroimaging studies utilizing functional Magnetic Resonance Imaging have consistently revealed that the brain's dopaminergic reward system is highly associated with romantic love, both early-stage and long-term (for a review, see Acevedo & Aron, 2012). The release of dopamine in this system is linked to approach-related behaviors.

Physical contact with a partner is also strongly associated with the endogenous physiological reward systems, which are implicated in the consummatory phase that regulates feelings of satiation and sedation that comes after achieving the reward (Nelson & Panksepp, 1998). In this phase, individuals engage in certain behavioral patterns that are relatively specific to affiliation. Some examples of these inherently rewarding behaviors include courtship, gentle stroking and grooming and mating (Berridge, 1999; Hofer, Shair, & Murowchick, 1989; Polan & Hofer, 1998).

In addition to the dopaminergic and opioidergic systems, there is some direct evidence to suggest that oxytocinergic system is also closely associated with physical touch (for a review, see Dunbar, 2010). Intimate physical contact such as hugging, sexual interactions, and orgasm stimulates the release of oxytocin (Insel, 1992; Uvnas-Moberg, 1997). Light and colleagues (2005) found that in premenopausal women, frequent hugs between spouses/partners are associated with higher oxytocin levels.

Partner presence has also been found to regulate neural activity. In a study that tested the benefits of social contact, Coan and colleagues (2006) used functional magnetic resonance imaging to identify part of the neural circuitry underlying the stress-buffering effects of spouses. In this study, women in highly satisfying marriages were scanned while anticipating a mild electric shock. All the participants were randomly assigned to three conditions: holding hands with their spouses, holding a stranger's hand or no hand holding at all. The results revealed that holding hands with someone (whether it is a stranger's hand or the spouse' hand) attenuated the neural activation in regions implicated in self-regulation of affect indicating that social contact led to a clear reduction in threat response. This effect was larger in the spousal hand-holding condition compared to the stranger condition. Moreover, women with higher levels of marital quality benefited from this effect more showing a greater attenuation in threat response. In another study, Montoya and colleagues (2004) have shown that when patients with fibromyalgia were stimulated at the painful tender point in the presence of their significant others (versus while alone) reported less pain and thermal pain sensitivity. Furthermore, when the significant other was in the recording room, brain activity elicited by tactile stimulation of a tender point was significantly lower compared to the levels when the patients were alone.

Cardiovascular and respiratory systems. Research has consistently demonstrated that attachment figures help calm down the autonomic nervous system (ANS) reactivity looking at the relationship between physiological measures (e.g., systolic and diastolic blood pressure, heart rate, and cortisol levels) and interactions with partners. For instance, Gump and colleagues (2001) investigated the effects of partner interactions on ambulatory blood pressure in a sample of 120 healthy adults who were monitored over a 6-day period. They found that daily interactions with partners are associated with significantly lower levels of systolic and diastolic

blood pressure compared with social interactions with any other person and also relative to periods of not interacting. The relationship quality did not moderate the observed effects suggesting that these buffering effects would hold true regardless of the level of satisfaction in the relationship. In a similar study conducted with 102 healthy adults over a 3-day period, it was demonstrated that interactions with family members and spouses were associated with lower ambulatory blood pressure compared to other social interactions (Holt-Lunstad, Uchino, Smith, Olson-Cerny, & Nealey-Moore, 2003).

One concern with these findings is that although these studies demonstrated that interactions with one's partner are associated with a physiologically calmer state, they examined naturally occurring situations and hence correlational in nature. However, further and stronger evidence comes from studies conducted with experimental manipulations indicating that interactions with their partners before a stressful situation would lead to dampened ANS reactivity. Ditzen and colleagues (2007), for instance, randomly assigned participants to conditions in which they either received social support from their partners or prepared alone before a 5-min job interview and subsequent serial subtraction task performed out loud in front of an unknown panel of one man and one woman. Results revealed that although there were no significant differences in the baseline cortisol levels, the groups differed significantly in their cortisol levels taken immediately before the stressful task. Specifically, the group, which received social support, had significantly attenuated cortisol levels compared to the group that prepared alone. These results are in line with the idea that warm partner contact would have a down-regulating effect on hypothalamic-pituitary-adrenal (HPA) reactivity (manifested in reduced cortisol secretion) in response to perceived threats.

In another study, Grewen and colleagues (2003) had a similar design, in which participants were assigned either to a warm contact condition or a no contact condition before giving a tape-recorded 3-min speech describing a recent interpersonal situation that caused anger or stress. In the warm contact condition, participants sat together with their partners and were told to touch their partners in a way that was comfortable for both parties. In the no contact condition, participants sat alone quietly. Participants' blood pressures and heart rates were assessed right before giving the speech, during the speech and then during the replay of the videotape. All participants were alone during the speech and the replay portion of the study. Results showed that participants in warm contact condition had lower ANS reactivity, as indexed by significantly lower increases in systolic blood pressure, diastolic blood pressure, and heart rate across all assessments compared to those in the no contact condition. These findings provide further evidence that warm contact with attachment figures could have calming effect on ANS reactivity in the face of stressful situations.

Additionally, when romantic partners were instructed to sit face-to-face and try to synchronize their physiological responses with one another, coregulation was detected in their respiration and heart rate indicating that individuals adjusted their physiology to that of their partners' (Ferrer & Helm, 2013; Helm, Sbarra, & Ferrer, 2012). A similar pattern for respiratory sinus arrhythmia (RSA) was observed in a study in which partners engaged in positive, negative and neutral conversations (Helm, Sbarra, & Ferrer, 2014). Specifically, when one had high levels of RSA response at a given occasion, their partner had reliably higher RSA response at the following occasion. Relationship satisfaction was found to moderate this effect such that partners in higher quality relationships showed a stronger RSA synchrony.

Not surprisingly, interpersonal touch was found to increase autonomic coupling, specifically the electrodermal activity, between romantic partners (Chatel-Goldman, Congedo , Jutten, & Schwartz, 2014). Moreover, women who reported more frequent hugs from their partners had lower blood pressure and heart rates (Light et al., 2005).

Research on individuals who recently went through a divorce or a romantic break-up has shown that partner absence is linked to cardiovascular changes in adults. For instance, Sbarra and colleagues (2009) found that participants who experienced a greater degree of divorce-related emotional intrusion had higher blood pressures and men who found the divorce-related task emotionally difficult evidenced significant increases in blood pressure during the task. In another study, Krietsch and colleagues (2014) showed that in recently separated individuals, greater sleep complaints were associated with future increases in blood pressure.

Regulation of endocrinological and immunological systems. Regular contact with partners has immediate immunological and endocrinological benefits. For instance, Gouin and colleagues (2010) looked at wound healing in married couples and found that higher oxytocin levels were linked to faster wound healing. In another study, researchers found that reliable support from the spouse had positive effects in adhering to healthy lifestyle changes in women with Type 2 diabetes (Beverly, Miller, & Wray, 2007).

In fact, just thinking about partner triggered eustress responses and an increase in blood glucose levels (Stanton, Campbell, & Loving, 2014). On the contrary, perceived loneliness and lower levels of relationship satisfaction in married and cohabitating women led to increased consumption of sugar-containing beverages (Henriksen, Torsheim, & Thuen, 2014).

Also, as previously reviewed, romantic partners have been found to have a down-regulatory role on the HPA as evidenced by the decreases in cortisol levels (e.g., Ditzen et al.,

2007). Research on coregulation has provided further evidence that daily cortisol levels between spouses covaried (Saxbe & Repetti, 2010). Specifically, for both husbands and wives, one's cortisol level was positively associated with partner's cortisol level, even after sampling time was controlled. In line with expectations, within-couple coregulation was stronger for the samples taken in the early morning and evening, when spouses were together at home, suggesting the importance of the physical presence of the partner. Similarly, Liu and colleagues found that husbands and wives synchronize their diurnal cortisol patterns on a day-to-day basis (Liu, Rovine, Klein, & Almeida, 2013). In other words, on days when one experienced faster or slower decline in diurnal cortisol than usual, the partner also experienced faster or slower decline than usual. Papp and colleagues (2013) also found a similar linkage between partner's cortisol levels after accounting for the effects of the diurnal rhythm of cortisol (Papp, Pendry, Simon, & Adam, 2013). They also reported that husbands' cortisol levels were lower when they were in the presence of their spouse. Moreover, cortisol synchrony was stronger when spouses spent more time together.

Physical affection with the partner has also been associated with a decrease in somatic symptoms such as aches, insomnia, upset stomach, rashes, and injuries (Stadler, Snyder, Horn, Shrout, & Bolger, 2012). Specifically, when participants reported increased intimacy from one day to the next day, they experienced a decrease in their symptoms in the following days. Receiving affectionate touch has also been linked to reduced risk of getting infected with common cold (Cohen, Janicki-Deverts, Turner, & Doyle, 2015). Even if individuals got infected with the cold virus, those who received more frequent affectionate touch had less severe symptoms.

Research has also shown that separations from attachment figures might result in dysregulations in immunological and endocrinological systems. For instance, women who had been separated/divorced from their romantic partners for one year or less had significantly poorer immune function than their sociodemographically matched married counterparts (Kiecolt-Glaser et al., 1987). Shorter separation periods and greater attachment to the partner were associated with poorer immune function and greater depression. Reduced natural killer cell activity, an important mechanism to fight against tumors and viral infections, and increased plasma cortisol levels were detected in women who recently lost their husbands (Irwin, Daniels, Risch, Bloom, & Weiner, 1988). Diamond and colleagues (2008) also found that brief separations would result in increased cortisol levels especially in anxiously attached individuals.

1.5.2. Regulation at the level of behavior

Separation distress behaviors. The phases adults experience in response to unwanted separations such as the death of a spouse or getting a divorce are very similar to the protest (e.g., initial panic and anxiety, crying) -despair (e.g., lethargy and depression) -detachment (e.g., resumption of daily activities) sequence infants experience when they are separated from their caregivers (Hazan & Shaver, 1992; Parkes, 1972; Parkes & Weiss, 1983; Weiss, 1975). This sequence is observed almost exclusively in two social relationships: infant-caregiver bonds and adult pair bonds. It is also important to note that separation distress is considered to be the strongest indicator of an attachment bond in adults. Other attachment behaviors could be observed in different types of social relations, whereas separation distress experienced in this distinct sequence is unique to attachment bonds (Beckes & Coan, 2015).

When attachment bonds are severed due to permanent separations (e.g., divorce, break-up, death), individuals are at significantly increased risk for mental and physical health problems.

For instance, compared to married individuals, divorced individuals have a greater risk of alcoholism, substance abuse, motor vehicle accidents, suicide, and several other physiological and mental problems (see Amato, 2000 for a review). Extended separations due to war-related or job-related reasons in pair bonds could cause heightened anxiety, sleep problems, depression, agitation, and anger (see Vormbrock, 1993 for a review). Even brief, temporary separations could lead to sleep problems, increase in negative affect and changes in cortisol levels (Diamond et al., 2008).

Exploratory behaviors. In well-functioning relationships partners provide a secure base for each other. That is, partners encourage each other to explore the world by pursuing goals and achieving one's ideal self (Feeney & Collins, 2014). Accordingly, supportive partners can provide motivation and resources for each other and facilitate the search for meaning and purpose in life. Feeney and Collins (2015) argue that close relationships are integral in thriving in life because they promote engagement in life opportunities. In fact, partners' support for each other's opportunities for self-expanding activities such as taking up a new hobby, making new friends or exploring a new part of the city has been shown to increase relationship satisfaction in long-term relationships (Fivecoat, Tomlinson, Aron, & Caprariello, 2014). However, partners need to be not only sensitive and responsive to each other's needs and goals, but also non-intrusive and encouraging to facilitate real growth (Feeney, 2004; Feeney & Collins, 2001; Reis & Patrick, 1996).

Research has shown that individuals who received more responsive support from their partners engaged more in exploratory activities and attained their personal goals (Feeney, 2007). In another study, participants' willingness to engage in exploratory behavior and perceived likelihood of achieving their personal goals were positively linked to their perception of partner

responsiveness (Feeney, 2004). Partner's encouraging and non-intrusive support also found to be positively associated with higher persistence in and enthusiasm about a laboratory exploration activity (Feeney & Thrush, 2010). On the other hand, project-relevant hindrance, particularly from the person most important to an individual, was found to be significantly related to psychological distress (Ruehlman & Wolchik, 1988). Similarly, responsive and nurturing partner support for self-improvement desires predicted greater relationship quality and more self-improvement (Overall, Fletcher, & Simpson, 2010). In fact, individuals whose ideal self-goals were affirmed by the partner - both perceptually and behaviorally - experienced greater personal and relationship well-being and more success attaining their ideal self goals (Rusbult, Kumashiro, Kubacka, & Finkel, 2009; Rusbult, Finkel, & Kumashiro, 2009). Also known as the Michelangelo phenomenon, this process, in which romantic partners support and sculpt one another so that each can reach their ideal self, has been shown to predict movement towards one's ideal (Drigotas, Rusbult, Wieselquist, and Whitton, 1999).

Sleep. Cohabitating partners may regulate each other's circadian sleep-wake rhythms. Although exposure to light has been found to be the most important regulator (i.e. zeitgebers) of sleep-wake cycle, partners still play a huge role in adjusting sleep and wake times (Mistlberger & Skene, 2004). Going to bed together with the partner provides an opportunity to get the security and warmth one would need throughout the day. Troxel (2010) argues that sleeping together enables a down-regulation of vigilance, which is a process most optimized when partners feel physically and emotionally secure and comfortable with each other (also see Hicks & Diamond, 2011). In fact, couples whose wake and sleep patterns were matched reported better marital adjustment, less marital conflict, more time spent in serious conversation and shared activities, and more frequent sexual intercourse (Larson, Crane, & Smith, 1991). In another study, the

concordance in sleep timing predicted female participants' perceived quality of daytime interactions with their partners (Hasler & Troxel, 2010).

Troxel and colleagues (2007) speculated that increased levels of oxytocin could actually promote sleep due to oxytocin's attenuating effects on cardiovascular stress response and anxiolytic features. Accordingly, emotional closeness and physical intimacy between partners would lead to better sleep quality.

Taken together, these findings underscore the importance of sleeping together for cohabitating partners. In line with this, partners experience sleep disruptions when they are away from each other. In her extensive review of the literature on short- and long-term physical separations, Vormbrock (1993) found that sleeplessness was one of the main problems partners experienced. Brief separations from partners were also highly associated with sleep problems (especially strongly for highly anxious participants) and these problems were quickly resolved when individuals reunited with their partners (Diamond et al., 2008).

Food intake. Although variations in food intake is one of the precise systems Hofer (1984) proposed to be regulated by the presence of the attachment figure, there are only a few studies on pairbonds providing any account of this system in response to the presence or absence of relational partners. Vormbrock (1993) reported in her review that changes and disturbances in appetite were observed in women whose husbands were away for a long while. Hofer (1984), based on his review of the literature, concluded that decreased food intake was a symptom of both maternal separations and bereavement. Shahar and colleagues (2001) found that weight loss was significantly higher among widowed participants compared to married participants. These participants ate more meals alone, more commercial meals per week, and fewer snacks and homemade meals. They also enjoyed their eating less. In another study, Lee and colleagues

(2005) reported that divorced and widowed women had lower intake of food (in terms of overall caloric intake) compared to married women. Marital disruption was also highly associated with skipping regular meals. According to a series of studies conducted by Bloom and colleagues (1983), divorced participants reported both loss of appetite and weight loss in the first 6 months after marital separation.

Sharing a meal is an important feature in relationships as it facilitates social interaction in relationships. One daily diary study on the eating habits of young married couples has shown that couples saw eating meals together as an affirmation of their identity as a couple. These couples reported putting an effort into eating together with their partners whenever possible (Marshall & Anderson, 2002).

1.5.2. Regulation at the level of affect

As reviewed above, attachment behaviors such as cuddling, touching, and sexual contact activate both oxytocin and opioid systems, which together induce pleasure and alleviate distress (Diamond, 2001; Sbarra & Hazan, 2008). This does not only create a physiological basis for felt security, but also contributes to the maintenance of positive affect and down-regulation of negative affect.

Being touched, for instance, has been shown to improve mood. In one study, Burleson and colleagues (2007) found that women who received nonsexual physical signs of affection from their romantic partner reported diminished negative affect and increased positive affect on the same day. Receiving spontaneous affectionate touch from the partner reduced distress before a stressful task even when the partner was not intentionally providing support (Robinson, Hoplock, & Cameron, 2015). In another study, kissing more frequently has been linked to higher relationship satisfaction and lower perceived stress levels (Floyd et al., 2009). Jakubiak and

Feeney (2016) demonstrated that even thoughts about receiving support from the partners through affectionate touch 5 minutes prior to experiencing a stressor buffered participants from stress more effectively than thoughts about receiving verbal support.

As partners psychological systems become connected, both partners benefit from the regulation of emotions even when a certain interaction is intended to enhance one partner's emotional experience (Schoebi & Randall, 2015). For example, Debrot and colleagues (2013, 2014) revealed evidence that touching a partner in a responsive way not only improved the partner's momentary emotional state, but also that of the partner who provided the touch.

Furthermore, research suggests that face-to-face interaction, visual observation, and simple proximity have important roles in coregulation of emotions. For example, Butner and colleagues (2007) used a diary methodology assessing romantic partners' daily positive and negative emotional experience. They found that partners' level of positive and negative affect covaried, even after controlling for the influence of shared daily interactions. A greater effect was observed on the days couple spent more time together.

In addition to touch and time spent together, just sharing the positive and negative events of the day with the partner is strongly related to daily affect. For instance, Hicks and Diamond (2008) used a daily diary method to investigate the effects of daily disclosure of positive and stressful events on partners' affect regulation. Participants in this study reported greater positive affect on the days when they shared the most positive event of their day with their partner. Similarly, greater positive affect was observed when partners shared their most positive event of the day with the participants of the study. This is in line with the findings of Gable and colleagues (2004) that communicating positive events with others is associated with increased

daily positive affect, above and beyond the impact of the positive event itself and other daily events.

Since proximity to partner has such an important role in emotion regulation, separations from relational partners have the potential to undermine felt security and result in negative feelings such as sadness, anger, anxiety, loneliness and longing. It is well documented that these feelings indeed arise in response to break-ups and loss of the partner (e.g., Davis, Shaver, & Vernon, 2003; Sbarra & Emery, 2005; Shear & Shair, 2005). Research on long-distance relationships linked physical separation to increased distress and depression (Guldner, 1996) and reductions in relationship satisfaction (Van Horn et al., 1997) and stability (Helgeson, 1994; Lydon, Pierce, & O'Regan, 1997). Furthermore, Diamond and colleagues (2008) revealed that brief separations from partners were also associated with a decline in positive affect and an increase in negative affect.

1.5.2. Regulation at the level of cognition

As romantic partners move through successive phases of attachment formation just like infants do with their caregivers, they become less reliant on the physical presence of their partners and more dependent on their mental representations (Hazan & Zeifman, 1999; Zayas, Gunaydin, & Shoda, 2014). In fact, even in the pre-attachment phase, partners begin to make inferences about each other using verbal and non-verbal cues. During the attachment-in-the-making phase, partners engage in cuddling, nuzzling, prolonged gazing, mutual ventro-ventral contact as well as baby talk. During this phase, partners also become the preferred source of comfort and distress alleviation compared to other people. Time spent together as much as the frequency of physical contact make mental representations richer while also allowing the formation of expectations about partner responsiveness and availability. In the clear-cut

attachment phase, partners are habituated to each other's presence. The relative importance of sex declines, whereas mutual attachment and caregiving takes in. Although partners have sex less often now, they become *sufficiently reliant* on each other and thus experience distress in response to separations. In the final, goal-corrected phase of attachment formation, partners feel confident about the endurance of their bonds. Therefore, they engage in secure base behaviors such as redirecting attention toward work-related obligations or personal hobbies (Hazan et al., 2004). Starting with the clear-cut attachment phase, mental representations of the partner start to have an increasing effect on information processing.

Thanks to repeated positive interactions particularly during times of stress, positive associations regarding partner are reinforced. As a result, simply the mental representation of the attachment figure becomes capable of activating psychological and physiological states of safety and calmness originally induced by actual interactions with them (e.g., Depue & Morrone-Strupinsky, 2005; Uvnäs-Moberg, 1998). Beckes and Coan (2015) refer to this process as the distress-relief dynamic.

According to Uvnäs-Moberg (1998), the positive effects of oxytocin are highly conditionable and they become more evident after repeated activation. Thus, mental representations of positive experience could reactivate physiological processes that were initially induced by physical interactions. This is in line with the idea that the positive physiological states are encoded into the mental representation of the partner, and eventually simply thinking about the partner is sufficient to trigger the release of oxytocin and the endogenous opioids even in the absence of partner's physical presence (Carter, 1992; Sbarra & Hazan, 2008; Selcuk et al., 2010, Zayas et al., 2015).

A number of studies have provided support that simply priming the availability of attachment figures elevates mood (e.g., Mikulincer, Hirschberger, Nachmias, & Gillath, 2001) and diminishes trauma-related cognition (Mikulincer, Shaver, & Horesh, 2006). In other studies, the activation of the mental representation of the partner incurred distress-relief benefits. Simply viewing pictures of the partner while receiving painful stimulation led to reductions in self-reported pain ratings (Master et al., 2009) and reductions in pain-related neural activity (Eisenberger et al., 2011). In one study, participants, who thought and wrote about their significant others before a potentially stressful task, reported significantly lower distress scores compared to participants who wrote about an acquaintance (McGowan, 2002). Moreover, Selcuk and colleagues (2012) have showed that activating the mental representation of an attachment figure mitigates the negative affective and cognitive consequences of recalling an upsetting autobiographical memory.

Moreover, romantic partners rely less on their own resources and outsource to their significant others for problem-solving, decision-making, or being vigilant for potential threats. As partners spend time together, they also become cognitively interdependent. As time passes, "partners may come to think as a unit; they may come to experience the world in cognitive concert" (Rusbult & Buunk, 1993, p. 185).

1.6. The present research

The extensive literature on the regulatory role of romantic partners clearly demonstrates that once an attachment bond is formed between partners, the regulation provided by the actual or imagined presence of the partner is evident at multiple levels. Combining this with the propositions of social thermoregulation theory and the rich body of findings on the bidirectional link between social intimacy and physical warmth, it is hypothesized that being in the presence

of the romantic partner would be associated with perceptions of physical warmth. Conversely, being away from the romantic partner is predicted to be linked to perceptions of physical coldness. Moreover, being away from the partner is also hypothesized to be associated with a greater desire for warm activities to compensate for the feelings of coldness. A simple visualization task was employed to mentally simulate the experience of being in the presence of or being away from the partner. Study 1 sought to examine whether the imagined presence (or absence) of a romantic partner alters thermal perceptions. Study 2 employed a within-participant design to examine whether thermal perceptions would vary as a function of imagined presence (vs. absence) of the partner. Study 3 was a direct replication of Study 1 using a larger and more representative sample and some additional dependent variables to better assess thermal perceptions. Finally, Studies 4 and 5 were designed to examine whether individuals' interest in physically or socially warm activities changes as a response to the imagined presence or absence of their romantic partners.

CHAPTER TWO

"*I imagined looking into her eyes, and touching her hair. Smiling at her, while she's [sic] talk about her day, and feeling a warmth in my heart."* -- A participant describing his thoughts as he was imagining his partner's presence

2.1 Study 1

Previous studies have consistently shown that physical warmth is closely linked to social intimacy (Fay & Maner, 2012; IJzerman & Semin, 2009). For instance, perceiving the imagined or real presence of other people has been shown to induce feelings of warmth (Ijzerman & Semin, 2009; Inagaki & Eisenberger, 2013). On the other hand, being socially excluded results in feeling colder (Zhong & Leonardelli, 2008). The aim of this initial study is to extend these findings to romantic relationships, which are typically characterized by intimacy. In line with previous studies, it was predicted that the imagined presence of the romantic partner would induce feelings of warmth and therefore result in perceptions of higher ambient temperature compared to baseline estimations. Conversely, the imagined absence of the romantic partner was predicted to induce feelings of coldness and thus result in perceptions of lower ambient temperature compared to baseline assessments.

2.1.1 Method

2.1.1.1 Participants

One hundred and nine undergraduates (77 women, $M_{age} = 19.86$, SD = 1.43, modal age=19) from Cornell University were recruited to participate in the study in exchange for cash or course credit. All participants were in a romantic relationship at the

time of the study ($M_{relationship\text{-}length}$ = 14.59 months, SD = 17.61, modal length = 6 months). Considering the effect sizes obtained from previously conducted studies (IJzerman & Semin, 2010; Zhong & Leonardelli, 2008), a sample size of at least 60 participants was predetermined based on the power analysis of an estimated effect size *f* of 0.3 and a desired power of 0.80 with an alpha level of 0.05.

2.1.1.2 Design

This experiment employed a mixed design with partner status (present vs. absent) as the between-participant factor and temperature estimation (baseline vs. post-manipulation) as the within-participant factor.

2.1.1.3 Procedure and Materials

Overview. Upon signing the consent form, participants were asked to estimate the current temperature of the room in which the experiment was taking place. They were free to choose the temperature scale they wanted to use, but asked to indicate it explicitly before moving on to the next question. They proceeded to complete a short pretest about their current romantic relationship and demographics. Qualtrics software (Qualtrics, Provo, UT) was utilized to collect pretest data. After the pretest, participants were given their randomly assigned visualization task to complete. In the *partner absence* visualization task, participants were instructed to imagine as vividly as possible that their partner had to be away from them for a week. They were given a minute to think about what they would most miss and how that would make them feel. In the *partner presence* visualization task, participants were instructed to imagine as vividly as possible that their partner was sitting next to them. They were again given a minute to think about what they would most enjoy and how that would make them feel. Immediately after the

visualizations task, participants were asked to estimate the room temperature one more time. Additionally, as manipulation checks, participants completed the mood measures and a single question about how vividly they were able to visualize their assigned scenario. Inquisit 4.0.9.0 (Inquisit, 2015) was used to collect the data for all the measures except the ones in the pretest. The actual room temperature was recorded throughout the experiment[1]. Participants were probed for suspicion after completing the experiment.

Measures. ***Pretest.*** All participants filled out an online pretest before the experimental session. The pretest included questions about participants' current romantic relationship as well as shortened versions of the Experiences in Close Relationships - Revised (ECR-R; Fraley, Waller, & Brennan, 2000) questionnaire and the WHOTO scale (Hazan & Zeifman, 1994). Developed by Zayas, Mischel, Shoda and Aber (2011), the 10-item version of the ECR-R consists of 5 items to measure relational anxiety ($\alpha = .82$) (e.g., "I often worry that my partner doesn't really love me") and 5 items to measure relational avoidance ($\alpha = .72$) (e.g., "I don't feel comfortable opening up to my partner") on a 7-point scale (1-strongly disagree, 7-strongly agree) (see Appendix A). The short version of the WHOTO scale included 4 items, each of which corresponds to one attachment behavior (proximity seeking, separation distress, safe haven, and secure base) (see Appendix B). Participants were asked to list up to four people from their lives who would qualify for the description given (e.g., "List up to four people in order of significance who you make sure to see or talk to frequently"). Two criteria were employed to assess whether the partner was considered as an attachment figure for each of the attachment behaviors: whether the partner was listed as one of the people that

[1] The actual room temperature did not have an effect on the findings reported here and therefore will not be discussed further.

would qualify for the attachment behavior described and whether the partner was listed as the first person on the list. Other questions included in the pretest assessed participants' satisfaction and commitment levels in their romantic relationships as well as the length of the relationship and whether it was a long-distance relationship. Lastly, participants' demographic information (i.e., age, sex, gender identity, sexual orientation, race) was collected.

Manipulating partner presence vs. absence. Visualization tasks are commonly used in social psychological research as a convenient manipulation method (e.g., Bartz & Lydon, 2004; Fitzsimons & Bargh, 2003; Huang, Ackerman, & Bargh, 2013; Jakubiak & Feeney, 2016; Mikulincer, Gillath, & Shaver, 2002; Mikulincer & Shaver, 2001; Stanton, Campbell, & Loving, 2014). For this experiment, the wording of the visualization tasks was carefully chosen in order to immerse participants in the experience of their partners' presence or absence. A modified version of the visualization task used by Dewitte and De Houwer (2008) was used for the *partner absence* condition. Whereas the separation imagined in their study was for 1 to 2 years, the duration of the separation for the current study was 1 week. The reason for this change was to use a more commonly experienced and therefore familiar separation situation that is still stressful, but only for a brief period of time. In the *partner presence* condition, "sitting right next to the partner" was chosen as an ordinary and familiar moment in a couple's life which could still invoke feelings associated with partner's presence. In both conditions, follow-up questions were used with the aim of motivating participants to think about the feelings associated with their assigned scenario. Please see Appendix C for the instructions used in each condition.

Manipulation checks. A 3-item questionnaire (*"sad/happy", "good/bad", "pleasant/angry")* with a 7-point scale was used to assess how participants felt in response to visualizing their assigned scenarios (See Appendix D). Past research provided evidence that brief separations worsen mood and result in negative feelings such as sadness, anxiety, and loneliness (Diamond et al., 2008; Espino et al., 2002; Rhodes, 2002; Sahlstein, 2004; Vormbrock, 1993). Thoughts about being away from the partner also elicited distress, manifested as enhanced negative feelings and worsened mood (Dewitte & De Houwer, 2008). Because the Cronbach's alpha was .92 for the mood questionnaire, a single composite score was calculated to represent all mood items in further analyses[2]. In addition to the mood scale, a single question (customized according to the condition) was included in the experiment to assess how vividly participants were able to imagine their assigned scenarios (See Appendix D).

Suspicion probe. In addition to the manipulation checks, all participants were probed for suspicion at the end of the experiment using specifically designed questions. These questions included close and open-ended questions such as "Did something distract you during the experiment?", "Were you paying attention throughout the experimental tasks?" and "Do you have any guesses about what this experiment was trying to assess?". Although none of the participants could guess the specific hypotheses of the experiment, 36 participants' (19 in the partner presence condition, 17 in the partner absence condition) predictions were similar to what the study was aiming to assess. After the analyses were rerun excluding these participants, the results remained unchanged from those based on the entire sample.

[2] Analyses conducted using each mood item individually produced similar results.

2.1.2 Results

As a manipulation check, the mood and vividness scores of participants were compared across conditions. An independent samples t-test showed that participants who visualized being away from their partners for one week felt worse than those who visualized sitting together with their partners (partner presence: $M = 5.71$, $SD = .94$; partner absence: $M = 4.56$, $SD = 1.18$, $t(107) = 5.64$, $p < .0001$, $d = 1.09$) (See Figure 4.1). There was no significant difference between conditions in terms of how vividly participants were able to imagine their given scenarios ($t(107) < 0$, $p = .804$).

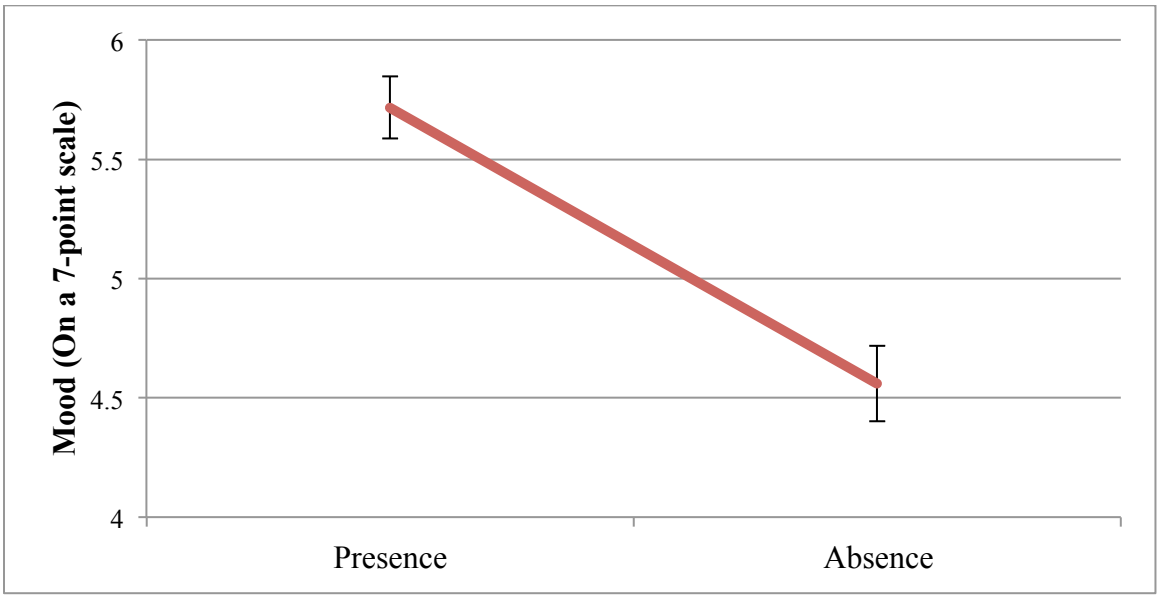

Fig 2.1. Mood ratings across conditions (Chapter 2, Study 1). Error bars indicate 1 standard error.

After establishing that participants were able to imagine the presence or absence of their partners, a 2 (condition: partner presence vs. partner absence) x 2 (temperature: baseline vs. post-manipulation) mixed model analysis of variance (ANOVA) with temperature as a within-participant variable was conducted. Temperatures reported in

Celsius were converted to Fahrenheit before the analyses. The results revealed that the interaction between condition and temperature was statistically significant ($F(1,107) = 5.72$, $p = .02$, $\eta_p^2 = .051$, see Figure 4.2) and the main effects of condition and temperature were not significant. This effect was primarily driven by the fact that participants who visualized being together with their partners estimated the room to be significantly warmer compared to their baseline estimations as evidenced by a pair-samples t-test (baseline temperature: $M = 72.18$, $SD = 6.13$; post-manipulation temperature: $M = 73.64$, $SD = 5.02$; $t(52) = -2.14$, $p = .037$, $d = .29$). In other words, in line with the predictions, imagining the presence of the romantic partner induced feelings of warmth and led to higher estimations of ambient temperature compared to the baseline estimations. However, participants who visualized being separated from their partners did not perceive the ambient temperature to be significantly lower relative to their baseline estimations (baseline temperature: $M = 72.04$, $SD = 10.34$; post-manipulation temperature: $M = 71.76$, $SD = 10.04$; $t(55) = .973$, $p = .34$).

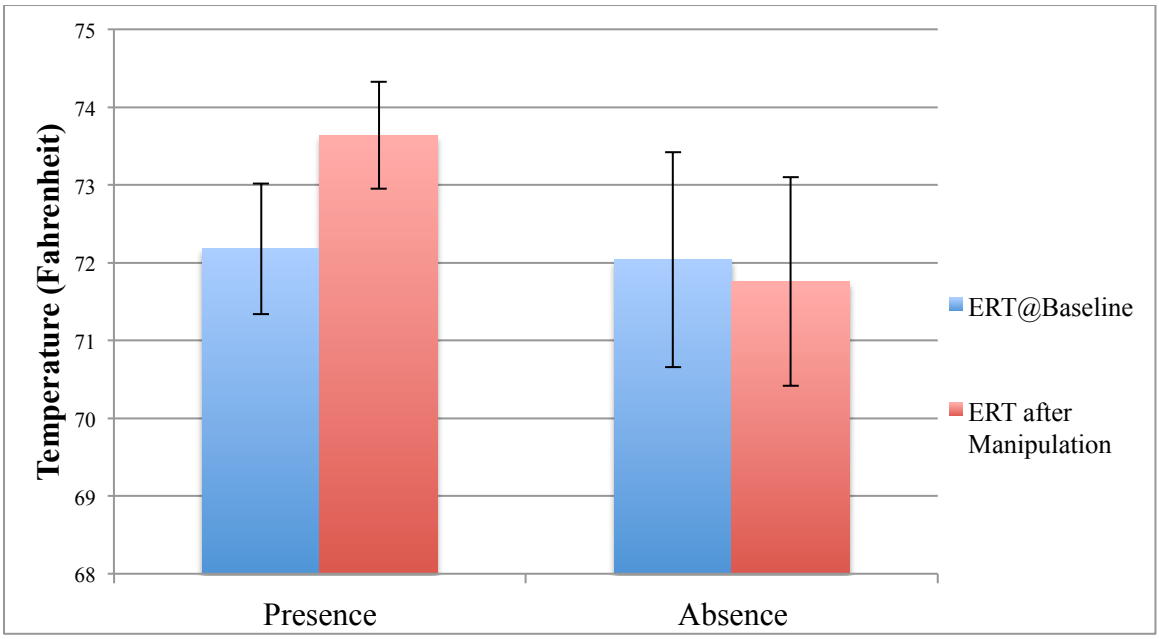

Fig 2.2. Estimated room temperatures (in degree Fahrenheit) across conditions and time (Chapter 2, Study 1). Error bars indicate 1 standard error.

The effects reported were present even after controlling for participants' age, sex, mood, relationship length, relationship satisfaction, WHOTO and ECR-R scores, and whether they were in a long-distance relationship or not.

2.1.3 Discussion

These results showed that imagining being physically together with the partner was associated with perceiving the ambient temperature to be higher. This finding is in line with past research indicating that being close to other people induces feelings of warmth. This finding is also consistent with the notion that the regulation provided by the real or imagined presence of the partner is evident at multiple multiples. Specifically, the imagined presence of the partner had a regulatory effect on individual's perceptions of their environment (i.e. ambient temperature) as well as their moods. Interestingly, participants who imagined partner absence did not perceive the ambient temperature to be

lower than baseline. This finding contradicts with previous research indicating that the absence of social connections was linked to feeling colder. One possibility to explain this contradiction might be that the threat manipulation used in the current study (i.e., one-week long separation from the partner) was a mild one compared to a social exclusion manipulation, which triggers a very powerful and hypersensitive system known as ostracism detection system and causes immediate detrimental effects (Kerr & Levine, 2008; Spoor & Williams, 2007). After all, it was an imagined separation and it was only for a fairly short amount of time considering that college students, who constituted the majority of the sample of this study, experience temporary (and often longer) separations from their partners periodically. In fact, research shows that up to 70% of students become involved in a long-distance romantic relationship while they are in college while 25%-50% of all romantic relationships in college are long distance relationships (Stafford, 2005)[3]. However, controlling for whether participants were in long-distance relationship or not has not changed the effect. Another possibility might be that since since this study was conducted using a college sample, participants had not been together with their partners for a long time (the median relationship length was 6 months). This is important for two reasons: First, interdependence between partners is usually quite low when they initially start their relationship and it only increases with time spent together (as a function of both the duration of the relationship and the frequency of interaction within the relationship; Berscheid, 1983). Second, since full-blown attachment bonds take time to form, young adults in early-stage romantic relationships might still be reliant on their parents (Zeifman & Hazan, 2008) and therefore, not be affected by the potential

[3] 51% of the participants in this study indicated being in a long-distance relationship. The results remained unchanged after controlling for being in a long relationship or not.

separations from their partners as much as someone who mostly relies on their partner for such regulatory functions. However, results remained the same even after controlling for relationship length, frequency of interactions, and whether the partner is seen as an attachment figure (based on WHOTO scores). Therefore, further research is required to understand why imagining partner absence was not linked to lower estimates of ambient temperature.

2.2 Study 2

Study 2 sought to replicate the findings of Study 1 and also to examine whether the perception of ambient temperature would change as a function of the imagined presence of the partner. With this aim, a within-participant design was used in which participants were instructed to imagine both partner presence and absence in a counter-balanced order. To our knowledge, there has not been a study looking at the change in perceptions in response to the imagined presence or absence of the partner. Based on previous research, it was predicted that participants who visualize partner absence (vs. presence) at Time 2 would perceive the room to be colder (vs. warmer) compared to their baseline estimations at Time 1. It was also expected to see an increase in estimated room temperatures for participants who visualized partner presence after partner absence at Time 3, whereas visualizing partner absence after partner presence should lead to a decrease in the estimations.

2.2.1 Method

2.2.1.1 Participants

One hundred undergraduates (68 women, M_{age} = 21.27, SD = 3.16, modal age = 21) from Cornell University participated in the study in exchange for cash or course credit. All participants confirmed being in an ongoing romantic relationship ($M_{relationship\text{-}length}$ = 21.80 months, SD = 27.08, modal length = 15 months). Based on the effect size calculated in Study 1, a sample size of at least 60 participants was predetermined for a desired power of 0.80 with an alpha level of 0.05.

2.2.1.2 Design

This experiment employed a mixed design with the order of visualization task (visualizing partner absence first vs. visualizing partner presence first) as the between-participant factor and temperature estimation (baseline vs. post-manipulation) as the within-participant factor.

2.2.1.3 Procedure and Materials

Overview. The procedure and materials were exactly the same as those described in Study 1 except that participants went through both visualization tasks in the present study and they were given a Stroop Task and a memory recall task in a counter-balanced order as distractors between visualization tasks. Participants were randomly assigned to receive the *presence* or the *absence* visualization task first. The room temperature estimations were reported immediately after the visualizations tasks. After each visualization task, participants completed the same manipulation checks as in Study 1 (**α** = .89 for the mood scale at Time 1 and **α** = .90 at Time 2). Participants were probed for suspicion after completing the experiment[4].

[4] Although none of the participants were able to specify the hypotheses of the present study, 23 participants (14 participants in the *visualizing partner absence first* condition and 9 participants in the *visualizing*

Measures. ***Distraction tasks.*** Participants were given two distraction tasks, a color-word Stroop task (Stroop, 1935) and the Sternberg memory recall task (Sternberg, 1966), in a counter-balanced order between visualization tasks to reduce carry-over effects[5]. In the Stroop task, participants were instructed to name the color of a word presented on the computer screen while ignoring the meaning of that word. Participants responded to randomly sampled 84 trials that consisted of either a color word ("red," "blue," "green," or "black") or a colored rectangle. The trials with color words were made up of congruent (the word red printed in red) and incongruent trials (the word green printed in red). The trials with colored rectangles were the control trials. Participants were instructed to respond as fast as they can without making too many errors by pressing a key. The main idea behind the color-word Stroop task is that the incongruent trials result in a response conflict because one has to overcome the urge to take the meaning of the word into account and focus on the color of the word. This conflict causes slower and less accurate responses compared to the control and congruent trials. In the Sternberg memory recall task, participants were given a memory set of 2, 3, 4, 5, or 6 digits with interstimulus intervals of 1 second. After a 1.5 second delay, they were presented a probe digit, which was either part of the series presented or not. Participants indicated their response by pressing one of the two different keys on the keyboard. Half of the trials were randomly selected to have probes from the memory set while the other half had probes that were not from the memory set. Each participant went through 18 trials consisting of 3 repetitions of each set-size. Both distraction tasks were carefully

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partner presence first condition) were able to guess that the study was about "the variations in perceived room temperature in response to thinking about partner presence or absence". After the analyses were rerun excluding these participants, the results remained unchanged.

[5] The order of the distraction tasks did not have an effect on the results reported here and therefore will not be discussed further.

chosen to create a cognitive load that was distracting for the participants so that the effects of the first visualization task would be cleared away before moving on to the second visualization task.

2.2.2 Results

First, to confirm that the manipulations worked, a 2 (condition: visualizing partner absence first vs. visualizing partner presence first) x 2 (mood: after 1st visualization task vs. after 2nd visualization task) mixed model ANOVA with mood as a within-participant variable was conducted. The interaction between condition and mood was found to be significant ($F(1,98) = 77.36$, $p < .0001$, $\boldsymbol{\eta}_p^2 = .441$) while the main effects of condition and mood were not statistically significant (See Figure 4.3). Paired samples t-tests revealed that there was a significant increase in mood ratings when participants visualized being separated from their partners first ($M = 4.71$, $SD = 1.18$) and being together with their partners second ($M = 5.46$, $SD = 1.06$), $t(53) = -5.27$, $p < .0001$, $d = .72$. In contrast, mood ratings worsened significantly when participants visualized being together with their partners first ($M = 5.73$, $SD = 1.02$) and being separated from their partners second ($M = 4.73$, $SD = 1.12$), $t(45) = 7.36$, $p < .0001$, $d = 1.09$. Another 2 (condition: visualizing partner absence first vs. visualizing partner presence first) x 2 (vividness: after 1st visualization task vs. after 2nd visualization task) mixed model ANOVA with vividness as a within-participant variable showed that neither the main effects of condition and vividness, nor the interaction between condition and vividness was significant. Thus, it was concluded that participants were able to imagine their given scenarios equally vividly regardless of the content of the scenarios or the order in which they were given.

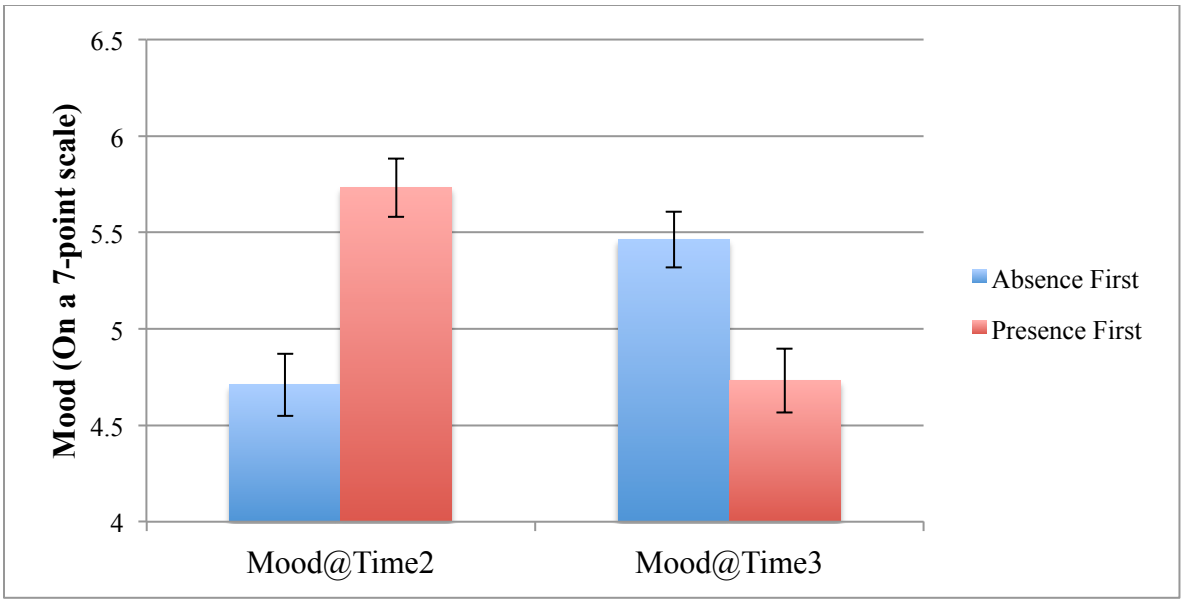

Fig 2.3. Mood ratings across conditions and time (Chapter 2, Study 2). Error bars indicate 1 standard error.

After the manipulation check, a 2 (condition: visualizing partner absence first vs. visualizing partner presence first) x 3 (temperature: Time 1 vs. Time 2 vs. Time 3) mixed model ANOVA with temperature as a within-participant variable was conducted. Temperatures reported in Celsius were converted to Fahrenheit before the analyses. It was found that although the main effects of condition and temperature were not significant, the interaction between condition and temperature was statistically significant ($F(2,196) = 2.93$, $p = .05$, $\boldsymbol{\eta}_p^2 = .03$, see Figure 4.4). This effect was primarily driven by the changes observed in the group who visualized partner presence first. Specifically, when participants visualized being together with their partners, they perceived the room to be significantly warmer relative to their baseline estimations (baseline temperature: $M = 70.85$, $SD = 4.94$; post-presence manipulation temperature: $M = 71.8$, $SD = 5.00$; $t(45) = -2.80$, $p = .008$, $d = .41$). When these participants visualized being separated from their partners at Time 3, they estimated the room to be colder compared to their post-presence

manipulation estimations at Time 2 (post-absence manipulation temperature: $M = 70.74$, $SD = 5.43$; $t(45) = 2.37$, $p = .022$, $d = .34$). The difference between the estimations at Time 1 and Time 3 is not significant, $t(45) = .228$, $p = .821$. We did not observe any significant changes either after the absence or the presence manipulations for the group who visualized being separated from their partners first and then being together with them (baseline temperature: $M = 70.51$, $SD = 4.86$; post-absence manipulation temperature: $M = 70.29$, $SD = 5.15$; post-presence manipulation temperature: $M = 70.53$, $SD = 5.42$).

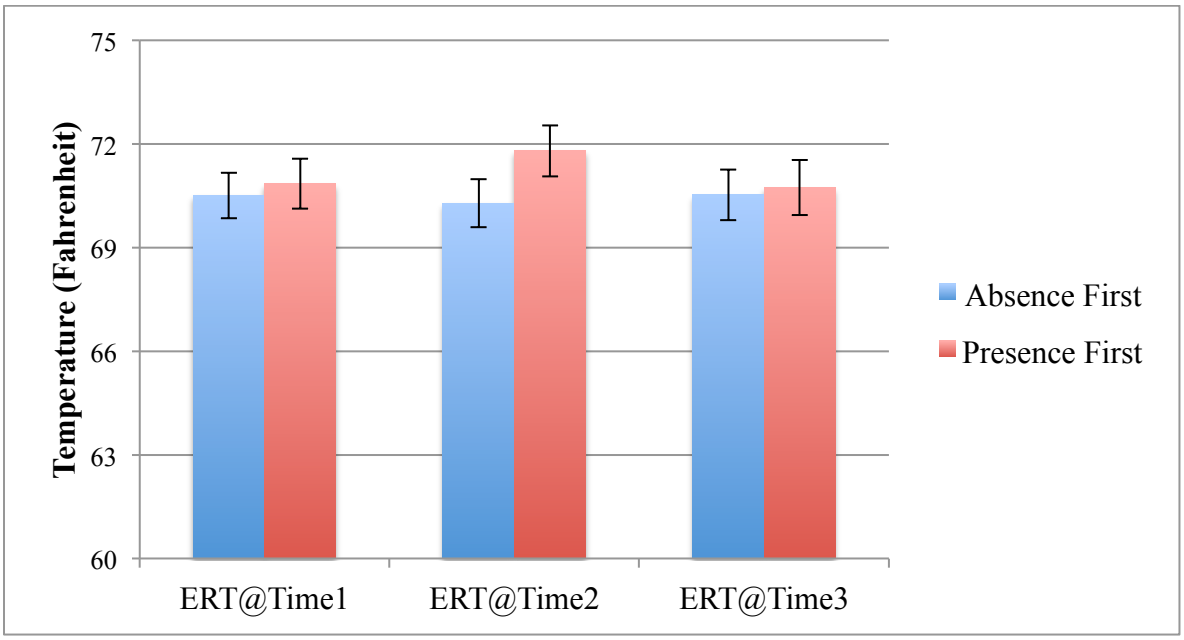

Fig 2.4. Estimated room temperatures (in degree Fahrenheit) across conditions and time (Chapter 2, Study 2). Error bars indicate 1 standard error.

The results remained unchanged even after controlling for age, sex, mood, relationship length, relationship satisfaction, WHOTO and ECR-R scores, and whether participants were in long-distance relationship or not[6].

[6] 38% of the participants in this study reported being in a long-distance relationship.

2.2.3 Discussion

In this study, it was found that thinking about the presence of the partner resulted in perceiving the environment to be warmer replicating the main finding of Study 1, which showed that imagining partner presence was linked to estimating the ambient temperature to be higher. However, this effect was only observed when participants thought about being together with their partners before thinking about being separated from them. When partner absence manipulation preceded partner presence manipulation, participants did not estimate the room to be warmer in response to imagining partner presence. One potential explanation might be that since being separated from the partner is a violation of expectations, thinking about it resulted in a lingering negativity that still affected the perception of ambient temperature at Time 3. One way to examine this possibility would be to compare the mood scores reported right after partner presence manipulation between conditions. However, results showed that although participants reported a better mood when they thought about partner presence as their first, rather than second, manipulation, the mood scores were not significantly different from each other (Order 1 (absence first, presence second): $M = 5.46$, $SD = 1.06$; Order 2 (presence first, absence second): $M = 5.73$, $SD = 1.02$, $t(98) = -1.28$, $p = .2$).

Another interesting finding from this study was that unlike Study 1, participants perceived the room to be colder in response to thinking about being separated from their partners. However, this result should be carefully interpreted because participants estimated the room to be colder only in comparison to their estimations following partner presence manipulation, but not to their baseline estimations. Therefore, this finding is not contradictory to Study 1 findings.

Overall, this study provided further evidence that imagining partner presence is linked to perceiving ambient temperature to be higher relative to baseline estimations. Conversely, imagining partner absence is linked to lower estimations of ambient temperature relative to imagining partner presence.

2.3 Study 3

Study 3 was designed to replicate Study 1 in a more representative sample. Since Studies 1 and 2 were conducted using a college sample, which was composed of young people who had not been together with their partners for a long time, the aim was to reach older individuals who were together with their partners for a long time. Therefore, Amazon's Mechanical Turk platform was utilized for this study. Additionally, a control condition was included to establish that the observed variations in estimated room temperature were a result of the partner-related manipulations. In line with Studies 1 and 2, it was predicted that imagining being together with the romantic partner would cause individuals feel warmer and estimate the ambient temperature to be higher relative to baseline estimations. Considering that the sample for this study would be composed of participants who are in longer-term relationships, it was expected that imagining partner absence would result in feeling colder and perceiving the ambient temperature to be lower. It was expected that no changes between baseline and post-manipulation perceptions would be observed in the control condition since the participants in this condition did not receive any cues regarding the availability or unavailability of their partners.

2.3.1 Method

2.3.1.1 Participants

One hundred and eighty-two individuals (103 women, M_{age} = 35.86, SD = 10.06, modal age=33.5) from Amazon's Mechanical Turk platform were recruited to participate in the study in exchange for $0.30. Participants were only able to participate in this study if they were currently in a romantic relationship and located in the United States ($M_{relationship\text{-}length}$ = 93.31 months, SD = 94.77, modal length = 60 months). Based on the effect sizes calculated in Studies 1 and 2, a sample size of 60 participants per each condition was targeted for a desired power of 0.80 with an alpha level of 0.05.

2.3.1.2 Design

This experiment employed a mixed design with condition (partner presence vs. partner absence vs. control condition) as the between-participant factor and perception of warmth (baseline vs. post-manipulation) as the within-participant factor.

2.3.1.3 Procedure and Materials

Overview. The procedure employed in the present study was exactly the same as the one described in Study 1. However, some minor changes were made on the materials used for this study.

Measures. ***Perception of warmth.*** A new within-participant variable (measured both at baseline and after visualization tasks) was used in this study in addition to the temperature estimation variable. All participants were asked to rate how warm they were feeling on a 7-point scale (1-really cold, 7-really hot) immediately after estimating room temperature.

Pretest. The shortened pretest for this study included questions assessing participants' satisfaction and commitment levels in their romantic relationships, the length of their relationship and whether it was a long-distance relationship as well as their age, sex, and race. It also included a binary version of the WHOTO scale. Instead of asking participants to list up to four people that would qualify for the description of the each attachment behavior (i.e., proximity seeking, separation distress, safe haven, and secure base), participants were asked a) whether the partner was on their short list of people that would qualify for the attachment behavior and b) whether the partner would be the first person on their list (see Appendix E).

Visualization tasks. A control condition was included in this study in addition to the partner absence and partner presence conditions. In this condition, participants were instructed to imagine as vividly as possible that they were going to the grocery store at that moment. They were given a minute to think about what they would buy and how they would spend their time at the grocery store (see Appendix F). With this new condition, it was aimed to create a scenario about an activity that could be completed without the regular involvement of the partner. Previous studies have used thinking about grocery shopping as a control condition (Meuwly & Davila, 2017; Mikulincer & Shaver, 2001; Sbarra & Borelli, 2013).

Manipulation checks. After completing the visualization task, all participants were asked to write about what they imagined during their visualization session in a few sentences. This question was used as a new manipulation check to confirm that participants actually thought about their given scenarios during their allocated time (for a similar manipulation check, see Jakubiak & Feeney, 2016). Additionally, instead of the

bipolar 3-item mood scale that was used in previous studies, an extended mood scale that measures how calm, cold, happy, hot, angry, sad, hungry, excited, tired, and anxious participants were feeling at the moment on a 7-point scale (1-not at all, 7-extremely) was introduced (see Appendix G). This scale was previously used in the studies conducted by Zhang and Risen (2014). A new vividness question to be used in the control condition was created to assess how vividly participants were able to imagine going to grocery shopping (see Appendix G).

Suspicion probe. A single question to probe for suspicion was used in this study due to time constraints. All participants were asked to guess what the study was about in a few sentences[7].

2.3.2 Results

First, it was confirmed that participants thought and wrote about their assigned scenarios. As a second manipulation check, the *sadness* ratings were subtracted from the *happiness* ratings. A one-way ANOVA showed that the effect of condition on this difference score was significant ($F(2, 179) = 3.16$, $p = .045$). Planned contrasts revealed that the difference was significantly smaller for participants in the partner absence condition than those in the partner presence condition ($t(179) = 2.51$, $p = .013$), indicating that participants who visualized being separated from their partners felt significantly worse compared to those who visualized being together with their partners (partner

[7] The study findings reported here remained relatively unchanged after the analyses were rerun excluding participants (16 participants: 6 participants in the *partner presence* condition, 5 participants in the *control* condition, 5 participants in the *partner absence* condition) whose predictions were similar to what the study was aiming to assess. The marginally significant change in the estimated room temperatures in the *partner absence* condition became statistically non-significant (baseline temperature: $M = 68.98$, $SD = 4.55$; post-manipulation temperature: $M = 68.82$, $SD = 4.50$; $t(54) = 1.64$, $p = .107$, $d = .22$) and the significant change in subjective warmth in the absence condition became marginally significant (baseline warmth: $M = 3.85$, $SD = .678$; post-manipulation warmth: $M = 3.75$, $SD = .673$; $t(54) = 1.76$, $p = .08$, $d = .22$).

presence: $M = 3.92$, $SD = 1.92$; partner absence: $M = 2.9$, $SD = 2.50$, $d = 0.46$; see Figure 4.5). Another mood measure that was significantly different between partner presence and absence conditions was excitement. Those who imagined being together with their partners reported being significantly more excited than those who imagined being separated from their partners (partner presence: $M = 3.10$, $SD = 1.70$; partner absence: $M = 2.52$, $SD = 1.58$, $t(179) = 2.01$, $p = .046$, $d = 0.35$). No other mood measures were significant. There was no significant difference across conditions in terms of how vividly participants were able to imagine their given scenarios ($F(2, 179) = 2.16$, $p = .119$).

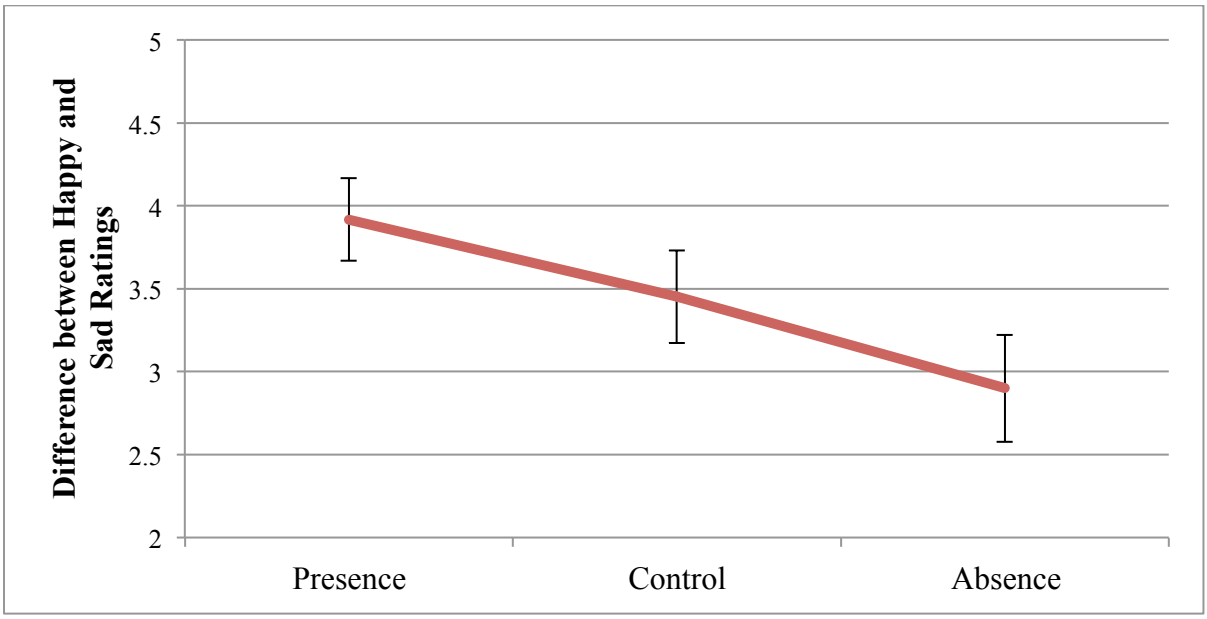

Fig 2.5. Mean difference scores between happy and sad ratings across conditions (Chapter 2, Study 3). Error bars indicate 1 standard error.

After confirming that the visualization manipulations worked, a 3 (condition: partner presence vs. partner absence vs. control condition) x 2 (temperature: baseline vs. post-manipulation) mixed model ANOVA with temperature as a within-participant variable

was conducted. Temperatures reported in Celsius were converted to Fahrenheit before the analyses. The results revealed that the interaction between condition and temperature was statistically significant despite the fact that the main effects of condition and temperature were not significant ($F(2,179) = 5.77$, $p = .004$, $\boldsymbol{\eta}_p^2 = .061$). This effect was primarily driven by the significant change in estimated room temperatures between Time 1 and Time 2 in the partner presence condition. Specifically, participants who visualized being together with their partners perceived the room to be significantly warmer compared to their baseline estimations (baseline temperature: $M = 69.96$, $SD = 3.42$; post-manipulation temperature: $M = 70.19$, $SD = 3.43$; $t(59) = -2.12$, $p = .038$, $d = .27$). This change, although in the opposite direction, was marginally significant in the absence condition (baseline temperature: $M = 69.03$, $SD = 4.44$; post-manipulation temperature: $M = 68.83$, $SD = 4.36$; $t(59) = 1.94$, $p = .057$, $d = .25$)[8]. In the control condition, no change was observed (baseline temperature: $M = 69.83$, $SD = 3.16$; post-manipulation temperature: $M = 69.84$, $SD = 3.14$). Figure 4.6 shows the differences between room temperature estimations at baseline and post-manipulation for each condition.

[8] Planned contrasts showed that the post-manipulation temperature estimations are significantly different from each other between presence and absence conditions (Post-absence manipulation: $M = 68.83$, $SD = 4.36$, post-presence manipulation: $M = 70.19$, $SD = 3.43$, $t(179) = 2.02$, $p = .045$, $d = .35$) whereas baseline estimations are not.

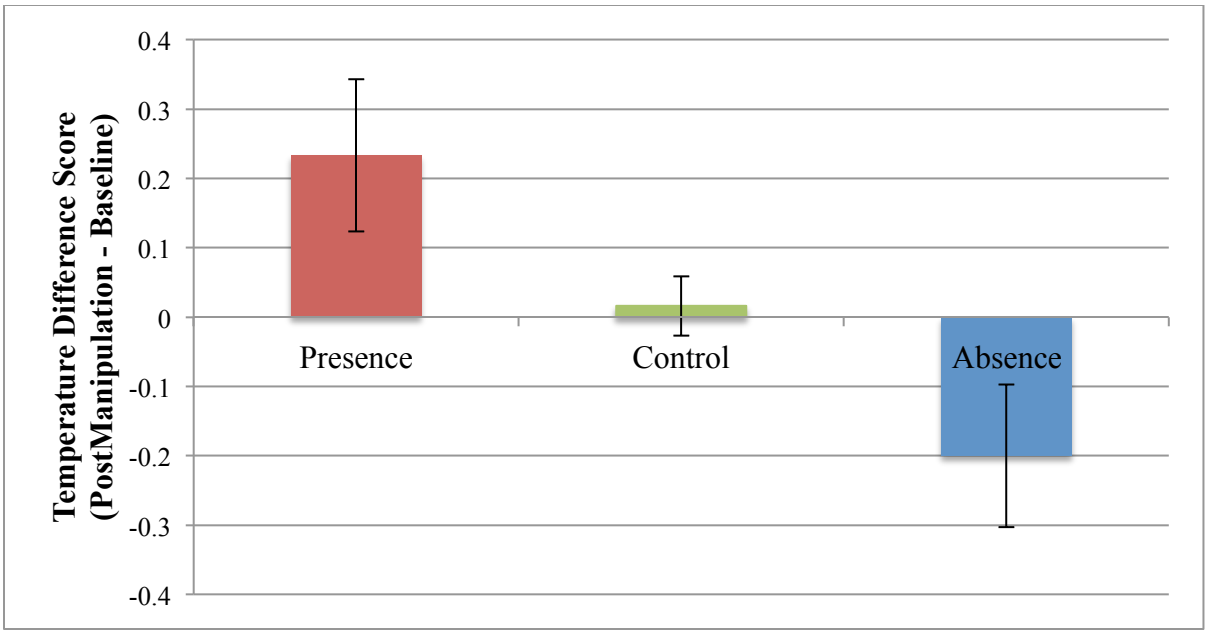

Fig 2.6. Mean difference scores between room temperature estimations at baseline and post-manipulation across conditions (Chapter 2, Study 3). Error bars indicate 1 standard error.

Another 3 (condition: partner presence vs. partner absence vs. control condition) x 2 (subjective warmth: baseline vs. post-manipulation) mixed model ANOVA with subjective warmth as a within participant variable revealed that although the main effects of condition and subjective warmth were not statistically significant, the interaction between condition and subjective warmth was significant ($F(2,179) = 3.74$, $p = .026$, $\boldsymbol{\eta}_p^2 = .04$). Follow-up paired samples t-tests showed that participants reported being significantly colder compared to their baseline after visualizing being separated from their partners for a week (baseline warmth: $M = 3.85$, $SD = .659$; post-manipulation warmth: $M = 3.72$, $SD = .691$; $t(59) = 2.05$, $p = .045$, $d = .26$). No significant changes were observed in the partner presence (baseline warmth: $M = 3.90$, $SD = .630$; post-manipulation warmth: $M = 3.95$, $SD = .594$) or control conditions (baseline warmth: $M =$

3.77, *SD* = .525; post-manipulation warmth: *M* = 3.76, *SD* = .592)[9]. Figure 4.7 shows the differences between subjective warmth ratings at baseline and post-manipulation for each condition.

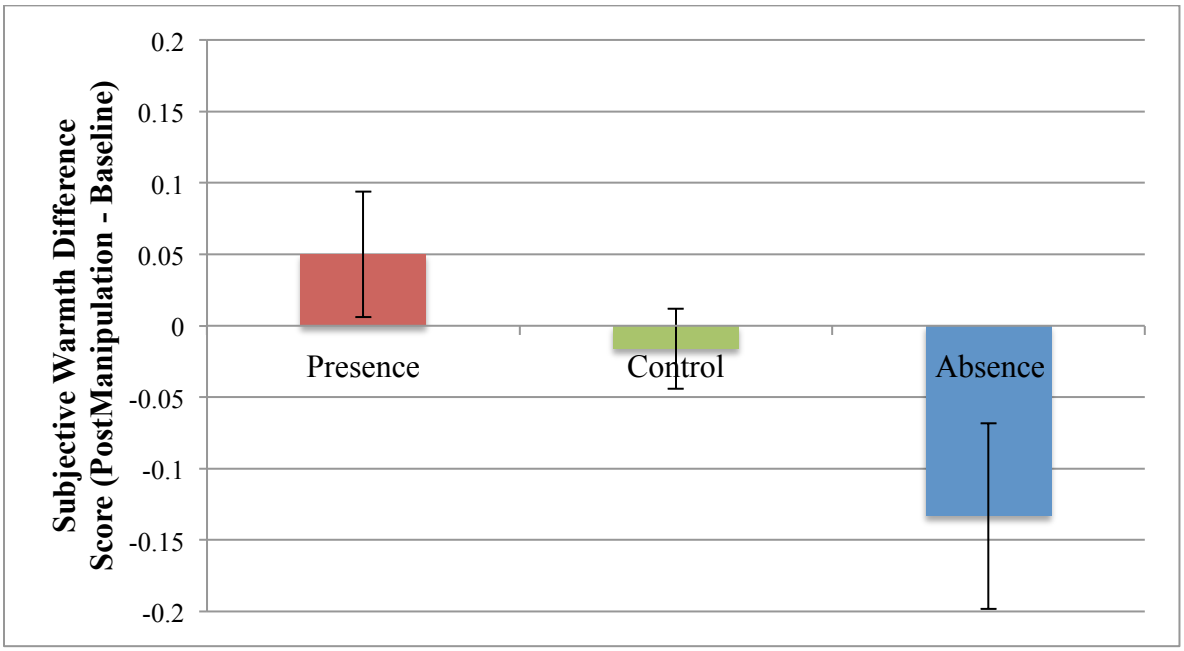

Fig 2.7. Mean difference scores between subjective warmth ratings at baseline and post-manipulation across conditions (Chapter 2, Study 3). Error bars indicate 1 standard error.

In this study, the post-manipulation ratings of *hotness* and *coldness* were also included in the mood scale as an additional dependent measure. For this analysis, the *coldness* ratings were subtracted from the *hotness* ratings and this difference score was compared across conditions. A one-way ANOVA showed that the effect of condition on this difference score was not significant ($F(2, 179) = 2.47$, $p = .087$). However, planned contrasts revealed that the difference was significantly greater for the partner presence

[9] Planned contrasts showed that the post-manipulation subjective warmth ratings were significantly different from each other between presence and absence conditions (Post-absence manipulation: *M* = 3.72, *SD* = .691, post-presence manipulation: *M* = 3.95, *SD* = .594, $t(179) = 2.04$, $p = .043$, $d = .36$) whereas baseline estimations were not.

condition than the partner absence condition ($t(179) = 2.13$, $p = .034$) indicating that participants who imagined being together with their partners reported being significantly warmer than participants who imagined being separated with their partners (partner presence: $M = 0.2$, $SD = 1.95$; partner absence: $M = -0.52$, $SD = 1.84$, $d = .38$; see Figure 4.8).

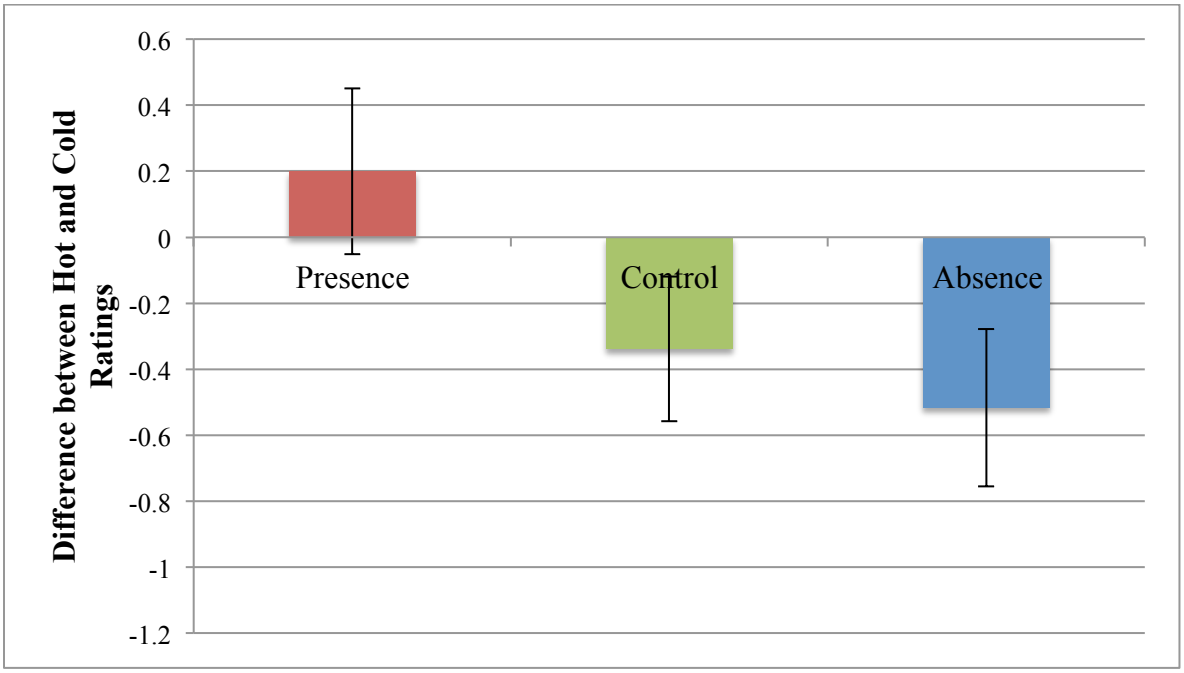

Fig 2.8. Mean difference scores between hot and cold ratings across conditions (Chapter 2, Study 3). Error bars indicate 1 standard error.

Similar to Studies 1 and 2, the effects reported here were not moderated by age, sex, mood, relationship length, relationship satisfaction, WHOTO scores and whether participants were in long-distance relationship or not[10].

.

[10] 9% of the participants in this study indicated being in a long-distance relationship.

2.3.3 Discussion

These results show that when primed with the idea of being together with the partner, individuals perceived the ambient temperature to be warmer relative to baseline estimations. In contrast, the idea of being separated from the partner caused individuals to perceive the room to be colder. Additionally, individuals reported feeling warmer when they thought about being in close proximity of their partners and colder when they thought about being away from their partners. Not only are these findings in line with past research indicating that proximity to close others results in perceiving the environment to be warmer, but also they replicate the primary findings of the first two studies.

The inclusion of the control condition also provided a baseline to see if temperature estimations are affected by the simple passage of time or the act of answering questions. The absence of significant changes in the control condition for the dependent variables used in this study suggests that the significant changes observed in the partner absence and partner presence conditions were caused by the experimental manipulations.

One main difference between this study and Studies 1 and 2 is that it was found that individuals perceived the room to be colder even compared to their baseline estimations. This might potentially be related to the fact that participants in this study reported having been in their current romantic relationship for a longer time than participants of Studies 1 and 2. Moreover, since participants in this study were older than typical college students, who constituted the majority of the samples in Studies 1 and 2, their romantic partners were also their main attachment figures. Thus, it is more likely

that participants in this study were more reliant on their partners in terms of regulatory functions. However, testing for the effect of relationship length and participants' WHOTO scores (as an indicator of their attachment status) did not change the results. Since the characteristics of the sample used for this study is different than the characteristics of the samples of Studies 1 and 2, it is possible that a variable that is not included in this study may explain this inconsistency. Thus, further research is required to understand why imagining partner absence had different effects on different samples.

CHAPTER THREE

"I imagined him sitting next to me. I imagined not sitting here alone and cold." -- A participant describing her thoughts as she was imagining her partner's presence

Studies 1-3 demonstrated that the imagined presence or absence of romantic partners alters thermal perceptions. Specifically, the imagined presence of the partner induces of feelings of warmth, whereas their imagined absence induces feelings of coldness. The aim of the following studies was to test whether the imagined presence or absence of romantic partners leads to changes in behavior in relation to the experience of warmth. Past research has shown that the absence of social connections motivates individuals to be more interested in activities that could potentially make them feel warmer (e.g., Bargh & Shalev, 2012; Shalev & Bargh, 2014; Zhong & Leonardelli, 2008; Zhang & Risen, 2014). It is suggested that when individuals are manipulated to experience physical or social coldness, they use physically warm activities (e.g., taking a hot shower, drinking a hot beverage) or socially warm activities (e.g., watching a romantic movie, having dinner with a loved one) as a compensation method. To date, research has only focused on complementary embodiment effects. That is, experiencing physical coldness triggers a desire for psychological warmth, whereas experiencing social coldness triggers a desire for physical warmth. However, no studies thus far have explored whether social warmth can compensate for social coldness.

The following studies sought to conceptually replicate past research by examining whether individuals' interest in physically warm activities changes as a response to the imagined presence or absence of their romantic partners and to test whether these effects

could be extended to socially warm activities. Based on the assumption that the imagined absence of the partner would be associated with an increase in perceived coldness, it was predicted that individuals would report a greater interest in engaging in physically or socially warm activities if they were primed with their partners' absence compared to their presence or a control condition. It was further predicted that participants who imagined being together with their partners would not express a greater interest in physically or socially warm activities compared to the control condition. With the aim of replicating Studies 1-3, participants in both studies were also asked to estimate the room temperature and report on their current state of warmth following visualization tasks. In line with previous studies, participants were expected to report feeling warmer and provide a higher estimate of the ambient temperature in response to thinking about being together with their partners than thinking about being separated from their partners[1].

3.1 Study 4

The present study was designed to test the desirability of physically warm activities as a response to imagining being away from or together with one's partner. The desirability of physical warmth was assessed using a single question that asked individuals to indicate their choice of beverage at that moment. Based on the findings of previous studies that included a similar measure (Zhong & Leonardelli, 2008; Zhang & Risen, 2014), it was predicted that individuals would be more interested in drinking a warmer beverage when primed with thoughts of partner absence (vs. presence). Priming with thoughts of partner presence was expected to result in a similar level of interest in

[1] Studies 4 and 5 did not include a baseline assessment of the room temperature estimations and subjective warmth ratings so that participants would not be primed to think about the concept of warmth.

warm beverages as priming with a neutral scenario since it is the absence of the partner that is associated with physical coldness.

3.1.1 Method

3.1.1.1 Participants

Two hundred and sixty-nine participants who indicated being in a current romantic relationship and living in the United States were recruited from Amazon Mechanical Turk (140 women, M_{age} =37.16, SD = 10.81, modal age=35, $M_{relationship\text{-}length}$ = 94.43 months, SD = 108.68, modal length = 56 months) in exchange of $0.30 for this study. Based on the effect sizes calculated in Studies 1-3 and the effect sizes obtained from similar designs reported in Zhang and Risen (2014) and Zhong and Leonardelli (2008), a sample size of at least 90 participants per condition was targeted for a desired power of 0.80 with an alpha level of 0.05.

3.1.1.2 Design

This experiment employed a between-participants design in which participants were randomly assigned to visualize one of the three scenarios: partner presence, partner absence, or grocery shopping (control condition).

3.1.1.3 Procedure and materials

Overview. After signing the consent form and completing the pretest, participants were randomly assigned to the visualize one of the three scenarios used in Study 3 (partner presence, partner absence, and grocery shopping) and asked to write about what they thought in a few sentences. Immediately after the manipulation, participants completed the question regarding their beverage choice. Next, participants were asked to

estimate the temperature of the room they were currently in and report how warm they were feeling at the moment. They completed the experiment by filling out the mood and vividness questions. All participants were probed for suspicion after completing the experiment[2]. The materials used for this study are exactly the same as Study 3 with the exception of the question about participants' beverage choice.

Measures. ***Beverage Choice.*** Following the visualization task, all participants were asked to indicate what they would prefer to drink at the moment on a 5-point scale, with an icy cold beverage anchored on one end (1) and a steaming hot beverage on the other (5) (See Appendix H).

3.1.2 Results

After confirming that all participants thought and wrote about their assigned scenarios, the difference between *sadness* and *happiness* ratings were compared across conditions. A one-way ANOVA revealed that the effect of condition on the difference score between sadness and happiness ratings was marginally significant ($F(2, 266) = 2.56$, $p = .079$, $\eta_p^2 = .02$). Follow-up planned contrasts showed that the difference was significantly smaller for those who visualized partner absence than those who visualized partner presence ($t(266) = 2.17$, $p = .03$). Therefore, it was concluded that participants in the partner absence condition felt significantly worse compared to those in the partner presence condition (partner presence: $M = 3.70$, $SD = 1.85$; partner absence: $M = 3.00$, $SD = 2.49$, $d = 0.32$; see Figure 5.1).

[2] After we re-ran the analyses excluding 14 participants (10 participants in the partner presence condition, 4 participants in the partner absence condition) whose predictions about the study were similar to what the study was aiming to assess, the results remained unchanged.

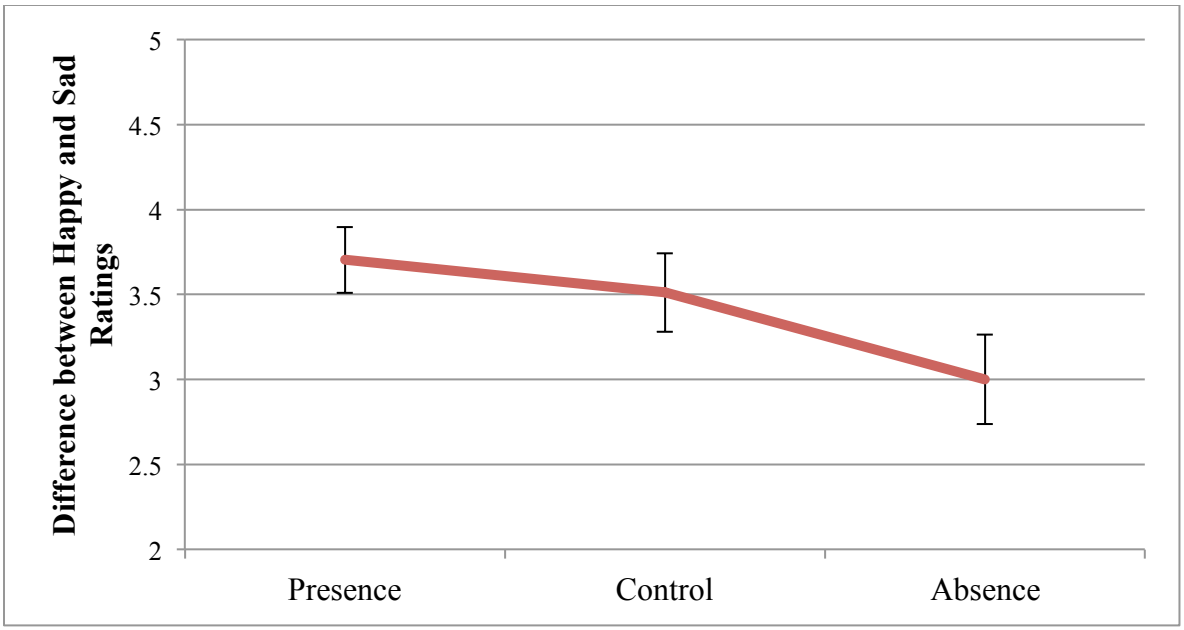

Fig 3.1. Mean difference scores between happy and sad ratings across conditions (Chapter 3, Study 4). Error bars indicate 1 standard error.

It was also observed that those who imagined being together with their partners reported being significantly calmer than those who imagined being separated from their partners (partner presence: $M = 5.88$, $SD = 1.12$; partner absence: $M = 5.49$, $SD = 1.4$, $t(266) = 1.98$, $p = .049$, $d = 0.31$). No other mood measures were significant. Participants did not differ in terms of how vividly they were able to imagine their given scenarios across conditions ($F(2, 266) = .461$, $p = .631$).

Next, we tested whether imagining different scenarios had an effect on how participants perceived the ambient temperature. A one-way ANOVA revealed that the effect of condition on the room temperature estimations was significant ($F(2, 266) = 3.38$, $p = .035$, $\eta_p^2 = .025$). Follow-up planned contrasts indicated that this effect was primarily driven by the significant difference between partner absence and partner presence conditions ($t(266) = 2.59$, $p = .01$). That is, participants who visualized being together with their partners perceived the room to be significantly warmer than those who

visualized being separated from their partners for a week (partner presence: $M = 70.27$, $SD = 3.67$; partner absence: $M = 68.74$, $SD = 4.25$, $d = 0.38$; see Figure 5.2).

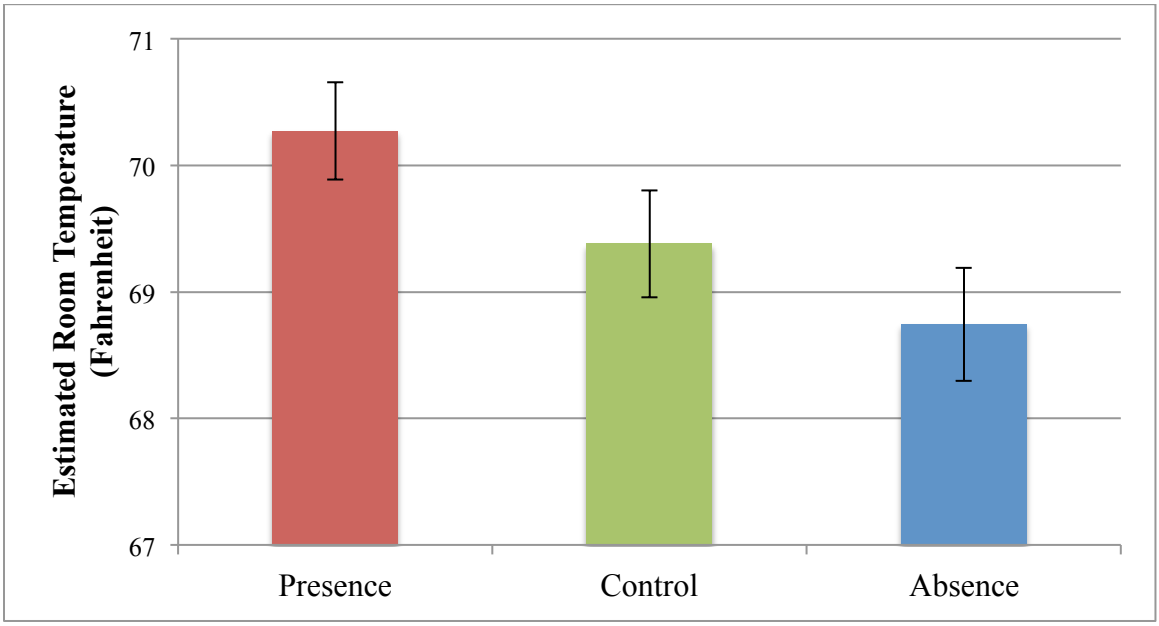

Fig 3.2. Estimated room temperatures (in degree Fahrenheit) across conditions (Chapter 3, Study 4). Error bars indicate 1 standard error.

A similar pattern was also observed in subjective warmth ratings. Although the effect of condition on the subjective warmth ratings was not statistically significant ($F(2, 266) = 2.27$, $p = .110$), planned contrasts revealed that participants in the partner presence condition reported feeling significantly warmer than those in the partner absence condition, $t(266) = 2.05$, $p = .042$ (partner presence: $M = 3.89$, $SD = .781$; partner absence: $M = 3.68$, $SD = .65$, $d = 0.29$; see Figure 5.3).

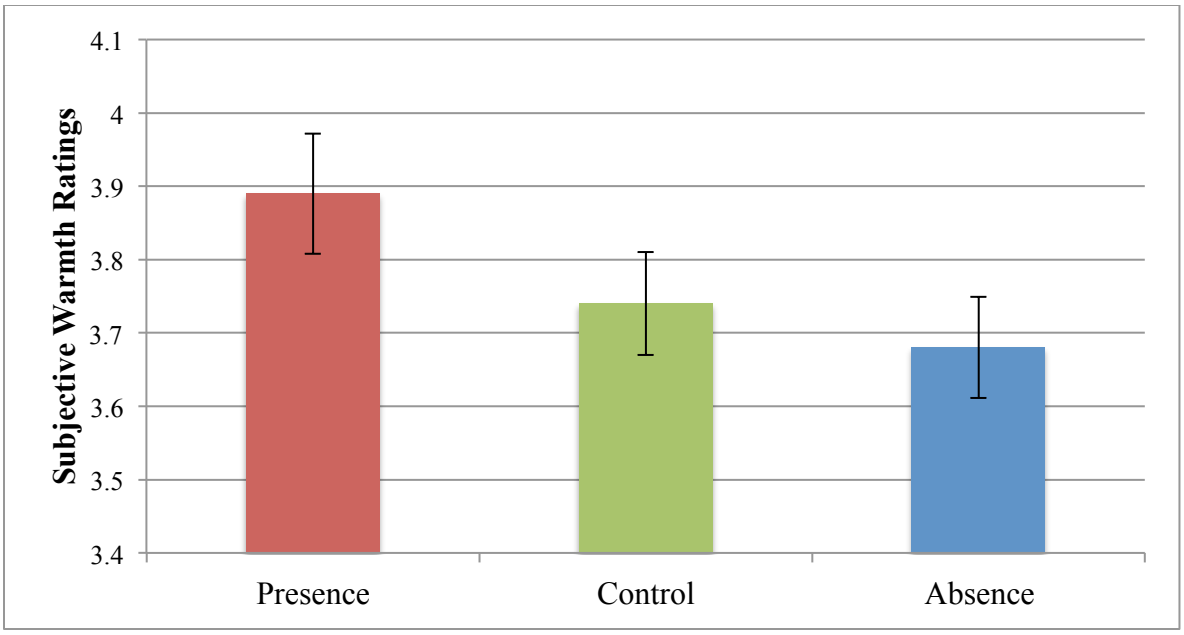

Fig 3.3. Mean ratings of subjective warmth across conditions (Chapter 3, Study 4). Error bars indicate 1 standard error.

The difference scores between coldness and hotness ratings were also compared across conditions. A one-way ANOVA showed that the effect of condition on this difference score was significant ($F(2, 266) = 6.48$, $p = .002$, $\boldsymbol{\eta}_p^2 = .046$). Follow-up planned contrasts showed that there was a significant difference between partner absence and partner presence conditions (partner presence: $M = .12$, $SD = 1.9$; partner absence: $M = -.82$, $SD = 1.87$, $t(266) = 3.59$, $p < .001$, $d = 0.5$, see Figure 5.4). Thus, replicating Studies 1-3, it was found that thinking about partner presence resulted in perceiving warmer temperatures and feeling warmer overall, whereas thinking about partner absence resulted in perceiving colder temperatures and feeling colder.

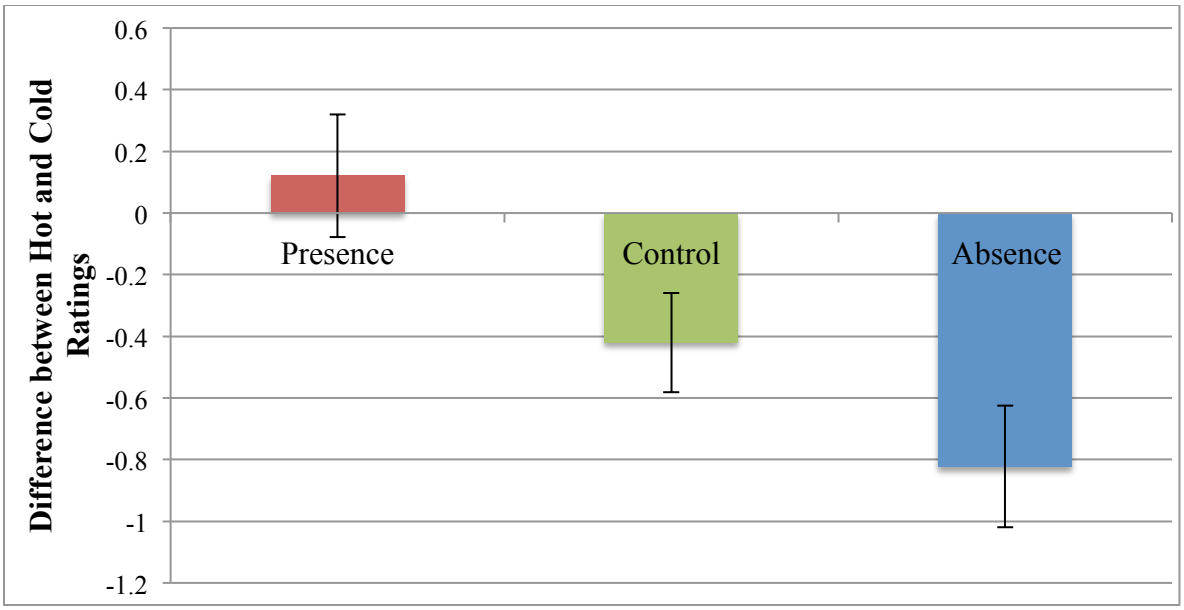

Fig 3.4. Mean difference scores between hot and cold ratings across conditions (Chapter 3, Study 4). Error bars indicate 1 standard error.

Finally, the effect of condition on participants' beverage choices, the primary dependent variable for this study, was tested. The main effect of condition was significant on the beverage preferences ($F(2, 266) = 3.22$, $p = .042$, $\boldsymbol{\eta}_p^2 = .024$) and follow up planned contrasts revealed that in line with our predictions, participants who thought about being away from their partners preferred to drink significantly warmer drinks compared to those who thought about being together with their partners (partner presence: $M = 2.23$, $SD = 1.38$; partner absence: $M = 2.77$, $SD = 1.5$, $t(266) = -2.48$, $p = .014$, $d = 0.37$, see Figure 5.5). Moreover, it was found that there was no significant difference between the beverage choices of participants in the control condition and participants in the partner presence condition (control condition: $M = 2.40$, $SD = 1.47$, $t(266) = -.769$, $p = .443$).

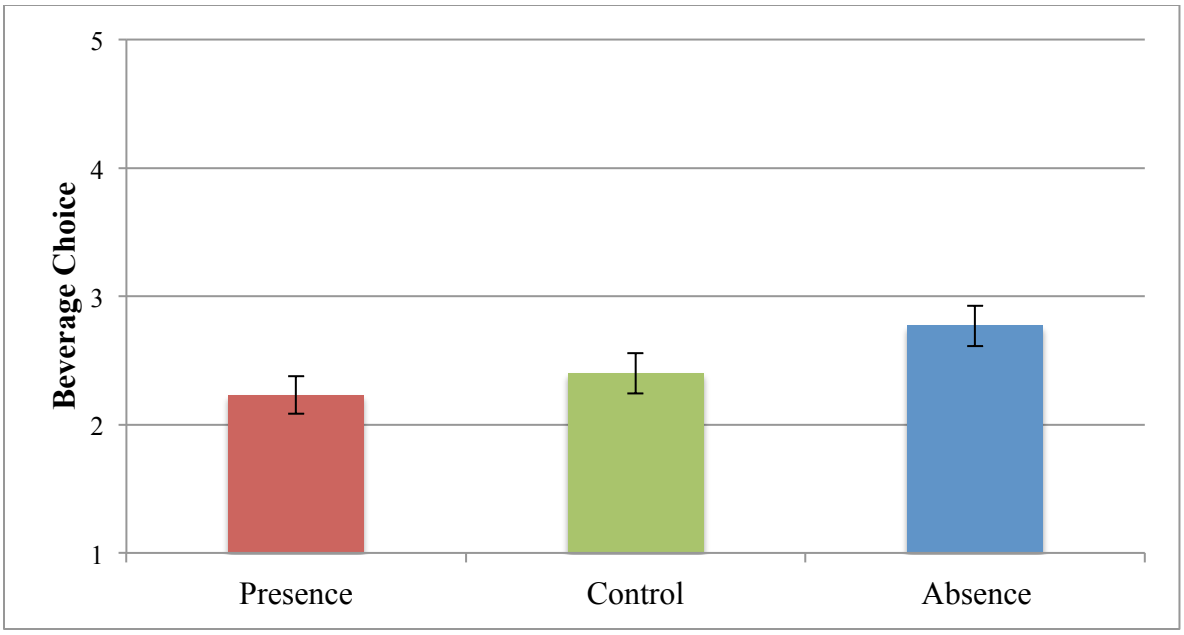

Fig 3.5. Mean beverage choice ratings across conditions (Chapter 3, Study 4). Error bars indicate 1 standard error.

In line with previous studies, no moderation on the effects as a function of age, sex, mood, relationship length, relationship satisfaction, WHOTO scores and whether participants were in long-distance relationship or not was observed[3].

3.1.3 Discussion

The findings from Study 4 showed that thoughts about being separated from the partner were correlated with a reported preference for a warmer drink compared to other conditions. Moreover, consistent with Studies 1-3, thinking about partner absence was associated with a decrease in subjective warmth and lower estimations of the ambient temperature. The imagined absence of the partner seems to induce feelings of coldness and motivates individuals to seek warmth to compensate for those feelings. These findings are in line with past research which showed that when people are socially

[3] 8% of the participants in this study reported being in a long-distance relationship.

excluded or lonely, they would feel colder and be more interested in physically warmer activities such as taking a hot shower or drinking a warm beverage (Bargh & Shalev, 2012; Shalev & Bargh, 2014; Zhong & Leonardelli, 2008; Zhang & Risen, 2014). Overall, this study provides support for the suggestion that feelings of social coldness arising due to the momentary absence of social connections (in this case, imagined absence of one's romantic partner) has two major effects: 1) it changes how individuals perceive their environments (i.e., ambient temperature), and 2) it triggers a regulatory motivation to reduce physical coldness by restoring warmth through physically warm activities (Bargh & Shalev, 2012; IJzerman et al., 2015).

3.2 Study 5

The aim of the present study is to conceptually replicate Study 4, which revealed that individuals who imagined being separated from their partners reported greater interest in a physically warm activity (i.e., drinking a warm beverage) than those who imagined being together with their partners and those in the control condition, and test whether these findings can be extended to socially warm activities. With this aim, participants were given a list of activities that included physically or socially warm activities along with positive (but not warm) control activities and asked to indicate their level of interest in each activity. These measures were borrowed from Zhang and Risen (2014). In line with previous studies, it was predicted that participants who were primed with partner absence would report a greater level of interest in warm (vs. control) activities than those who were primed with partner presence or the control scenario. Similar to Study 4, no significant differences in level of interest in warm or control

activities were predicted to be observed between partner presence and control conditions.

3.2.1 Method

3.2.1.1 Participants

Three hundred and fifty-nine participants who indicated being in a current romantic relationships and living in the United States were recruited from Amazon Mechanical Turk (198 women, M_{age} =38.53, SD = 11.27, modal age=36, $M_{relationship\text{-}length}$ = 103.52 months, SD = 106.4, modal length = 65 months) in exchange of $0.30 for this study. Based on the effect sizes calculated in Studies 1-4 and the effect sizes obtained from similar designs reported in Hong and Sun (2011) and Zhang and Risen (2014), a sample size of at least 60 participants per condition was predetermined for a desired power of 0.80 with an alpha level of 0.05.

3.2.1.2 Design

In this experiment, a between-participant design was employed for the assessment of warmth perception. Participants were randomly assigned to visualize one of the three scenarios: partner presence, partner absence, or grocery shopping (control condition). For the assessment of the interest level in activities, a mixed design was used with condition (partner presence vs. partner absence vs. control condition) and warmth type presented in the activity (social vs. physical) as the between-participant factors and activity type (warm vs. control) as the within-participant factor.

3.2.1.3 Procedure and materials

Overview. The procedure and materials were exactly the same as those described in Study 4 except that instead of completing the beverage choice questionnaire, participants filled out the activity scale immediately after the visualization task. All participants were probed for suspicion after completing the experiment[4].

Measures. ***Interest in Activities.*** Following the manipulation, participants were given a list of 10 activities composed of 5 warm and 5 control activities (e.g., "getting a great haircut"). Participants were randomly assigned to receive either *physically* warm activities (e.g., "reading by the fire") or *socially* warm activities (e.g., "having dinner with a loved one"). The control activities were identical for both conditions. For the list of the activities based on Zhang and Risen (2014), see Appendix I. They were intentionally chosen to be positive (but not warm) to rule out the alternative explanation that the imagined absence of the partner might spark a greater interest in positive activities in general, but not just socially or physically warm ones. Although it was possible that individuals would also be more interested in positive control activities when they thought about partner absence (to compensate for the sadness they were feeling), it was predicted that their interest in engaging in warm activities would still be greater than their interest in control activities and that this difference between their interest levels in warm vs. control activities would be greater than those in other conditions.

Participants rated their level of interest in engaging in each activity on a 9-point scale (1-not interested at all, 9-very much interested). For each participant, a mean interest score in control activities was created by averaging their interest ratings of the

[4] After we re-ran the analyses excluding 7 participants (4 participants in the partner presence condition, 2 participants in the control condition, and 1 participant in the partner absence condition) whose predictions about the study were similar to what the study was aiming to assess, the results remained unchanged.

five control activities (α = .73). A mean interest score in warm activities was created by averaging participants' interest ratings of either five socially warm (α = .85) or five physically warm (α = .65) activities depending on the warmth type (social vs. physical) they randomly received.

3.2.2 Results

Similar to Studies 3 and 4, it was first confirmed that participants thought and wrote about their assigned scenarios. A one-way ANOVA was conducted to compare the difference scores between *sadness* and *happiness* ratings across conditions. It was found that the effect of condition on the difference score between *sadness* and *happiness* ratings was marginally significant ($F(2, 356) = 2.95$, $p = .077$, $\boldsymbol{\eta}_p^2 = .014$). The difference score was significantly smaller for participants in the partner absence condition than those in the partner presence condition as revealed by follow-up planned contrasts ($t(356) = 2.02$, $p = .044$) indicating that participants who imagined being separated from their partners felt significantly worse than those who imagined being in the presence of their partners (partner presence: $M = 3.58$, $SD = 1.98$; partner absence: $M = 2.98$, $SD = 2.51$, $d = 0.26$; see Figure 5.6).

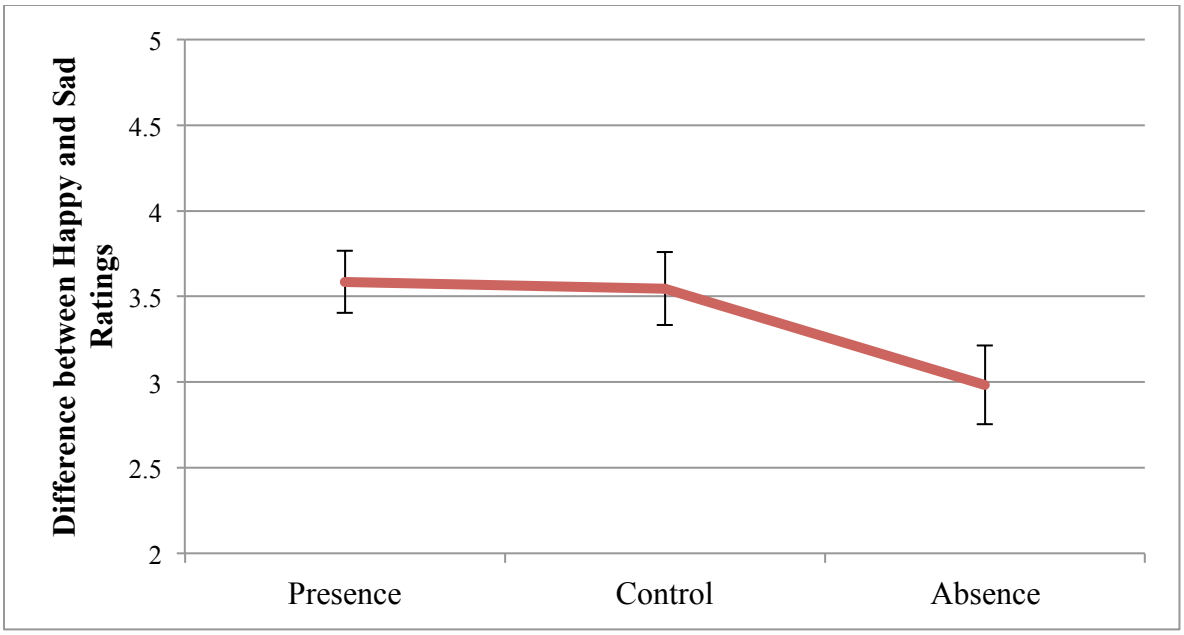

Fig 3.6. Mean difference scores between happy and sad ratings across conditions (Chapter 3, Study 5). Error bars indicate 1 standard error.

Participants in the partner presence condition also reported being significantly more excited than those in the partner absence condition (partner presence: $M = 3.29$, $SD = 1.88$; partner absence: $M = 2.66$, $SD = 1.52$, $t(356) = 2.89$, $p = .004$, $d = 0.37$). No other mood measures were significant. No other mood measures were significant. Another one-way ANOVA showed that condition did not have an effect on how vividly participants were able to imagine their given scenarios ($F(2, 356) = 1.52$, $p = .22$), confirming that all conditions were equally successful in invoking participants' imaginations..

Next, it was explored whether thinking about different scenarios changed participants' perceptions of physical warmth. A one-way ANOVA revealed that the effect of condition on the room temperature estimations was significant ($F(2, 356) = 3.09$, $p = .047$, $\eta_p^2 = .017$). In line with previous findings, this effect was primarily observed due to the significant difference between partner absence and partner presence conditions as

confirmed by follow-up planned contrasts ($t(356) = 2.45$, $p = .015$). In other words, participants who thought about being in close proximity to their partners perceived the room to be significantly warmer than those who thought about being away from their partners (partner presence: $M = 70.38$, $SD = 4.03$; partner absence: $M = 69.15$, $SD = 3.94$, $d = 0.31$; see Figure 5.7).

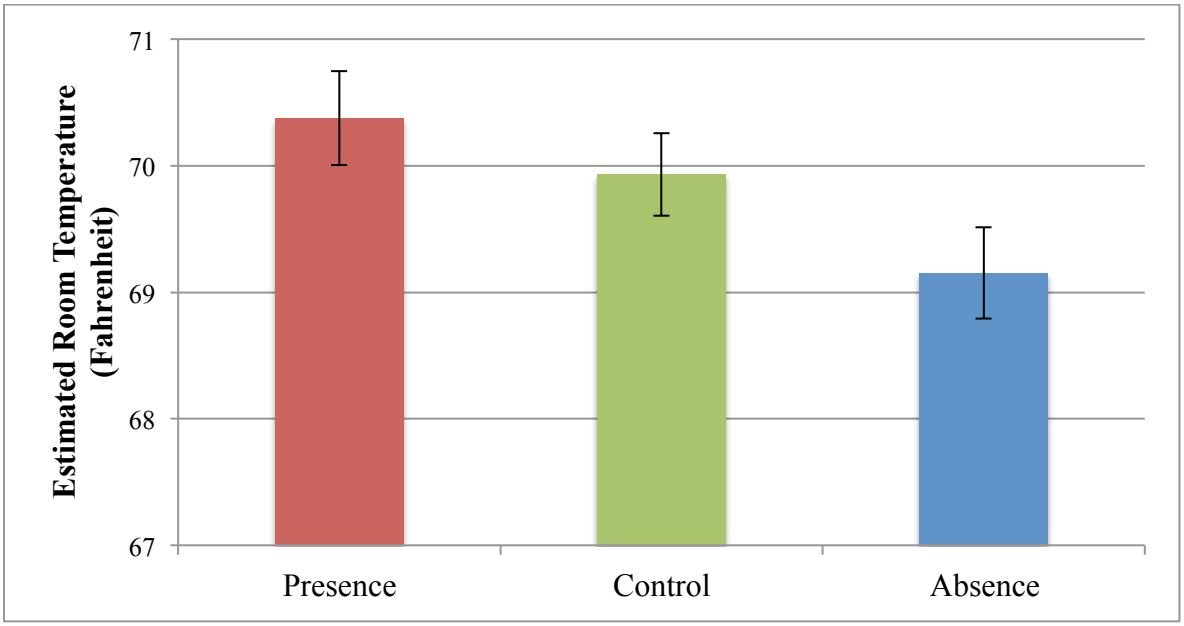

Fig 3.7. Estimated room temperatures (in degree Fahrenheit) across conditions (Chapter 3, Study 5). Error bars indicate 1 standard error.

Similarly, the effect of condition on the subjective warmth ratings was significant ($F(2, 356) = 2.95$, $p = .054$, $\eta_p^2 = .016$) and this effect was driven by the significant difference between partner absence and partner presence conditions $t(356) = 2.34$, $p = .02$ (partner presence: $M = 3.96$, $SD = .68$; partner absence: $M = 3.76$, $SD = .70$, $d = 0.29$; see Figure 5.8).

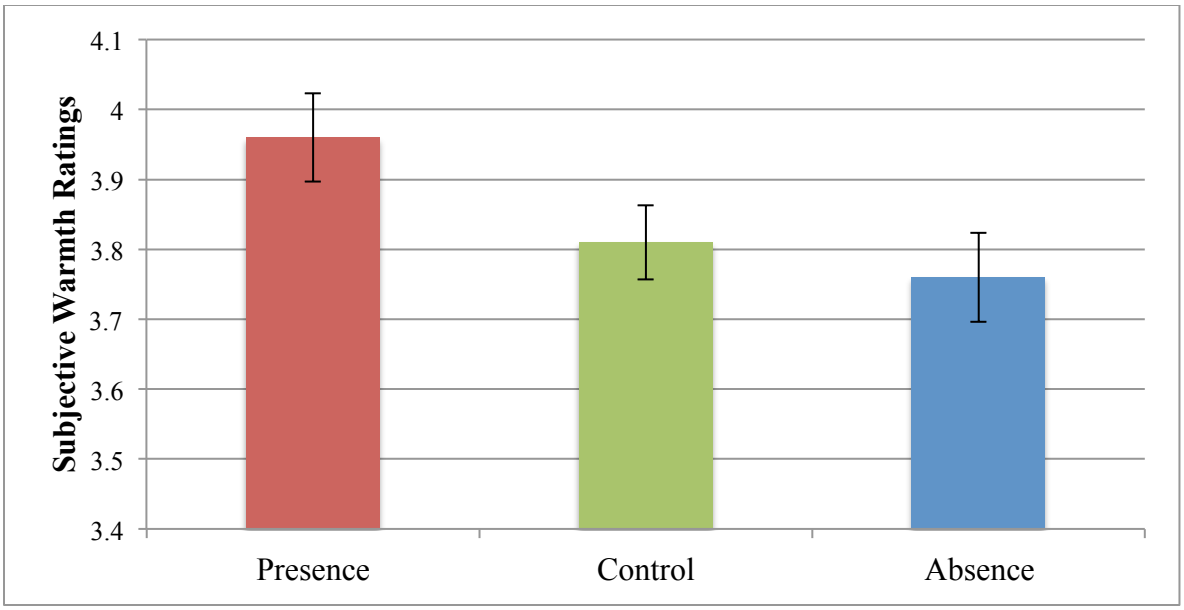

Fig 3.8. Mean ratings of subjective warmth across conditions (Chapter 3, Study 6). Error bars indicate 1 standard error.

Lastly, the effect of condition was found to be significant on the difference scores between coldness and hotness ratings ($F(2, 356) = 3.17$, $p = .043$, $\eta_p^2 = .017$). Follow-up planned contrasts showed that there was a significant difference between partner absence and partner presence conditions (partner presence: $M = -.02$, $SD = 1.7$; partner absence: $M = -.59$, $SD = 1.84$, $t(356) = 2.51$, $p = .013$, $d = 0.32$, see Figure 5.9). Overall, these findings provide converging evidence that visualizing being together with the partner leads to perceiving an increase in physical warmth while visualizing being away from the partner results in a decrease.

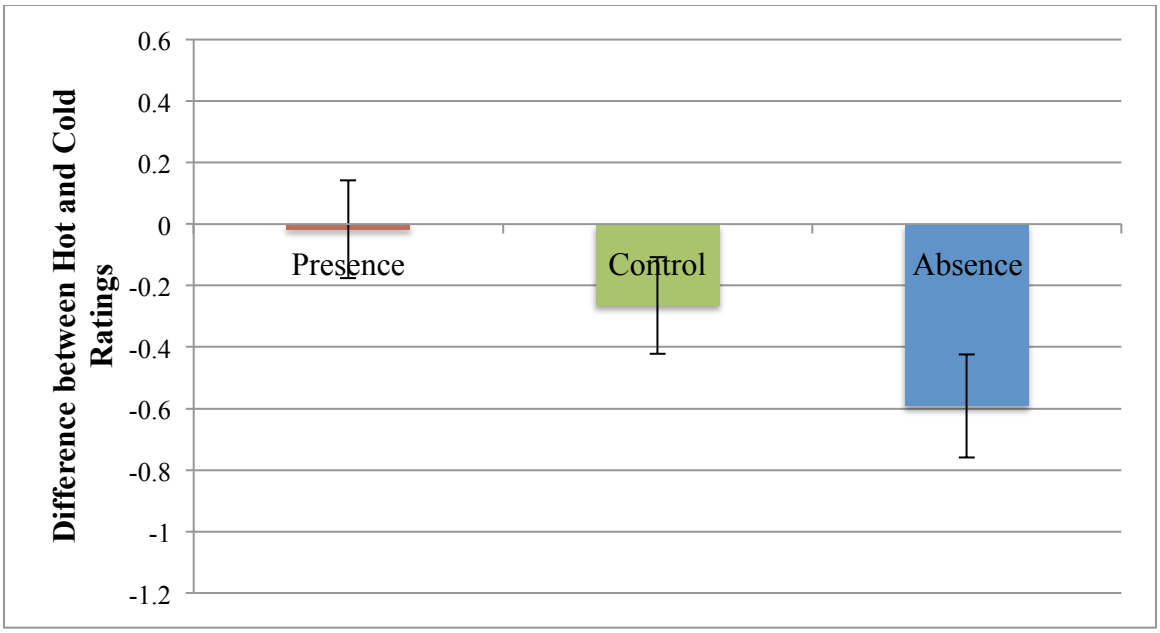

Fig 3.9. Mean difference scores between hot and cold ratings across conditions (Chapter 3, Study 5). Error bars indicate 1 standard error.

As the final step, a 3 (condition: partner presence vs. partner absence vs. control condition) x 2 (activity type: warm vs. control) x 2 (warmth type: social vs. physical) mixed model ANOVA with activity type as a within-participant variable and other variables as between-participant variables was conducted to test whether thinking about different scenarios would have an effect on participants' interest levels in the provided list of activities. It was found that the main effect of activity type was significant, $F(1, 353) = 253.88$, $p < .0001$, $\boldsymbol{\eta}_p^2 = .418$. Across all three conditions, participants indicated a greater interest in warm activities compared to control activities (warm activities: $M = 5.51$, $SD = 1.93$; control activities: $M = 4.15$, $SD = 1.84$; $d = .83$). The interaction between condition and activity type was also significant, $F(2, 353) = 5.56$, $p = .004$, $\boldsymbol{\eta}_p^2 = .031$ indicating that what participants were instructed to imagine had an effect on how much they were interested in social vs. control activities (see Figure 5.10).

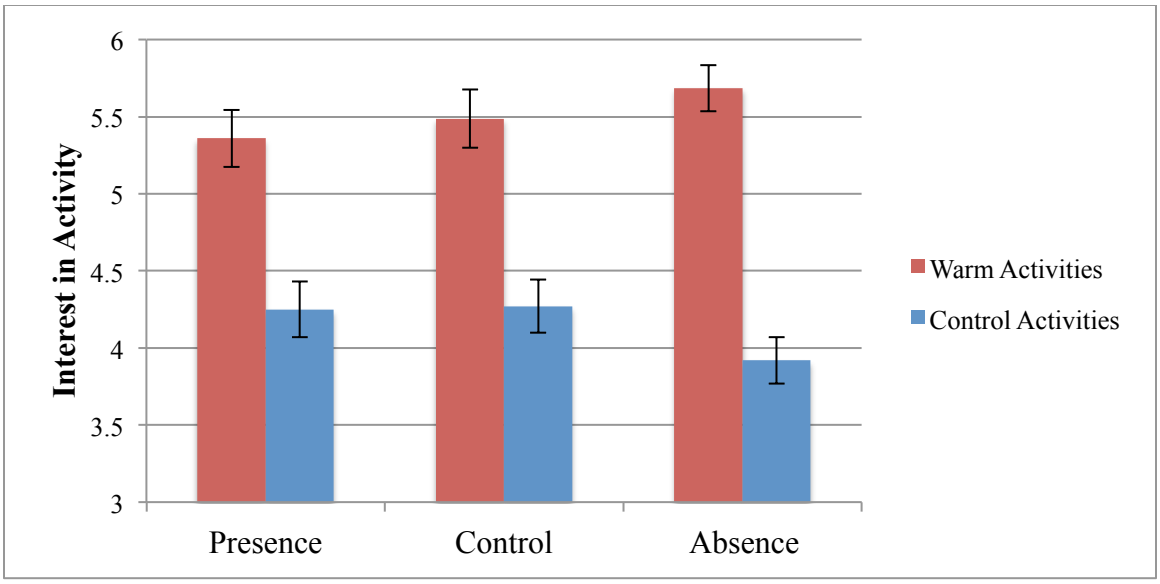

Fig 3.10. Mean interest scores in warm vs. control activities across conditions (Chapter 3, Study 5). Error bars indicate 1 standard error.

To investigate this interaction further, follow-up planned contrasts were conducted using the difference score between the mean interest score in warm activities and the mean interest score in control activities. It was found that this difference was significantly greater for the partner absence condition (M = 1.76, SD = 1.65) compared to both the partner presence condition (M = 1.11, SD = 1.66, $t(356) = -3.10$, $p = .002$, $d = 0.39$) and the control condition (M = 1.22, SD = 1.58, $t(356) = -2.61$, $p = .009$, $d = 0.33$). The difference scores were not statistically different between control and presence conditions ($t(356) = -.504$, $p = .614$). Finally, the three-way interaction between condition, activity type, and warmth type was not significant, $F(2, 353) = .506$, $p = .603$, $\boldsymbol{\eta}_p^2 = .003$ suggesting that the interaction between condition and activity type was similar for both physically and socially warm activities. Therefore, it was concluded that regardless of the warmth type (physical vs. social), participants who imagined being away from their partners indicated a greater interest in warm activities compared to those

who imagined being together with their partners and those who imagined going to the grocery store.

In line with previous studies, the effects reported were not moderated as a function of age, sex, mood, relationship length, relationship satisfaction, WHOTO scores and whether participants were in long-distance relationship or not[5].

3.2.3 Discussion

This study has provided additional converging evidence that imagining the absence of one's romantic partner is correlated with perceptions of social coldness and a greater desire for warm activities. Accordingly, consistent with Study 4, it was found that preference for warm activities, regardless of whether they are physical or social, over control activities was greater for participants who imagined being separated from their partners than those who imagined being together with their partners or those who imagined a trip to the grocery store. To our knowledge, this is the first study to show that feelings of social coldness trigger an interest in socially warm activities as well, not just physically warm activities. Furthermore, the findings revealed that individuals who were primed with thoughts of partner absence perceived their environment to be colder than those who were primed with thoughts of partner presence, thus replicating findings from Studies 1-4. The findings are consistent with social thermoregulation theory as well as social baseline theory, both of which suggest that the availability of momentary social resources –derived from the real or imagined presence of a partner – might affect how individuals perceive their environments and their corresponding cognitive, psychological,

[5] 7.5% of the participants in this study indicated being in a long-distance relationship.

and physiological responses (Beckes & Coan, 2011; Beckes et al., 2015; Coan, 2008; IJzerman et al., 2015; Sbarra & Coan, 2018).

CHAPTER FOUR

GENERAL DISCUSSION

"I imagined her resting her head on my shoulder and feeling relaxed at her warmth." -- A participant describing his thoughts as he was imagining his partner's presence

An important construct that has long been associated with feelings of social connectedness, interpersonal closeness, and security is warmth. Although a growing body of empirical research has consistently demonstrated that physical warmth is closely linked to social intimacy and proximity, extant research has not examined whether the presence of romantic partners is similarly associated with physical warmth. The studies presented in this dissertation demonstrate, for the first time, that imagining romantic partner presence or absence alters thermal perceptions. Across five studies, simply imagining being together with the partner induced feelings of warmth, whereas imagining being separated from the partner induced feelings of coldness. Moreover, thinking about partner absence (vs. partner presence or a control scenario) was associated with a greater interest in warm activities, regardless of they were physical or social. Overall, these findings are highly consistent with the propositions that social warmth (or coldness) triggers feelings of physical warmth (or coldness) and that experiencing social coldness motivates individuals to seek warmth to compensate for those feelings.

Although the effect sizes reported were typically small (*d*s ranging from .24 to .5), they were consistent across studies and also with previous studies reporting similar effect sizes (e.g., IJzerman et al., 2015a; IJzerman & Semin, 2010). Additionally, the fact that the findings were replicated across different samples, designs, and methodologies (with more than 1000 participants in total) demonstrates the robustness of the effects.

4.1. Implications for the Link between Social and Physical Warmth

The implication of the present work for the link between social and physical warmth is threefold. First, current studies provided empirical support for both assimilative and compensatory embodiment effects. Across all five studies, participants who were primed with social coldness (i.e., imagined absence of the romantic partner) reported feeling colder. Conversely, participants who were primed with social warmth (i.e., imagined presence of the romantic partner) reported feeling warmer. On the other hand, two studies (Studies 4 and 5) revealed that participants who were primed with social coldness reported a greater interest in warm activities, regardless of whether the activities were physical or social.

Second, this work extended the well-established findings on the link between social and physical warmth to romantic relationships and showed that partner absence was associated with feeling colder, whereas partner presence was associated with feeling warmer. Third, Study 5 provided the first empirical evidence that social coldness can also motivate individuals to be more interested in socially warm activities. To date, social coldness was linked to a greater interest only in physically warm activities. It should be noted that this finding is not surprising given that participants who experience social exclusion (which has been consistently linked to social coldness) reported a greater desire in making new friends (Maner, DeWall, Baumeister, & Schaller, 2007), attended to smiling faces for a longer time (DeWall, Maner, & Rouby, 2009), and selectively looked more at the eyes of an interaction partner who could potentially reintegrate them to the group (Böckler, Hömke, & Sebanz, 2014).

4.2. Implications for the Regulatory Role of Romantic Partners

The regulatory effect of physical or imagined partner presence has been shown to be operative at multiple levels (i.e., physiology, behavior, affect, and cognition). Although the

thermoregulatory role of romantic partners was not previously explored, theories on social thermoregulation as well as findings from empirical studies on infant-caregiver bonds have been hinting at this possibility. Current findings provided initial empirical support for this possibility demonstrating that imagined partner presence (or absence) had a regulatory effect on individual's perceptions of ambient temperature and subjective warmth.

The present studies also showed that a simple, one-minute long mental simulation of being together with (or away from) one's romantic partner was enough to trigger changes in not only thermal perceptions, but also mood and motivations. Research has shown that imagining an experience in detail can indeed create similar responses as actually experiencing it (Kappes & Morewedge, 2016). Moreover, activating partner representation has previously been found to mitigate negative affect and elevate mood (e.g., Mikulincer et al., 2001; Selcuk et al., 2012). In line with these findings, imagining being together with the partner improved people's moods in addition to inducing feelings of warmth, whereas imagining being away from the partner worsened moods, induced feelings of coldness, and resulted in a greater interest in warm activities. These findings highlight the powerful regulatory effect of partner presence -- real or imagined -- in individuals' daily lives.

An important question that follows from these findings is whether actual body temperatures would vary in response to thinking about partner presence (or absence). Previous studies have, indeed, revealed that social warmth is linked to higher oral temperatures (Inagaki et al., 2016), whereas social coldness is linked to lower skin temperatures (IJzerman et al., 2012). Given the findings about the regulatory role of caregivers on infants' body temperatures, it seems reasonable to expect variations in actual body temperature in response to partner presence (or absence). However, since the effects of mental simulations are not as strong as actual

experiences (Kappes & Morewedge, 2016), future research on this question might benefit from using a different design that allows for actually experiencing partner presence (vs. absence).

Furthermore, employing a daily diary design to investigate the (thermo)regulatory role of imagined or real partner presence might provide a more detailed account of the underlying mechanism of the effects observed in this study. A daily diary design was used by Fetterman and colleagues (2017) to examine whether the link between social and physical warmth was operative in individuals' daily life. Similarly, Diamond and colleagues (2008) conducted a daily diary study to investigate the effects of short-term, temporary separations from the partner . Combining these two ideas, a daily diary study could be designed to examine thermal responses to short-term separations from and reunions with the partner.

Lastly, another important question that stems from the present research is whether the application of physical warmth could be used as a regulatory mechanism to cope with the unavailability of the partner, which could be due to a temporary or permanent separation as well as an argument that leaves partners distressed. It was previously found that individuals use physical warmth as a proxy for social warmth and therefore benefit from holding a warm object after experiencing social exclusion (Bargh & Shalev, 2012; IJzerman et al., 2012). Moreover, a thermoregulatory intervention has been shown to reduce depression levels in patients with depression (Hanusch et al., 2013; see Raison et al., 2015 for a review). There is also a rich literature on the positive relational effects of warm touch (for a review, see Jakubiak & Feeney, 2016), although one should be careful in associating warm physical touch to physical warmth. In one study, physical warmth has been found to be processed differently than touch and overlapping neural activity was only observed between physical and social warmth (but not touch) (Inagaki & Eisenberger, 2003). Although it is not possible to disregard the connection

between physical touch and social affection, more research is needed to understand the role of physical touch in feelings of social warmth.

4.3. Implications for Monitoring Social Connections

The findings from the present investigation provided support for the prediction system that monitors social connections. That is, individuals base their estimations of ambient temperature on their perceptions of the momentary availability of social resources. The availability (vs. unavailability) of social resources is linked to higher (vs. lower) estimates of ambient temperature (IJzerman et al., 2015b). The present work demonstrated that imagining partner presence (vs. absence) was associated with higher (vs. lower) estimates of the room temperature. Thus, partner's imagined physical presence (vs. absence) was perceived as momentary availability (vs. unavailability) of social resources. Additionally, Studies 4 and 5 revealed that when primed with partner absence (vs. presence vs. a control scenario), individuals reported a greater interest in warm activities suggesting that they were motivated to restore warmth by engaging in warm activities.

These findings also fit with Panksepp and colleagues' (1997) idea that thermoregulatory system works as a social monitoring system, which fosters alertness and motivates individuals to seek out social connections in response to coldness. In fact, Panksepp (1998) argued that "the experience of separation establishes an internal feeling of thermoregulatory discomfort that can be alleviated by the warmth of reunion." (p.278).

4.4. The Role of Nonconscious Goal Activation on Compensatory Embodiment Effects

Indeed, what Panksepp describes as *thermoregulatory discomfort* could be the motivation behind individuals' enhanced desire to engage in warm activities in response to social coldness. Past research has used a goal activation account to explain the motivational processes behind the

compensatory embodiment effects (Zhang & Risen, 2014). Using Kruglanski and colleagues' (2002) goal systems framework, researchers have shown that the desire for warm activities would be enhanced when social or physical coldness is unpleasant enough to activate the goal of becoming warm. To this aim, they explicitly drew participants' attention to the unpleasant state (physical or social coldness) they were experiencing.

However, compensatory embodiment effects were still observed in the present work as well as other work (e.g., Bargh & Shalev, 2012; Zhong & Leonardelli, 2008; Zhou et al., 2012) without any interventions to activate the goal of becoming warm in response to being primed with coldness. Given that social and physical warmth have been associated at such an implicit level and individuals are not even aware of the link between social and physical warmth (Bargh & Shalev, 2012), it seems reasonable to speculate that the goal of seeking warmth might actually be getting nonconsciously activated in response to experiencing cold. In fact, in line with the nonconscious goal activation theory (Ferguson, 2008), current studies have revealed that goal-relevant activities (i.e., physically or socially warm activities) were consistently rated more favorably by those who imagined partner absence than those in the partner presence and control conditions. And this effect was not observed for control activities, which were not goal-relevant.

It should be noted, though, nonconscious goal activation did not influence individuals' explicit attitudes toward goal-relevant stimuli in the original study and this was consistent with previous studies (Bargh & Ferguson, 2004; Ferguson, 2008). However, desirability of warm activities was assessed using a Likert scale. In fact, the extant research on the link between physical and social warmth has mainly used explicit measures. For this reason, designing a study on compensatory embodiment effects in which the desirability of warmth is measured using implicit measures would be a novel and essential contribution to the existing literature. In line

with the theory of nonconscious goal activation, participants who experience social or physical coldness (vs. warmth) would be expected to automatically evaluate warmth more positively.

4.5. General Summary and Conclusions

The studies presented in this dissertation were the first studies to investigate the link between romantic partner presence and perception of physical warmth. Five studies have revealed that imagining romantic partner presence or absence altered thermal perceptions. Specifically, imagining partner presence was associated with feeling warmer, whereas imagining partner absence was associated with feeling colder. Moreover, participants who were primed with partner absence (vs. partner presence or a control scenario) reported a greater interest in activities that would induce warmth. Together, these studies are the first to extend the consistent findings on the link between social and physical warmth to romantic relationships and document that just thinking about being together with (away from) a romantic partner can induce feelings of warmth (coldness), providing further evidence for the regulatory role of romantic relationships and the robust link between physical warmth and interpersonal affection.

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Appendix

Appendix A: Experiences in Close Relationships – Revised – Short Version

Please take a moment to think about how you typically feel, think, and behave in romantic relationships with your partner. Respond to each statement by indicating how much you agree or disagree with it.

Strongly disagree			**Neutral/Mixed**			**Strongly agree**
1	**2**	**3**	**4**	**5**	**6**	**7**

_____ 1. I worry that my partner thinks that I don't measure up to other people.
_____ 2. I feel comfortable sharing my private thoughts and feelings with my partner.
_____ 3. I worry a lot about my relationship with my partner.
_____ 4. I find it difficult to allow myself to depend on my partner.
_____ 5. I often worry that my partner doesn't really love me.
_____ 6. I am very comfortable being close to my partner.
_____ 7. I worry that my partner doesn't care about me.
_____ 8. I don't feel comfortable opening up to my partner.
_____ 9. My partner makes me doubt myself.
_____ 10. I prefer not to show my partner how I feel deep down.

Scoring: Odd-numbered questions assess attachment-anxiety, whereas even-numbered questions assess attachment-avoidance. The second and sixth questions are reverse scored. Higher scores indicate higher avoidance and anxiety.

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Appendix B: WHOTO Scale – Revised – Short Version (Studies 1 & 2)

Below you are asked to list people who are significant in your life. Rather than providing their names, answer with a term that defines how they are related to you (e.g., mother, boyfriend, sister). If you write in more than one person, list them in order of significance, starting with the most significant.

Note:
1. Please DO NOT use terms like "family" or "friends" that refer to more than one person.
2. If you are including more than one "friend"/"housemate"/etc. on your list, please specify which individual you are referring to (i.e., friend1, friend2, and so on).
3. There is no need to fill in all of the boxes.

1. Person(s) you make sure to see or talk to frequently.

A _____

B _____

C _____

D _____

2. Person(s) you seek out when worried or upset.

A _____

B _____

C _____

D _____

3. Person(s) whose absence make you feel like something is not quite right.

A _____

B _____

C _____

D _____

4. Person(s) you know will always be there for you.

A _____

B _____

C _____

D _____

Appendix C: Instructions for Visualization Tasks (Studies 1 & 2)

Partner Presence **Condition:** Imagine as vividly as possible that your partner is sitting right next to you. Spend the next minute thinking about what you would most enjoy and how that would make you feel.

Partner Absence **Condition:** Imagine as vividly as possible that your partner has to be away from you for a week. Spend the next minute thinking about what you would most miss and how that would make you feel.

Appendix D: Manipulation Checks Used in Studies 1 & 2

Mood Scale:

Please answer the following questions based on how you feel AT THE MOMENT.

	1	2	3	4	5	6	7	
Sad	○	○	○	○	○	○	○	Happy
Good	○	○	○	○	○	○	○	Bad
Angry	○	○	○	○	○	○	○	Pleasant

Vividness Questions

Not at all						**Extremely**
1	**2**	**3**	**4**	**5**	**6**	**7**

***Partner Presence* Condition:** How vividly were you able to imagine the presence of your partner right next to you?

***Partner Absence* Condition:** How vividly were you able to imagine the week-long separation from your partner?

Appendix E: WHOTO Scale – Revised – Short Version (Studies 3 - 5)

Please answer the following questions about your partner.

	Yes	No
Is your partner on the short list of special people you are in touch with most frequently?	o	o
Is your partner number one on the list of people you are in touch with most frequently?	o	o
Is your partner on the short list of special people you turn to when you need comfort?	o	o
Is your partner number one on the list of people you turn to when you need comfort?	o	o
Is your partner on the short list of special people you miss most when they are away?	o	o
Is your partner the number one person you miss most when they are away?	o	o
Is your partner on the short list of special people you know will always be there for you?	o	o
Is your partner the number one person you know will always be there for you?	o	o

Appendix F: Instructions for Visualization Tasks (Studies 3 - 5)

Partner Presence **Condition:** Imagine as vividly as possible that your partner is sitting right next to you. Spend the next minute thinking about what you would most enjoy and how that would make you feel.

Partner Absence **Condition:** Imagine as vividly as possible that your partner has to be away from you for a week. Spend the next minute thinking about what you would most miss and how that would make you feel.

Control **Condition:** Imagine as vividly as possible that you are going to the grocery store right now. Spend the next minute thinking about what you would buy and how you would spend your time at the grocery store.

Appendix G: Manipulation Checks Used in Studies 3 - 5

<u>Mood Scale:</u>

Please answer the following questions based on how you are feeling RIGHT NOW:

	Not at all			Somewhat			Extremely
How CALM are you right now?	○	○	○	○	○	○	○
How COLD are you right now?	○	○	○	○	○	○	○
How HAPPY are you right now?	○	○	○	○	○	○	○
How HOT are you right now?	○	○	○	○	○	○	○
How ANGRY are you right now?	○	○	○	○	○	○	○
How SAD are you right now?	○	○	○	○	○	○	○
How HUNGRY are you right now?	○	○	○	○	○	○	○
How EXCITED are you right now?	○	○	○	○	○	○	○
How TIRED are you right now?	○	○	○	○	○	○	○
How ANXIOUS are you right now?	○	○	○	○	○	○	○

Vividness Questions

***Partner Presence* Condition:** How vividly were you able to imagine the presence of your partner right next to you?

***Partner Absence* Condition:** How vividly were you able to imagine the week-long separation from your partner?

***Control* Condition:** How vividly were you able to imagine your trip to the grocery store?

- ○ I was unable to imagine it at all. (1)
- ○ I was just barely able to imagine it. (2)
- ○ I was able to imagine it a little. (3)
- ○ I was able to imagine it. (4)
- ○ I was able to imagine it pretty well. (5)
- ○ I was able to imagine it really well. (6)
- ○ I was able to imagine it vividly. (7)

Appendix H: Beverage Choice Question Used in Study 4

Given the choice, what would you prefer to drink RIGHT NOW?

- ○ An icy cold beverage (1)
- ○ A slightly chilled beverage (2)
- ○ A room-temperature beverage (3)
- ○ A slightly warm beverage (4)
- ○ A steaming hot beverage (5)

Appendix I: List of Activities Used in Study 5

List of Activities – Physically Warm

How interested are you doing the following right now?

Not at all interested								Very much interested
1	2	3	4	5	6	7	8	9

1. Getting a great haircut
2. Drinking a hot beverage
3. Listening to a provocative lecture
4. Working on a New Year's resolution
5. Reading by the fire
6. Taking a hot bath or shower
7. Successfully building something by yourself
8. Eating delicious homemade soup
9. Sunbathing on the beach
10. Having your plane arrive one hour early when traveling

List of Activities – Socially Warm

How interested are you doing the following right now?

Not at all interested								Very much interested
1	2	3	4	5	6	7	8	9

1. Getting a great haircut
2. Visiting a close other
3. Listening to a provocative lecture
4. Working on a New Year's resolution
5. Having dinner with a loved one
6. Buying a gift for someone you love
7. Successfully building something by yourself
8. Looking at a photo album filled with pictures of loved ones
9. Receiving encouragement from someone regarding a life challenge you are facing
10. Having your plane arrive one hour early when traveling