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Temperature Perceptions as a Ground for Social Proximity

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Keywords: embodiment, social cognition, interpersonal relations, warmth
Word Count (Excluding Abstract & References, Including Footnotes): 6,621
Submitted 16/12/2009 to Journal of Experimental Social Psychology
Revision submitted 23/03/2010 to Journal of Experimental Social Psychology
Second Revision submitted 09/07/2010 to Journal of Experimental Social Psychology
Accepted 17/07/2010 in Journal of Experimental Social Psychology

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Abstract

Literature in interpersonal relations has described the sense of intimacy towards others in terms of physical closeness and warmth. Research suggests that these descriptions should be taken literally. Past work (IJzerman & Semin, 2009) revealed that temperature alterations affect the construal of social relations. Lakoff and Johnson (1999) suggest that such findings are unidirectional. However, recent research indicates that the recollection of social exclusion induces perceptions of lower temperature (Zhong & Leonardelli, 2008). In this work, we elaborate on these findings to provide new insights into processes central to interpersonal relations. In four studies, we hypothesized and found that actual *physically* induced experiences of proximity not only increase feelings of social proximity but more importantly perceptions of higher temperature. Moreover, we show that *verbally* induced social proximity also induce perceptions of higher temperature. The broader implications of these findings for interpersonal relations are discussed.

Temperature Perceptions as a Ground for Social Proximity

People often describe their feelings as warm when they are thinking about a trustworthy and loving partner. Conversely, popular culture often describes the absence of a partner as giving rise to a cold, distant sensation. Such feelings might appear as a result of physical distance from a partner, or worse, upon hearing those awful words that end a relationship and puts the beloved away from the self psychologically. The concept of warmth has in fact been identified in social psychological research as a central concept driving how people perceive others (Asch, 1946; S. T. Fiske, Cuddy, & Glicke, 2007). As recent findings have indicated, such descriptions about temperature and interpersonal closeness should be taken literally (see also Lakoff & Johnson, 1999). The experiences and recollection of social exclusion truly induce perceptions of coldness and desire for warmth (Zhong & Leonardelli, 2008). In earlier work, we (IJzerman & Semin, 2009) found that changes in ambient temperature alter relationship construal, perception, and communication. In the current article, we introduce a grounded perspective on interpersonal relations and report research that examined how physically as well as verbally induced feelings of social proximity lead to changes in perceptions of ambient temperature. We conclude by discussing implications of our findings on temperature perception for research in interpersonal relationships.

A common approach to conceptualize interpersonal relationships is by focusing on cognitive outcomes of relationships, such as mental representations expressed in descriptions of the relationship, amounts of pronouns used in relation to the partner, etc. (cf. Agnew, Van Lange, Rusbult, & Langston, 1998). This has been called 'cognitive interdependence'. Cognitive interdependence commonly generalizes over specific situations in which the situation's participants reflect upon relation between self and other. The cognitive outcomes are reflective inferences, which can lead to an inaccurate assessment of the relationship (q.v. Nisbett & Wilson, 1977). In the current paper, we append to these highly abstracted cognitive

outcomes in relationships. The focus is on the *sine qua non* of the relationship, namely its experience. We examined the importance of the experience of the relationship by inducing proximity of another person verbally or physically. Our conceptualization of relationships is based on recent views in grounded cognition (often referred to as *embodiment).*

Grounding Relations in Situations

Grounded cognition (for an overview, see Semin & Smith, 2008) is an alternative to the view that higher-level mental content is driven by abstract, language-like representations (Fodor, 1975). In the newly emerging cognitive sciences that were also embraced by psychology, the human mind was compared to a computer as a solitary processing unit. In this mind-as-computer metaphor, human cognition was divorced from its sensorimotor bases, and seen as independent from action, perception, and introspection. Instead of a Cartesian perspective of a mind separated from a body, psychological research in the last decade has now recognized the importance of a unity between mind and body with the body in interaction with other agents in the world (see also Sheets-Johstone, 2009). A wide of array of research now supports the view that human cognition is grounded in and shaped by sensorimotor experiences (for an overview, see Barsalou, 2008).

This idea of grounded cognition was recognized and extended to human interactions and expressed in one of the most basic elements of A. P. Fiske's relational model, Communal Sharing (CS). CS relationships emphasize the common essence between participants that connect their bodies. CS relationships are grounded in people's actions that later become abstracted, forming the basis to communicate about and for norms regulating relationships. The common essence, as A. P. Fiske (2004) suggests, is grounded in actions that connect people's bodies (giving birth, feeding, empathic sex, grooming, etc.). The contact between bodies represents the equivalence of and evokes a feeling of 'oneness' between persons.

The proposal that a feeling of oneness is tied to action connecting people's bodies has been examined in parallel by researchers in social cognition, who investigated whether social concepts such as psychological closeness are perceptually processed (IJzerman & Semin, 2009; Paladino, Mazzurega, Pavani, & Schubert, in press; Williams & Bargh, 2008a&b; Zhong & Leonardelli, 2008). These social concepts are experienced in *situations* entailing concrete experiences in interpersonal relationships, for example eye-gaze, smiling, physical distance, or approach or avoidance postures (see also Argyle & Dean, 1965). These situations are experienced and conceptualized in childhood (cf. Lakoff & Johnson, 1999), though they might also be evolutionarily prepared proclivities (cf. Cohen & Leung, 2009). Such situations become abstracted only later and co-expressed in metaphors. The psychological or social distance to another person is thus a more abstracted version of the direct physical distance when in interaction with this other person.

Earlier views converging on A. P. Fiske's notion of common essence comes from Bowlby (1969) who argues for the importance of (1) close physical contact and (2) warm feelings to the parent during infancy as a prerequisite for many animals to survive. People thus first come to understand social relations through situations of physical prioximity and warmth. Subsequently, they attach non-perceived, abstracted aspects *to* these situations through which they make inferences *about* these situations (Schubert & Koole, 2009). We will first address this association of physical proximity with social relations and warmth, after which we will discuss the concept of social relations in terms of temperature perceptions.

Grounding Interpersonal Relations in Physical Proximity

Physical closeness between people influences affiliative behaviors in general; when their intimate space is violated, people will gaze less towards one another while a distance too large will increase eye gaze, arguably to balance the social distance equilibrium (Argyle & Dean, 1965). Williams and Bargh (2008b) indicated the importance of this spatial

representation to social concepts; when increasing spatial distance between self-irrelevant objects, participants show greater enjoyment of embarrassment of other people, less distress from violent media, lower estimates of calories in unhealthy food, and less emotional attachment to family and hometowns.

Williams and Bargh' (2008b) research supports the idea that physical distance or proximity shapes much of people's social life. The importance of perception of physical proximity has been recognized as one of the major means to measure social relations in the relationship literature as exemplified by the Inclusion of Self in Other-scale (IOS; Aron, Aron, & Smollan, 1992). The IOS utilizes a representation of physical distance to indicate a degree of intimacy and feelings of interpersonal closeness towards others (both in terms of feeling and behaving, see Aron et al., 1992). This type of scale has proven effective to relate feelings of social distance with connectedness to other ingroup members (Tropp & Wright, 2001), forgiveness (McCullough, et al. 1998), other cognitive measures of closeness (Aron, Aron, Tudor & Nelson, 1991), etc. In prior research, we also found that participants in a warm condition revealed a sense of greater physical proximity than those in a cold condition, expressed in the IOS (IJzerman & Semin, 2009).

Grounding Interpersonal Relations in Warmth

Social psychologists have often used a semantic concept of (psychological) warmth to indicate different levels of social relationships between people. For example, people recruit warmth and coldness to describe their social relations, and when judging others, people predominantly do so on (psychological) warmth (Asch, 1946; S. T. Fiske, et al., 2007). S. T. Fiske et al. (2007) argued that judgments on (psychological) warmth determine the likelihood to approach or avoid another, making judgments on (psychological) warmth (versus hostility) a fundamental aspect of evaluation. They also suggested that the concept of warmth is central to human survival, as its detection displays whether another's intentions are trustworthy.

Further, the concept of (psychological) warmth has been viewed as an important dimension in romantic relationships: for example, Simpson, Rholes, and Philips (1996) found that couples that were judged as 'warmer' reported less distress and anger in their relationship.

In addition, Lakoff and Johnson (1999) proposed that people conceptualize social relations in physical experiences of temperature related to the connection between bodies. They posed that people first co-experience (source) situations in which physical experiences are tied to more abstract (target) representations of affection, which are later co-expressed in metaphors (e.g. 'a *cold* fish' or 'a *warm* embrace'), when explicit reflection or communication about these social relations is required. Already in infancy, people co-experience close contact, affection, and warmth when held by the caregiver (q.v. Lakoff & Johnson, 1999). Williams and Bargh (2008a) tested the resulting hypothesis that the actual physical sensation of warmth can influence social relations. They found that participants saw a target person as more sociable and were themselves more generous in a physically warm condition as compared to a physically cold condition. We further investigated this concept and found that warm conditions (as compared to cold conditions) shape participants' language use and perception related to social relations. By indicating that participants also felt closer to others in warmer conditions, we built upon Williams and Bargh's (2008a) concept of affection to a more direct construal of social proximity. Moreover, our results support that the experience of interpersonal relations is influenced by contextual cues. These environmental cues thus change the manner in which people utilize language and perceive the environment as a function of their perception of social distance (IJzerman & Semin, 2009).

Social Proximity Altering Temperature Perceptions

Recent research has addressed the question whether processing abstract concepts activates specific concrete experiences. Lakoff and Johnson (1999) suggested that the co-occurrence of an abstract concept and a concrete experience possesses an asymmetric

character, with inferences flowing in one direction only. This argument is underlined in research by Casasanto and Boroditsky (2008) who found that priming the experience of space affected how people represented time, but priming information about time did not influence how people processed the concept of space. Recent evidence by Zhong and Leonardelli (2008) has suggested that this asymmetric relationship between a target domain and a concrete experience does not hold for social relations; people perceived lower temperatures and preferred warm food when they recalled or virtually experienced social exclusion. In other words, the social relations that people experience in situations from early on in life are embodied and are only later in life abstracted when people communicate about them in metaphor or otherwise. Yet, one should raise the question whether participants, after social exclusion, experience *cold* anger or *cold* distance. Indeed, participants become more aggressive after they have been excluded in experiments (Warburton, Williams, & Cairns, 2005). In the current research, we thus extend Zhong and Leonardelli's (2008) research to situate interpersonal relations in a wider framework of abstractions from sensorimotor representations.

Overview of the Current Studies

In our research, a first test was to investigate whether a sense of social distance experienced in terms of experimentally induced physical proximity extended to perceptions of temperature perception. Furthermore, we wanted to abstract experiences of physical proximity into feelings of closeness (or distance) primed through language, as "much of (our) mental representation of the physical world is in fact constituted not out of direct experience but out of reused perceptual representations, with the reuse guided by what we hear in language" (Boroditsky & Prinz, 2008, p. 112). Thus, Experiments 1 through 4 tested whether a verbally induced sense of social proximity or distance induces perceptions of higher or lower temperature. Across four studies, we thus tested two central ideas, namely that (1) greater

physical proximity induces a perception of higher temperature, and (2) greater social proximity (or distance) manipulated through semantic primes induces perceptions of higher (or lower) ambient temperature. It is important to note here that such perceived differences in temperature are subtle and automatic; we thus predicted that perceived temperatures centered on comfortable ranges of actually measured temperatures.

Experiment 1: *Being* Closer and Feeling Warmer

In prior research, we found that putting people in higher temperature rooms induced a sense of reduced social distance towards another person (IJzerman & Semin, 2009). Furthermore, Zhong and Leonardelli (2008) found that participants felt *colder* after social exclusion. Williams and Bargh (2008b) demonstrated the relevance of spatial representation to social concepts. We now wanted to test the hypothesis more directly to examine whether a directly experienced sense of *social proximity* induces feelings of warmth. In the current experiment we thus predicted that physical closeness leads participants to perceive a higher ambient temperature.

We placed participants either close or far from two confederates; temperature perception was asked under the guise of a laboratory test. Participants were asked to estimate ambient temperature (in degrees Celsius). This targeted temperature question was embedded in a list of questions in the laboratory test, in order to hide the purpose of the experiment.

Method

Participants

Fifty (*only* native Dutch, 72% female, $M_{age} = 21.0$, $SD_{age} = 3.69$) Utrecht University students were recruited via leaflets around campus and paid 2 Euros for 5-10 minutes participation. Twenty-four were in the far condition; twenty-six were in the close condition.[1]

Procedure

One participant joined two other 'participants' (whom they did not know and in reality were confederates blind to the experiments' purpose), in a room where temperature was held constant. They were placed in a triangular position standing at a lectern either close (50 centimeters) or far (270 centimeters)[2] from the confederates. Given that participants' body heat could have potentially altered temperature perception between the close- and far-conditions, we hid a thermometer under the participant's lectern (outside the view of the participant), which was read at the end of the experiment.

Confederates (one male and one female) switched positions across participants, such that for half of the participants the male was standing on the participant's left. In order to call attention to the others, participant and confederates were first asked to describe one another in terms of what the person does or who the other is in terms of relationships or categories. This first test was an ostensible task about the intuition of strangers, where participants, without any prior knowledge about the others, were to generate as much information about this stranger as possible. Confederates in reality were instructed (prior to the experiment) not to write about the other but merely write about what they opted for. Consequently, we asked participants to engage in an ostensibly unrelated laboratory test. They were asked to estimate ambient temperature (in degrees Celsius) and to judge the laboratory on 7-point Likert-scales on temperature-comfort, space, crowdedness, ceiling-height, noise, light, and perceived freedom.[3] Our targeted temperature question was embedded in a list of questions, in order to hide the purpose of the experiment.

Results

A univariate analysis of variance revealed that participants who were placed closer to the confederates perceived a significantly higher ambient temperature (M = 19.88, SD = 1.75) than those placed further (M = 19.33, SD = 1.31), F (1, 48) = 4.25, p = .045, η_p^2 = .083 (Cohen's d = .36) [4], thereby confirming our hypothesis that physical closeness induces a

perception of higher ambient temperature. A viable alternative explanation is that body heat might have altered the actual temperature. We therefore analyzed the real temperature measured *in between* the participant and the confederates per round of the experiment and found no significant differences between the close and far condition, F (1, 49) = .678, p = .414.

Experiment 2: The Warmth of Similarity, An Internet Test

A subsequent test was to test whether a higher degree of semantically primed feelings of closeness would lead to perceptions of different ambient temperatures. Semantically primed feelings of closeness are abstracted versions of a relationship with another person, as compared to the direct physical distance experienced with the other. According to research on interpersonal relationships, people draw inferences about others on the basis of available, salient information about the other. When this information portrays a larger amount of information on similarity particularly in attitudes, background, and to a lesser degree in personality, people are suggested to feel a greaterq sense of similarity with the other (Heider, 1958). We thus asked participants to pick an avatar under the guise of an investigation of intuition and personality and name either three or ten similarities about a stranger on the basis of the avatar the other had ostensibly picked.

A greater sense of similarity induces a greater amount of intimacy (e.g. Reis & Shaver, 1988), which leads people to be more likely to ‘confuse’ themselves with the other, indicating psychological closeness (Aron, et al., 1991). We predicted, in line with our first study, that naming a greater amount of information on similarities leads to a perception of higher ambient temperature. In the first part of this experiment we predicted that naming more similarities leads to feeling more similar to the target person. In the second part of this experiment we predicted that naming more similarities leads to perception of higher ambient temperature.

However, the generation of a greater number of similarities is not indubitably linked to a greater feeling of similarity (and thus higher ambient temperature). Research on ease-of-retrieval showed that across different reports, accessibility of content has played a major role in attitude judgments and moods (Schwarz, 1998), memory judgments (Winkielman, Schwarz, & Belli, 1998), etc. In these studies, participants found it more difficult to recall many than few chunks of information making them rely on different strategies for recall. In the current set of studies, we asked participants to name either three or ten interpersonal judgments about a target-participant in agreement (or disagreement) with their own personality, *after* participants had described themselves extensively. In order to rule out the hypothesis that people would rely on different strategies for recall because of ease-of-retrieval processes, it is important to test whether participants find it more difficult to name chunks of interpersonal information (and would thus be hindered by an availability heuristic in either recalling three or ten similarities with the target-participant).

In short, we thus hypothesized that participants 1) feel more similar after naming more similarities. Because of the expected greater sense of intimacy, we also predicted that participants 2) feel *warmer* after naming more similarities. On the basis of these predictions, we further suspected that participants 3) should not be hindered by an availability heuristic, given that they were asked to describe themselves extensively prior to the task and were asked to generate relatively easy interpersonal judgments. In order to prevent participants to guessing the target of our study, we split this study in two different parts (with two different samples). We reported the study here jointly due to the high degree of similarity in the two tests. The purpose of these internet experiments (often characterized by greater error variance due to lack of control, see also Birnbaum, 2004) was to test the proposed method for the laboratory.

Method

Participants

In the first part of the study, eighty-three (75.9% female, $M_{age} = 27.1$, $SD_{age} = 9.61$[1]) participants took part in an internet-based study. Fifty-seven were in the few similarities-condition; twenty-six in the many similarities-condition. In the second part of the study, forty-nine (92.2% female, $M_{age} = 26.4$, $SD_{age} = 9.56$) participants took part in an internet-based study. Twenty-six were in the few similarities-condition; twenty-three in the many similarities-condition. In both studies, participants were randomly assigned to conditions. Gift certificates of 25 Euros were raffled off in exchange for participation in both studies.

Procedure

Participants entered the experiment via a link that was distributed by e-mail to an existing participant pool, via a link advertised at http://www.in-mind.org, and via Hyves, a Dutch social networking site. Ostensibly, participants were taking part in an experiment linking intuition to personality. They were first requested to choose one of five Chinese ideograms as an avatar to represent themselves. Afterwards, they were requested to describe themselves in terms of categories, behavior, and personality (supposedly linking their 'personality' to the avatar). Subsequently, they were shown a Chinese ideogram different from the previous five and were told that this ideogram was chosen by a previous participant, who had also described him/herself. In our experimental conditions participants were asked to 'examine the avatar and name three/ten similarities with the other' on the basis of the avatar. Participants were told that this experiment was designed to establish a link between intuition about an image and personality.

In the first part, we asked participants, after a set of unrelated questions, how similar they felt to the target participant (1 (not similar at all)-7 (very similar)). In the second part, again after a set of unrelated questions, we asked participants to estimate the ambient room

temperature (in degrees Celsius) without examining the thermometer and how difficult they found the task (on a scale from 1 (not difficult at all)-7 (very difficult)).

Results

For the first part of this test, an independent samples t-test revealed that participants who were in the many similarities-condition (M = 4.58, SD = 1.55) felt marginally significantly more similar to the target-participant than participants in the few similarities-condition (M = 3.95, SD = 1.49), t (82) = -1.76, p = .082, Cohen's d = -.41, confirming our hypothesis that an increase in naming similarities induced a feeling of similarity towards a 'stranger'.

A univariate analysis of variance revealed that participants who were in the many similarities-condition (M = 20.62, SD = 3.92) perceived a marginally significantly higher ambient temperature than participants in the few similarities-condition (M = 18.05, SD = 5.58), F (1, 48) = 3.95, p = .052, η_p^2 = .069 (Cohen's d = .53), suggesting that verbally primed feelings of social proximity literally *feel* warmer. In order to investigate whether task difficulty caused the feelings of warmth rather than similarity feelings, we conducted another univariate analysis of variance with task-difficulty inserted as covariate. This analysis revealed a similar result; participants who were in the many similarities-condition (M = 20.89, SD = 4.15) perceived a marginally significantly higher temperature than participants in the few similarities-condition (M = 18.01, SD = 5.69), F (1, 47) = 3.25, p = .078, η_p^2 = .066 (Cohen's d = .58), supporting our hypothesis that verbally primed feelings of social proximity literally *feels* warmer. Additionally, participants in the many similarities-condition did not find the task more difficult than participants in the few similarities-condition, F (1, 48) = 1.91, p = .173, confirming our hypothesis that giving person judgments in relation to the self, after giving an extensive description about the self, is not more difficult for many chunks of information than few chunks of information.

Experiment 3: The Warmth of Similarity, Lab Confirmation

In our internet studies, we found that a verbal manipulation of social closeness led to a perception of higher ambient temperature, while generating similarities was not more difficult in the ten similarities condition than in the three similarities condition. However, internet research in certain type of experiments is characterized by a lack of control over experimental conditions (such as temperature) or the manner in which participants complete the experiment, possibly creating greater error variance (see also Birnbaum, 2004). Differences in room temperatures in people's room could have potentially explained our effect or the marginal character of our effects. In the following experiment, we thus wanted to replicate our marginally significant findings that people perceive a higher temperature when naming ten similarities than when naming three similarities in a laboratory. We conducted a similar experiment, however now under the guise of a laboratory test (also employed in Experiment 1). Again we predicted that when people name more similarities, they would perceive the ambient temperature to be higher.

Method

Participants

Seventy (67.1% female, $M_{age} = 22.1$, $SD_{age} = 2.00$) Utrecht University students were recruited via leaflets around campus and paid 2 Euros for 15 minutes of participation. Thirty-four were in the few similarities-condition; thirty-six in the many similarities-condition.

Procedure

The procedure was similar to the one used in Experiment 2. Participants were first requested to choose one of five Chinese ideograms as an avatar to represent them. Afterwards, participants were again requested to describe themselves in terms of categories, behavior, and personality (supposedly linking their 'personality' to the avatar). Subsequently, they were shown a Chinese ideogram that was different from the previous five and were told that this

ideogram was chosen by a previous participant, who had also described him/herself. In our experimental conditions participants were asked to 'examine the avatar and name three/ten similarities with the other' on the basis of the avatar.

However, instead of asking how similar participants felt to the other, we now asked participants to engage in the ostensibly unrelated laboratory test. We used the same dependent variables as in Experiment 1, asking participants to estimate the ambient temperature (in degrees Celsius). The targeted temperature question was again embedded in a list of questions, in order to hide the purpose of the experiment. After placing the participant in a cubicle, the experimenter (unbeknownst to the participant) read the temperature from a hidden thermometer.

Results

An analysis of variance, with the measured temperature inserted as a covariate[5], revealed that participants in the many similarities-condition (M = 23.06, SD = 2.92) perceived the room to be significantly warmer than participants in the few similarities-condition (M = 22.06, SD = 2.63), F (1, 68) = 4.53, p = .037, η_p^2 = .064 (Cohen's d = .36), thereby confirming that naming a higher number of similarities literally leads to higher temperature perceptions.

Experiment 4: Chilly Differences

The previous experiment revealed that naming more similarities about a stranger indeed leads to a perception of higher ambient temperature. Given that participants engaged in a longer activity in the many similarities condition, a feasible alternative hypothesis could be based on the idea that participants felt warmer after engaging in a longer and more intense task. Switching to a semantically different task could preclude the hypothesis that the effect of perceptions of higher ambient temperature arises from engaging in a more intense task.

We hypothesized that our results are due to feelings of social proximity. However, in order to further support this argument, we used the same method, but now asked participants

for their temperature perception after naming three versus ten *differences* regarding the target-participant, creating a smaller versus larger social distance. As in previous experiments, participants were again asked to pick an avatar under the guise of an investigation of intuition and personality. They then described what they were *not*. Subsequently, participants were requested to name either three (few) or ten (many) differences about a target-person, prior to engaging in the ostensibly unrelated laboratory test asking them for temperature perception. Here, we now predicted that naming ten differences with a target-participant would lead to lower temperature perceptions than naming three differences.

Method

Participants

Thirty-six (80.6% female, M_{age} = 19.8, SD_{age} = 1.78) Utrecht University students were recruited via leaflets around campus and paid 2 Euros for 15 minutes participation. Nineteen were in the few differences-condition; seventeen in the many differences-condition.[5]

Procedure

The procedure was similar to the procedure used in the two prior studies. However, participants were now asked to describe what they were *not* and we then asked to name either three (few) or ten (many) *differences*. Again, participants were asked participants to engage in the ostensibly unrelated laboratory test (in which they again estimated ambient temperature). The experimenter (again unbeknownst to the participant) read the temperature from a hidden thermometer.

Results

An independent samples t-test revealed that participants in the many differences-condition (M = 19.76, SD = 1.20) perceived a significantly lower ambient temperature than participants in the few differences-condition (M = 21.74, SD = 2.63), t (34) = 2.46, p = .019,

Cohen's d = .97, thereby confirming the hypothesis that inducing feeling different literally leads to lower temperature perceptions.[6]

General Discussion

In this package, we found both physical as well as semantic manipulations to increase social proximity (and distance) lead to perceptions of higher (and lower) temperature. In the first study, we found that physically putting someone close induces a perception of higher ambient temperature. In Experiments 2 through 4, we found that inducing a more abstract, semantically primed perspective of *feeling* similar (or different) to another, unknown, person can leave participants to literally perceive ambient temperature to be higher (or lower). The current line of research provides support to Zhong and Leonardelli's (2008) implicit suggestion that feelings of social distance induce feelings of coldness and extend their research by finding that social proximity leads to perceptions of warmth. We thus confirm the high accessibility of the link between social proximity and temperature by demonstrating that this effect can be induced through feelings of similarities rather than direct social proximity and by finding the proposed bi-directionality of the warmth and (social) proximity link (see also IJzerman & Semin, 2009; Williams & Bargh, 2008a). Our research questions the assumption that relationships are conceptualized merely in highly abstracted representations. In other words, it seems viable to assume that relationships are embodied first and subsequently abstracted from situated experience in order to reflect and/or communicate. Our findings corroborate prior evidence on relationships and temperature, and locate cognitive interdependence within perspectives of sensorimotor experiences. The question then becomes *how* cognitive interdependence develops as a function of 'internal models' built on very basic building bricks of interpersonal relations (Bowlby, 1969).

One pitfall to our current research is that we were not able to measure whether the feeling of similarity with a target-participant mediated temperature perception. We did not

measure similarity and temperature perception in the same experiment, as we suspected that this would raise participants' suspicion towards our experimental procedure. Given that we induced different perceptions of temperature across a range of three different manipulations (physical and two alternative semantic manipulations), we can conclude that our manipulations were successful in altering temperature perceptions as related to social proximity.

There are a couple of important conclusions and questions we would like to draw from our research. First, changing one's physical distance delivers commensurable effects in terms of temperature perceptions as compared to verbal primes. Having participants stand close to two other people induces increases in perceptions of temperature similar to inducing people to feel more similar through verbal manipulations. Our evidence thus further supports Damasio's (1999) suggestion that the body landscape is changed through "as-if body loops" and that mental representations of the physical world are often reused perceptual representations, guided by what is expressed in language (Boroditsky & Prinz, 2008, p. 112). That is, semantically primed representations of social closeness induced similar perceptions of a physical state as the physical state itself (cf. Zajonc & Markus, 1984). Through learning that a verbal manipulation induces a different temperature perception, we further contribute to the hypothesis that perceptual representations are essential for thinking about social concepts abstractly. Indeed, rather than a dual system of *hard* and *soft* representations, our results suggest that the intensity of the representation in the physical move along a continuum of concrete experiences. Assuming such a continuum adds to the understanding of developing a model for cognitive interdependence.

An important hypothesis that follows from the assumed continuum is the idea that actual bodily temperatures might actually rise as a function of said verbal representations of proximity towards another. Even more so, it seems viable to assume that the social

circumstances of the situation alter the bodily state, which is consequently expressed and communicated about in language. Subsequent research should thus focus on whether it is the physical state which actually alters, or whether *only* the perception of the ambient temperature has been altered. This would supply important evidence for or against the hypothesis that relations are grounded in sensorimotor experiences.

More suggestively, Damasio (1999) discusses that the most important alterations in the central nervous system include the induction of certain behaviors, such as bonding and nurturing. Caporael (2007) argues that this occurs through *repeated assemblies* throughout years of evolution. Throughout the ages, bonding experiences for human beings in its practice has remained the same, allowing for these repeated experiences. These types of behaviors, subsumed under the abstract representations tied to *warmth is social proximity* have been regarded as fundamental to human sociality and are perhaps even pre-wired. Social bonding has remained unaltered for human beings throughout evolution, thereby making close, warm contact vital. In other words, the body indeed makes sociality essential (Caporael, 2007). The co-occurrence between psychological warmth, physical warmth, and physical distance has thus developed as a central extension of the human mind throughout evolution through these repeated assemblies (Caporael, 1997). The mental systems inherent to human beings correspond to repeated structures and patterns in multiple levels of selection. On the basis of such "repeated assemblies" and a further developed model of "cognitive interdependence", one could potentially formulate a more dynamic representational model between abstract concepts and bidirectional feedback models. Bodily actions (see Cohen, Leung, & IJzerman, 2009; Maass, 2009) activate complex not only representations, but complex representations also activate bodily actions, feeding into an integrated self-reinforcing cycle.

Our findings suggest further possibilities for research on interpersonal relations. The link between temperature and social proximity seems to operate outside of conscious

awareness, and can thus be used as a much more subtle measurement of feelings towards another than other measurements which require reflection upon the self-in-relationship (e.g. the IOS). Further, older research on social distance equilibria (Argyle & Dean, 1965) suggested ways in which eye-gaze, physical distance, posture, and smile function in order to maintain an optimal social balance. Do temperature perceptions relate to these different monitoring behaviors of (different) others and self, like seeking distance, gazing at others, etc.? The suggestion that repeated assemblies have altered the human landscape such that physical proximity and warmth are necessary for human living possibly suggests that their effects penetrate more common elements of human thinking, behavior, and language and could even supply new insights into clinical solutions for problems in the interpersonal sphere. Subsequently, clinical research on the basis of recent reports like ours and Zhong and Leonardelli (2008) could open up potential solutions for questions about Seasonal Affective Disorder or attachment disorders.

Furthermore, it is important to examine the role of culture in physical distance. In line with anthropological evidence (Hall, 1955) we held proximity at a comfortable distance for Dutch (Western) participants. Suggestively, if participants in our first experiment would be placed at a distance too intimate, it might be possible that they would perceive the temperature to be colder or even too hot, in order to maintain perceived social distance equilibria (see also Argyle & Dean, 1965). Further, research from cultural psychology indicates that relationship construals differ across cultures (Uskul, Hynie, & Lalonde, 2004). Can similar questions be posed for temperature perceptions, in that ranges and limitations of relationship construal are determined by the physical experience in one's culture? If this is indeed the case, one might be able to answer difficult empirical questions related to adjustment problems in interpersonal spheres related to migration from warmer to colder climates.

The distinctions between 'cognitive interdependence' and our embodied perspective of interpersonal relations unlock new research questions. For example, some research in social psychology has examined how computer-mediated communication affects deindividuation and decision making (Spears, Lea, & Lee, 1990). What are the long-term effects of computer-mediated communication in terms of attachment to significant others and in social interactions? Our research suggests that both verbally primed feelings and physical changes in social proximity deliver similar effects; on the basis of our research one could thus argue that no difference exists between the two different interactions. Yet, the actual *physical* component of social interaction seems so vital to processes underlying social relationships that prolonged computer-mediated communication could severely harm norms regulating social behavior.

Our findings have important implications for interpersonal relations and open up new avenues for research. It is possible that prior researched and more abstracted concepts of interpersonal relationships are guided by abstract, amodal representations (see for example Mahon & Caramazza, 2008). Mahon and Caramazza (2008) argue that sensorimotor activation as a function of human thought is not irrelevant, but serves as an 'ornament'. There is however no evidence for this account (see also Zwaan, 2009a). We assume the safe working hypothesis that interpersonal relationships and their representations are grounded in experiences and (partly) simulated when called-upon, though leave open the possibility in contrast to classical theories to ask "how are interpersonal relations embodied?" (see also Zwaan, 2009b). We propose here that even more abstracted and stable conceptions of interpersonal relationships (such as those conceptions measured by pronoun uses or self-descriptions) are grounded within perception and action in the self-in-relation.

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Footnotes

[1]Consistent with our prior research on social proximity, we only analyzed data from native Dutch participants. Depending on cultural background, participants can vary on perceptual focus, language use, or self-other overlap (q.v. IJzerman & Semin, 2009). Also, in all studies participants were thanked and debriefed via funneled debriefing as recommended by Bargh and Chartrand (2000). Only in Study 5 two participants indicated that they were aware of the purpose of the study, as they had participated in similar previous studies. We removed these participants from our further analyses.

[2]We based these distances on the distinctions made by Hall (1955) in his research on physical proximity in the United States. For strangers in interaction, 50 centimeters is the maximum level of interpersonal proximity without discomfort. Given the cultural similarities between the Netherlands and the United States (Hofstede, 1980), we chose to maintain this distance.

[3]Across our experiments, the only significant consistent finding of the social proximity is that on temperature. We therefore refrain from reporting the non-significant findings on these other variables.

[4]Argyle and Dean (1965) argue that one way people attempt to restore an equilibrium level of physical proximity is by increasing language production. We counted our confederates' language production on the first task. The averaged total of words was indeed higher in the far condition (M = 39.65, SD = 15.1) than in the close condition (M = 26.9, SD = 7.47), F (1, 49) = 14.77, $p < .001$, $\eta^2 = .235$. In our subsequent analyses we used this variable as a control for our confederates' behavior towards participants. Further, the real temperature remained constant throughout the experiment. Inserting the measured temperature in the room as a covariate did not significantly change the results of this analyses (p = .046).

[5]In contrast to study 1 (which was conducted in a different laboratory), inserting measured temperature was necessary, as lab temperatures differed significantly per day on the days that

the experiment was conducted, F (1, 69) = 10.92, $p < .001$, $\eta^2 = .417$. This temperature did not differ per day in Experiment 5. We therefore did not control for measured temperature in this experiment.

[6]Examining the different temperatures in the different studies shows that estimated temperatures in Experiment 4 were higher than in Experiment 5. The actual temperature in Experiment 4 was 23.27, while in Study 5 the mean actual temperature was 19.19 degrees Celsius. The difference in actual temperatures could have played a role in explaining our effect. Inserting temperature as a covariate in our analyses however controlled for such a potential confound in our research.