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Research Article

The Thermometer of Social Relations

Mapping Social Proximity on Temperature

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ABSTRACT—*"Holding warm feelings toward someone" and "giving someone the cold shoulder" indicate different levels of social proximity. In this article, we show effects of temperature that go beyond these metaphors people live by. In three experiments, warmer conditions, compared with colder conditions, induced (a) greater social proximity, (b) use of more concrete language, and (c) a more relational focus. Different temperature conditions were created by either handing participants warm or cold beverages (Experiment 1) or placing them in comfortable warm or cold ambient conditions (Experiments 2 and 3). These studies corroborate recent findings in the field of grounded cognition revealing that concrete experiences ground abstract concepts with which they are coexperienced. Our studies show a systemic interdependence among language, perception, and social proximity: Environmentally induced conditions shape not only language use, but also the perception and construal of social relationships.*

The concepts of temperature and social proximity are often jointly expressed in metaphors such as "holding warm feelings toward someone" or "giving someone the cold shoulder." Where do such sayings stem from? Lakoff and Johnson (1999) proposed that concrete experiences (e.g., temperature) ground abstract concepts (e.g., affection). This perspective is referred to as *embodied realism.* Metaphors summarized by "warmth is affection" express one of human beings' most central abstract ideas: People judge others predominantly on the basis of warmth (Asch, 1946; Fiske, Cuddy, & Glicke, 2007). Studies have shown that affection is induced by warmth (Williams & Bargh,

2008a), but in this article we address the broader construct of social proximity. We examine how notions of temperature ground the abstract idea of affection by scrutinizing the effects of alterations in temperature on social proximity, language, and perception of reality.

Comprehending the processes underlying abstract thought has presented a challenge in recent attempts to link thought, perception, and action. A key to solving this problem can be found in the use of sensory-based metaphors, which allow people to represent and communicate abstract concepts that would otherwise have no link to sensorimotor experiences. Diverse studies have shown that abstract thought includes more grounding in physical and perceptual content than is often assumed (cf. Barsalou, 2008; Glenberg, 1997).

The significance of embodiment has been shown in many areas, from memory (Glenberg, 1997) to the grounding of abstract concepts. For instance, Boroditsky and Ramscar (2002) demonstrated that participants' experience of space influenced their perception of time. These authors asked participants when a meeting scheduled for Wednesday would take place if it was "moved forward" by 2 days. The more participants had moved forward in a lunch line, the more likely they were to answer that the meeting would be on Friday (rather than Monday). Leung and Cohen (2007) showed that even highly complex and abstract cultural concepts affect the psychological placement of the body in time and space: Compared with European Americans, Asian Americans were more likely to narrate a story from a third party's physical perspective rather than their own physical perspective. In this latter study, when participants reflected about narrations abstracted from experience, they simulated the concrete experiences physically; whether they simulated these experiences from the third party's or their own perspective was a function of their cultural background. In the studies we report here, we investigated the reverse relationship, asking whether physical experiences associated with an abstract idea influence perceptual focus and language use.

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This question is derived in part from Lakoff and Johnson's (1999) argument concerning the function of metaphor, namely, that the perceptual content of concrete experiences is used to ground abstract ideas (see also Barsalou, 2008). In this view, abstract concepts and concrete experiences that are jointly expressed in a metaphor are coexperienced. In the case of "warmth is affection," Lakoff and Johnson (1999, pp. 45–60) argued that this coexperience is primary: Babies experience the feeling of being held affectionately by their mothers, and being so held induces a warm sensation. This association is underlined by evidence that the insular cortex is involved in processing both psychological and physical warmth (see Williams & Bargh, 2008a). As a result, people express and share the abstract notion of affection in terms of the coexperienced sensation of warmth. Examples are abundant in mainstream culture: "The cold shoulder" and "a cold fish" are examples of metaphors relating lack of warmth to social distance, whereas "warm embrace" and "giving a warm welcome" are metaphors linking warmth to social proximity.

OVERVIEW OF THE PRESENT STUDIES

On the basis of these considerations, we propose that manipulating ambient temperature should influence the abstract idea of social proximity. We define *social proximity* as perceived distance between self and other, which is different from physical distance between self and other (see also Williams & Bargh, 2008b). In Experiment 1, we tested the hypothesis that social proximity and distance vary as a function of the temperature (within a comfortable range) experienced. In Experiment 2, we examined the effect of a different temperature manipulation on social proximity and extended the implications of our study by examining systematic differences in language use. We based this extension on research showing that social proximity and distance are manifested in language, with distance being associated with use of more abstract language and proximity being associated with use of more concrete language (Semin, 2007; see also construal-level theory—Liberman, Trope, & Stephan, 2007). Experiment 3 was designed to extend our inquiry by examining the consequences of differences in ambient temperature not only for language use, but also for perceptual processes. We reasoned that if warmth (coldness) induces a focus on relationships and reduces (increases) social distance, then it should also affect perceptual processes. We examined whether high ambient temperature would induce a more relational perceptual focus than low ambient temperature.

EXPERIMENT 1: WARMING AND COOLING OF SOCIAL RELATIONSHIPS

In the first experiment, we investigated the hypothesis that an increase in temperature within a comfortable range would increase social proximity. This experiment was inspired by recent research by Williams and Bargh (2008a), who used Asch's (1946) impression-formation paradigm to show that third parties were judged as warmer and friendlier by participants who had held a hot cup of coffee, rather than an iced cup of coffee. In our study, we introduced a new dependent variable: Participants were handed either a warm or a cold beverage and were then asked to rate their social proximity to another person.

Method

Participants
Thirty-three students (84.8% female, 15.2% male)[1] were recruited via leaflets and paid €2 for their participation. Participants were randomly allocated to the cold ($n = 16$) or the warm ($n = 17$) condition.

Procedure
Participants entered the laboratory and were asked to hold a beverage temporarily, while the experimenter ostensibly installed a questionnaire on a laptop computer. After participants filled out an unrelated questionnaire, they were asked to select a person they knew and then rated themselves and that person on the Inclusion of Other in Self (IOS) scale (Aron, Aron, & Smollan, 1992). We used a 7-point version of this scale, with two circles at each point indicating a perceived degree of overlap between self and other. The greater the overlap between the circles (and the higher the score), the greater the inclusion, and thus the higher the social proximity. After the experiment, participants were thanked and debriefed via an orally administered, funneled debriefing, as recommended by Bargh and Chartrand (2000); no participant indicated suspicion regarding the experiment's purpose.

Results
An independent-samples t test revealed that perceived overlap with a known other was significantly greater for participants who were handed a warm beverage ($M = 5.12$, $SD = 1.22$) than for participants who were handed a cold beverage ($M = 4.13$, $SD = 1.41$), $t(32) = -2.17$, $p_{rep} = .93$, Cohen's $d = 0.78$. This supported our hypothesis that the warm condition induced more social proximity than the cold condition.

EXPERIMENT 2: WARMING AND COOLING EFFECTS ON LANGUAGE USE

The second experiment was designed to generalize the manipulation to ambient temperature and to examine whether the effects of temperature extend to language use. Although our

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[1]In all three experiments, we analyzed data from only one cultural group, namely, native Dutch participants. Participants from different cultural backgrounds can vary in perceptual focus (Nisbett & Miyamoto, 2005), language use (Semin, Görts, Nandram, & Semin-Goossens, 2002), or self-other overlap (Üskül, Hynie, & Lalonde, 2004).

prediction for social proximity remained the same, the target was a specific person (the experimenter), rather than a person chosen idiosyncratically by the participant.

Prior to measuring social distance to the experimenter, we examined language use. We expected that if a higher ambient temperature induced greater social proximity, then the description of social events would be more concrete in warmer conditions. This hypothesis was derived from two sources of evidence. First, research on language use in independent and interdependent cultures has revealed that people from cultures that anchor the self in interdependencies (i.e., put the self in close proximity with others) tend to use more concrete language than people from independent cultures, who put distance between the self and others; Maass, Karasawa, Politi, & Suga, 2006; Semin, Görts, Nandram, & Semin-Goossens, 2002). Second, construal-level theory has marshaled considerable empirical evidence revealing a systematic tendency to represent proximity concretely and distance abstractly (see Liberman et al., 2007, for a review), and this relationship holds in the case of language used to represent social proximity and distance (see Semin, 2007, for a review).

Method

Participants

Fifty-two students (mean age = 21.30 years, SD = 2.70; 55.8% female, 44.2% male) were recruited via leaflets and paid €3 for participating in a session that lasted approximately 10 to 15 min. Participants were assigned randomly to the cold (n = 27) or the warm (n = 25) condition.

Procedure and Scoring

Upon entering the laboratory, participants were seated in the room, which was either cold (15–18 °C) or warm (22–24 °C).[2] They first viewed a 39-s film clip showing animated chess figures making movements unrelated to chess and were then asked to describe "in their own words" what they had seen in the clip (cf. Stapel & Semin, 2007; the film clip can be viewed by going to the Supporting Information available on-line—see p. 1220).[3] A

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[2]Van Ooijen, Van Marken Lichtenbelt, Van Steenhoven, and Westerterp (2004) suggested that the temperature ranges we used alter metabolic responses, so an alternative explanation of our findings might be that the temperature manipulation influenced performance as a result of fatigue. However, Van Ooijen et al. observed an effect on metabolism only after a 45-min exposure, whereas the exposure in our study was much briefer.

[3]Because of the measurement's sensitivity, we chose this neutral film fragment in order to avoid valence problems or additional sources of error that might have arisen, for example, if we had used randomly imagined target persons or target persons of a different gender than the participant. The abstraction level of language people use to describe others depends on both valence and the status of the others' group: People tend to use concrete language when describing negative behaviors of in-groups and abstract language when describing negative behaviors of out-groups. Conversely, people tend to use abstract language when describing positive behaviors of in-groups and concrete language when describing positive behaviors of out-groups (Maass, Salvi, Arcuri, & Semin, 1989). Our analyses demonstrated that the valence of participants' descriptions of the chess pieces was unrelated to abstraction in language use, both in Experiment 2, $t(50)$ = −1.65, p_{rep} = .87, and in Experiment 3, $t(38)$ = 0.275, p_{rep} = .58.

rater blind to participants' experimental condition coded these descriptions for abstraction level according to the coding manual for Semin and Fiedler's (e.g., 1988) linguistic category model (LCM; Coenen, Hedebouw, & Semin, 2006).

The LCM distinguishes four categories, which can represent the same event in four different ways ranging from the very concrete to the very abstract. For example, the same event can be described as "John punched David," "John hurt David," "John hates David," or "John is aggressive." The predicates in these examples correspond, respectively, to the four linguistic categories in the model: descriptive action verbs, interpretive action verbs, state verbs, and adjectives (for definitions and examples, see Table 1). These linguistic categories can be represented on a concrete-abstract dimension (Semin & Fiedler, 1988, 1989). Instances of these categories were counted and scored, with each descriptive action verb receiving 1 point, each interpretive action verb receiving 2 points, each state verb receiving 3 points, and each adjective receiving 4 points. The total number of points was divided by the weighted total number of predicates to calculate the mean abstraction level. This score could thus vary from 1 (*concrete*) to 4 (*abstract*) and provided a measure of the abstraction level of a participant's description of the film clip. Intercoder reliability was obtained for 20% of the descriptions and was satisfactory (Cohen's κ = .66).

After describing the film clip, participants completed the IOS scale in relation to the experimenter. They were thanked and debriefed via a funneled debriefing; no participant indicated suspicion regarding the experiment's purpose.

Results

An independent-samples t test confirmed that participants in the warm condition described the film clip more concretely (M = 2.23, SD = 0.49) than did participants in the cold condition (M = 2.64, SD = 0.55), $t(51)$ = 2.78, p_{rep} = .97, Cohen's d = 0.79. We analyzed IOS scores in an analysis of variance, including experimenter as a categorically independent covariate because three different experimenters were involved in the data collection. The data replicated findings from the first experiment: Warm participants felt significantly closer to the experimenter (M = 2.63, SD = 1.52) than cold participants did (M = 2.08, SD = 1.04), $F(1, 48)$ = 2.95, p_{rep} = .88, η_p^2 = .058.

EXPERIMENT 3: WARM PATTERNS AND COLD PROPERTIES

In the third study, we tested our prediction that a higher ambient temperature would induce a more relational perceptual focus relative to a lower ambient temperature. Concrete language has been shown to signal not only social proximity (Liberman et al., 2007; Semin, 2007), but also a detail-oriented style of analytic processing; in contrast, use of abstract language signals a global processing style (Beukeboom & Semin, 2006).

TABLE 1

Definitions and Examples of the Four Categories of Interpersonal Predicates as Defined in the Linguistic Category Model

Category	Examples	Definition
Description action verbs	Hit, yell, walk	Verbs that refer to a single, specific action with a clear beginning and end, and with a physically invariant feature
Interpretive action verbs	Help, tease, amaze, anger	Verbs that refer to a general group of behaviors with a clear beginning and clear end, but no physically invariant feature; these verbs refer to either an action or its emotional consequences
State verbs	Admire, hate, appreciate	Verbs that refer to an enduring cognitive or emotional state with no clear beginning and end
Adjectives	Honest, reliable, aggressive	Adjectives that refer to a characteristic or feature of a person

Note. This table is adapted from Coenen, Hedebouw, and Semin (2006, p. 7). Metasemantic categories are listed with the most concrete at the top and the most abstract at the bottom.

A contrasting argument found in cultural psychology suggests that cultures emphasizing interdependence (placing the self in general in social proximity to others) are more likely to emphasize relationships, whereas cultures emphasizing independence (placing the self in general in lower social proximity to others) are more likely to emphasize properties (Nisbett & Miyamoto, 2005). Similar conclusions have been drawn in a wide array of research: Individuals from cultures emphasizing interdependence not only tend to categorize objects on the basis of interrelatedness (Ji, Peng, & Nisbett, 2000), but also perceive Rorschach cards more as patterns (Abel & Hsu, 1949) and detect more changes in relationships between objects (Masuda & Nisbett, 2001), compared with individuals from cultures emphasizing independence, who tend more to categorize objects on the basis of shared categories (and features), to focus on details, and to detect changes in central properties of objects. In line with Maass et al. (2006) and Semin et al. (2002), Nisbett and Miyamoto (2005) argued that these differences in focus result from socialization processes. Early in the socialization process, mothers from interdependent cultures use more verbs than mothers from independent cultures in order to emphasize relationships, whereas mothers from independent cultures use more adjectives than mothers from interdependent cultures in order to label properties and categories (see also Tardif, Gelman, & Xu, 2003).

On the basis of this reasoning in cultural psychology, and the fact that warmer temperatures led to use of more concrete language in Experiment 2, we hypothesized that a warmer temperature would produce a greater focus on relationships, or interdependence, between objects portrayed in a perceptual-focus task, and that this effect would be mediated by language use.

Method

Participants
Thirty-nine participants (mean age = 21.05 years, $SD = 3.27$; 43.6% female, 56.4% male) were recruited via leaflets at Utrecht University and paid €3 for participating in a 10- to 15-min session. They were randomly assigned to the cold ($n = 17$) or the warm ($n = 22$) condition.

Procedure
We used the same temperature manipulation as in Experiment 2 by putting participants in a cold (14–18 °C) or a warm (22–24 °C) room. Participants first performed a perceptual-focus task, modeled after Kimchi and Palmer (1982). On each of 24 trials (presented randomly), they examined a target object, such as a triangle (larger pattern) made up of three smaller triangles (properties). They were asked to judge which of two alternative figures was more similar to the target object: for instance, a triangle made up of three squares (relational, or interdependent, perspective) or a square made up of four triangles (property, or independent, perspective; see Fig. 1). Participants received 2 points for choosing a figure demonstrating a relational perspective and 1 point for choosing a figure demonstrating a property perspective. In 12 of the trials, the target and the smaller figures it was made up of had the same shape; in the other 12, they did not.[4]

After completing this task, participants viewed and then described the film clip from Experiment 2. We scored the event descriptions according to the method outlined in Experiment 2, with higher scores indicating higher levels of abstraction (intercoder reliability was high, Cohen's $\kappa = .77$). Again, participants were thanked and debriefed via a funneled debriefing; no participant indicated suspicion regarding the experiment's purpose.

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[4]Whether each of the alternative figures was made up of smaller figures of the same shape could have influenced participants' choices. A repeated measures analysis of variance revealed, however, that this factor had no systematic effects related to our manipulation; the Condition × Alternative Type interaction was not significant, $F(4, 35) < 1$, $p_{\text{rep}} = .65$.

Fig. 1. Example of an item used in the perceptual-focus task in Experiment 3. Following presentation of the target object, two alternative objects were presented: A is an example of a relational-perspective figure, and B is an example of a property-perspective figure.

Results

We performed a multiple regression analysis with temperature condition as the independent variable.[5] This analysis confirmed that participants in the warm condition had a greater relational perspective than participants in the cold condition, $t(38) = 2.25$, $p_{rep} = .94$, $b = 0.082$, $sr = .345$, and also used more concrete language than participants in the cold condition, $t(38) = -3.53$, $p_{rep} = .99$, $b = -0.451$, $sr = -.526$. When both language-abstraction score and temperature condition were included in the regression analysis, more concrete language predicted a more relational focus, $t(38) = -2.41$, $p_{rep} = .95$, $b = -0.107$, $sr = -.346$, and the effect of the temperature condition became nonsignificant, $t(38) < 1$, $p_{rep} = .72$. Thus, the results meet all four of Baron and Kenny's (1986) conditions for full mediation. Additional analyses indicated that language-abstraction score was a robust mediator (Sobel's $Z = 3.47$, $p_{rep} = .99$).

GENERAL DISCUSSION

In three experiments, we examined the metaphorical mapping of social proximity on temperature and the interface of ambient temperature, social relationships, language, and perception in a relational context. Our findings lend support to Lakoff and Johnson's (1999) embodied realism, as well as to Williams and Bargh's (2008a) and Zhong and Leonardelli's (2008) evidence that temperature has a direct relationship with social relations. We showed that temperature differences are directly tied to differences in social proximity. It is possible to argue that the temperature manipulation used by Williams and Bargh (2008a)

primed the concept of warm or cold and that the pattern of impression-formation results they reported was driven by semantic similarity inferences (Semin, 1989). This leaves room for a semantically driven explanation of Williams and Bargh's findings, that is, an explanation based on word associations between warmth and affection. Such an alternative explanation is unlikely to account for the systemic relationship demonstrated in the experiments reported in this article, as our environmental conditions (differences in temperature) shaped not only language use, but also perception and the construal of social relationships. In other words, our results are difficult to interpret using a representational or amodal account.

Our findings have a number of implications. One obvious implication concerns the effect of lab temperatures on social-cognitive processes in experimental studies, such as those examining the effect of mood on processing (e.g., Isen, 1987; Martin & Clore, 2001; Schwarz & Clore, 1996). A second implication concerns the repeated finding that warmer conditions induced both concrete event descriptions and a relational focus. One could argue that our results contradict prior research investigating perceptual focus on the form (or shape) versus texture (or material) of the elements used in our perceptual-focus task (cf. Kimchi & Palmer, 1982): Stapel and Semin (2007) demonstrated that priming individuals with concrete language induced a focus on the texture of the materials (the "trees" in the forest). These findings align with research finding that people from interdependent cultures, who use more concrete language, are more focused on situational details than people from independent cultures, who use less concrete language (e.g., Morris & Peng, 1994). However, we demonstrated that putting participants in higher-temperature rooms affected the use of relationships in making similarity judgments, rendering salient the configuration of the relationship between objects. The usage of verbs as glue in representing relationships is conceptually different from using verbs to focus on detail and (perceptually) on texture (vs. trait; see also the trait-vs.-texture and global-vs.-local distinctions in Kimchi & Palmer, 1982). Indeed, our temperature manipulation induced a configurational focus on relational patterns, rather than properties (see also Abel & Hsu, 1949; Chiu, 1972; Ji et al., 2000; Masuda & Nisbett, 2001; Nisbett & Miyamoto, 2005).

The third and central implication concerns embodied grounding. Barsalou (2008) discussed the difficulties associated with grounding abstract concepts. Lakoff and Johnson (1999) argued that abstract concepts are grounded in concrete experiences. Some prior evidence supports this notion (e.g., Boroditsky & Ramscar, 2002). Our research adds further evidence that "the cognitive system evolved to support action in specific situations," emphasizing "interactions between perception, . . . the body, the environment, and other agents" (Barsalou, 2008, p. 2). An essential element of human functioning, interpersonal distance, is grounded in temperature; warmer conditions induce social proximity and a focus on both actions and relational

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[5]In Experiment 3, we also included participants' perception of temperature as a manipulation check; participants provided these ratings after completing the main tasks. Our manipulation proved successful, as participants perceived the colder room ($M = 16.64$ °C, $SD = 1.52$) as colder than the warmer room ($M = 22.56$ °C, $SD = 0.84$), $F(1, 38) = 208.24$, $p_{rep} = .99$, $\eta_p^2 = .849$. Moreover, females ($M = 18.94$ °C, $SD = 4.85$) perceived the room as colder than males did ($M = 20.09$ °C, $SD = 2.71$), $F(1, 38) = 4.23$, $p_{rep} = .92$, $\eta_p^2 = .108$. There was no significant interaction between condition and participants' gender, $F(1, 38) = 2.65$, $p_{rep} = .87$. The main effect of gender on perceived temperature thus introduced variance unrelated to our hypotheses about between-condition differences. We therefore controlled for gender in all analyses in Experiment 3.

aspects of reality. We thus have provided evidence for grounding social proximity in temperature. Furthermore, other research (Zhong & Leonardelli, 2008) suggests a reverse relationship: Social exclusion leaves people to actually feel colder. Lakoff and Johnson (1999) argued that abstract concepts are grounded in concrete experience, and not vice versa. Together with Zhong and Leonardelli's results, our findings go beyond the proposal that temperature grounds social proximity only; the relation between temperature and social proximity is bidirectional. The embodiment of social relations is likely to have actually *preceded* the human capability to abstract concepts from concrete experiences.

Finally, understanding the metaphorical mapping of social proximity on temperature goes beyond the scope of (social) psychology. It is not coincidental that many of the links we have drawn among the environment, relationships, and perception stem from cultural psychology. One of the most prominent theories on the development of societies was furthered by Diamond (1997), who elaborately discussed how proximal factors shape human behavior. The present line of research offers a step in understanding how and under what circumstances proximal factors have influenced (and still influence) the cognitive system's adaptation for action. To gain better understanding of human adaptation for action, researchers must go beyond descriptive analyses of temperature or other concrete experiences, and investigate the social-cognitive processes underlying the effects of these experiences.

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SUPPORTING INFORMATION

Additional supporting information may be found in the on-line version of this article:

Video S1

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