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28. We thank J. Beggs, E. S. Choi, A. Pidoux, F. Simmer, I. Stancheva, and D. Tollervey for comments; N. Kaufer, D. Moazed, and T. Tani for materials; and the

Allshire lab for support. Supported by Epigenome Network of Excellence (EC-FP6/Contract/LSHG-CT-2004-503433), of which R.C.A. and K.E. are members (E.B.); UK Medical Research Council grant G0301153/ID:69173 (A.K.); Wellcome Trust Prize Studentship 067844 (M.P.); Marie Curie Excellence Grant MEXT-CT-014171 from the European Commission (J.R.); and Wellcome Trust Principal Research Fellowship grant 065061/Z (R.C.A.).

Supporting Online Material

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31 July 2008; accepted 18 September 2008
10.1126/science.1164029

Experiencing Physical Warmth Promotes Interpersonal Warmth

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“Warmth” is the most powerful personality trait in social judgment, and attachment theorists have stressed the importance of warm physical contact with caregivers during infancy for healthy relationships in adulthood. Intriguingly, recent research in humans points to the involvement of the insula in the processing of both physical temperature and interpersonal warmth (trust) information. Accordingly, we hypothesized that experiences of physical warmth (or coldness) would increase feelings of interpersonal warmth (or coldness), without the person’s awareness of this influence. In study 1, participants who briefly held a cup of hot (versus iced) coffee judged a target person as having a “warmer” personality (generous, caring); in study 2, participants holding a hot (versus cold) therapeutic pad were more likely to choose a gift for a friend instead of for themselves.

Ever since Solomon Asch’s (*1*) original demonstration of the transformational power of “warm” and “cold” as personality traits in first impressions of individuals, the concept of psychological warmth has been prominently featured in research on social perception and interpersonal liking (*2–4*). The warm-cold dimension has emerged as one of two main components of the first impressions (along with competence) we quickly form of other people (*2, 5*); together they account for a large proportion (82%) of the variance in people’s evaluations of social behaviors (*6*). Notably, the warmth and competence dimensions have been found to be the principal ones underlying every group stereotype studied across dozens of countries (*2, 5*). Of these two fundamental dimensions, warmth is primary, as “people are more sensitive to warmth information than to competence information” (*5*, p. 79) and make trustworthiness judgments of faces faster than for other traits, including competence (*7*).

What does it mean, exactly, to perceive someone as a “warm” versus a “cold” person? According to recent theory and research in social cognition, interpersonal warmth refers to a constellation of traits related to perceived favorability of the other person’s intentions toward us, including friendliness, helpfulness, and trustworthiness (*5*). The warm-cold assessment is the social perceiver’s immediate “first-pass” as to whether the target individual (or social group) can be trusted as a friend (*7*), or at least as a “non-foe” (i.e., warm), or is instead a potential foe who might

attempt to interfere with one’s ongoing goal pursuits (i.e., cold). [The competence assessment is then a “second-pass” evaluation of whether the newly encountered individual (or group) has the capacity to act on those perceived intentions (*5*).] This assessment appears to be an automatic and obligatory evaluation that does not require the perceiver’s intent to make it.

Why, then, do we speak so naturally of “warm” and “cold” individuals (and not “friend” or “foe,” or “trustworthy” and “not trustworthy”)? Asch (*1*) gave no rationale to support his hypothesis that warm and cold would be uniquely “central traits” in impression formation, other than his own intuitions. However, in subsequent theorizing he offered a clue, arguing that most abstract psychological concepts are metaphorically based on concrete physical experiences (*8*). Contemporary cognitive linguists have advanced similar arguments that people conceptualize their internal, mental worlds by analogy to the physical world (*9–13*). Applied to the question of how warm objects can produce the same affective states as a “warm” person, embodiment theorists have noted how objects and events that produce the same quality of affective response are associated (categorized) together in memory (*14*). In this way, the feelings of warmth when one holds a hot cup of coffee or takes a warm bath might activate memories of other feelings associated with warmth (trust and comfort), because of early experiences with caretakers who provide warmth, shelter, safety, and nourishment.

Harry Harlow (*15*), in his classic studies on maternal-infant bonding in nonhuman primates, demonstrated that macaque monkeys preferred to stay close to a cloth surrogate mother rather than a wire mother. This preference held even when the wire mother was the infant’s source of food (a

bottle was attached to the wire) and the cloth mother was not. Tellingly, the cloth and the wire mothers differed in another important respect: The cloth (but not the wire) mother was a source of warmth for the infant monkey (a 100-W light bulb had been placed behind the cloth). As Harlow (*15*) concluded, contact comfort with the mother was a very important factor to the infant monkey, over and above her meeting nourishment needs; moreover, monkeys “raised” by the warm cloth mother showed relatively normal social development as adults, in stark contrast to the infants left alone with the wire mother.

In agreement with Harlow’s findings, the seminal attachment theorist John Bowlby (*16*) also posited an innate need for direct physical contact with the caretaker, over and above the caretaker’s satisfaction of the infant’s primary needs of hunger and thirst. Bowlby, as had Lorenz (*17*) before him, argued that maintaining closeness to caretakers during infancy, a period of relative helplessness, is critical for the survival of many animals.

Because of these frequent early life experiences with the trustworthy caregiver, a close mental association should develop between the concepts of physical warmth and psychological warmth. Indeed, recent research on the neurobiology of attachment has added further support for the proposed link between tactile temperature sensation and feelings of psychological warmth and trust (*18*). This research has revealed that the insular cortex is implicated in processing both the physical and the psychological versions of warmth information (*19*). First, the dorsal posterior insula is active during both temperature and touch sensation (*20, 21*). For example, activity in the right anterior insular cortex was strongly correlated with normal participants’ reported perceptions of the thermal intensity of stimuli (*20*), and warm thermal stimulation with a fomentation pack (as compared to neutral thermal stimulation) produced an increase in activation of the contralateral insular cortex, among other regions (*21*).

The insula is also involved in feelings of trust, empathy, and social emotions of guilt and embarrassment. Indeed, there appear to be specialized neurons for these social functions that have been observed in only two regions of the brain, one of which is the frontoinsula cortex (*22*). The insula is more highly activated after social exclusion or rejection than after social inclusion and acceptance (*23, 24*), and heightened activity in the anterior insular cortex was associated with the rejection of unfair offers in an economic trust game (*25*). Recently, the severe mental illness of borderline personality disorder, characterized by a profound

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inability to cooperate with others, has been linked to a lack of differential responsiveness in the anterior insula to trustworthy versus untrustworthy behavior in economic game partners (19, 26).

For these theoretical and empirical reasons, we hypothesized that mere tactile experiences of physical warmth should activate concepts or feelings of interpersonal warmth. Moreover, this temporarily increased activation of interpersonal warmth concepts should then influence, in an unintentional manner, judgments of and behavior toward other people without one being aware of this influence. Such priming or construct accessibility effects, in which concepts activated in one context are residually active for a short time thereafter and exert influence on judgment and behavior in subsequent contexts without the person's awareness, are a staple of contemporary social psychological research (27). We recruited 41 undergraduates, modally white and female, with an average age of 18.5 years. Participants were assigned to one of two temperature priming conditions. Participants were primed with temperature by briefly holding either a cup of hot coffee, or a cup of iced coffee. To do this, a confederate blind to the study's hypotheses met participants in the lobby of the psychology building, carrying a cup of coffee, a clipboard, and two textbooks. During the elevator ride to the fourth-floor laboratory, the confederate casually asked participants if they could hold the coffee cup for a second while she recorded their name and the time of their participation. After the confederate wrote down the information, she took back the coffee cup. The temperature of the coffee cup (hot versus iced) was the only between-subjects manipulation (28).

When participants arrived at the experimental room, they received a packet containing a personality impression questionnaire, following the same procedure as in Asch's original study (1). Participants read that "Person A" was intelligent, skillful, industrious, determined, practical, and cautious. They then rated the target person on 10 personality traits using bipolar scales anchored by a trait and its opposite. Half of the personality traits were semantically related to the warm-cold dimension, and half were unrelated, again following Asch's procedure.

As hypothesized, people who had briefly held the hot coffee cup perceived the target person as being significantly warmer (mean = 4.71; 1 = cold, 7 = warm) than did those who had briefly held the cup of iced coffee [mean = 4.25, $F(1, 39) = 4.08$, $P = 0.05$]. The coffee manipulation did not affect ratings on traits unrelated to the warm-cold dimension [$F(1, 39) = 0.67$, not significant], replicating the findings of Asch (1) and Kelley (3) in their original demonstrations of the warm-cold effect on impression formation. The effect of the coffee manipulation was specific to feelings of interpersonal warmth and was not a general mood or "halo" effect. Thus, a brief warm or cold physical experience influenced participants' subsequent interpersonal judgments of a target person in the same way that presenting the words "warm" or "cold" was found

to affect judgments of the target person in Asch's original study; moreover, participants in the present study showed no awareness of the impact of the physical experience on their judgments (28).

The second study had two aims. First, whereas the experimenter in the initial study had been blind to hypotheses, she was of course aware of the participant's experimental condition (as she herself held the hot versus iced coffee), and so could have inadvertently treated participants in the two conditions differently. In the second study this potential issue was eliminated through the use of Icy Hot therapeutic pads retrieved directly by the participant after receiving an instructional packet; the experimenter was blind to the experimental condition before handing participants the instructional packet, and did not interact with participants again until all dependent measures had been completed. Second, we sought to extend the initial findings from the domain of interpersonal judgment to that of the participant's own behavior. In line with research demonstrating the direct behavioral consequences of concepts automatically activated during social perception [e.g., (29)], we expected the primed feelings of interpersonal warmth to affect not only judgments of another person but one's behavior toward others as well.

We asked a separate group of 53 participants to briefly hold either the hot or cold therapeutic pad under the guise of a product evaluation. After participants rated the effectiveness of either the hot or cold pad, they were given a choice of reward for participating in the study. This choice constituted the dependent variable of the study. Participants were asked to choose either a Snapple beverage, or a \$1 gift certificate to a local ice cream shop. These rewards were framed either as a prosocial gift to "treat a friend," or as a personal reward for the participants themselves. The framing condition was counterbalanced such that half of participants chose between a Snapple reward for themselves and a gift certificate reward for a friend, and the other half chose between a Snapple reward for a friend and a gift certificate reward for themselves.

We hypothesized that participants who evaluated the hot pad would be more likely to choose the interpersonally warmer option of a reward for a friend, whereas participants who evaluated the cold pad would be more likely to choose the reward for themselves. Consistent with this prediction, a significant interaction was obtained between pad temperature and framing conditions (logistic regression $B = 2.85$, $P < 0.05$), such that regardless of type of gift (Snapple or ice cream), participants primed with physical coldness were more likely to choose the gift for themselves (75%) than the gift for a friend (25%), whereas those primed with physical warmth were more likely to choose the gift for a friend (54%) than the gift for themselves (46%). There were no main effects of either temperature condition or framing condition on gift preference.

In summary, experiences of physical temperature per se affect one's impressions of and prosocial behavior toward other people, without one's

awareness of such influences. The findings are in agreement with emerging knowledge about the role played by the insula in both the sensation of one's physiological state (such as skin temperature) and the detection of the trustworthiness of others (19), and thus provide support for Bowlby's (16) contention that early childhood experiences of physical warmth from caregivers are critical for the normal development of interpersonal warmth detection and behavior in adults. A half century after Asch's original intuitions, we are beginning to learn just why the warm-cold dimension is so central to interpersonal perception and behavior.

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Supporting Online Material

www.sciencemag.org/cgi/content/full/322/5901/606/DC1
Materials and Methods
SOM Text

30 June 2008; accepted 16 September 2008
10.1126/science.1162548