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The Substitutability of Physical and Social Warmth in Daily Life

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Abstract

Classic and contemporary research on person perception has demonstrated the paramount importance of interpersonal *warmth*. Recent research on embodied cognition has shown these feelings of social warmth or coldness can be induced by experiences of physical warmth or coldness, and vice versa. Here we show that people tend to self-regulate their feelings of social warmth through applications of physical warmth, apparently without explicit awareness of doing so. In Study 1, higher scores on a measure of chronic loneliness (social coldness) were associated with an increased tendency to take warm baths or showers. In Study 2, a physical coldness manipulation significantly increased feelings of loneliness. In Study 3, needs for social affiliation and for emotion regulation, triggered by recall of a past rejection experience, were subsequently eliminated by an interpolated physical warmth experience. Study 4 provided evidence that people are not explicitly aware of the relation between physical and social warmth (coldness), as they do not consider a target person who often bathes to be any lonelier than one who does not, all else being equal. Together, these findings suggest that physical and social warmth are to some extent substitutable in daily life and that this substitution reflects an unconscious self-regulatory mechanism.

Classic as well as contemporary research in social psychology has demonstrated the central importance of interpersonal *warmth* (versus *coldness*) in person perception, both in forming first impressions (Asch, 1946; Kelley, 1951) and as one of two main dimensions of out-group stereotypes around the world (Fiske, Cuddy, Glick, & Xu, 2002). Fiske, Cuddy, and Glick (2007) concluded from their stereotype-content research that assessing interpersonal warmth versus coldness is the first step taken in forming impressions of any new acquaintance, and is essentially a `friend or foe' judgment. A `warm' individual is considered to be prosocial, cooperative, generous, and trusting, whereas `cold' individuals are viewed as self-centered, competitive, and untrustworthy.

But why exactly do we use the terms `warm' and `cold' to refer to these two basic sorts of individuals (and not the more straightforward `friend' vs. `foe', `cooperative' vs. `competitive', etc.)? The explanation Asch later offered (1958) for the power of the warm-cold dimension in person perception was that abstract psychological concepts such as interpersonal warmth are metaphorically based on concrete physical experiences. Asch thus anticipated Lakoff and Johnson (1980), Barsalou (1999) and modern research on the `embodied grounding' of abstract concepts in physical experience (see Anderson, in press;

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Haggard, Rossetti, & Kawato, 2008; Semin & Smith, 2008; Williams, Huang, & Bargh, 2009). Concepts concerning the physical world (e.g., distance, size, temperature) form early in childhood as they are based on direct concrete experience (Mandler, 1992) and do not require the language abilities or memory retrieval skills that come on-line years later. According to one approach, the `conceptual scaffolding' model of Williams et al. (2009), abstract concepts then develop based on (and thus become strongly associated with) these physical concepts to the extent they are analogous (i.e., share key features). This assumed associative relation helps to explain the fact that we so easily and fluently use physical terms to refer to and describe more abstract phenomena (Lakoff & Johnson, 1980; Mandler, 1992) – especially social and psychological phenomena, as in a `close' relationship, a `warm' smile, and a `higher calling'.

As to the underlying reason for the tight connection between physical and social warmth (and coldness), it seems clear how early childhood experiences with caretakers who provide both physical (holding close) and psychological warmth (love, trust, help, support) could lead to the development of a strong associative connection between the concepts of physical and social warmth. Indeed, the attachment theorist John Bowlby (1969) argued that the conjoined needs for both physical and social warmth across evolutionary time periods has resulted in an innate drive for the young of many species, including humans, to maintain close distances to their parents and kin. As discussed below, there is now neuroanatomical evidence that the association between physical and social `temperature' is indeed hard-wired in humans. For present purposes, however, both the innate and the early-experience accounts of the physical-to-social warmth association lead to the prediction that physical warmth (coldness) experiences can produce the same subjective, phenomenal feeling states associated with psychological warmth (coldness). We now turn to evidence bearing on this prediction.

Harry Harlow (1958) first demonstrated the importance of early physical warmth experiences in the social development of infant monkeys raised alone. Those in the `cloth mother' condition, which critically included a 100-watt light bulb behind the cloth, did not have nearly the social deficits in adulthood that characterized monkeys raised alone with a cold, wire mother. Thus, Harlow was the first to show how physical warmth could be effectively *substituted* (in monkeys) for the absent maternal warmth, leading to significantly greater social warmth capacities for the monkey later in adulthood.

More recently, Williams and Bargh (2008) showed that incidental warmth experiences (such as when holding a cup of hot coffee or taking a warm bath) produce in turn `warm' psychological experiences of trust and behavioral effects on generosity, without the person's awareness. In one experiment, having participants briefly and incidentally hold a paper cup of hot coffee versus iced coffee replicated the effects of the words *warm* or *cold* in Asch's (1946) original impression formation study. In a second study, those first primed with warm physical experience were more selfless and generous regarding donation of their experimental payment than were those in the cold prime condition. Following up on this finding, IJzerman and Semin (2009) first seated participants in either a cold or warm room, and found that those in the warmer room reported feeling interpersonally closer to the experimenter than those in the colder room. Most recently, Kang, Williams, Clark, Gray, and Bargh (2010, Study 1) showed that warm physical priming produced greater trust in an economics trust game (Delgado et al., 2005) compared to cold physical priming. Across all these studies, physical warmth (coldness) led to judgments and behavior that were socially warm (cold).

Reversing the causal direction, Zhong and Leonardelli (2008) showed that after an actual or remembered social-rejection experience (i.e., social coldness), participants reported the

room temperature as being colder than did those who had just recalled an inclusion experience, and also showed greater desire for warm food and drinks (but not control food and drinks, such as apples) than did those not excluded. Notably, the researchers suggested that perhaps “experiencing the warmth of an object could reduce the negative experience of social exclusion”. IJzerman and Semin (in press) found that social distance manipulations also produced changes in the perception of room temperature; being seated relatively close versus distant from other participants in the experimental room produced higher estimations of room temperature, as did manipulations of the similarity of a target person – the more similar, the higher the temperature reported. As similarity has long been known to increase attraction and the probability of friendship (i.e., social warmth; Byrne, 1971), together these studies show that experiences of social warmth produce concomitant feelings of physical warmth.

There is growing evidence from social neuroscience research that the association between physical warmth (coldness) and social warmth (coldness) might be `hardwired' in humans (Meyer-Lindenberg, 2008). Insular cortex is implicated in the processing of both physical temperature (e.g., Craig, Chen, Bandy, & Reiman, 2000; Sung et al., 2007) and the psychosocial version of warmth information: feelings of trust (e.g., Sanfey, Rilling, Aronson, Nystrom, & Cohen, 2003; Todorov et al., 2008), empathy, and social emotions such as embarrassment and guilt (Eisenberger, Lieberman, & Williams, 2003; Kross, Egner, Ochsner, Hirsch, & Downey, 2007). The most recent available evidence suggests that anterior insula provides the basis for subjective feelings and emotional awareness (Craig, 2002, 2009, for reviews). Consistent with this hypothesized direct anatomical connection, Kang et al. (2010, Study 2) observed in a recent fMRI investigation that left anterior insula became more activated following cold versus warm temperature sensation, and also more activated following betrayals of trust in the economics game.

It seems therefore that the `coldness' of loneliness or rejection could be treated somewhat successfully through application of physical warmth – that is, physical and social warmth might be at some level substitutable for each other. If so then the physical-social warmth association may be a boon to the therapeutic treatment of syndromes that are mainly disorders of emotion regulation, such as Borderline Personality Disorder (BPD; see Glenn & Klonsky, 2009). Indeed, in her influential biosocial approach to BPD, Linehan (1993) emphasized the affective intensity and lability of patients and suggested that they could benefit from learning techniques to self-regulate their affective levels (p. 143).

In the present studies we extend the contemporary research on the relation between physical and social warmth by documenting in Study 1 how people already tend to self-regulate their feelings of social warmth (connectedness to others) with applications of physical warmth (as through taking warm baths or showers), yet apparently do so implicitly, without explicit awareness of the relation. We followed these studies with an experimental test of the coldness-loneliness relation involving physical temperature primes in Study 2. Next, in Study 3 we provide the first experimental test of whether interpolated physical warmth experiences can reduce feelings of social coldness, as caused by actual or recollected rejection experiences. These studies also expand on previous research by including chronic, individual difference measures of social connectedness (i.e., the UCLA Loneliness scale) in addition to temporary manipulations of those feelings (as in the previous research), and showing that these chronic measures produce conceptually similar effects. (The use of the chronic loneliness measure also helps rule out the “semantic priming” alternative interpretation that applies to much metaphor-priming research.)

Studies 1a and 1b focused on the predicted use of physical warmth (specifically, baths or showers) by the general public as a form of self-therapy to restore feelings of social warmth

when those are lacking (as when one is feeling lonely). We followed these studies with an experimental test of the coldness-loneliness relation involving physical temperature primes in Study 2. Next, Study 3 directly tested the prediction that physical warmth experiences can effectively substitute for social warmth needs produced by social rejection experiences.

A further goal of the present research is to test for both implicit and explicit levels of awareness in our participants of the physical-social warmth relation, as the implicit knowledge may unconsciously manifest itself in actual behavior (e.g., increased bathing) in the absence of experienced distress or any explicit awareness of the relation (see Wilson & Brekke, 1994). The lack of explicit awareness of the relation is especially surprising given how pervasive the use of the metaphor is in everyday language (“A warm smile”, “a cold shoulder”); clearly, people easily understand the social meanings of these physical terms and use them to effectively communicate about the personality and behavior of others (see Lakoff & Johnson, 1980). Indeed, there are signs that at the cultural level we have possessed this knowledge for centuries: for example, Dante in the *Inferno* linked the sin of betrayal of trust (i.e., extreme social coldness) with the poetic justice of being *physically* frozen, indicating Dante for one appreciated the metaphorical relation between physical and social coldness. Yet our experimental participants (as well as those in previous research on this effect) showed no explicit awareness of the physical-social warmth relation in post-session debriefing (Studies 2 and 3), and the direct test of such awareness in Study 4 provided further evidence that people are not aware of the effect at a conscious level.

Study 1a

Studies 1a and 1b were designed to test the hypothesis that people (implicitly) compensate for the lack of social warmth in their lives with increased physical warmth experiences. Specifically, we hypothesized that chronic or `trait' loneliness (the self-perceived deficit in social connectedness; Russell, 1996) of our participants would be positively associated with the frequency, duration, and preferred water temperature of the showers and baths that they take. In this way, people are hypothesized to self-regulate their deficits in social warmth with applications of physical warmth, thus effectively substituting physical for social warmth.

To test this hypothesis we recruited both a university student sample (Study 1a) and an adult community sample (Study 1b) of participants. Both samples completed a brief survey concerning how frequently they take a shower or bath, what water temperature they prefer while bathing, and also how long their typical bath or shower lasts in minutes. Following this bathing activities survey, participants completed the short version of the UCLA Loneliness Scale (Russell, 1996).

Participants

Fifty-one undergraduates (26 females, and 25 males) were recruited for the study outside of their “commons” dining hall in exchange for $2. Their ages ranged from 18 to 45 years of age, with a mean age of 20.11 (*SD*=4.17).

Method

After giving their informed consent, participants completed two surveys in a random order that purportedly involved life style habits (e.g., “In the past 3 months, how often have you been involved in physical activity?”; “How many meals do you have per day?”), including three key items about their bathing habits: “How often do you usually take a bath?” (on an 8-point scale ranging from “more than 3 times a day” to “less than once a week”); “What temperature water do you use?” (on a 6-point scale ranging from cold to very hot), and “About how much time do you spend in the bath”? (on a 7-point scale ranging from “less

than 2 minutes" to "over 30 minutes"). Next, participants filled out the short version of the UCLA Loneliness scale (Russell, 1996), which includes 10 statements worded in a negative or "lonely" direction, individuals indicate how often they agree with each statement on a ranging from 1="never" to 4="often." Finally, participants were debriefed as to their awareness of the study hypotheses (none of the participants were able to identify the purpose of the study), and thanked for their participation.

Results

Pearson product moment-correlation coefficients were computed to examine the relationship between participants' bathing habits and degree of loneliness. As hypothesized, significant positive associations were obtained between loneliness and (a) frequency of bathing (r=.48, p< .001, two-tailed), (b) typical duration of a bath or shower (r=.29, p< .05), and (c) preferred water temperature (r=.26, p=.07). In other words, participants' degree of loneliness accounted for fully 23% of the variance in how often this student sample took baths or showers; also, the lonelier the participant, the warmer they preferred the bath or shower to be, and the longer they spent under the warm water.

We created a summary index variable of the bathing frequency, duration, and preferred-temperature items by standardizing each score and taking the mean; this score can be understood conceptually as "physical warmth extraction" from the bathing activity, as the more often, longer, and warmer the bath, the greater the total warmth experienced by the participant. This index variable correlated r=.57, p=.0001, with UCLA Loneliness scores, such that 32.5% of the variation in physical warmth extraction during bathing was explained by how lonely the participant was. Overall, then, in this student sample, chronic levels of "social coldness" were strongly related to the amount of physical warmth the individual consumed each week in the form of bathing.

Study 1b

Participants

In this replication study, a community sample of participants (16 female, 25 male) was recruited on the town green of a small New England city. This sample was significantly older than that of Study 1, with ages ranging from 19 to 65, with a mean age of 43.60 (SD=11.49).

Method

After providing their informed consent, participants filled out the same lifestyle habits survey and the UCLA loneliness scale as in Study 1a, in exchange for $2 compensation. Finally, participants were debriefed as to their awareness of the hypothesis of the study, thanked for their participation, and dismissed. None of the participants were able to identify the purpose of the study with any accuracy.

Results

As in Study 1a, significant positive associations were obtained between loneliness and (a) the average duration of the participant's bath or shower (r=.33, p< .05) and (b) the preferred water temperature of the typical bath or shower taken by the participant (r=.34, p<.05). Unlike Study 1a, however, there was no association obtained between loneliness and the frequency of taking showers/baths (r=.03, p>.25). Still, as in Study 1a, the overall "physical warmth extraction" index variable was significantly correlated with chronic levels of loneliness, r=.37, p=.017, such that 14% of the variance in weekly physical warmth extraction through bathing in this more diverse community sample was explained by degree of chronic loneliness. We suspect that the difference between the two samples on the

frequency item was because the bathing habits of the older community sample are likely more routine and regular than in the dormitory-based student sample, so that needs for social warmth are met more by increases in duration and temperature of baths or showers, not so much by increases in their frequency. Importantly for our central hypothesis, however, in both the student and community samples, the lonelier the participant, the warmer the preferred water temperature of the bath or shower.

Study 2

The Study 1 results supported the hypothesis that people tend to substitute physical warmth experiences for the social warmth that is missing from their lives. According to our model, loneliness is “social coldness”, a negative emotional state that can be ameliorated somewhat through applications of physical warmth (as in taking warm baths or showers). The results of Study 1 were consistent with this model by showing that lonely people do tend to bathe more often, longer, and prefer warmer water temperatures when bathing, compared to less lonely individuals. But as this evidence was correlational, it does not by itself demonstrate an equivalence of physical and social coldness.

Study 2 directly tested our model's prediction that cold physical experiences produce feelings of social coldness, by first inducing a warm versus cold (versus none) physical temperature experience, and then administering participants the UCLA Loneliness Scale. This experiment moves beyond previous research on the physical-social warmth relation in two important ways: first, it tests whether physical warmth versus cold experiences produce analogous changes in a trait measure of the participant's feelings of social warmth/coldness – that is, not a fleeting impression of the warmth or prosociality of a single target individual (as in Williams & Bargh, 2008, and IJzerman & Semin, 2009), but a report of the experienced chronic warmth or coldness of the participant's longer-term social environment (i.e., the UCLA Loneliness scale). Secondly, unlike all previous temperature priming studies (IJzerman & Semin, 2009, in press; Williams & Bargh, 2008; Zhong & Leonardelli, 2008) – with the exception of Kang et al. (2010) – a baseline or control condition was included that did not receive either the warm or cold temperature experience, enabling us to ascertain whether it is the warm or the cold experience (or both) that is mainly driving the effect. Is it that physical warmth increases prosociality and reduces interpersonal distance, or that physical coldness decreases prosociality and increases interpersonal distance (or both)?

Participants

A total of 75 students (38 females, 37 males) ranging from 18 to 45 years of age with a mean age of 20.17 (SD=3.55) were recruited for the study outside a university dining hall; they first provided their informed consent, and then participated in return for $2.

Method

Following the warm/cold temperature-priming manipulation of Williams and Bargh (2008, Study 2), experimental participants were given a `product evaluation' task in which they first held a therapeutic pack (260 × 370 × 10 mm, MD Prime Co., Korea) that had just been heated in a microwave oven for 41 sec or cooled in a freezer for one hour; and then answered items concerning their opinion of the product. The experimenter placed the pack on each participant's left palm; after a minute the participant completed a consumer questionnaire with the pack still resting on their palm. The questionnaire consisted of three items: 1) was application of the pack pleasant (yes/no), 2) was it effective (yes/no), and 3) would the participant recommend the product to their friends (yes/no). Participants in the control condition were not presented with this task and did not hold the warm or the cold pack.

Next, as part of an ostensibly separate study, participants completed the short form of the UCLA Loneliness Scale. We probed participants' suspicion and awareness of the primes using a funneled debriefing procedure (Bargh & Chartrand, 2000). None of the participants were able to identify the purpose of the prime, the connection between the studies, or the experimental hypothesis being tested.

Results

We expected that the cold temperature prime would increase participants' scores on the loneliness scale, as physical coldness experience should increase feelings of social coldness (disconnectedness). A one-way ANOVA (cold vs. warm vs. control) ANOVA on loneliness scores revealed the predicted main effect of temperature, $F(2,74)=3.80$, $p < .05$, $\eta_p^2 = .096$. Planned comparisons indicated that the cold-pack manipulation significantly increased loneliness scores ($M = 2.52$, $SD=.91$) compared to both the warm-pack ($M = 2.04$, $SD=.64$; $t(49) = 2.12$, $p = .04$) and the neutral-pack ($M=1.97$, $SD=.68$; $t(48)=2.55$, $p < .01$) conditions. The mean loneliness score in the warm-pack condition did not significantly differ from that in the neutral-pack condition ($t(49) < 1$).

These findings support the interpretation of the positive relation between loneliness and taking warm baths or showers, observed in Study 1, in terms of physical warmth-seeking in compensation for the feelings of physical coldness associated with social coldness (loneliness). The association between physical and social coldness appears to be bidirectional: even a brief physical coldness experience as in the present Study 2 significantly increases reported feelings of chronic loneliness (social coldness), and Zhong and Leonardelli (2008) have shown that recalling an episode of past rejection (social coldness) makes one feel physically colder (lower estimates of room temperature). For many people, then, taking a warm bath or shower is at least partly in the service of returning oneself to normal feelings of *social* warmth.

Also noteworthy in these findings is that the mean loneliness score in the warm-pack condition was quite similar to that in the neutral condition, with both means close to the overall scale norm of 2.0 (see Russell, 1996), and both significantly lower than in the cold-pack condition. Two recent studies also suggested that “cold is stronger than warm”: Kang et al. (2010, Study 2) found that cold-priming produced greater activation of left anterior insula compared to both the warm-priming and the control conditions (which were equivalent), and IJzerman and Semin (in press) found that a social distance (coldness) manipulation (reading about a dissimilar target person) had three times the effect on room temperature estimation than did a comparable social closeness (warmth) manipulation (reading about a similar target person; Cohen's $d = .97$ versus .36, respectively).

It seems then that the default state or orientation towards other people is mild warmth, such that additional physical warmth experiences do not change the default as much as does a physical coldness experience. This “default warmth” interpretation is in harmony with the conclusions of Cacioppo and Gardner (1999) that people have a basic default approach motivation toward the social world but that avoidance motives, when triggered, are stronger than approach motivations generally. It is also consistent with the conclusions reached by Baumeister, Bratslavsky, Finkenauer, and Vohs (2001) in their comprehensive review that “bad is stronger than good” in terms of stimulus effects on judgment and behavior.

Study 3

Although physical warmth experiences may not have a strong effect on feelings of social warmth when a person is already feeling connected to family, friends, and co-workers, we do expect it to have a strong restorative or compensatory effect when the person is not

feeling so connected (i.e., lonely). Zhong and Leonardelli (2008) showed that participants who were excluded during a simulated on-line interaction (the "Cyberball" game; Williams, Cheung, & Choi, 2000) showed a greater desire for warm food and drinks (but not control food and drinks, such as apples) than did those not excluded. The researchers suggested that perhaps "experiencing the warmth of an object could reduce the negative experience of social exclusion". Similarly, the present Study 1 showed that the lonelier the individual, the more likely was he or she to take warm baths or showers. Thus feelings of social coldness, whether acute following a rejection episode, or chronically in the form of general loneliness and social isolation, appear to trigger a compensatory motivation to restore the missing warmth. What remains to be shown is that such applications of physical warmth do indeed temporarily reduce or even eliminate feelings of social coldness; in other words, that physical warmth is an effective *substitute* for social warmth. Study 3 was designed to test this hypothesis that physical warmth experiences can ameliorate the negative `cold' feelings caused by social rejection.

Following the procedure of Park and Maner (2009), participants first recalled a time in which they were socially excluded, socially included, or in the control condition, their most recent meal. Next they took part in the warm or cold pack product testing task as in Study 2 above. Finally their need to affiliate and also their desire to take part in emotion-improving activities (e.g., going shopping, eating candy) were assessed. We predicted that remembering an exclusion experience would activate a need to affiliate with others (replicating Park & Maner, 2009), and also increase the desire to engage in mood-improving activities, but that holding the warm pack following the exclusion experience would help to satisfy and thus significantly reduce both needs.

Method

A total of 176 undergraduates (88 females, 88 males) ranging in age from 18 to 25 years with mean of 20.46 (*SD*=2.94) participated in the study, in return for $2. After providing their informed consent, participants were randomly assigned to write about a time in which they had felt socially excluded, a time in which they felt socially included, or in the control condition, about their most recent meal. Then, following the same procedure as in Study 2 above, participants momentarily held a warm-pack or cold pack as part of a supposedly unrelated product evaluation task (or in the control group, were not given this task), after which their momentary need to affiliate was assessed using the five-item measure of Park and Maner (2009), with items such as "Do you want to spend time with a close friend?", and "Do you want to talk on the phone with a friend?". Next, participants responded to several items taken from the emotion-regulation activity survey of Thayer, Newman, and McClain (1994), which asked about their degree of interest in activities such as eating candy, going shopping, exercising, taking a nap, and taking a shower. Finally, participants were debriefed as to their awareness of hypotheses (again, no participant correctly guessed the underlying hypothesis of the study), thanked, and dismissed.

Results Need for affiliation

The statements concerning the need for affiliation were averaged to create a composite score, which was then subjected to a 3 (temperature: cold vs. warm vs. neutral) × 3 (social experience: exclusion vs. inclusion vs. neutral) analysis of variance (ANOVA). Consistent with hypotheses, a significant main effect was obtained for temperature, $F(2,175)= 3.89$, $p < .05$, $\eta_p^2 = .04$, indicating the participants' overall tendency to affiliate in the cold-pack condition (M=4.69, SD=1.04) was greater than in the no-pack (M=4.21, SD=1.23) or warm-pack (M=4.22, SD=1.13) conditions. Replicating Study 2, the effect of cold temperature experiences to increase feelings of social coldness was found to be stronger than the effect of warm physical experiences to increase feelings of social warmth (compared to baseline).

The analysis also revealed the predicted Social Experience × Temperature interaction, $F(4, 175)=3.22$, $p < .01$, $\eta_p^2 = .07$. In the exclusion-followed-by-cold-pack condition, participants showed a higher need for affiliation than did participants in the control (describe last meal)/ cold-pack condition ($M=5.08$, $SD=.83$ vs. $M=4.15$, $SD=1.21$) $t(36)=2.73$, $p < .01$. However, as predicted, the warm-pack intervention significantly decreased the need for affiliation provoked by recalling the exclusion experience: indeed, here, participants showed a lower need for affiliation compared to participants in the control/warm-pack condition ($M=3.85$, $SD=.92$ vs. $M=4.51$, $SD=.84$), $t(38)= -2.37$, $p < .05$. There was no simple main effect of temperature condition on need for affiliation within the inclusion condition, $F(2, 54) = 1.57$, $p > .21$. Thus, warm physical experiences were found to significantly reduce the distress of social exclusion, effectively substituting for needed social warmth experiences and eliminating the need for affiliation triggered by the exclusion event.

Interest in emotion regulation activities

Although need for affiliation is one consequence of social rejection (Park & Maner, 2009; Williams et al., 2000), it is not the only one: rejection and other difficulties in social relations also produce negative affective states which require regulation. Thus we included the additional emotion-improvement items to test the hypothesized effectiveness test of an intervening physical warmth experience in reducing the need for emotion regulation, not only the need for affiliation, produced by a social rejection experience.

The statements concerning interest in emotion regulation activities were averaged to create composite scores for each participant, which were then subjected to a 3 (social experience: exclusion vs. inclusion vs. neutral) × 3 (temperature: cold vs. warm vs. neutral) ANOVA. This analysis revealed significant main effects for temperature, $F(2, 175) = 3.11$, $p < .05$, $\eta_p^2 = .03$, and for type of social experience recalled, $F(2, 175) = 10.03$, $p < .001$, $\eta_p^2 = .10$; both of these main effects were qualified however by the predicted Temperature × Social Experience interaction, $F(4, 175) = 2.79$, $p < .05$, $\eta_p^2 = .06$. Further analyses of the components of this interaction revealed significantly higher interest in emotion-improvement activities following social exclusion compared to social inclusion, in both the cold-pack ($M=4.86$, $SD=.88$ vs. $M=3.58$, $SD=1.35$), $t(34)=3.40$, $p < .005$, and no-pack ($M=4.14$, $SD=.21$ vs. $M=3.04$, $SD=.22$), $t(38)= 3.37$, $p < .005$, conditions. However, in the warm-pack condition interest in emotion regulation activities following social exclusion was reduced to be no greater than that following social inclusion ($M=3.80$, $SD=.23$ vs. $M=3.76$, $SD=.22$), $t < 1.0$.

Overall, then, the results of Study 3 show that an intervening experience of physical warmth effectively satisfied and `turned off' the needs for affiliation and emotion regulation caused by recalling the exclusion experience. Together with the findings of Study 1 and 2, this pattern of results suggests that physical warmth experiences can effectively substitute for needed social warmth experiences.

Study 4

Thus far we have shown (correlationally) that people tend to seek out physical warmth experiences when in a situation of social coldness, and (experimentally) that this is an effective strategy for reducing those negative feelings of coldness. At the same time, however, neither our participants nor those in previous studies on the physical-social warmth relation showed any explicit awareness of the potential effect of physical temperature experiences on their feelings of social connectedness, or vice versa. It appears then that people know of the relation implicitly as shown in their actual behavior, yet lack explicit knowledge of the effect (i.e., it is an unconscious form of self-therapy). Study 4 was designed to provide a direct test of explicit awareness of the bathing-loneliness relation,

following the procedure of Nisbett and Bellows (1977; see also Nisbett & Wilson, 1977). We conducted a person-perception experiment in which participants were asked to evaluate the loneliness of a person who takes versus doesn't take several baths or showers within a limited time period. Everything else in the vignettes was held constant. We hypothesized that the person who frequently takes a bath or shower will not be perceived as any lonelier than the person who doesn't.

Participants

A total of 60 participants (32 females and 28 males) ranging from 18 to 31 year of age with a mean age of 20.40 (*SD*=2.64) contacted outside a university dining hall participated in return for $2.

Procedure

Participants provided their informed consent, and were told they would be reading a story written by a previous participant. At the top of the page were the instructions ostensibly given to the previous participant as to what to write about, concerning a time when they had suddenly remembered an event they had long forgotten about. The story was presented in hand-written form to bolster the cover story. It described a woman helping one of her cousins ("Barb") to move into her new apartment and then both going out to eat. The experimental and control versions of the stories (see Appendix) were identical except for several key moments in which Barb takes a shower in one version, but some other mundane activity (e.g., changing her clothes) in the other.

After reading their randomly assigned version of the story, participants were asked to rate Barb's degree of loneliness on the UCLA Loneliness scale-short version (Russell, 1996), her momentary need to affiliate, and lastly her degree of interest in emotion regulation activities, using the same two measures as in Study 3 above (Park & Maner, 2009; Thayer et al., 1994). Each activity was scored on a 6-point Likert scale (1 = *strongly disagree*, 6 = *Strongly agree*). After completing these three measures participants were debriefed and dismissed; none were able to guess the experimental hypothesis.

Results

An independent-samples t-test was conducted to compare the loneliness scores in the bathing versus no-bathing story conditions. Consistent with our hypothesis of a lack of explicit awareness of the bathing-loneliness effect, participants did not consider the target person Barb to be any lonelier in the bathing (*M*=1.90, *SD*=.51) compared to the no-bathing (*M*=2.23, *SD*=.74) versions of the story; $t(58)=-1.97$, $p < .05$. If anything, there was a trend for our participants to consider "bathing Barb" to be *less* lonely. There were also no significant differences between the two story versions as to Barb's rated need for affiliation (bathing *M*=4.60, *SD*=.73; no-bathing *M*=4.44, *SD*=.66), $t(58)<1$, or interest in emotion regulation activities (bathing *M*=3.69, *SD*=.81; no-bathing *M*=3.84, *SD*=.99), $t < 1$.

It does appear then that people lack explicit awareness, or an accurate theory (Nisbett & Wilson, 1977; Wilson & Brekke, 1994) of the physical-social warmth relation. Reading about a target person who takes frequent showers within a short time period does not cause social perceivers to consider that person to be any more lonely than a target person who fills the same time with other mundane behaviors. Indeed, if anything our participants tended to consider the frequent-bather to be less lonely, not more, perhaps due to a semantic priming effect (bathing being associated with warmth), similar to Asch's (1946) original study. But note that this semantic priming effect would be in the opposite direction to the behavioral effects observed in Study 1, in which increased bathing was associated with increased social

coldness (loneliness), not warmth -- further evidence that the behavioral effect cannot be accounted for in terms of semantic priming.

To return to Dante and his great poem, it appears that people do appreciate the substitutability of physical and social warmth, but only at an implicit level, as they lack an accurate theory of how loneliness and other forms of “social coldness” increase physical warmth-seeking activities. Dante reserved the ninth and deepest circle of Hell for those sinners who had betrayed the trust of others (Satan himself included), and tellingly consigned them to the *contrapasso* (`punishment that fits the crime') of being frozen in ice for all eternity – pointedly overturning the traditional image of a fiery Hell in doing so. Contemporary humans also show appreciation of the connection between physical and social temperature in the tendency to self-regulate feelings of loneliness with warm physical sensations, yet the evident lack of explicit awareness of the relation leads us to conclude that this is an unconscious self-regulatory mechanism.

General Discussion

In Studies 1–3, feelings of social coldness and disconnectedness were shown to trigger a need for social warmth that can be satisfied instead by applications of physical warmth, as in taking warm baths or showers. Extending previous studies (IJzerman & Semin, 2009, in press; Williams & Bargh, 2008; Zhong & Leonardelli, 2008), the present research included a chronic individual difference measure of social coldness (the UCLA Loneliness Scale) as well as experimental manipulations of social coldness (remembering past exclusion experiences), and showing their equivalence in experimental designs. Study 1a (student sample) and 1b (community sample) showed that chronic loneliness (social coldness) was associated with a greater tendency to experience physical warmth through taking more frequent, longer, and warmer baths and showers. Study 1 thus supported the central hypothesis that people tend to substitute physical warmth for the social warmth that is missing from their lives.

Study 2 showed that a physical coldness manipulation significantly increased feelings of loneliness (social coldness). Thus just as social coldness influences feelings of physical coldness (reported room temperature; Zhong & Leonardelli, 2008), physical coldness experiences can cause feelings of social coldness (loneliness). Next, Study 3 provided an experimental demonstration of the `self-therapeutic' effect of physical warmth in which feelings of social coldness, caused by recall of an experience of social exclusion, were significantly reduced by an interpolated physical warmth experience. Socially excluded participants who then held the warm pack showed a significant decrease in their need for affiliation and desire for emotion improving activities, compared to excluded participants who next held the cold or no pack. Finally, Study 4 provided direct evidence that people lack explicit awareness, or the correct `theory', regarding the loneliness-bathing effect, suggesting that the tendency to seek physical warmth as a substitute for absent social warmth reflects an unconscious self-regulatory strategy on their part.

Thus it would appear that the `coldness' of loneliness or rejection can be treated somewhat successfully through application of physical warmth – that is, physical and social warmth might be to some extent substitutable for each other (see also Zhong & Leonardelli, 2008). In harmony with this conclusion, researchers have recently posited associations between physical pain and social pain systems (e.g., Eisenberger et al., 2003; MacDonald & Leary, 2005a, 2005b; Panksepp, 2003, 2005). The neural overlap between physical pain and social pain systems (see Eisenberger et al., 2003; Panksepp, 2003) suggests that potential threats in both goal domains are processed similarly. People who are made to feel rejected while playing a computerized ball-toss game ostensibly with other participants exhibited increased

activity in dorsal anterior cingulated cortex (dACC), an area also implicated in the body's pain response system (Eisenberger et al., 2003).

The therapeutic value of the substitutability of physical and social warmth would seem promising, not only for the self-soothing of emotional distress as in DBT (Linehan, 1993) but also for the treatment of Seasonal Affective Disorder (SAD), in which large fluctuations in ambient external temperature (along with non-temperature influences such as amount of daylight per day) may well influence fluctuations in one's internal "social" temperature. Moreover, because feelings of loneliness and perceived isolation lead to poorer physical and mental health outcomes among the elderly (e.g., Chappell & Badger, 1989; Larson, Zuzanek, & Mannell, 1985; Tomaka, Thompson, & Palacios, 2006), and do so independently of actual social disconnectedness (Cornwall & Waite, 2009; Tomaka et al., 2006), ameliorating these feelings (through physical warmth) by itself could significantly improve the life quality of the elderly. Again, as with the tendency of lonely individuals to take more warm showers or baths (Study 1), it would seem that the elderly already appreciate the benefits of physical warmth given their traditional preference to retire to warm locations (e.g., Florida and Arizona in the U.S.); our findings suggest that they may be seeking out the increased physical warmth for psychosocial and emotional reasons in addition to physical ones (e.g., poorer circulation).

In conclusion, then, we have shown that people tend to self-regulate their feelings of social connectedness through the use of physical warmth experiences, but that this self-regulatory technique appears to be unconscious and implicit, with our participants manifesting no explicit awareness that physical warmth can be substituted for needed social warmth. Our experimental evidence suggests that the substitution of physical for social warmth can reduce needs for affiliation and for emotion regulation caused by loneliness and social rejection, needs that characterize several mental and social disorders with major public health significance.

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Appendix: Stories used in Study 4

A. "Bathing" version

In late March or could have been early April last year I was helping one of my cousins move into her new apartment and we were going to head out for some food; I was starving and was ready to head out right away but Barb wanted to take a shower first. While I was waiting I surfed her bookcase for anything interesting to look at and found out she liked Cezanne a whole lot because she had these three really expensive art books about him, and I'd never known she was even interested in art that much; then I felt a little funny like I was snooping around or something so I just flipped through some magazines until she came out again – it seemed like hours but maybe it was because I was so hungry… Then at lunch I asked about the Cezanne books and what kind of art she liked and she looked a little sheepish and then told me about this epiphany she had about his paintings, while looking at one of his still lifes at the Metropolitan one day, and then buying all three of those books at the gift shop before going home, which she admitted was pretty extravagant – and then I remembered! and it was weird because I'd completely forgotten about this, but it turns out the day she got those books I had called her about something completely unrelated and she

happened to be in the bathtub and she was so excited about the painting she had seen and talking on and on about it and all the time I was worrying about her having that phone near the tub and imaging her dropping it in the tub and ruining it or shocking herself or something – so I guess that distracted me at the time from what she was saying about the painting and the books. Barb still kids me about getting shocked with my phone like when it's raining – well I'd heard about it happening to someone I knew, but ok, ok, I feel silly about it now.

B. “No-bathing” version

In late March or could have been early April last year I was helping one of my cousins move into her new apartment and we were going to head out for some food; I was starving and was ready to head out right away but Barb wanted to change clothes first. While I was waiting I surfed her bookcase for anything interesting to look at and found out she liked Cezanne a whole lot because she had these three really expensive art books about him, and I'd never known she was even interested in art that much; then I felt a little funny like I was snooping around or something so I just flipped through some magazines until she came out again – it seemed like hours but maybe it was because I was so hungry… Then at lunch I asked about the Cezanne books and what kind of art she liked and she looked a little sheepish and then told me about this epiphany she had about his paintings, while looking at one of his still lifes at the Metropolitan one day, and then buying all three of those books at the gift shop before going home, which she admitted was pretty extravagant – and then I remembered! and it was weird because I'd completely forgotten about this, but it turns out the day she got those books I had called her about something completely unrelated and she happened to be walking home from the museum in the pouring rain and she was so excited about the painting she had seen and talking on and on about it, and all the time I was worrying about her talking on her cell phone in the rain and imagining it getting ruined or Barb getting shocked or something – so I guess that distracted me at the time from what she was saying about the painting and the books. Barb still kids me about getting shocked with my phone like when we're near a fountain or drinking fountain – well I'd heard about it happening to someone I knew, but ok, ok, I feel silly about it now.

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