Homely Thermoregulation: How Physical Coldness Makes an Advertised House a Home

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Abstract

House brokers typically intuit that any type of warmth cause people to buy houses more frequently. Is this empirical reality? The authors investigated this through people's attachment towards advertised houses. A wealth of research has now linked thermoregulation to relationships (cf. IJzerman et al., 2015), and here the authors purport that this extends to people's relationships with house as a more novel solution to an ancient problem: Shielding from the cold. The present package tests a preregistered idea that colder temperatures increase people's need to affiliate and, in turn, increase people's estimations of how homely a house is (measured through communality). The hypotheses of the first two studies were partly right: The authors *only* found that actual lower temperatures (not motivation and through a cup and outside temperature) induced people to find a house more communal, predicted by their need to affiliate. Importantly, this even predicts whether people find the house more attractive, and increases their willingness to pay for the house (Studies 1 and Study 2). The third study did not pan out as predicted, but still affected people's need to affiliate. The authors reason that this was caused by a methodological shortcoming (namely not directly being affected by temperature). The present work provides novel insights into how a house becomes a home.

Keywords: grounded cognition, social thermoregulation, need for affiliation, home, communality, attachment

Homely Thermoregulation: How Physical Coldness Makes an Advertised House a Home

Throughout history, humans have been searching and creating spatial demarcations – for example alcoves, grottos, huts, and eventually houses - keeping its members safe not only from predation, but also warm under temperatures endangering survival. Because of this vital role in survival, people have formed models of houses with functions beyond survival, as houses can fulfill an belonging need by making it a home (e.g., Dovey, 1985; Fullilove, 1996), or, as attachment theory would have it, a "safe haven" (Manzo, 2003; Moore, 2000). Here, we propose that the cognitive mechanisms framing those spatial demarcations as "home" are derived from the same physiological mechanisms that originally helped us to be shielded from the cold through other people.

Amongst early humans and other mammals, conspecifics helped in keeping us warm in order to decrease the metaboblic costs of a cold environment (cf. IJzerman and colleagues, 2015). But as effective as relationships may be in relating to others, a house may well have (partly) replaced those socially borne functions, in the same way as lower temperatures sparks attachment to other people and can be fulfilled through renting romance movies (Hong & Sun, 2012) or feeling nostalgic (Zhou et al., 2012). We will explicate and empirically validate how houses offer a socially supportive function - fulfilling the "need to affiliate" through "feeling at home" - all of it fulfilling thermoregulatory needs. Finally, we think that the link between temperature and homeliness is mediated by people's motivations to be with others. Together, in three studies (two of which were pre-registered), we investigated how lower temperatures elicit a Need For Affiliation (Park & Maner, 2009), and how this need in turn yields a house to feel more homely.

How relationships shield from the cold – and make houses more homely

A wealth of research has now linked thermoregulation – the regulation of body temperature (e.g., Winberg, 2005) - with relationship representations and affiliation motives.

Touching a warm (vs. cold) cup for example induces prosociality and activates perceptions of greater sociability (Williams & Bargh, 2008; for skepticism, see Lynott et al., 2014; for a moderation by attachment, see IJzerman, Karremans, Thomsen, & Schubert, 2013), while experiencing warmth (vs. coldness) leads to greater communal cognitions more generally (IJzerman & Semin, 2009; see also Schilder, IJzerman, & Denissen, 2014, for a high-powered replication).

But why should temperature cues play such an important role in how we relate to others? IJzerman and colleagues (2015; see also Beckes, IJzerman, & Tops, 2014) reason that – evolutionarily speaking – others help shield us from colder climates. They reason that relationships should create a distributed – and thus more predictable – way to regulate energy more efficiently than more ancient mechanisms, like shivering (cf. Davies, Krebs, & West, 2012; Proffitt, 2006). And modern times have afforded us with even more predictable temperature environments, like wearing clothes or turning up the thermostat in one's home. As a consequence, we start thinking as of other people and of houses as being more or less *communal* as a gage of how well we are protected from the cold.

Becoming Warmer through Attachments

This idea of communality can help us understand why people find houses more homely when colder (an effect we had not predicted in our first study). Whereas spreading activation effects revealed assimilative effects like gaging an experimenter as closer, other research has observed complementary effects in case of coldness. Hong and Sun (2012), for instance, discovered that physical coldness yields increased liking of romance movies and novels, whereas Zhou and colleagues (2012) found that nostalgia - a positive and social emotion - is triggered by coldness. Zhang and Risen (2014) found self-regulatory properties of people preferring socially warm activities in the cold, while Kolb, Gockel and Werth (2012; see also Bargh & Shalev, 2012) learned that physical coldness triggers a Need For

Affiliation in sales-people, letting them affiliate more with their customers. Finally, it appears that people feeling lonely tend to apply non-human physical warmth (Bargh and Shalev, 2012; see also Zhong & Leonardelli, 2009; but see Donnellan, Lucas, & Cesario, 2014; Wortman, Donnellan, & Lucas, 2014 for skepticism, and see Bargh & Shalev, 2014, for a rebuttal), just like loneliness in PTSD patients yields preference for warm foods (Li & Liao, 2013; see also Ong, IJzerman, & Leung, 2012). In other words, there is a reciprocal relationship between thermoregulation and motivation to seek socially warm activities or targets, independent from people's working models of their social environments. In the course of it, an evoked Need For Affiliation should channel this motivation. In line with the above complementary findings, we hence think that the (typically inter-human concept of) Need For Affiliation caused by coldness could equally make a house more homely – that is, increase perceptions of communality (and a felt sense of security) of the house.

Attachment to Home as a Thermoregulatory Mechanism

In effect, houses help us thermoregulate in comparable ways as our relationships. While in older times, people could resolve being cold by sleeping with many in one bed (Lacroix & Naunton, 2010; Tjew-a-Sin & Koole, 2013), a house – instead of other people - provides ample and stable warmth through its central heater, blankets, and other furniture, and by serving as a place where we eat warm food, snuggle our cat, take a warm bath, or sit by the fireplace.

A house's warmth could be an important constitutive feature in holding communal feelings towards it - or what environmental psychology and architecture suggests to be the attachment towards the home (for an overview, see Manzo, 2003, and Moore, 2000). This may explain why Dovey (1985) proposes the bond with our home to be an emotional relationship (or a "mutual caretaking bond", Fullilove, 1996, p. 1516), a relationship that results in an internal working model of that place (Proshansky et al., 1983) letting the home

be a center of security (Dovey, 1985, see also Chawla, 1992 and Oswald & Wahl, 2005) providing comfort, safety, and belonging (Manzo, 2003). In other words, like all of the effects that have been found with other people, colder temperatures should motivate people to find affiliation in a potential home. Because of the home's importance, we think that colder temperatures first activates people's need for affiliation, which thereafter let people find a house more communal, and even incline people to be more willing to purchase the house and pay more for it (cf., McGraw, Tetlock, & Kristel, 2003).

Overview of Studies

In total we report three studies: One non-preregistered pilot and two preregistered main studies. In our pilot (Study 1) we initially reasoned, based on previous assimilative findings (and contrary to what we wrote here in our introduction), that holding warm (vs. cold) cups would incline people to rate a house for sale presented in an advertisement as *more* communal. We were wrong: We found instead the opposite and updated our hypotheses accordingly for our (registered) Studies 2 (advertised house) and 3 (own house; for a screenshot and details of our registrations, see Appendix A), this time however using environmental and outdoor temperatures, respectively, instead of cups. In addition, by comparing both types of houses, we could test whether known associations with one's house matter (or not). For both studies, we now hypothesized that coldness would induce a greater sense of communality towards the house (and potentially also attractiveness, willingness to purchase and perceived value), and we expected this relationship to be mediated by participants' Need For Affiliation. We also thought that actual temperatures would moderate the relationship between our conditions. For convenience sake, we provide an overview in Table 1 with our hypotheses and final results.

Study 1: Pilot

Method

Participants

There was little information to go on in terms of power, so we collected 60 per condition (which was sufficient for a comparable manipulation; Schilder, Denissen, & IJzerman, 2014). One hundred and twenty (71,7% female, *M*age = 50.93, *SD*age = 16.832, N_{Dutch} = 119, $N_{Belgian}$ = 1) participants were recruited inside an indoor Dutch shopping mall and randomly assigned to the cold (*N*=60) or the warm (*N*=60) condition.

Procedure

In this unregistered study, four mugs were put on a table and in a random order filled with either cold or warm water by Experimenter 1, blind to the hypotheses. Under the guise of a consumer test[1], Experimenter 2 - not aware of the temperature of the cups - asked people to pick up and hold one mug (for about 30 seconds) and to give their opinion on some of the aspects of the cup. We worked with two experimenters, so as to make the experimenter interacting with our participant blind to condition (for a comparable strategy, see Schilder, IJzerman, & Denissen, 2014). In a next, ostensibly unrelated task, participants were asked to imagine that they were looking for a house and to evaluate a property presented in an advertisement containing an overview of its features, a price indication, two pictures of the house front and twelve pictures of the interior (e.g., living room, kitchen, bathroom, bed rooms). Accordingly, subjects rated the house on the communality items 'Safe', 'Familiar', 'Warm', 'Homely', 'Soothing', 'Relaxing', 'Comfortable', 'Private' and 'Being a Quality House' (averaged into "Communality"; all measured on a 7-point Likert-scale from 1 *not at all* to 7 *to a great extent*; Cronbach's Alpha = .95; a factor analysis revealed only one component exceeding an Eigenvalue of 1, Eigenvalue = 6.30, explaining 70.04 % of the total variance). In addition, we asked them to give an overall valence judgment of the house ("Valence"), to what extent they would be interested to buy the house if they would be looking for one

[1] In the consumer test, we asked participants how beautiful they found the cup (rated from 1 through 7), how pleasant participants thought it was to hold the cup (1-7), and an open question on what they would change about the cup.

("Interest"; both measured on the same 7-point Likert-scale) and how much they would be prepared to pay for the house ("WTP"; in Euros).[2]

Results and Discussion

Contrary to our initial hypothesis, an independent samples t-test revealed a marginally significant effect of people rating the house higher on Communality in the cold (M = 4.56, SD = 1.23) as compared to the warm (M = 4.13, SD = 1.15) condition, Cohen's d = .36 (CI 95,.01 .72), $t(118) = 1.95$, $p = .05$. Furthermore, in the cold (M = 185070.33, SD = 720004,76) as compared to the warm (M = 150875.00, SD = 93266.37) condition participants had significantly higher WTP scores, Cohen's d = .41 (CI 95, .05 .77), $t(110.90) = 2.48$, $p = .03$.[3] There was no difference in overall valence judgment of the house (p = .13), but participants' Interest was marginally significant higher in the cold (M = 3.33, SD = 1.94) as compared to the warm (M = 2.68, SD = 1.72) condition, Cohen's d = .35 (CI 95, -.01 .72), $t(118) = 1.94$, $p = .05$.

Thus, a consistent picture emerged that participants in the cold (vs. warm) condition estimated the house as more communal, were more likely to purchase the house, and willing to pay more for the house (with no difference in overall valence). We reasoned that increases in communality would determine participants' willingness to pay and their interest in the house, and we explored the mediation using the INDIRECT macro, leveraging a bootstrap analysis with 1000 resamples (Preacher & Hayes, 2008), between condition and WTP and Interest in the house. Both the mediation of condition via communality onto WTP ($p < .001$, CI 95, -24888.64 -1078.39) and onto Interest ($p < .001$ CI 95, -92 -.03) were significant. For

[2] Due to an oversight, we did not record temperature of the cups. The preparation of the study was done jointly with the first author of Schilder, IJzerman, and Denissen (2014), meaning that the materials were the same. In that report, temperature information was available. The temperatures were likely comparable.

[3] Levene's test for equality of variances was significant, $F = 13.65$, $p < .001$, and equal variances were thus not assumed. The variance was unequal, because 23 participants had filled in that they were not willing to pay anything for the house. When we excluded these participants, the effect disappeared (p = .43). There were 7 people in the cold condition that were not willing to pay anything for the house, and 16 in the warm condition. We thus think that whether or not people were willing to pay was largely determined by temperature condition.

graphical displays and coefficients and standard errors, see Figure 1 (WTP) and Figure 2 (Interest).

At that time, these effects were surprising for us. We then reasoned that people in the warm condition (besides triggering a memory or cognition that may be more communal) might have had a lower need to affiliate with others. We hence conducted a follow up to discover this potential mechanism, in which we included the so-called Need For Affiliation as potential mediator. In addition, we learned about a recent empirical demonstration that people's motivations may matter to self-regulate their temperature (Zhang & Risen, 2014). That is, people's motivation to self-regulate temperature may be reduced if they know they are going to be warmed up. We thus added such a condition in our Study 2.

Study 2: Pre-registered

For convenience reasons, and based on Zhang and Risen (2014), we now tested participants in cold outdoor (vs. warm indoor) temperatures instead of giving them cold (vs. warm) cups to hold. We thus set up a design with a cold staying "outside" condition, a warm staying "inside" control condition, but also with a cold "going inside" condition. Specifically, in the latter we added a "prime" by telling this third group they would go inside shortly, this in order to reduce their motivation to self-regulate their warmth (hence taking away the effects of coldness). Based on Zhang and Risen (2014), we hypothesized that the cold Outside condition (vs. Inside and vs. Going Inside) would reveal an increased estimation of Communality and Attractiveness of the advertised house (and also a higher WTP for the house and an increased Interest), all of which mediated by our participants' Need For Affiliation.[4] We also expected environmental temperatures to play a role, moderating the relationship between our conditions.

[4] At our midway point (point of submission for this journal) we also included temperature estimates as an additional measurement to discover another potential mechanism (namely, do people future resources differentially). At this stage, that variable is still inconclusive, likely because of the limited sample that we collected for that variable.

Method

Participants

A power analysis using G*Power (Faul, Erdfelder, Buchner, & Lang, 2007), based on the effect size of our Study 1 (Cohen's d = -.36), a power of .08, and an alpha of .05 suggested that our study required 226 participants. To be sure, we recruited two hundred and thirty participants (57.4 % female, M_{age} = 40.60, SD_{age} = 16.57, N_{Dutch} = 115, $N_{Belgian}$ = 112, $N_{Turkish}$ = 1; $N_{Surinamese}$ = 1, $N_{African}$ = 1) outside a shopping mall in Tilburg (The Netherlands) and outside a downtown library in Bruges (Belgium). The "Inside" control condition (N = 77) was completed inside the offices of the first three authors' student holiday jobs and internship companies. Participants in the outside condition were randomly assigned to the "Outside" and "Going Inside" conditions ($N_{outside}$ = 54 and $N_{going\text{-}in}$= 57).

Procedure

In a pilot study – with houses from a Dutch housing advertisement page from a residential area our participants would not be familiar with - we first selected a house that was relatively neutral in its communality (M = 3.08, SD = 1.13, N = 88, on a 5-point scale from 1 *negative* to 5 *positive*).[5]

We approached participants in three different conditions. In our "outside condition", participants were approached outside. In the "going inside condition", we informed participants that they would go inside after filling in the first few pages of the questionnaire. In the "inside condition", people were approached inside where temperatures were always higher than 19 degrees Celsius. Upon approaching, we first asked participants to view an advertisement containing a description, a price indication, a picture of the front of the house, and nine pictures of the interior (e.g., living room, kitchen, bathroom, bed rooms; questionnaire included on our Open Science Framework page). Subsequently, participants were asked to fill out our five-item Need For Affiliation questionnaire (measured on a 7-item

[5] For a description and data, see https://osf.io/afdr6/?view_only=5da2bfb7fd8e4cc6ad94df4073ec9ba1

Likert scale from 1 *not at all* to 7 *to a great extent*; Cronbach's Alpha = .86; example item: "to what degree do you want to call a friend"; Park & Maner, 2009). Next, we used the same communality scale as in our Study 1, with the exception of the item "warmth" to ascertain that we did not prime our participants semantically (Cronbach's alpha = .87). This time our factor analysis suggested two factors (Eigenvalue 1 = 4.29; Eigenvalue 2 = 1.00). For exploratory purposes, we now created two variables: Our original "Total Communality" variable (including all items), and a "Safe Haven" variable (only including "safety" and "familiarity" of the house), respectively. Next, we probed how attractive people perceived the house, and again the amount they would be Willing to Pay (WTP) for it and their willingness to purchase (Interest) and performed a funneled debriefing revealing that no participant was aware of the actual goal of the study.[6]

Results and Discussion

Confirmatory Analyses.

To examine how our three conditions affected how communal and attractive participants found a house (and to what degree Need For Affiliation determined this), we ran a number of Analyses of Variances (we ran our analyses including and excluding people above 10 degrees Celsius). With our entire sample, we found no effects on Need For Affiliation (p = .13), on Total Communality (p = .51), on Safe Haven (p = .36), on Attractiveness (p = .20), on WTP (p = .47), and on Interest (p = .52). Because we did not find our suggested condition effect, we did not explore our mediation including condition, and neither our moderation of temperature.

[6] Initially (before registration of this study), participants were approached outside on colder days (below 10 degrees Celsius) for the "Outside" and the "Going Inside" condition. After our midway point (and thus upon forking this study), we loosened our selection criteria and approached participants also on days warmer than 10 degrees Celsius outside (in order to discover whether real temperature would moderate the effect, and for convenience reasons). When we ran participants excluding above 10 degrees Celsius (in the outside condition, which we had registered), there were also no effects of condition on Need for Affiliation (p = .13), on Total Communality (p = .32), on Safe Haven (p = .11), on Attractiveness (p = .49), on WTP (p = .50), and on Interest (p = .66).

However, inside vs. staying outside conditions and temperature displayed multicollinearity when inserting into a regression. This suggested to us that it is not our condition variable (including motivation), but the *actual temperature* that influenced our participants' Need For Affiliation and communality. Because of that, we proceeded with actual temperature as predictor through the remainder of our (now exploratory) analyses.[7]

Exploratory Analyses.

Given our Study 1 and our confirmatory analyses, we immediately ran our newly proposed mediation model of actual temperature onto Total Communality and Safe Haven via Need for Affiliation, using the INDIRECT macro, leveraging a bootstrap analysis with 5000 resamples (Preacher & Hayes, 2008), in which we predicted that lower temperatures should lead to a higher score onto Total Communality or Safe Haven. Both the mediation onto Total Communality (p = .02, CI 95, -.01 0; R^2 = .04) and Safe Haven (p = .01, CI 95, -.01 0; R^2 = .05) were significant (see Figures 3 and 4 for graphical displays and coefficients and standard errors).[8]

Because both variables were highly comparable and to avoid redundancy, we proceeded to only analyze our results with Total Communality to find out about WTP and Interest. To accommodate for both Need for Affiliation and Communality as mediators, we ran Hayes' (2013) PROCESS macro's model 6 to check for effects onto WTP, Interest (Figure 5), and Attractiveness (Figure 6). The model for Interest (F(3, 224) = 35.37, p < .01) and Attractiveness (F(3, 224) = 67.55, p < .01) were significant, but the model for WTP was not (F(3, 193) = 1.11, p = .35), meaning that temperature affected interest in the house via the proposed mediators Need for Affiliation and Communality, but this time not their willingness

[7] To be sure, we repeated the above analyses on our new Safe Haven variable. We thus first performed an analysis of variance to test whether this new Safe Haven variable elicited the hypothesized effect for our three conditions. We again did not detect any significant effect onto our new dependent variable, indicating that our motivation prime did not play a role.

[8] The effects were comparable when running the analyses for people who filled in the questionnaire by themselves, Total Communality (p = 02, CI 95, -.012 -.0001 R^2 = .04) and Safe Haven (p = .01, CI 95, -.01 -.001, R^2 = .05).

to pay for the house. The proposed mediation onto WTP was significant when excluding those participants in the outside condition above 10 degrees Celsius ($F(3, 165) = 6.30$, $p < .01$; we report this in Figure 7), as it was when excluding those who filled it in together (see Footnote). Given that the effects were relatively consistent, we think that the non-significant mediation for WTP was a fluke.[9]

Together, we have now found in a pilot study and a preregistered study that the actual temperature (be it a cup or outside temperature) predicts that people find a house more communal (in particular it being a safe haven), and that this even predicts how attractive they perceive the house and their willingness to purchase the house (though this latter effect was less stable). Both results were only marginally significant, but the model improved in our second study when inserting relevant mediators like Need for Affiliation and Communality.

The effects were not entirely in line with what we had pre-registered. Based on recent work by Zhang and Risen (2014) we had predicted that a motivational prime would matter; In our sample, it did not, and only temperature was related to our results. In our General Discussion we return to potential reasons. Because we now have an experimental and correlational study with comparable results, we think that a relatively consistent picture has emerged with temperature causally affecting our proposed mediators (Need for Affiliation and Communality) and dependent variables (WTP and Interest). Now, if a house in an advertisement could show protective functions against colder temperatures, and if this effect is mediated by people's Need for Affiliation, would this then work similarly for houses people actually live in? Perhaps not, because people have built up existing associations with their homes, as it has protected them from the harsh outside world in the past.

Study 3: Pre-Registered

[9] Effects remained similar when only analyzing those who completed the questionnaires alone, Interest ($F(2, 181) = 27.31$, $p < .01$), and Attractiveness ($F(3, 181) = 58.86$, $p < .01$), and became significant for WTP ($F(2, 155) = 4.61$, $p < .01$) .

We ran this study in parallel with Study 2. In line with Zhou and colleagues' (2012) Study 1 and Hong and Sun's (2011) Study 4 we thought that people would experience a Need For Affiliation (and in turn effects on perceived communality of the house) caused by decreasing outside temperatures, even when they do not directly influence them, like while our participants are sitting in their house while filling in their questionnaires (instead of outside, like in our Study 2). Importantly, based on an intermediate analysis in a pilot study (with a smaller sample, $N = 113$, see our pre-registration page https://osf.io/ips2w/wiki/home/?view_only=5da2bfb7fd8e4cc6ad94df4073ec9ba1) - we thought that this effect would be moderated by the length people lived in their house. That is, the longer people live in the house, the less they are affected by temperature onto Need For Affiliation and Communality of the house.

Method

Participants

Based on our power analysis in Study 2, we again aimed to have at least 226 participants. Two hundred thirty seven participants completed an online survey in Qualtrics. We excluded participants because they had suspicions about the purpose of our study ($N = 6$), because the study lasted too long (longer than 30 minutes; $N = 4$), because they were renovating their house ($N = 2$), or because they provided no address ($N = 9$), leaving us with a total of 216 participants (65.3% female, 34.7% male, $M_{Age} = 39.28$, $SD_{Age} = 14.48$, $N_{Belgian} = 194$, $N_{Dutch} = 21$, $N_{German} = 1$).[10]

Procedure

We recruited participants via online forums. After indicating interest via email or indirectly via friends who sent the request to people we did not know (e.g., via work, their gym, sports clubs, et cetera), participants received a link with a questionnaire with an ostensible marketing study in cooperation with a housing realtor, assessing how people

[10] One participant indicated the questionnaire was completed in Bujumbura (Burundi) and IP-tracking located a participant in Düsseldorf (Germany), Ingolstadt (Germany) and Göteborg (Sweden). To be conservative, we excluded them from our main analyses, and kept them ($N = 4$) in our exploratory analyses using the matching temperatures.

perceive houses. We also asked to fill it out before 6pm, in an attempt to reduce noise in our temperature variable as much as possible. The questionnaire again contained the same Need For Affiliation-scale (a one factor solution, Eigenvalue = 3.55, explained 71.00% of the variance, Cronbach's alpha = .90) and Communality survey (this time only a one factor solution, Eigenvalue = 4.96, explained 61.98% of the variance; given that both variables appeared redundant in the previous study, we only created one version of the scale; Cronbach's alpha = .91) and a question measuring perceived Attractiveness. We then asked whether they knew the current value of their house (if yes, what it is, if no, what their Estimated Value would be), how long the participant was living in his or her current house (i.e., Dwelling Time), and if the participant was looking for another house. In the demographics part, we then asked for participants' postal code in order to look up outside temperature at their location in national weather records.[11]

Results and Discussion

Confirmatory Analyses. We analyzed our data with several hierarchical multiple regression analyses to assess that the interaction effect between Dwelling Time and Outside Temperature on Total Communality (*p*s > .35) and Attractiveness (*p*s > .36) were not significant. The interaction effect between Dwelling Time and outside temperature on Need For Affiliation however showed to be significant (*sr* = .15, *t*(212) = 2.20, *p* = .03), with also a main effect of Dwelling Time (*sr* = -.21, *t*(212) = 3.20, *p* < .01), and no main effect of outside temperature (*p* = .61). The interaction is displayed in Figure 8. We ran them both with outside temperatures based on participants' IP address and on the basis of their provided postal code, both the minimal and maximal temperature of that day.[12]

[11] Instead of mean daily temperatures, we were largely able to obtain temperatures somewhat closer to the time the questionnaires were completed. That is, for Belgian participants (N = 199) we used a database (www.meteobelgie.be) providing daily minimum temperatures and daily maximum temperatures, but also temperatures measured at 00:00, 06:00, 12:00 and 18:00. For the Dutch sample (N = 22), only mean daily temperatures where available (www.knmi.nl). For Need for Affiliation, we ran all the effects, and reported the biggest *p* value for the interaction term (*p* values ranging from .012 to .029).

[12] We traced people's location by their IP address using two "raters": https://www.iplocation.net/ and http://www.latlong.net/Show-Latitude-Longitude.html.

Thus, the effects onto Need for Affiliation appeared to work as predicted, but they appeared to be too weak to sort effects onto people's judgments of communality of their own houses. Why may temperature not have related to the variables we did detect in our earlier studies? One reason is that participants filled in the questionnaires inside and the effects were not sufficiently strong. Second, when comparing people's postal codes to IP-addresses and geographical coordinates obtained through Qualtrics, we also found mismatches possibly indicating that people did not always answer the questionnaire at home. Of 123 of all participants, IP and postal code did not match, 58 did, and 48 were inconclusive (e.g., when we traced an IP, locations that were provided ranged from Brussels to Antwerp to Bruges). Finally, the effects onto communality of one's own house may simply not work. We suspect that the nonsignificant findings in Study 3 can be attributed to too much noise as a result of our methodology.

General Discussion

We conducted three studies (two of them preregistered), in which – upon registration - had predicted that conditions that *suggest* coldness (either as a function of temperature or motivation) would increase people's perceptions of communality, or homeliness, of a house, and that this would be mediated by people's Need for Affiliation. We based ourselves on previous research, and were partly wrong. Instead, we found that the *real* temperature (through a cup or ambient temperature) predicted this relationship, and that there was no role for motivation in our samples, and no effects onto communality for temperature outside of one's own house (though this may have been attributable to failures in our methodology).

Our findings were bolstered when adding theoretically relevant mediators (e.g., Need for Affiliation). In our second study, we found a relationship, but in our first study, we found this through an experimental manipulation. In addition, when temperatures drop, people find a house more attractive (Study 2), are willing to pay more for it (Study 1, and to some extent Study 2), and are more interested in purchasing the house (Studies 1 and 2). This likely

contradicts the intuition of many house brokers, who may think that making their offices warmer increase buyers' willingness to purchase a home. Our final study did not show the predicted effects, but it is likely that this occurred because of a methodological shortcoming. The effects on Need for Affiliation worked as predicted, and, longer dwelling times were related to lesser need for affiliation (again relating to our idea that the house becomes a home).

We relied on a theory of social thermoregulation to predict that lower temperatures spark a need for affiliation, and in turn, trigger a feeling that a house is more a home (IJzerman & Koole, 2011; IJzerman et al., 2015). Despite that not all relations were exactly predicted a priori, our first two studies reveal quite a consistent set of effects. These effects are exciting, and speak to the idea that houses are indeed more novel inventions to shield us from thermoregulatory threats. Our attachments towards others thus extrapolate to our relationships with houses, a finding that previously already has been detected with consumer brands (IJzerman, Janssen, & Coan, 2015). It is that feeling that we all have when we describe our own house as being a safe haven, a place of refuge, or of shelter, and these feelings are rooted in the way that we shield ourselves from temperature threats. These effects are likely to emerge in more recent cognitive systems, resonating with the idea of a house being a hierarchically higher and, for some, more predictable source of social thermoregulation than other people (see Figure 9).

Although our data provide us with quite a coherent story, further close replications will still be needed to provide an accurate model that can be used in application (cf., Brandt et al., 2014). Furthermore, we had presumed that the motivation to go inside would take away people's "thermoregulatory motives" (cf. Zhang & Risen, 2014). This was however not the case. In our sample, *only* temperature differences predicted people's need to affiliate and their perception of communality. It could be that our prime was insufficiently strong in our case,

that the motivational prime does not work at all, or that there are cultural differences (e.g., caused by better temperature control in Zhang & Risen, 2014's Chicago buildings).

There are many questions that remain. If a house indeed fulfills some of the needs that other people fulfill, could it be that these more novel technologies reduce the need to be with other people? Furthermore, we relied only on constructs like the Need for Affiliation and Communality to assess affiliation motives and perceptions how homely a house is. This partly limits our generalizability, but also are not the constructs that are closest to our theoretical ideas. It is the more impressive that we detected our effects, because questionnaires assessing whether our participants want to email their friends are somewhat distantly removed from underlying processes, like metabolic regulation.

To discover whether metabolic regulation is central to our feelings of houses as home, consider findings by Ein-Dor and colleagues (2015). They found that avoidantly attached people have higher basal glucose levels. Could it be that people who feel less communal about their own homes also have higher basal glucose levels? More modern ways to thermoregulate, like other people and homes are more optimal, because it allows people to schedule energy more efficiently (a more ancient method, like shivering, only has an efficiency of about 10%; Tansey & Johnson, 2015). Although we think that more novel applications (a home) could partly take on some of the (thermoregulatory) functions of relationships because of their increased predictability, it is not necessarily the case that this is true for all individuals. Indeed, those people who are more securely attached may benefit more from other people because of their increased *responsiveness* (Reis, Clark, & Holmes, 2004), a trait that homes are unlikely to have (though modern technology makes a decent attempt to make a house more responsive). This can be teased apart in part by looking at single people versus those in a relationship. Theoretically, we think that others'

responsiveness and basic metabolic rates or basal glucose levels are two relevant variables to discover why and how houses become more a home, and how this relates to our relationships.

Relatedly, our findings indicate an important role of social thermoregulation in people's sense of homeliness, and future research could then assess people's internal working models of others, stress, anxiety, and depression linked to their home. As such, we can start understanding the role of the home in a larger spectrum of regulatory resources, like other people (Beckes & Coan, 2011). There may thus be an important caregiving role for realtors in helping people find the right home for their individual needs. Still, it remains unclear which specific items then exactly defines the "home". Could it be that a house, like a person, becomes internalized with coldness and instability, and do these internal working models of homes and people diverge?

Like Harlow's (1958) rhesus monkey and the piece of cloth, a house is not a substitute for another human being. But like Harlow's (1958) rhesus monkey, houses can fulfill an evolutionary need for people to belong. Houses, like other people, can reduce our thermoregulatory needs, and make our environments more predictable. We look forward to extension of this research, and learning about how houses and people can reduce our metabolic rates, and increase our explorative behaviors.

Tables

Study 1 (pilot, non-preregistered)
- **Original Hypothesis**: Holding a warm (vs. cold) cup leads to a higher 1) perceived Communality of the house, 2) amount Willing to Pay (WTP) for the house, 3) Interest in the house.
- **Result:** Not confirmed, opposite result, with perceived communality mediating relationship between temperature condition and WTP and interest. We updated our hypothesis for Study 2.

Study 2 – (pre-registered)
- **Hypothesis:** Being in a colder environment relates to a higher 1) perceived Communality of the house, 2) perceived Attractiveness, 3) WTP, and 4) Interest, with Need to Affiliate (NFA) mediating the relationship between temperature and communality, and fulfilled motivation (going inside) should take away this effect.
- **Exploration:** Are temperature estimates, perceived attractiveness, amount willing to pay, and willingness to purchase related to this mediation?
- **Result:** Partly confirmed; temperature predicts Communality, Attractiveness, WTP, and Interest, and this relationship is mediated by NFA. Motivation did not predict our dependent variables (and temperature, rather than condition, predicted our effects). We added mediation model 6 to make our analyses more accurate. Future studies likely need filling in questionnaires alone.

Study 3 – Pre-Registered **Confirmatory Analyses**
- **Hypothesis** Colder outside temperatures (while inside the house) will relate to a higher 1) perceived Communality of their own house, and Attractiveness of their own house, but only when they live in their house a shorter period of time, mediated by NFA.
Result: No effects on dependent variables; interaction effect on NFA confirmed. Potential methodological shortcoming, or no effect.

Figures

Figure 1:

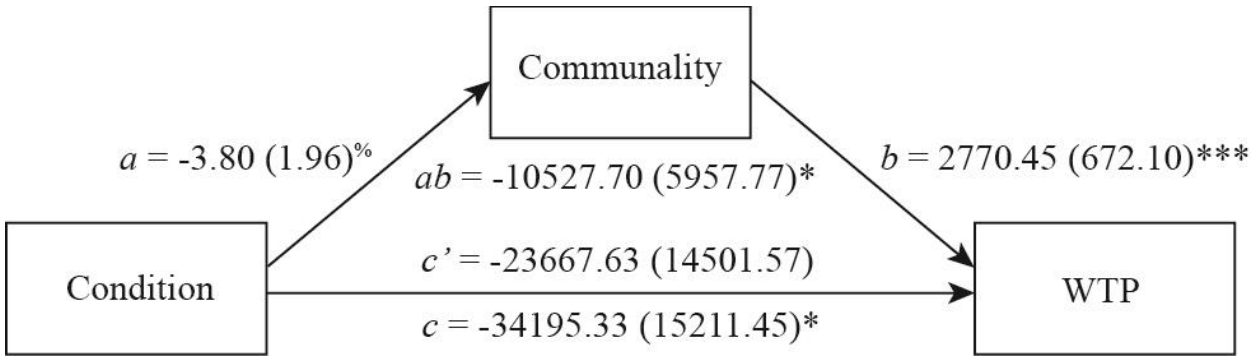

Figure 2:

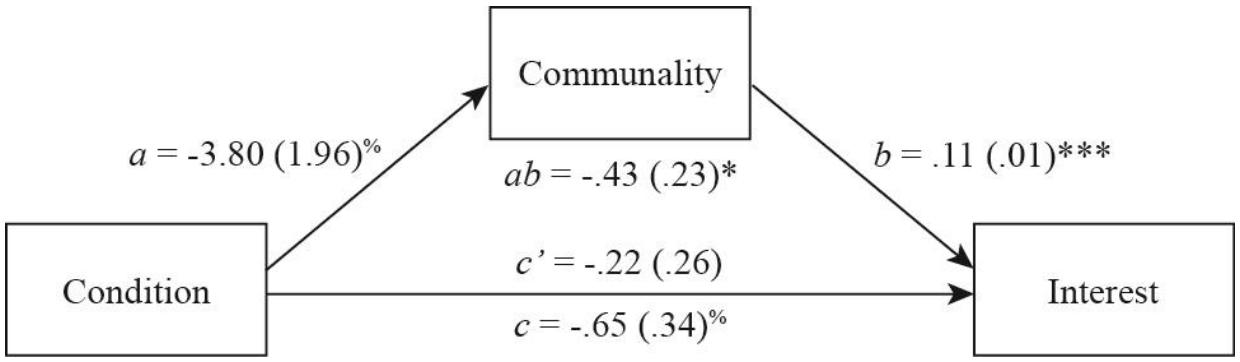

Figure 3:

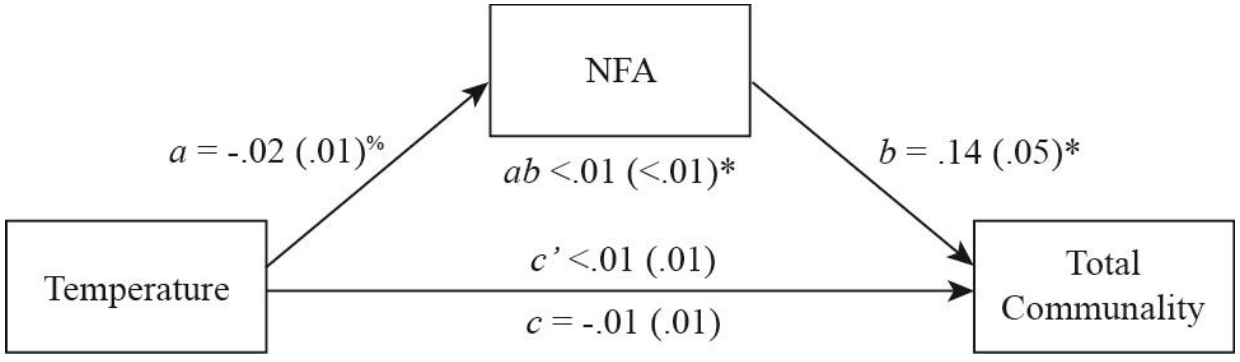

Figure 4:

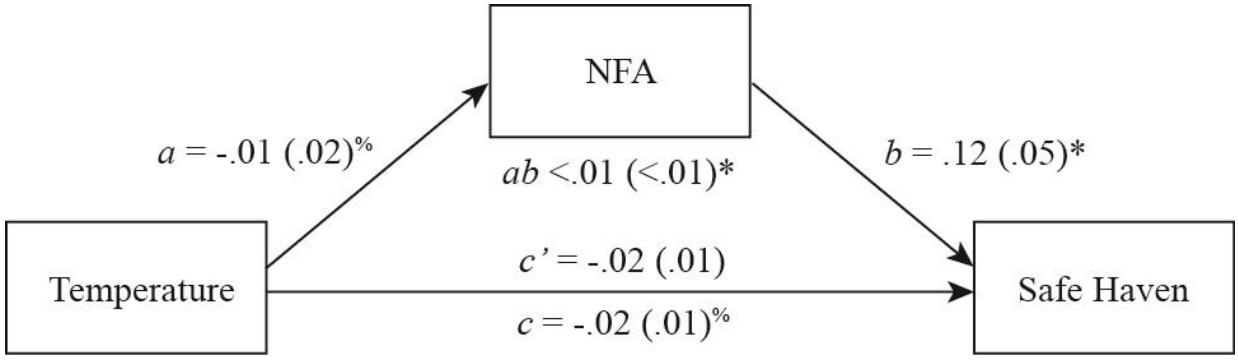

Figure 5:

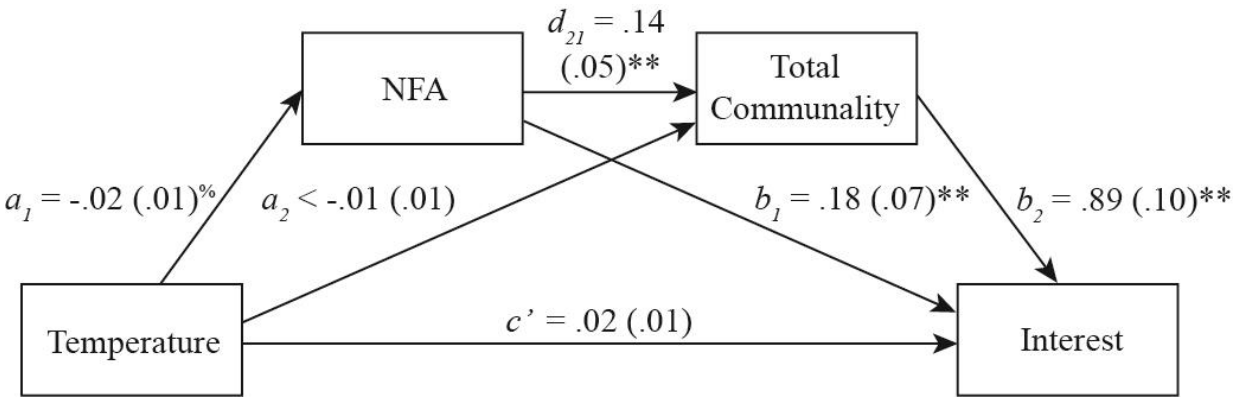

Figure 6:

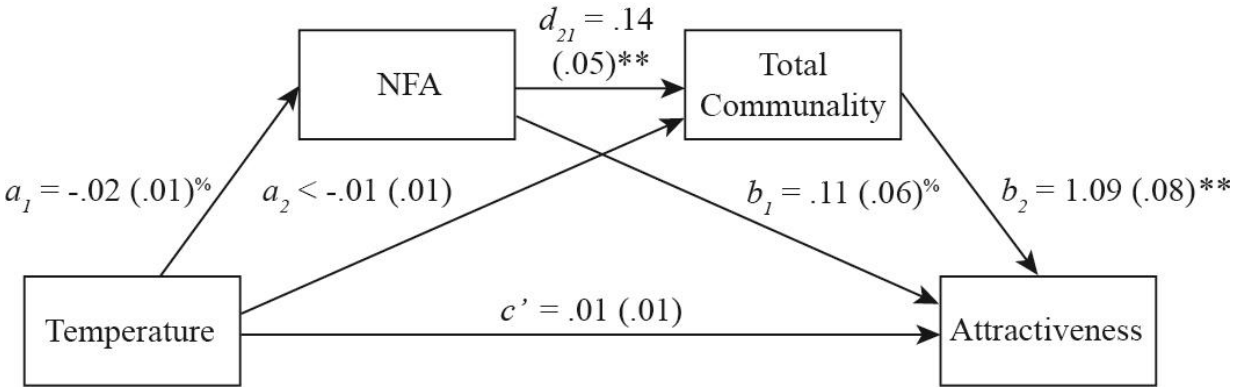

Figure 7:

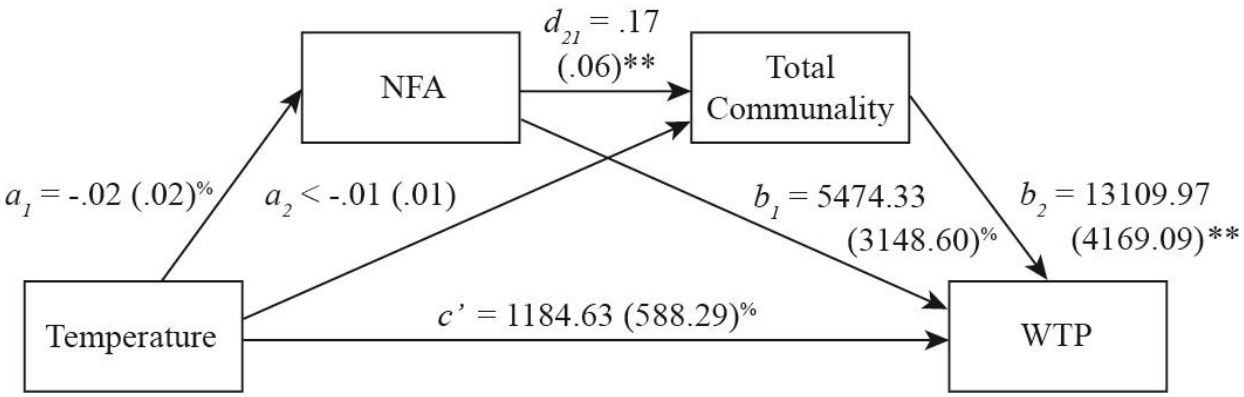

Figure 8:

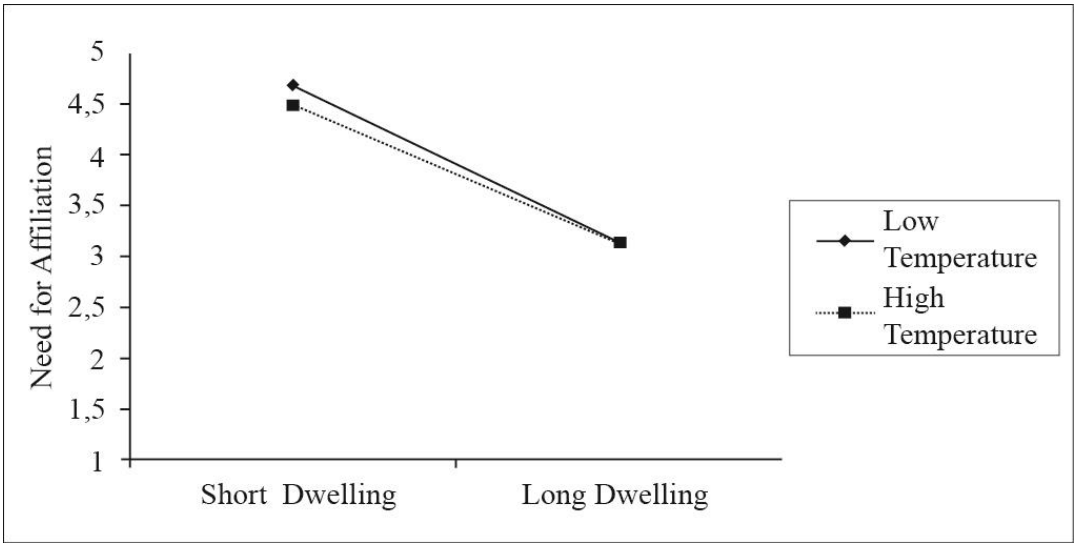

Figure 9:

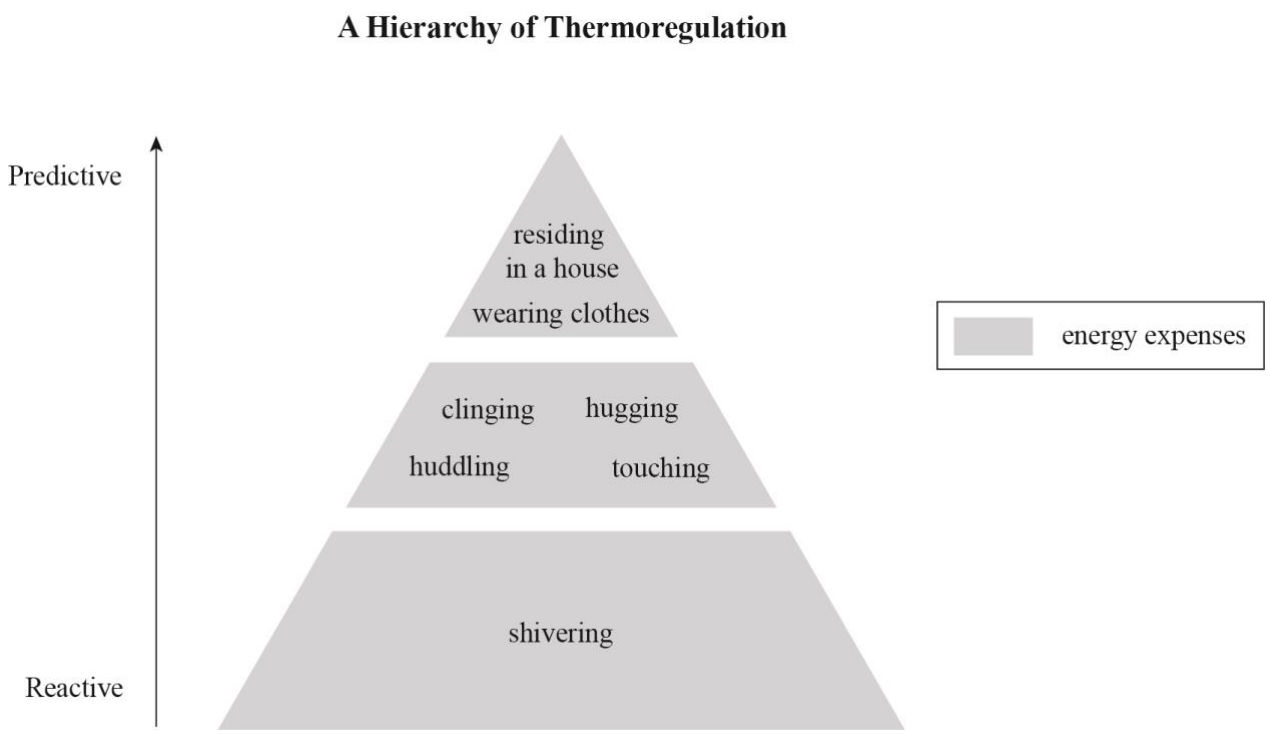

Figure Caption

Figure 1. Mediation of temperature condition onto WTP via Communality. $^{\%}p < .10$, two tailed, $^{*}p < .05$, two-tailed, $^{**}p < .01$, two-tailed, $^{***}p < .001$.

Figure 2. Mediation of temperature condition onto Interest via Communality. $^{\%}p < .10$, two-tailed, $^{*}p < .05$, two-tailed, $^{**}p < .01$, two-tailed, $^{***}p < .001$.

Figure 3. Mediation of temperature onto Total Communality via NFA. $^{\%}p < .10$, two tailed, $^{*}p < .05$, two-tailed, $^{**}p < .01$, two-tailed, $^{***}p < .001$.

Figure 4. Mediation of temperature onto Safe Haven via NFA. $^{\%}p < .10$, two tailed, $^{*}p < .05$, two-tailed, $^{**}p < .01$, two-tailed, $^{***}p < .001$.

Figure 5. Mediation of temperature onto Interest via NFA and Total Communality. $^{\%}p < .10$, two tailed, $^{*}p < .05$, two-tailed, $^{**}p < .01$, two-tailed, $^{***}p < .001$.

Figure 6. Mediation of temperature onto Attractiveness via NFA and Total Communality. $^{\%}p < .10$, two tailed, $^{*}p < .05$, two-tailed, $^{**}p < .01$, two-tailed, $^{***}p < .001$.

Figure 7. Mediation of temperature onto WTP via NFA and Total Communality. $^{\%}p < .10$, two tailed, $^{*}p < .05$, two-tailed, $^{**}p < .01$, two-tailed, $^{***}p < .001$.

Figure 8. A hierarchy of thermoregulation. More cognitively recent thermoregulation processes should be more predictable and thus less energy demanding than more ancient, reactive sources. We use the terms reactive and predictive here to match IJzerman et al.'s (2015) theory.

Appendix A

Note. Screenshot of our registration, which is available at https://osf.io/2bgtu/. Note that our project was pre-registered as a forked version of an initially pre-registered project, containing only Study 1 and a halfway analysis of Study 2. We already detected our hypothesized effect at that stage, including the hypothesized motivational effect (which did not appear in our final analyses).

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