Social coldness induces a preference for warmer colors: Revealing a social aspect of thermal comfort through the use of a word-scrambling test

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ABSTRACT (144 words)

Thermal comfort is a condition of mind, which expresses that one's central body temperature is close to its optimal value. In addition to the purely physical aspect of temperature-regulation principles, we question here the existence of a social component to thermal comfort.

Thirty-five adults performed first a scrambled-sentence test that included (or not) words suggesting social exclusion. Participants were then presented with a forced choice task for which they had to select a preferred color between two. Colors were selected as a function of three categories of thermal warmth. Results revealed that those individuals who were primed with social exclusion were more likely to choose warmer colors than those who had not received priming.

These findings suggest that thermal comfort includes a social component that predicts our preferences for warmer environments, providing new guidelines for the social benefits of light-therapy and color indoor design.

Keywords (5): embodied cognition; social exclusion; thermal comfort; color-temperature correspondence; homeothermy.

How are the claims made in the article justified by the methods used?

- A scrambled sentence test was used to induce social exclusion

- Social coldness encourages individuals to seek perceptual warmth from color schemas

- Homeothermia includes a social aspect that influences the thermal comfort of wellbeing

INTRODUCTION

Humans are homeotherms and thus, must maintain body temperature constant (Ivanov, 2006). When the environment is hot, the problem is how to dissipate the body heat; when the environment is cold, the problem is how to produce enough extra heat to keep the body temperature consistent despite the unavoidable heat losses. Because of this homeothermy principle, a cold sensation will be pleasing when the body is overheated, but unpleasant when the core is already cold. Thermal comfort is thus defined as that condition of mind which expresses satisfaction with the thermal environment at a given time during which one's central body temperature is close to its optimal value (Hammel & Pierce, 1968).

But psychologically what defines the perception of thermal comfort? Within the theoretical framework of embodied cognition (Barsalou, 1999), we report experimental results suggesting that thermal comfort includes not only physiological and perceptual components but also a social component that predicts our preferences for warmer environments.

In addition to the purely physical aspect of temperature-regulation principles, studies have reported a perceptual component to thermal comfort (Kim & Tokura, 1994; Kim & Tokura, 2000). Indeed, experimental work dealing with the relationship between thermal comfort and color perception have reported that human participants prefer cooler colors after body-heating than after no body-heating (Aizawa & Tokura, 1998). Preferences for warmer reds were also reported in face-cooling protocols (Kim & Hiromi, 1998), confirming again that perceptual preferences for colder/warmer colors are modulated by core physical body temperatures. The reciprocal relationship has also been reported in object design. Specific colors can create

illusions of physical warmth (Wright, 1962). Furthermore, colors and shapes can induce thermal impressions with a blue round object being perceived for example as being cold in contrast to square red blocks (Ho, Van Doorn, Kawabe, Watanabe, & Spence, 2014). When measuring physiological responses, the color of a material has also been shown not only to be perceived as cold/warm but can induce true thermal sensations (Michael & Rolhion, 2008) confirming the bi-directional relationship between the perceptual and the physiological components of homeothermy.

In social psychology, empirical studies have indirectly suggested a possible social component to homeothermy. In 1946, Asch showed in his pioneering experiment that he could guide people's impression of a hypothetical person by inserting adjectives such as "cold" or "warm" amongst other personality traits (Asch, 1946). Kelley (1950) influenced participants' impressions of a real person whom they actually encountered by priory describing him as a "cold" or a "warm" person (Kelley, 1950). In a most recent study, Williams and Bargh (2008) implicitly manipulated social temperature by asking participants to briefly hold a cup that contained hot or iced coffee, while the experimenter was filling out administrative documents. Participants then received a packet containing a personality impression questionnaire where a target person was described. People who had held the hot cup perceived the target person as being significantly warmer than those who had held the cup of ice coffee (Williams & Bargh, 2008).

The findings by Williams and Bargh (2008) are consistent with theories in embodied cognition. Indeed, our perception of the world is modulated by physical-bodily states and also by our

emotional-affective states (for a review, see Barsalou, 2008). As such, the experience of physical warmth - holding a warm object or being in a warm room - might activate long-term memories of social warmth, e.g., trust, comfort, safety and nourishment, feelings that we have earned during early experiences with our parents and close family (Bargh & Shalev, 2012).

If physical warmth has the power to recall past experiences related to social warmth, we question here whether social temperature can be more specifically a component of homeothermy and as such, have a significant impact on thermal comfort. In the following section, we describe a *Scrambled Sentence Test* (inspired by work by Srull & Wyer, 1979) that we adapted to prime social coldness by inducing the impression of social exclusion. Such test has previously been used in social psychology to prime abstract concepts such as rudeness and politeness (Bargh, Chen, & Burrows, 1996). Then, to reveal the changes in thermal comfort, we designed a force-choice color preference test, with the hypothesis that after social coldness, participants will choose warmer colors, like red and Seville orange in contrast to colder colors like blue-green, blue and purple-blue.

MATERIAL AND METHODS

We here describe the paper and computer-based materials before detailing the procedure followed in the main study. All protocols were carried out in accordance with the Declaration of Helsinki.

1-Constructing the stimuli to prime social exclusion

For the priming manipulation, a scrambled sentence test was developed. A total of 15 series of

6 cards were presented to the participants. On each card was written a single word. The participants' task was to use 5 of the 6 words to construct a grammatically correct sentence. The task was presented as a grammatical ability test.

Two series of words were constructed. One was intended to prime social-coldness whereas the other was used as the control (neutral) condition. All sentences in the social-coldness condition contained a word related to social exclusion. Specifically, the critical words in the priming stimuli were: *seul (alone), séparation* (separation), *haine* (hate), *rejeté* (rejected), *isolé* (isolated), *triste* (sad), *défaite* (defeet), *exclu* (excluded), *vide* (emptiness), *abandonné* (abandoned), *repli* (social withdraw), *échec* (failure), *déteste* (hate). In the control condition, neutral sentences were elaborated to avoid emotional content.

Both series of words were pre-tested in a quiet room on a group of ten undergraduate students from the Psychology department of the University of Lille (8 female, mean age=19.9, s.d. = 1.2). Difficulty was rated as similar for both series on a Likert 1-7 scale. The items in the social-coldness condition were described as sadder and more depressing than those items presented in the neutral condition. These ten participants were not included in the main study.

2-Constructing the three categories of color warmth

A total of twelve colors were selected from the color-wheel that presents warm colors on the left and cold colors on the right. Through E-Prime custom software, an inter trial interval of 3 seconds was set between the presentation of each color patch in order to avoid perceptual persistence. In a quiet room, fifteen naïve university post-graduate students from the Psychology department of the University of Lille (N=10 females, mean age=23.9, s.d. = 2.3) were invited to sit in front of the large screen of a laptop computer (DELL Latitude D830).

Their task was to rate the warmth/coldness of color patches that were presented in the center of the screen. Ratings were given using a unique Likert 1-7 scale, which was visualized as a horizontal 10cm-long bar, placed at the bottom of the screen. These participants were not included in the main study. The same laptop computer was used in the test sessions of the main experiment.

From this pre-test, we selected only the colors that received the greatest scores as well as the largest consensus amongst all participants. For each category (warm, cold and neutral), three colors were selected and paired with a color that was colder or warmer. Thereby, three types of pairs were constructed with five exemplars for each type (see Fig 1).

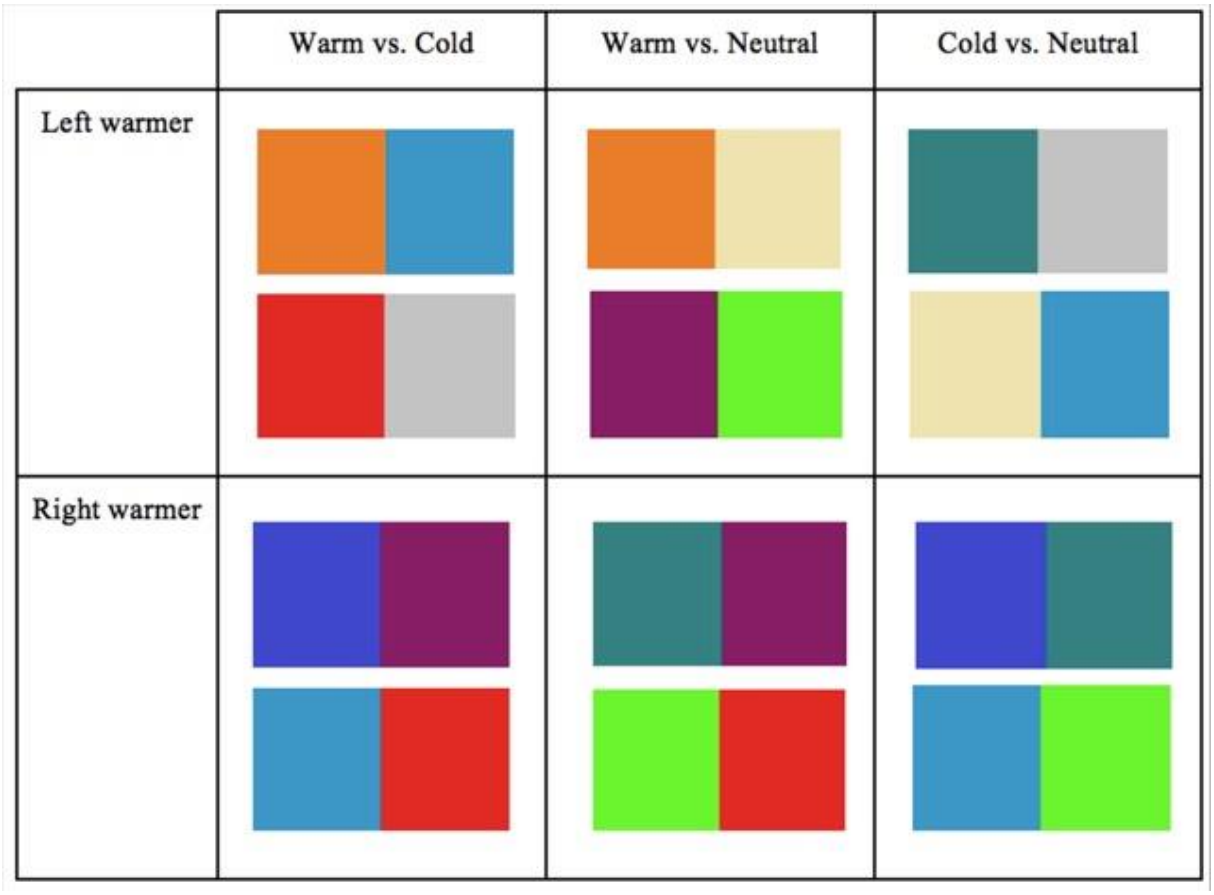

Figure 1: Examples of the color-patch pairs that were used in the main experiment to test the effects of social coldness on the preferences for warmer colors.

3- The main study

Thirty-five undergraduate students were recruited from the department of Human and Social Sciences of the University of Lille (27 females, mean age=20.9, s.d. = 1.6). Participants were randomly assigned to an experimental group (N=18) or a control group (N=17).

The experiment took place in a quiet experimental box for which the room temperature was monitored with a generic thermometer (set to 20°C). After entering the experimental box, participants filled out and signed a letter of informed consent.

Session 1: The lights of the room were turned off to make the color contrasts more intense. Each pair of color-patches was presented twice in a semi-randomized order: neutral-cold; neutral-warm; cold-warm. For each trial, the participants' task was to choose their favorite color between the two presented on the computer screen. The participants were told that the session was a pre-test for a color-preference study that would take place later in the term. The task took 10 minutes, approximately.

Session 2: Less than 3-month later, the same participants were invited to come back to the laboratory and were informed that they would participate in two completely separate experiments. They were told that the first task aimed to investigate grammatical ability. The second task was the follow-up of the first session.

Task 1: The participants were seated in front of a table on which was placed the fifteen stacks of paper tags. The instructions for the first task were thoroughly explained before the

experimenter left the room. When alone, the participants constructed as quickly as possible 15 grammatically correct sentences using, for each series, only five words among the six presented. After the task had been completed, the experimenter came back in the room and instructions for the second task were given.

Task 2: The lights of the room were turned off to make the color contrasts more intense. The participants' task was to select their favorite between the two color-patches. In this task, the experimenter also waited outside and re-entered the room only when the participant had completed the task. At this moment, participants were debriefed. No participants showed any suspicion as to a possible link between the different tasks.

RESULTS

The dependent variable was color preference. Hence, the number of times a participant chose the warmer color within a pair was calculated. The t-test analysis revealed an absence of significant differences in color preference between groups in session 1, $t(40) = 0.499$, $p = .620$. In session 2, after having performed the word-scramble test, the participants in the social-coldness condition tended to prefer more often the warmer color of the pair (M=23.4%) than did participants in the neutral condition (M=18.8%), $t(52) = -3.690$, $p < .001$, $\eta^2_p = 0.108$ – see Fig 2. This result could not be explained by a difference in the time taken to perform task 1 as participants in the experimental group (M=3.96 min) and in the control group (M=3.69 min) took a similar amount of time to complete the word-scrambling test, $t(52) = -1.211$, $p < .231$.

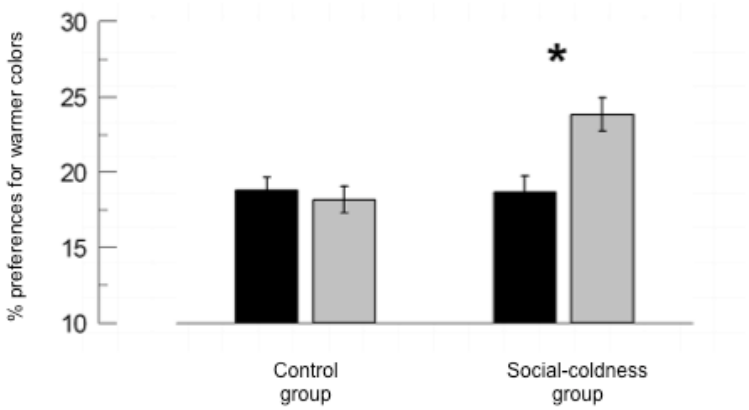

Figure 2: Mean results obtained for the percentage of preferences for warmer colors for each group of participants before (black) and after (grey) performing a word-scrambling test that included neutral words (control group) and words suggesting social exclusion.

DISCUSSION

In the present study, we wanted to investigate whether social coldness could modify one's preference for warmer colors. By using a word-scrambling test, we reported results revealing that young adults shift their preferences for warmer colors when performing a reading task that included words suggesting social exclusion. Because the same participants were tested twice, with and without experimental manipulation, we suggest here a direct relation between social exclusion and shift in color-preferences. Our panel overall preferred colder colors, choosing

warmer ones in one third of the trials only. Nevertheless, the important point here is that by inducing participants to imagine cold social situations like emptiness, rejection, isolation and exclusion, participants were lead to be biased towards warmer thermal colors, indicating that social temperature may be a component of homeothermy with a true impact on thermal comfort.

Theories in embodied cognition have suggested that our every-day social interactions are not independent of our physical and somatic experiences (Varela, Thompson, & Rosch, 1991). In their pioneer study, Williams and Bargh (2008) established the link between the physical experience of touching a warm or cold object, and the social judgment of personality assessment. Zhong & Leonardelli (2008) have reported the reversed effect: by priming social exclusion, they induced a true experience of coldness and a preference for warm foods and drinks. The results reported here complete the picture by suggesting that social exclusion encourages individuals to seek not only physical warmth but also perceptual warmth from color schemas present in the environment. Overall, these studies comfort the idea that humans are homeotherms with the need to maintain the central body temperature close to an optimal value, with a fragile equilibrium between physiological, perceptual and social temperatures.

The homeothermy principle may explain why people use cold colors (I was feeling *blue* today) and temperatures (their attitude was *ice cold* with him) to describe patterns of social interaction, partly because they observe, at an abstract level, that the experience of coldness and the experience of social rejection coincide. Indeed, notions of affection and warmth may be confounded because as an infant, held close to a caregiver is associated to bodily contact with a living being (Lakoff & Johnson, 2003), the person who is there to care and protect in the case of social distress. Hence, social closeness produces warmth, while a social distance is related

to coldness (IJzerman et al., 2012; IJzerman & Semin, 2010). Our preference for warmer room temperatures and warmer colors in our close surrounding could thus compensate for the emotional coldness that one is experiencing at a given moment in time.

Earlier research on ambient temperature tended to focus on its effects on productivity and cognitive processing (Allen & Fischer, 1978; Sinclair, Mark, & Clore, 1994). As social rejection not only reduces subjective well being (Leary, Tambor, Terdal, & Downs, 1995), but also induces hostile reactivity towards other people (Ayduk, Mischel, & Downey, 2002), the use of light therapy and color psychology should be more widely used to directly impact patients social abilities. Furthermore, controlling ambient colors and defining the 3-facet homeothermy rules for architectural indoor design of public spaces may reveal to be a relatively inexpensive and nonintrusive way to restore group cohesiveness, self well-being and prevent damage due to interpersonal friction.

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Contributions

N.Vladis and Y.Delevoye-Turrell developed the study concept and design. Testing and data collection were performed by N.Vladis. Y.Delevoye-Turrell and J.Boitout analyzed the data and drafted the paper. The three authors approved the final version of the paper before submission.

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