Exploring the Influence of Ambient Temperature on Cognitive Task Performance

Luqiong Tong, Tsinghua University, China
Rui (Juliet) Zhu, University of British Columbia, Canada
Yuhuang Zheng, Tsinghua University, China
Ping Zhao, Tsinghua University, China

This research examines the effect of ambient temperature on individuals’ cognitive performances. We find that relatively warm versus cool temperatures enhances performance on complex tasks, but this effect disappears when the tasks are rather simple. This effect appears to be driven by the enhanced unconscious thinking prompted by warm temperature.

[to cite]:

[url]:
http://www.acrwebsite.org/volumes/1009672/volumes/v39/NA-39

[copyright notice]:
This work is copyrighted by The Association for Consumer Research. For permission to copy or use this work in whole or in part, please contact the Copyright Clearance Center at http://www.copyright.com/.
Exploring the Influence of Ambient Temperature on Cognitive Task Performance
Luqiong Tong, Tsinghua University, China
Rui (Juliet) Zhu, University of British Columbia, Canada
Yuhuang Zheng, Tsinghua University, China
Ping Zhao, Tsinghua University, China

EXTENDED ABSTRACT

Although both practitioners and academics agree that temperature is important in affecting human cognition and behavior (Goldman, 2001; Hancock et al., 2007), mixed results have been observed in the literature with regards to which or what range of temperature will facilitate cognitive task performances (Ramsey, 1995). While some research suggests that warmer temperatures enhance performance (Chiles, 1958; Pepler and Warner, 1968), some others suggest the opposite (Coleshaw et al., 1983; Thomas et al., 1989). Further, prior research efforts in this domain are limited in a number of dimensions. For example, they have focused on extreme temperatures (i.e., higher than 30 Celsius or lower than 10 Celsius; note that human’s comfortable temperature range is between 16 to 29 Celsius, Baker and Cameron 1996), and have included predominately simple tasks, such as word memory and figure matching.

This research aims to address these limitations and therefore advance our understanding on the impact of temperature on task performance. Specifically, we examine how warm versus cool temperature, both within a comfortable range and are commonly experienced, can affect people’s performance on simple as well as complex tasks.

Prior research on temperature suggests that heat, which can induce thermal stress, competes for attentional resource and consequently hurts task performance (e.g., Hancock and Warm 1989). Thus, compared to individuals in the cool temperature condition, those in the warm temperature condition should have less attentional resource towards the focal task (Enander 1984, 1986).

A separate line of research has shown that different amounts of attentional resource allocated to the focal task can prompt alternative thinking modes. While abundant attentional resource to the focal task usually results in primarily conscious thinking, limited attentional resource is likely to prompt more unconscious thinking (Dijksterhuis et al. 2006). Thus, we expect that those in the warm (cool) temperature condition, which leads to limited (abundant) attentional resource to the focal task, would be more likely to engage in unconscious (conscious) thinking.

Finally, extant research has documented beneficial effects of unconscious thinking on complex task performance (Dijksterhuis and Nordgren 2006). Specifically, unlike conscious thoughts, which have limited processing capacity, unconscious thoughts don’t suffer from the capacity constrains, so unconscious thinking mode can benefit complex tasks. Combining the preceding notions, we hypothesize that warm versus cool temperature would enhance individuals’ performance on complex tasks. However, such an effect should be attenuated for simple tasks.

Two laboratory studies were conducted which provided systematic support to our hypothesis. Study 1A and 1B demonstrated the basic effect of temperature on task performances. Specifically, study 1A used 3 (temperature: warm vs. moderate vs. cool) * 2 (task complexity: simple vs. complex) between-subject design. The task used was a classic choice task, which requires participants to select their preferred lottery from four different options (Payne et al., 2008). Options were defined by payoffs for 12 equiprobable events defined by drawing 1 of 4 numbered balls (simple condition) or 1 of 12 numbered balls (complex condition) from a bingo cage. Among the four options, one option had the highest expected value, which represents the correct answer. The study was run with no more than four people per session. The same lab was used, but the temperature was set to warm (25-26 Celsius), moderate (21-22 Celsius), or cool (16-17 Celsius). These temperature conditions followed the comfortable temperature boundaries in Baker & Cameron (1996). Results confirmed our hypothesis, such that when the task was complex, a significantly higher percentage of individuals in the warm temperature condition selected the correct lottery (thus indicating better task performance) than those in the low or moderate temperature condition. However, we did not observe any treatment effect when the task was simple.

Study 1B was a theoretical replication of study 1A. By using a different task, we again demonstrated that warm versus cool temperature led to better performance on difficult tasks. Furthermore, additional measures taken in both studies ruled out a number of alternative explanations, such as mood, arousal, and involvement.

Study 2 aimed to shed light to the underlying mechanism. If warm temperature leads to more unconscious thinking and consequently enhances performance on complex tasks, then we should observe equally well performance under the cool temperature if we prompt people to enter the unconscious thinking mode in that condition. Prior research has shown that working memory load manipulation can lead to distraction, and thus reduced attentional resource to the focal task (Lavie, Hirst, and Fockert 2004). So, if we encourage individuals in the cool temperature condition to engage in unconscious thinking by a high load manipulation, they should perform on complex tasks equally well as those in the warm temperature condition. Thus, in this study, we first administered a seemingly unrelated task which varied in memory load in a neutral temperature room. Specifically, participants were asked to remember either a 2-digit number (low load) or an 8-digit number (high load, which would encourage unconscious thinking) throughout the entire study. Then they were escorted to the main lab where temperature was set to warm or cool. The focal task involved the same complex lottery task as in study 1A.

Results supported our theorizing. In particular, for those in the low memory load condition (i.e., people are primarily engaging in conscious thinking before entering the main lab which varied in temperature), we replicated earlier results. That is, warm temperature led to better performance. However, for those who were in the high memory load condition, they performed equally well whether they completed the focal task in warm or cool temperature room, presumably because the high memory load manipulation has prompted them to engage in unconscious thinking, which mitigated the effect of temperature.

Findings from this research make several important contributions. Foremost, they advance our understanding of the impact of ambient temperature on human cognition, esp. task performance. Second, we offer explanation as well empirical evidence with regards to the underlying process that drives these effects. Finally, this research offers practical implications in terms of setting up optimal ambient temperatures in various environments.
REFERENCES


Baker, Julie and Michaelle Cameron (1996), “The Effects of the


Duffy, Elizabeth (1962), Activation and Behavior, New York: Wiley


Keller, Matthew C., Barbara L. Fredrickson, Oscar Ybarra, Stephane Cote, Kareem Johnson, Joe Mikels, Anne Conway, and Tor Wager (2005), “A Warm Heat and a Clear Head”, Psychological Science, 16(9), 724-731


Duffy, Elizabeth (1962), Activation and Behavior, New York: Wiley


Keller, Matthew C., Barbara L. Fredrickson, Oscar Ybarra, Stephane Cote, Kareem Johnson, Joe Mikels, Anne Conway, and Tor Wager (2005), “A Warm Heat and a Clear Head”, Psychological Science, 16(9), 724-731


