Homophones with Dual Interpretations as Affected by Temperature

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This study investigated the effect of temperature on selection of neutral and negative connotations. Homophones, words with two meanings with the same pronunciations, with a neutral and negative connotation were used to detect differences in temperature environments (75° or 85°F). Homophones were selected based on their use in a study by J. B. Halberstadt, P.M. Niedenthal, and J. Kushner (1995) where homophone-meaning selection was affected by "happy" and "sad" music played during the experiment. The current study did not find statistical significance between the two temperatures to reject the null hypothesis, but demonstrated the need for further study in this area.

Temperature fluctuations are a common issue to all life. The extreme heat and cold determines what we wear, where we live, and what we eat. Obviously the physiological effects are noticeable to most people even if it is only verbalized with a comment of the high humidity. The psychological manifestations of this weather awareness are rather less known. The idea that temperature could affect what we think and how we feel is a concept that many researchers have set out to explain. However, cognition as affected by temperature is a lesser studied topic. This point was also noted by Keller et al. (2005), as they were only able to cite two studies that related cognition and weather. Their research also referenced a study by Allen and Fischer (1978), which reported that performance on a paired association memory task peaked at 72°F and declined with warmer or cooler temperatures. The room to explore in this category is massive.

A large portion of research is offered through the study of industrial and military workers who are in extreme heat environments because of their occupation. Faerevik and Reinertsen (2003) studied the deterioration of the cognitive ability of helicopter pilots while exposed to temperatures warm enough to raise their internal body temperature by 1.2°C, which found that mentally demanding tasks suffered the greatest decline under these conditions. The rate of mistakes and the amount of accidents/crashes increased with temperature and length of exposure. This point, task difficulty with respect to deterioration while exposed to heat, is confirmed by the article analysis of Hancock and Vasmatzidis (2003) as they compiled relevant research on the topic of temperature and cognition. However, most research has suffered from the presence of confounding variables reflected in people's personal preference and tolerance of heat.

The current study set out to determine if the physiological discomfort of the participants would manifest itself in the outward selection of the negative connotation of a set of homophones. A homophone is defined as a word that is pronounced in the same way as one or more other words but is different in meaning and sometimes spelling, as are "hair" and "hare." J. B. Halberstadt, P. M. Niedenthal, and J. Kushner (1995) used homophones with neutral and negative meanings to determine how music affected the emotional state or cognitive perception of the participants. In that situation, homophone definitions were demonstrated to fluctuate with the tone (sad or happy) of the music played.

The internal processes required to acquire a definition of a homophone cannot exactly be monitored in this experiment. According to Tanenhaus and Lucas (1987), information such as spelling, pronunciation, and meaning involves the first stage of

processing sensory input with the results then forwarded to the language processing system. Mathew, Richards, and Eysenck (1989) wrote, "Some contemporary positions on this issue suggest that all possible meanings of an ambiguous word are accessed automatically, even when only one of these meanings becomes conscious" (34). The aforementioned study examined how a predisposition toward anxiety would affect homophone-meaning selection and found that high anxiety individuals would select more negative or threatening meanings.

In the current study, homophones were utilized to show the effects of increased temperatures (85°F) on the state of the participant. The focus was to determine if a high heat environment would increase the likelihood that the participants would select the negative interpretation of a homophone more than the participants in the unaltered environment. It is hypothesized that the heat will increase the negative connotation selection. Participants entered the same room in one of two conditions: 75°F or 85°F. After signing a consent form, a list of words was read to them in which they verbally defined. The experimenter recorded their responses. A short questionnaire was given to obtain demographic information. This was followed by the feedback and debriefing. The results of this experiment will offer further knowledge to the growing pool of understanding of the effects of heat on emotion and cognitive ability.

Method

Participants

The group of participants was comprised of 31 undergraduate students, ages 18 to 26, who have participated through the Human Subject Pool to gain extra credit in a 100

level Social Science class in which they are currently enrolled. A single researcher conducted experiments for each session.

Materials

A space heater with an internal thermometer was used to increase the room's temperature to 85°F. A fan was used in two capacities: to cool the small lab room after a heated session and to create the 75°F situations needed for the experiment. A list of 15 words, consisting of 10 homophones and 5 filler words, were read to the participants. The homophones not only had dual meanings, but had specifically both a neutral and a sad/negative connotation. The filler words served as a vocabulary screening to ensure that the participants had an adequate understanding of the English language to complete the experiment. Three or more vocabulary words incorrectly defined resulted in their data being excluded. These vocabulary words were integrated into the homophone list and the two portions were given as one definition exercise. The verbal definitions made by each participant for each word were then recorded by the experimenter on a data sheet (see Appendix A). The final exercise was a questionnaire, which gathered demographic information such as age, gender, ethnicity, and original language whose results will be reported in the Discussion section (see Appendix B). Informed consent forms, participant receipts, and feedback letters were also utilized in each experiment session.

Procedure

Participants were met outside of the research lab room by the experimenter and walked into Lab B, which is located in the Psychology Lab in Young Hall on the campus of Lindenwood University. Group assignment was as random as possible. Being that the temperature had to be changed, alternating temperature between participants was not an

option. Therefore, for each day, the list of scheduled participants was divided in half. One half would be heated and the other not. This order alternated. Depending on which group that they were assigned, the room would either be 85° F (heated environment) or 75° F (the room's normal temperature). Upon entering, if the participant requested to change rooms because of the heat, they were told that all other rooms had been assigned and that the experiment would only take 20 minutes. They were also informed that they had the right to decline participation at any time and would still receive their credit. The participant and observer sat across from each other at a table with two chairs. The participant was then presented with 2 informed consent letters to read and sign. The participant kept one form. The participant receipt was also filled out at this time. The homophone portion was then initiated. They were told that a list of words would be read to them and they would be asked to verbally respond with the meaning of each word (definition). They were not told that some of the words had two meanings at this stage of the experiment. They were asked to give the first and only one definition for each word. Each word was read twice with 3 seconds in between each reading. The experimenter recorded participants' responses on a separate data sheet. All participants were then given a demographic questionnaire. Once the questionnaire was completed, if in the heated environment, the heater was turned off and a fan was turned on. Finally they were presented with a feedback letter. The experimenter also verbally explained the purpose of the study and gave the participant an opportunity to ask questions. The word list was identified as homophones with five filler words. The filler words were disclosed as a vocabulary screening for the experiment and the temperature change was explained as a

manipulated variable. The participants were thanked for their time and walked out of the room.

Results

The hypothesis was that exposure to a high heat environment would increase the selection of the negative meanings for a list of homophones. An independent t-test was conducted to analyze the data. The effect of temperature was not statistically significant, $t_{(29)} = -.024$, $p > .05$. The null hypothesis, that there would be no difference in response results due to temperature changes, could not be rejected in this study. Temperature was not shown to have a statistically detectable effect of the types of responses (i.e. increase in negative connotation selection while in heated environment).

Discussion

This particular study did not yield statistically significant results to support the hypothesis that increased temperature would result in an increase in the rate of selection of negative homophone meanings. However, there is still a lot that can be learned through this process. There are some comments to be made regarding the experimental design and there is much to say about the results.

In terms of design, if this hypothesis were to be pursued further, some changes would be made to the materials and the experimental situation. The list of words would be lengthened and refined. There were only ten words used in this experiment. A larger variety of words might increase the opportunity to find significance without distorting the data results. The refinement would entail the selection of words. There were a few homophones that never yielded neutral responses. This may have had more to do with

our use of these words in everyday language. A few examples of this would be pane/pain and steel/steal. The word pane, as in windowpane, is not used as regularly in daily language as the word pain. Steel, although a real word, is not commonly used either. The commonality of the word use may have large effects on the likelihood of selection. In fact, this is called the frequency effect, which is defined as a phenomenon in memory that we tend to remember information better if it is repeated. If the participant has never used the word in a natural sentence, how likely would he be to select that meaning regardless of the surrounding environment? Many homophones have this issue. Perhaps the second meaning developed because the first fell into disuse? Separate testing on a large list of homophones to determine the average rate of use would be beneficial in creating a proper list of homophones for this study. A lengthened and revised list of homophones may yield different results.

This experiment should be conducted again, but with a larger subject pool, perhaps 50 to 200 participants. In terms of the participants in this study, 10 were male and 21 were female. Of the 31 participants, 6 were Asian, 1 Hispanic, and 24 White. Their first languages are as follows: 25 English, 1 Japanese, 4 Nepali, and 1 Spanish. A larger subject pool is always a good idea, but particularly here. Another interesting angle to pursue would regard comparing results of those with English as a second language with results of English as a first language. In a non-statistical observation, there was a slight increase in ESL students to select the meanings with more literal connotations, such as pane instead of pain. A study could be designed to specifically investigate this superficial observation.

There is a secondary observation related to both the amount of participants and to amendments to the experimental procedure. The mood of the participant before taking the vocabulary portion could be assessed with a self-report questionnaire with a possibility of being repeated after the exercise is finished (integrated into the demographic questionnaire). This could record and measure many latent factors such as the participant's mood or disposition before and after the experiment as well as indicating their own perceptions of how temperature affects them (i.e. I am cold natured, I actually like the heat, etc.). These surveys and changes, compiled with a larger group of participants could help to decrease or at least discover their effects on the data.

The temperature gradient may not have been strong enough to yield any results. The difference between the settings was only 10°F, which may not have been a large enough difference. Furthermore, the neutral or non-heated environment should have been set at 72°F to replicate the previously mentioned ideal temperature environment. The heated environment could be increased to 90°, which is just below the documented maximum temperature for cognitive operations. A third environment could also be added to measure the other extreme reaction to cold temperatures. More research would need to be conducted to formulate the appropriate cold temperature. These additions and adjustments would be valuable if this study were repeated.

Although this study brings more questions than it offers answers, there is still a definite desire to continue research in this matter. Despite the lack of statistical significance, changes to the stimuli, changing the temperatures and subject pool size may be vital adjustments that could be made to a valuable experiment.

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Appendix A

Data Sheet

	Actual Response	Neutral Answer	X	Negative Answer	X	Other	X
1		Dye		Die			
2	**	Secret		**			
3		Fowl		Foul			
4	**	Extinct		**			
5		Steel		Steal			
6		Brake		Break			
7		Heroine		Heroin			
8		Pane		Pain			
9	**	Calm		**			
10		Slip		Slip			
11		Vein		Vain			
12	**	Overrated		**			
13	**	Wealthy		**			
14		Know		No			
15		Week		Weak			

Heater Environment: _____

Non-Heater Environment: _____

Appendix B

Questionnaire

1. What is your gender?   Male ____   Female ____

2. What is your age?   _____ years

3. How would you characterize your ethnicity?
       ____ Asian or Pacific Islander

       ____ Black, Non-Hispanic

       ____ Hispanic

       ____ American Indian or Native Alaskan

       ____ White, Non-Hispanic

       ____ Other

  4. What is your first language?

_____

Appendix C

Instructions

Now you will be asked to define or explain the meaning of a list of words that will be read to you.

I will read each word twice. After a single word has been read twice you will be asked to verbally explain its meaning. Please say the first explanation that comes to mind. Please only give one response. I will record your response on a data sheet with a pencil. This portion of the experiment will be followed by a short questionnaire. Please know that the quickness of your response is not important, so you may take your time.

Please follow these instructions very carefully. Now we will begin.

1. die, dye

2. secret **

3. foul, fowl

4. extinct **

5. steal, steel

6. brake, break

7. heroin, heroine

8. pain, pane

9. calm **

10. slip, slip

11. vain, vein

12. overrated **

13. wealthy **

14. know, no

15. weak, week

Please fill out this short questionnaire. Thank you.

** Denotes a word that is not a Homophone.