Auditory Cues Develop Mental Metaphors to Aid Word Learning

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Abstract: Previous researches have shown that motor actions that correspond to the "good is up/bad is down" metaphor may help people in retrieving memories with corresponding positive/negative emotion valence. The SUMM (strategic use of mental metaphors) effect is an extension of this research to provide evidence that metaphor-congruence helps word learning. In the present study, we use the Casasanto 2019 experiment as a model to investigate the relationship between an auditory generated metaphor-congruence and word learning. Experiment 1 will provide a test-ground to prove the auditory mental representation of "good" as corresponding to ascending pitch, and "bad" as descending pitch. Experiment 2 will test the effect of such auditory metaphor-congruence in word learning. The experiments will provide extended research to the effect of metaphor-congruence and memory, and their significant result is expected to support the SUMM effect in the auditory sense.

1. Introduction

In everyday life, when we talk about abstract concepts such as emotional valence, we often use spatial expressions. For example, we use expressions associated with "up" to describe something good – on top of the world, and expressions associated with "down" to describe something bad - down in the dumps[1]. Now, it is accepted that this space-valence metaphor is not only a link between how we talk and how we think, but it is also an association between how we act or perceive and how we think: the spatial location of something constitutes its emotional valence in part. This kind of mental metaphor suggests that we map our interaction with the external physical world through the perceptual-motor system to our understanding of abstract qualities. Therefore, there exists a correlation between space and emotional valences.

Based on the space-valence association between our perceptual-motor system and our perception of emotional valence, motor actions can be directed to influence people's recollection and improve people's learning by activating the mental metaphor of "good is up, bad is down".) Casasanto and Dijkstra showed that simple and meaningless actions as moving marbles upward or downward cues people to recall more memories charged with corresponding emotional valence[2]. In the experiment, participants recalled their own experiences to answer neutral questions (e.g., Tell me about something that happened yesterday) while being randomly assigned to move marbles in cardboard box either upward or downward, and the result shows that participants who moved marbles upward, and it turned out that participants retrieved more positive memories when moving marbles upward, and did the opposite when moving marbles downward. In a recent study, Casasanto and de Bruin demonstrated how motor actions may help people learn emotionally charged words, the effect which they termed the "strategic use of mental metaphor" - SUMM effect[3]. Participants studied emotionally charged words and were then randomly assigned to put flashcards with words they studied to either an upper or lower shelf. The result shows that participants who placed the cards with positive words on the top shelf and cards with negative words on the bottom shelf remembered the words better than their counterparts who did the opposite, or those who put the cards on desktop, which suggests that performing metaphor-congruent actions could enhance people's memory of emotionally charged words.

Just like the space-valence association in the "good is up, bad is down" metaphor, there may also be a pitch-valence association in spoken languages. Yap, Staum, Casasanto, and Casasanto found that in tonal Mandarin Chinese, there is an association between the pitch contour of many Chinese words and their meanings[4]. More Chinese words with positive English translations have upward pitch contour that level or downward pitch. This association conforms to the "good is up, bad is down" metaphor, suggesting that "up" and "down" in this metaphor may also refer to the qualities of sound pitch.

Here, we will investigate whether this pitch-valenced metaphor can be activated by the pitch contour in which words are delivered. In experiment 1, we use non-tonal English pseudowords as a testbed to determine whether listening to words read in ascending and descending pitch would affect how positive or negative people perceive the meanings of words to be. In experiment 2, we will test whether listening to ascending or descending sound pitch while presenting the pseudowords could activate this association and aid people in learning emotionally charged words in a metaphor-congruent condition. Through using a new testbed and new auditory stimulation, this study seeks to explore whether metal metaphors can be activated and whether the SUMM effect can operate in a different dimension of the sensory system. The results are expected to provide some new insight to the discussion of the metaphorical system of human cognition.

2. Methods

2.1 Experiment 1a

Experiment 1 will investigate whether delivering non-tonal words in ascending or descending pitch contour influences people's understanding of emotionally charged words. This experiment seeks to establish the pitch-valence association and determine whether this association can be activated by the pitch contour of words. Experiment 1 aims to indicate that ascending pitch contour carries the mental metaphor of positivity and descending pitch carry the mental metaphor of negativity. The experiment will expect that participants remember word definitions better in metaphor-congruent learning than participants in incongruent learning only if this premise was proved. In the experiment, participants' task is to match a score to the words which are spoken in ascending or descending tone.

2.1.1 Participants

90 US university students and staff whose native language is English will be randomly selected to participate in the experiment (i.e. a lottery system in the university's database). They are randomly divided into 3 groups of 30 each. Group 1 is the ascending pitch group, Group 2 is the descending pitch group, and Group 3 is the control group. All participants do not carry any symptom or illness that will affect their hearing ability or recognition of pitch direction. All participants are found physically and mentally fit and do not have a history of eye disease or learning disability.

2.1.2 Material

In experiment 1a, we use 45 pronounceable pseudo-words in English with definitions provided by the ANEW corpus[5]. 15 of them are assigned with positive English meanings(e.g., success), 15 are assigned with negative English meanings(e.g., murder), and 15 are assigned with neutral English meanings(e.g., puppy). Each pseudo-word is printed on a flashcard with its English meaning. We record computer-simulated pronunciations of each pseudo-word in either rising or falling pitch contour.

2.1.3 Procedure

The 30 participants from Group 3 (control group) each receive the 45 flashcards. Then they rate how positive each word according to its English meaning on a scale from -10 to +10(-10 being the most negative, +10 being the most positive, 0 being neutral). After that, all of their ratings for every word is collected. Outliers for the ratings of each word is eliminated. A mean rating for each word is

calculated to be a yardstick for the ratings of Group 1 and Group 2 to be compared to.

Next, the 30 participants from Group 1 and Group 2 receive the same 45 flashcards. The flashcards are put in the same order as the order they appear in the recording of the computer-simulated pronunciation of each word. Group 1 is in the metaphor-congruent learning condition so that participants hear words pronounced in ascending tone when study words with positive meanings and vice versa for descending tone and words with negative meaning. Group 2 is in the metaphor-incongruent learning condition so that participants hear ascending tones when studying words with negative meaning and vice versa for descending tone when studying words with a positive meaning. The participants are told not to look at each flashcard before hearing its pronunciation in the recording. After looking at each flashcard, the participants listen to the recorded pronunciation for the pseudo-word again and rate the word based on the same scale as Group 3 did. After that, all of their ratings are collected and a mean rating for each word is calculated separately.

2.2 Experiment 1b

2.2.1 Material

In experiment 1b, we use the same 45 pseudo-words each printed on a flashcard with its Chinese meanings. The Chinese meaning of each word is consistent with the emotional valence of its English meaning.

2.2.2 Participants

90 US university students and staff whose native language is Chinese are randomly selected to participate in the experiment (i.e. a lottery system in the university's database). They are randomly divided into 3 groups of 30 each. All participants do not carry any symptom or illness that will affect their hearing ability or recognition of pitch direction. All participants are found physically and mentally fit and do not have a history of eye disease or learning disability.

2.2.3 Procedure

The procedure of experiment 1b is the same as that of 1a except for the differences in participants and materials.

2.2.4 Predictions 1a & 1b

It is expected that the mean rating of the words in Group 1 and Group 2 of both experiments 1a and 1b will be influenced by the pitch contour of the recorded pronunciations, and will, therefore, be different from that of the control groups. In particular, Group 1 (metaphor-congruent group)'s rating will be higher than the control group, and Group 2 (metaphor-incongruent group)'s rating will be lower than the control group. If the difference in ratings is statistically significant, it confirms that sound pitch movements carry the mental metaphor of positivity and negativity, in which ascending pitch means positive, and descending pitch means negative.

2.3 Experiment 2: Does Listening to "Metaphor-Congruent" Tunes Help People Learn Words?

Experiment 2 tests whether learning vocabulary in an auditory metaphor-congruent setting could help participants learn the meaning of words with positive and negative emotional valence.

The experiment will use the method based on Casasanto and de Bruin's research "Metaphors we learn by: Directed motor action improves word learning"[3]. Based on the true prediction of experiment 1, experiment 2 is an attempt to test the relationship between auditory metaphor congruence and word learning. The experiment will be conducted through manipulating participants' exposure to ascending, descending, or constant pitch tunes, and participants' performance on word learning.

2.3.1 Participants

The experiment will involve 90 participants randomly recruited from a university as a psychology course requirement eligible for credit. Participants are randomly assigned to three

experimental groups corresponding to ascending, descending, or constant pitch. There are 30 students assigned to the ascending pitch group, 30 to descending pitch group, and 30 to constant pitch group.

2.3.2 Material

20 English pseudowords are created that carry no strong positive or negative connotations. We give these pseudo-words definitions by words from the ANEW corpus[5]. A pretest is conducted to verify no bias in the generated pseudowords. The pseudo English words are assigned half with positive and the other half with negative valence based on valence rating of their English definitions. The experiment uses an online sine wave generator. The descending pitch is created from C5 to C4. The ascending pitch is created from C4 to C5. The constant pitch is C4.

2.3.3 Procedure

The procedure involves a study phase and a test phase. During the study phase, participants memorize the definitions in an experimental setting. The same study procedure is repeated for all three groups. Within each study phase, each set of cards involves half of the positive pseudo words and half negative ones.

2.3.4 Study Phase

All participants are told that they are being tested on a memory test by learning new words in the English language. The words either have positive or negative meanings. The participants are required to study each word for 7s by a timer and memorize the definition of the word for a memory test later.

Each participant is randomly assigned to the ascending, descending, or constant pitch group. Concurrently when the participants study the words, the experimenter plays a corresponding ascending or descending octave (C4 to C5 and vice versa) based on metaphor congruent testing condition or metaphor incongruent condition, and the experimenter also plays a constant C4 pitch for the constant group. The pitch tone is played for a duration of 7s for each word the participant studies.

The experimenter is present in another room observing the experiment to ensure the following procedure is conducted correctly. The pitch, whether in ascending, descending or constant, is programmed by a computer to correspond to the starting and stopping points of the timer. The program automatically resets the ascending pitch whenever the participant finishes studying the previous word after 7s and begins studying a new word.

The encoding process for all the participants is the same across different conditions. The encoding process involves the concurrent presentation of words and tone. Therefore, the participants are to correlate the meaning of the word actively with the related pitch.

Participants are presented with one word at a time. The words are presented in random order for each participant. When one participant finishes with the set of cards, the experimenter generates a random order and presents the card set to the next participant.

2.3.5 Test Phase

After the study phase, each participant performs a choice recognition test in front of a computer screen. Each pseudo word appears on the screen for 7s. Then, two options of the word's definition appear on the left and right side of the screen. The participant is to determine and choose the correct definition by pressing two designated keys on the keyboard. The correct definition is worded differently through paraphrasing from the definition the participants study the words with. The entire test for each participant runs for 10 minutes strictly. Participants have 30 seconds to answer per word before the computer automatically continues to the next word.

2.3.6 Predictions

The auditory cue that participants are correspondingly exposed to during word learning will affect their recognition memory. The results will demonstrate higher accuracy on the memory test

from participants in the metaphor-congruent setting. In this case, participants who study positive pseudowords with ascending pitch tune and negative pseudowords with descending pitch tune will have the greatest accuracy in word recall. Participants in the constant pitch condition will exhibit worse word recall than the metaphor-congruent group, but their accuracy will be greater than metaphor-incongruent group. Based on this prediction, we may conclude that metaphor congruity will have an effect on helping participants' memory when such metaphors are produced by the auditory cues.

In light of the positive outcome of our prediction, we may conclude that this experiment will extend the discovery of SUMM effect to the effectiveness of memory aid by auditory cues[3].

However, if the result of the experiment does not exhibit the predictions as described above, such that participants in the metaphor congruent setting do not score higher accuracy on the vocabulary test, the outcome may suggest otherwise. In this case, this experiment will conclude a null result and will not be able to conclude the effectiveness of the SUMM effect extending beyond motor actions.

3. Discussion

In Experiment 1, if the mean rating of each pseudoword in ascending pitch group, regardless of its positive or negative meaning, is higher than the mean rating of each pseudoword in the control group, we can conclude that ascending pitch correlates with positivity. If the mean rating of each pseudoword in the descending pitch group, regardless of its positive or negative meaning, is lower than the mean rating of each pseudoword in the control group, we can conclude that descending pitch correlates with negativity. If both results were shown, we can conclude that sound pitch movements cue emotional valence as spatial metaphors do and that they are associated with the mental metaphor of positivity and negativity.

The second experiment extends beyond experiment 1 to verify whether metaphor-congruent setting with auditory cues may help word learning. Based on the predictions of experiment 1 that ascending pitch correlates to "good", and descending pitch correlates to "bad", experiment 2 seeks to validate whether the metaphor-congruent relationship exists in the auditory setting. The results of experiment 2 are to be compared with Casasanto and de Bruin study, which suggests a strong correlation between metaphor-congruent motor action and word learning[3]. If the result of experiment 2 is statistically significant and it suggests a significant effect of metaphor-congruent auditory cues in helping word learning, then the results validate the SUMM effect in an auditory metaphor-congruent condition. Casasanto and de Bruin's study indicates a strong correlation between metaphor-congruent motor action and word learning, thus the conclusion of the paper indicates the SUMM effect[3]. Consistent with the SUMM effect, people in metaphor-congruent condition by auditory cues exhibit better word learning through creating a mental metaphor of associating the emotional valence of the word with ascending or descending pitch that represents "good" or "bad". The association between the meaning of the words and auditory metaphors aids memory consolidation. If the results of the present study demonstrate such predicted patterns, the experiment suggests that people strategically use mental metaphors even when the concepts in the source domain are presented in an abstract format.

Further research may extend the research on auditory metaphor-congruence by investigating the effect of music tunes on memory rather than the ascending/descending pitch as in this paper. Researchers in the future may expand on this topic to develop the kinds of music tunes that will aid memory consolidation. Experiment 2 only focuses on finding the relationship between a simple pitch and its effect on memory. This study, nevertheless, provides a foundation for deeper research on music and memory.

4. Conclusion

Based on the experimental findings of Casasanto and de Bruin, we are inspired to extend the study to test the relationship between auditory metaphor-congruency and memory consolidation[3].

In using different pitches as the basis of our experiment, the present proposal aims to verify the SUMM effect from Casasanto and de Bruin to auditory metaphors[3]. If the assumptions of our experiments 1 and 2 prove to be true, we may conclude that metaphor-congruence does play an effect in sensory dimensions beyond motor actions. This, in the context of our experiment, means that providing participants with congruent ascending or descending pitch alongside the presentation of words with emotional valence helps memory consolidation through an association of mental metaphor and word definition. The significance of the results would suggest that the method we propose is promising in supporting the SUMM effect based on Casasanto and de Bruin[3].

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