Space Metaphor in the Representation of Concrete and Abstract Words: An Embodied Cognition Perspective

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Abstract: Research on embodied cognition is becoming increasingly crucial as society develops. To study embodied spatial metaphor, this study examines the relationship between perceived distance and understanding of abstract and concrete words. Concrete words are usually considered to be relatively close to people's lives, while abstract words are not. Thirty-five participants between the ages of 18 and 29 participated in the study. They were asked to make either "concrete" or "abstract" responses quickly and accurately to words displayed on a screen, where words were presented to be either distance or in close proximity to the participant. The response time for correct answers was recorded. The results show that the reaction time of the abstract words with a short distance is not significantly longer than that of the abstract words with a long distance, while the results of the concrete words are consistent. According to the results, it can conclude that there is no significant relationship between spatial metaphor and the nature of words.

Keywords: Embodied Cognition, Spatial Metaphor, Verbal Concreteness.

1. Introduction

Multiple studies have shown that embodied cognition, roughly defined as a cognition that is fundamentally grounded in sensory-motor or modality-specific systems instead of existing as an isolated form of information processing [1], plays an important role in our interpretation of the world [2]. Research has been so robust that the theory of embodied cognition has since been successfully applied to empirical fields such as robotics, vision, sports, and education [3].

Within the field, embodied spatial cognition has long been proposed to be one of the fundamental basis on which more abstract cognition processes are grounded [4]. For example, human perception of time seems to share similar structures with human perception of space [5]. Meanwhile, Tang et al's study has shown that embodied spatial metaphors influences Chinese subjects' understanding of high power versus low power words [6], concluding that people use "size" as a spatial metaphor for "power level."

Despite the relevant abundance of research, so far limited studies have examined how embodied cognition, and especially embodied spatial metaphors, can play a role in human's understanding of

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abstract versus concrete words. Some research data has shown that embodied cognition may influence how peopleprocess abstract vs concrete action verbs [7] as well as abstract vs concrete emotional vocabulary [8]. However, further research is needed to determine if these results can be extrapolated to other abstract/concrete concepts as well as other channels of embodied cognition.

Therefore, this study attempts to add to current research on embodied cognition and abstract reasoning by examining how spatial metaphor of short versus long distances play a role in our understanding of concrete versus abstract words. On a theoretical level, there has been some evidence suggesting that our representation of abstract/concrete ideas may be connected to our representation of space and distance. For example, Construal Level Theory (CLT), a theory in social psychology developed by Liberman and Trope, seeks to examine the mechanisms underlying abstract/concrete thinking by connecting them to the idea of "psychological distance," which can mean spatial, temporal, or social distances [9]. Interestingly, according to Construal Level Theory, psychologically distant objects and events tend to be construed in more abstract terms, while psychologically closer objects and events tend to be construed more concretely [9]. That is to say, abstraction seems to be more readily associated with distance, while concreteness is more readily associated with proximity, a framework that has already seen some empirical support in social psychology [10].

This study hopes to examine whether embodied spatial cognition can influence how we process abstract versus concrete words and whether this influence follows the framework proposed by the Construal Level Theory. We hypothesize that people are more likely to correctly and quickly discern that a certain word is abstract or concrete in "distance-concreteness congruent" situations, where abstract words are shown as more distant while concrete words are shown as closer. In comparison, we hypothesize that people will be less ready to discern whether a certain word is abstract or concrete in the "distance-concreteness incongruent" situations, where abstract words are shown as closer while concrete words are shown as more distant.

To test this hypothesis, we employ a classic Stroop task paradigm that mixes and match abstract and concrete words with near and far distances, hoping to gain valuable insight into how spatial cognition plays a role in how we understand abstract/concrete concepts.

2. Method

2.1. Participants

A convenient sample of 35 participants was recruited for the purpose of this experiment. Participants' ages range from 18 to 29 and average at 22.83. All of them are right-handed. 11 self-reported as male, and the rest as female. All participants signed informed consent sheets beforehand, where they were told that they would be participating in a study about cognitive psychology.

2.2. Experimental Materials

A total of 20 concrete words and 20 abstract words were selected from the MRC Psycholinguistic Database for the purpose of this experiment [11]. The MRC Database's Concrete Concreteness Rating System scores a wide range of words on a scale of 100-700, with higher scores corresponding to more perceived concreteness and vice versa. In this experiment, 20 words were pulled from the 200-300 scoring group to act as abstract words, and 20 words were pulled from the 600-700 scoring group to act as abstract words. All words used are nouns commonly found in daily speech. The words were then translated from English into Chinese as all participants were Chinese natives.

Distance and proximity are presented on a computer screen via contextual cues. Each word is showcased over a linear perspective grid pattern to make it look either nearer or further from the participant, while its actual position remains unchanged. The following table shows the four possible pairings and their respective "distance-concreteness" congruency.

The study was developed using the Psychopy software and the finished product was uploaded to the Naodao platform for web-based participation.

2.3. Experimental Procedure

The entire experiment takes around ten minutes to complete and is divided into a practice phase and two formal experiment phases, with 10 trials in the practice phase, 40 trials in the first experiment phase, and 40 trials in the second experiment phase. During the entire experiment, participants were asked to remain seated and maintain a 60 cm visual distance from the computer screen until the end of the experiment. Each subject completed the task individually, and in each trial, the gaze cue "+" was first presented in the middle of the screen for 250 ms, followed by abstract or concrete words being presented randomly in the middle of the screen, appearing either near or far away from the participants.

Participants are asked to quickly and accurately determine whether the word being shown is an abstract or a concrete word when it appears on the screen; they are asked to press "j" when the presented word was an abstract word (low concreteness) and press "k" when the presented word was a concrete word (high concreteness). Participants' reaction time and accuracy under both "distance-concreteness incongruent" conditions are collected and compared.

2.4. Data Analysis

Concrete in-congruent images

The software used to analyze the data was JASP, in which we performed a t-test, and descriptive statistics test it. All of the data were presented in the results section.

3. **Results**

The reaction time of congruent images and in-congruent images. As noted in Table 1 below, the reaction time of the subjects to the congruent images (M=1.33, SD=0.49) was longer than that of the in-congruent images (M=1.25, SD=0.41). However, there was no significant difference between the response time of congruent images (SD=0.49) and in-congruent images (SD=0.41). In addition, the lower absolute t value of the two-tailed t-test (t=-1.39, p =0.91) also indicated that there was no significant difference in response time between the two stimuli. Figure 1 records the average of the response times for the two stimuli selected by the subjects, and the error bars show one standard deviation from the mean.

Variables	Reaction-time(s)	
	М	SD
Total congruent images	1.33	0.49
Total in-congruent images	1.25	0.41
Abstract congruent images	1.59	0.94
Abstract in-congruent images	1.47	0.73
Concrete congruent images	1.13	0.40

0.45

Table 1: Descriptive statistics of every variable.

1.03

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Figure 1: Mean reaction times (RTs) for Total congruent images and Total in-congruent images.

Note. Error bars represent standard errors.

Abstract congruent images and in-congruent images. As noted in Table 1 below, the reaction time of the subjects to the in-congruent images of abstract (M=1.59, SD=0.94) was shorter than that of the congruent images of abstract (M=1.47, SD=0.73). However, there was no significant standard deviation difference between the response time of in-congruent images of abstract (SD=0.94) and congruent images (SD=0.73). In addition, the lower absolute t value of the two-tailed t-test (t=-0.94, p=0.82) also indicated that there was no significant difference in response time between the two stimuli. Figure 2 records the average of the response times for the two stimuli selected by the subjects, and the error bars show one standard deviation from the mean.



Figure 2. Mean reaction times (RTs) for Congruent images of abstract and In-congruent images abstract.

Note. Error bars represent standard errors.

Congruent images and in-congruent images of Concrete. As noted in Table 1 below, the reaction time of the subjects to the congruent images of concrete (M=1.13, SD=0.40) was shorter than that to the in-congruent images of abstract (M=1.03, SD=0.45). However, there was no significant standard deviation difference between the response time of in-congruent images of abstract (SD=0.45)

and congruent images (*SD*=0.40). In addition, the lower absolute *t* value of two-tailed *t*-test (*t*=-1.72, p = 0.95) also indicated that there was no significant difference in response time between the two stimuli. Figure 3 records the average of the response times for the two stimuli selected by the subjects, and the error bars show one standard deviation from the mean.



Figure 3:Mean reaction times (RTs) for Congruent images of concrete and In-congruent images concrete.

Note. Error bars represent standard errors.

4. Discussion

This paper has presented an experimental study to discuss the relationship between spatial metaphors, word abstraction, and people's cognitive perception. It must be pointed out that the reaction time of congruent images is longer than incongruent images, which is inconsistent with the hypothesis as well as previous studies showing that spatial metaphors will influence subjunctives' understanding of words related to words embodied at different power levels [6]. Thus, unfortunately, we cannot determine exactly how spatial metaphors would play a role in people's judgement on word abstraction or not.

There are some limitations to this study that should be noted. One limitation of the experiment design may be that the spatial distance metaphor is not obvious and does not achieve the desired degree of simulation. Also, the test vocabulary is translated from the English dictionary database. There might be an undetectable discrepancy in language usage, resulting in a certain deviation between the experimental results and the actual situation. Furthermore, our subjective experiences lack scientific universality, so the experimental results cannot be not generalized, and the results cannot necessarily cover everyone's situation.

5. Conclusion

This study was undertaken to design a particular spatial environment and presented subjects with a series of words with different distances and degrees of abstraction and set close (distant) distance and concrete (abstract) words as "congruent" otherwise "incongruent". Researchers assumed that the reaction time of congruent situation would be shorter than that of the incongruent situation. The result, however, does not support this hypothesis and shows the reverse situation. One dominant result is that under the congruent stimulation, the reaction time of abstract words are significantly longer than

incongruent words, which may mean that the degree of abstraction of words affects people's judgments more than distance. We propose that the drawbacks motioned above has led to this unexpected result. Despite these disadvantaged, this study does raise a significant research question which few researchers have explored before, and the result reminds us of experimental improvements rhat need to be made in the future.

Researchers who study related topics may gain some inspiration from this study for finding how spatial metaphor affects people's understanding of images and words, especially the judgement of their abstraction level through better experimental design, such as the presentation of spatial metaphors and the choice of test vocabulary and discussing in detail. When conditions permit, we hope to verify the relationship between the independent variable and the dependent variable through laboratory experiments, which can better manipulate the control variable and ensure that the experimental subjects meet our selection criteria. At the same time, we need more subjects with different background conditions, and we need to conduct interviews with the subjects after the experiment to understand other factors that influence decision-making during the experiment, e.g., whether the subjects guessed the purpose of the experiment, how they make responses, and their psychological activities, etc.

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