Comprehension of Concrete and Abstract Action-Sentence

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Many previous studies show the action-sentence compatibility effect; action-sentences activate our sensorimotor information and lead us to commit actions (Borreggine & Kaschak, 2006). If sentence comprehension includes the spatial images, our sensorimotor information affects our actual and automatic actions. In this research, we investigate the types of action-sentence: concrete action-sentence and abstract action-sentence.

Introduction

Spatial Image during Sentence Comprehension

Perceptual and spatial information are deeply related with concept and language processing. We can consider sentence comprehension to be a mental simulation because it requires the use of the same neural system that is needed in real situations, even when it is not actually needed (Zwaan, Madden, Yaxley, & Aveyard, 2004). For example, when we hear "The athlete lifted the barbell," we imagine a situation in which an athlete touches the barbell and lifts it up with force. Further, when reading this sentence, we place ourselves in the athlete's position even though we might not have had any experience in lifting a barbell in this manner.

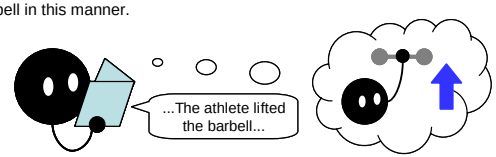

Figure1: Sentence Comprehension and Spatial Image

Spatial Image and

When we feel sad, we say "I feel in the bottom" despite not actually being at such a place. Many abstract concepts and emotions are often represented using these spatial expressions. These expressions are considered to have arisen from our embodied and experiential factors. These spatial images are known as "perceptual symbol" or "image schema," which are the sensoriomotor patterns abstracted from our experience (Barsalou, 1999; Lakoff, 1987).

Previous Studies & Research Aims

Verb Comprehension and Spatial Image

Richardson, Spivy, Edelman, & Naples (2001) revealed that verb comprehension (not only concrete verbs but also abstract ones) includes the strong spatial image.
e.g. "Lift", "Sink", "Respect" => "VERTICAL" image
"Pull", "Push", "Tempt" => "HORIZONTAL" image

Moreover, Richardson, Spivey, Barsalou, and McRae (2003) showed the interaction between verb comprehension and spatial processing. They revealed an interference effect when the sentence orientation matched the comprehender's reaction orientation. However, their dimensional settings (HORIZONTAL vs. VERTICAL) were disputable because they dealt with the conflict elements in the dimension simultaneously (e.g., UP vs. DOWN in the VERTICAL dimension).

Thus, the aim of our research is to simplify the dimensional settings in Richardson et al. (2003) and investigate the conflict factors in one simple dimension.

Verb Comprehension and Spatial Image in Japanese Research

Taira, Nakamoto, & Kusumi (2006) revealed that Japanese verb comprehension also includes the strong spatial image. Their research investigated two different elements (UP and DOWN) in the HORIZONTAL spatial image.
e.g. "lift", "respect" => "UP" image
"drop", "despise" => "DOWN" image

These results are the data from offline drawing, not online data like Richardson et al. (2003). Another aim of our research is to investigate the online relationship between the verb comprehension and spatial image.

Experiment-Method

Materials

36 Japanese sentences including vertical spatial image. Each sentence included 3 different spatial images: 12 UP, 12 DOWN, and 12 CONTROL (horizontal) image sentences. In addition, there were two types of sentences: concrete action-sentences and abstract action-sentences. All sentences were recorded by an experimenter speaking in a natural intonation and saved as wav sound file.

Table1: Examples of Target Sentence Type

Spatial Image	Concrete Action	Abstract Action
UP	The athlete lifted the barbell.	The student respected his teacher.
DOWN	The clerk dropped the pizza.	The emperor ruled his country.
CONTROL	The miner pushed the cart.	The player regretted his failure.

Procedure

1. Sentence Comprehension Task (SCT)

The fixation mark (+) appeared on the center of the PC display after 1000 ms, and the target sentence was heard from the headset. In this task, the participants were instructed to listen and make attempted to understand the target sentence while watching the fixation mark.

2. Stimuli Identification Task (SIT)

50-150 ms after the SCT ended, a circle (○) or a square (□) was presented in the upward or downward area relative to the fixation mark (the visual angle was ± 7 degrees), and the participants were required to determine which figure appeared, as quickly as possible.

We collected the decision time data in the SIT: this data shows the activation index of the spatial image from the target sentence.

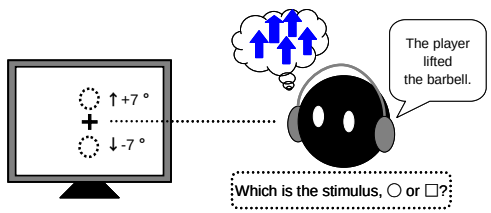

Figure2: Outline of Stimuli Identification Task

3. Meaning Judgement Task (MJT)

The other sentences were presented on the center of the PC display after the SIT ended. The sentences only shared verbs with the sentences in the SCT (e.g. "A section manager lifted his boss." The word "lifted" normally means "praise" in Japanese). The participants were required to judge whether the meaning of the verbs in SCT and the meaning of the verbs in this MJT was same.

Participants

Twenty-four undergraduates and students participated in the experiment as a partial fulfillment of course requirements. They were native Japanese speakers.

Experiment-Results & Discussion

Concrete Action-Sentence

The interaction between the sentence image and stimulus position was significant ($F(2, 46) = 7.547$, $p < .005$).

- **The UP image sentences facilitated the SIT of the UP direction** faster than that of the CONTROL and DOWN image sentences (UP vs. CONTROL: $t(23) = 2.292$, UP vs. DOWN: $t(23) = 2.498$, *ps* < .05).
- **The DOWN image sentences also facilitated the SIT of the DOWN direction** faster than CONTROL and UP image sentences (DOWN vs. CONTROL: $t(23) = 1.797$, $p < 0.1$ DOWN vs. UP: $t(23) = 3.075$, $p < .05$).

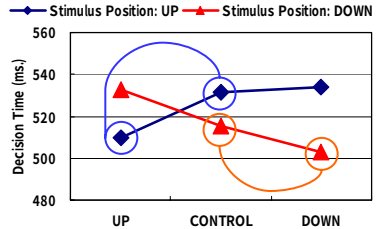

Figure3: Mean decision times of concrete action-sentences by sentence image and stimulus position

Abstract Action-Sentence

No interaction between the sentence image and stimulus position ($F(2, 46) = 0.060$, *n.s.*)

- Only the main effects of figure position ($F(1, 23) = 5.036$, $p < .05$).
- **We could not observe the effects of the sentence images.Abstract action-sentences has no effect on the SCT.**

Sentence comprehension requires the use of the same neural system in real-life situations, even when we do not act as per the meaning of the sentence (Zwaan et al., 2004).

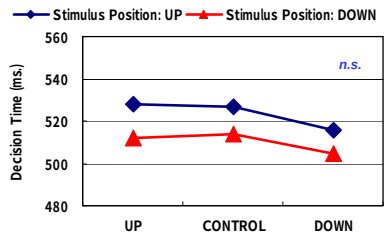

Figure4: Mean decision times of abstract action-sentences by sentence image and stimulus position

In this light, concrete action-sentences directly refer to embodied actions. The situations and content that the verb sentences represent can be combined with our sensorimotor information and action. As a result, the decision time that was meant for the activation of the sensorimotor system was facilitated. However, the abstract action-sentences, which are in fact understood on the basis of the given spatial frame, do not refer to the actual actions; these actions do not require one to move one's body. Spatial images are required only for our description of abstract concept.

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