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The relationship between Japanese spatial terms and visual factors in three- dimensional virtual space

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Introduction

How spatial terms correspond to visual factors has been a topic of interest (e.g. Regier & Carlson, 2001). In particular, how a spatial term categorizes a space is an important problem (Hayward & Tarr, 1995). Most studies have considered a line as a prototype of a spatial term. In this view, some spatial terms have the same prototypical line. However, it is possible to choose an appropriate spatial term from similar spatial terms that are based on a line. Therefore, a spatial term also has a prototypical point on a prototypical line that distinguishes it from another spatial term, also categorized by a line (Kojima & Kusumi, 2002).

This study examined the prototypical points for three Japanese spatial terms categorized by a spatial line, which are recognized as differing from each other, by using a method of adjustment instead of rating tasks. We also examine the effects of visual factors on choosing a spatial term.

Method

In this experiment, we focused on three Japanese spatial terms, *mae* (front), *ushiro* (back), and *saki* (ahead), and three visual factors, the distance between objects, the height of the viewing point, and the position of the viewing point.

Forty-five Japanese graduate or undergraduate students participated in this experiment. They were divided into three groups of fifteen, and each group participated in each session.

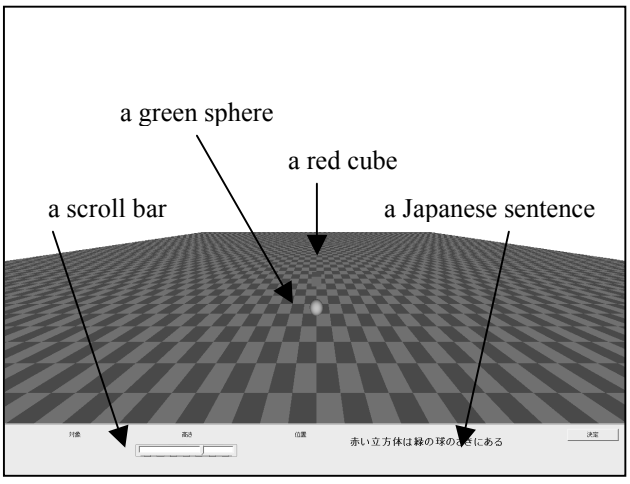

Fig.1. An example of a stimulus in the experiment

The experiment was run on a computer with a 17-inch monitor (Fig. 1) and consisted of one session for each of the three spatial terms. In any trial, only one of three scroll bars was shown and used to adjust a different factor: the distance between the green sphere and the red cube, or the height or the position of the viewing point. A Japanese sentence including a spatial term was presented in the lower part of the screen (*e.g.*, in English the sentence might be "A red cube is in front of a green sphere."). When the participant adjusted one factor, the coordinates of the other two factors remained fixed. Seven patterns were used in each session. The participants adjusted the pattern for each sentence.

Results and Discussion

The point of subjective equality (PSE) was computed from the data. The PSE values for each condition for the three spatial terms were analyzed using one-way ANOVA and Tukey's HSD. We found significant differences between all of the conditions: the position of the viewing point ($F(2,447)=54.06$, $p<.01$); the height of the viewing point in the near ($F(2,447)=92.28$, $p<.01$), middle ($F(2,447)=75.42$, $p<.01$), and far ($F(2,447)=48.27$, $p<.01$) distance conditions; and the difference in the distance between the green sphere and red cube in the near ($F(2,447)=58.22$, $p<.01$), middle ($F(2,447)=53.32$, $p<.01$), and far ($F(2,447)=68.75$, $p<.01$) distance conditions. Tukey's HSD indicated a significant difference between all but four of the conditions with respect to the spatial terms. The exceptions were the height in middle and far distance conditions, and the distance in middle and far distance conditions.

The result indicated that three visual factors affect the choice of spatial terms. It follows that humans can distinguish one spatial term from another, based on certain visual factors, even if the spatial terms are linked to a similar prototypical line in space. In addition, considering the values of the mean PSEs, it may be said that human beings choose an appropriate spatial term by differentiating visual differences accurately.

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