

Synchronized Non-metric Orientation as the Production System of Mental Maps

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In this study, we examine the concept of synchronized non-metric orientation as the production system of mental maps. The term ‘non-metric orientation’ is used here to designate spatial concepts that lie between topological space and metric space. We conducted an experiment in which each subject was asked to read the text (in Japanese) and draw a plan of the house described in it. The text contains a certain number of clues that depict relations between the various rooms in the house (names and sizes of rooms and relations such as “back”, “left”, and “south”), but not all the relations are clearly specified. The subjects were 70 university students and a variety of spatial configurations was indicated in the floor plans drawn by the subjects. However, if common structures exist in the spatial cognition of the subjects, it should be possible by some means to extract regularities from the floor plans. We defined three types of orientation: Orientation of a room entrance, Orientation of other rooms that can be seen from a certain room, Orientation of a certain room within the site. Using the mutual proximity of orientations (for every two orientations of the same type and of different types) as a criterion, we investigated the overall orientation structure according to non-metric MDS and the results are plotted in graphs. In this way, focusing on the similarity of certain pairs of orientations to bring out the overall structure, the plotted graph we made indicates a certain regularity wherein the individual orientations are synchronized and mutually stipulating. The characteristics of this non-metric orientation as the production rules of mental maps can be summarized as follows: a) Non-metric orientation is constructed of concrete units (for example, a room entrance, a room, the site, etc.). b) Individual rules that construct non-metric orientation are local. But being distributed over various places, though, they are synchronized like a ripple, and mutually stipulating each other in a chain-reaction, to build up the totality. c) This orientation can not be metric, due to the representational varieties derived from the different sizes of the objects forming the perceived units. We may say that our examination revealed the contents of the certain geometric properties and that, we believe, is very informative for the artificial intelligence of spatial representation and of the wayfinding.

In this study, we examine the concept of synchronized non-metric orientation as the production system of mental maps. The term ‘non-metric orientation’ is used here to designate spatial concepts that lie between topological space and metric space. Method: We conducted an experiment in which each subject was asked to read the text (in Japanese) and draw a plan of the house described in it. This text is characterized as follows: 1) A certain number of clues are contained in the text that depict relations between the various rooms in the house (names and sizes of rooms and relations such as “back”, “left”, and “south”), but not all the relations are clearly specified. 2) Accordingly, the subject must infer relations that are not clearly stated in the text. Therefore it is impossible for the subjects to identify only one suitable configuration. 3) The floor plan of the house is described from the viewpoint of daily life rather than from a bird’s-eye or geometrical perspective. The subjects were 70 university students. Analysis: A variety of spatial configurations was indicated in the floor plans drawn by the subjects. However, if common structures exist in the spatial cognition of the subjects, it should be possible by some means to extract regularities from the floor plans. We defined three types of orientation. Type • is the orientation of a room entrance, and four orientations are defined based on the direction that the entrance to a room faces. Type • is the orientation of other rooms that can be seen from a certain room and is indicated by eight zones that are formed by extending the wall lines of a room. Type • is the orientation of a certain room within the site that is divided into four sections by two lines. Let us assume that the responses of three subjects are dispersed over A, C and E for a certain orientation and over B, D and F for another orientation. Although each orientation shows no coincidence, a comparison of the relation between the two orientations by subject reveals that “A” and “B”, “C” and “D”, and “E” and “F” are respectively adjacent. In this case, a similarity of cognitive structure is observed in the mutual relations of the orientations. Using the mutual proximity of orientations (for every two orientations of the same type and of different types) as a criterion, we investigated the overall orientation structure according to non-metric MDS and the results are plotted in graphs. Results: In this way, focusing on the similarity of certain pairs of orientations to bring out the overall structure, the plotted graph we made

indicates a certain regularity wherein the individual orientations are synchronized and mutually stipulating. For instance, the orientation of the entrance to the guest room (•) is established first, and the orientation of the living room viewed from the guest room (•) conforms to it. On the other hand, the orientation of the study viewed from the living room (•) is separate from this, and it corresponds to the orientation of the study in the site (•). Moreover, this is located in the orientation opposite to the entrance to the entry hall (•). Discussion: Lynch (1960) distinguished 'four stages along a continuum of increasing structural precision' of the image of the city. In the second stage, Lynch says, the parts of the city are 'roughly related in terms of their general direction'. This assertion suggests the stage which does not provide metric orientation but provides more than just topological relationships, namely the stage which provides non-metric orientation. We further revealed the characteristics of this non-metric orientation in mental maps and summarized them as follows: a) Non-metric orientation is constructed of concrete units (e.g. a room entrance, a room, the site, etc.). b) Individual rules that construct non-metric orientation are local. But being distributed over various places, though, they are synchronized like a ripple, and mutually stipulating each other in a chain-reaction, to build up the totality. c) This orientation can not be metric, due to the representational varieties derived from the different sizes of the objects forming the perceived units. We may say that our examination revealed the contents of the certain geometric properties and that, we believe, is very informative for the artificial intelligence of spatial representation and of the wayfinding (see Yokoyama and Yokoyama(2006) for instances of applied studies). References: Lynch, K. (1960). *The Image of the City*. Cambridge: MIT Press. Yokoyama, K. and Yokoyama, Y. (2006). *A Study of Information Formulation in Auditory Map Systems*. International Symposium on Architectural Interchanges in Asia • ISAIA • . Daegu. 6, 577-82. <http://homepage3.nifty.com/yokoyama/>