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Image representation, scaling and cognitive model of object perception

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Abstract Neuropsychological investigations of visual imagery and representations have led to a deeper understanding of the spatial perception, representation and memory. But how each individual perceives object's geometrical properties and how they differ from person to person, both under event-related memory and normal recollecting memory in the presence or in the absence of direct sensory stimulation is still unclear. Spatial knowledge is diverse, complex, and multimodal, as are the situations in which it is used. All seem to agree that a cognitive map is a mental representation of an external environment. The image scaling is important in understanding the psychological dysfunctions of patients suffering from spatial cognition problems. The scaling becomes self-evident in art forms, when people are asked to draw image of objects they see actively or from their short or long term memory. In this paper we develop a comprehensive model of this scaling factor and its implications in spatial image representation and memory. We also extend its notion in understanding the perception of objects whose representations are normally not possible (like the perception of universal scales, infinities and parallel lines) but are well comprehended

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Osmania Medical College, NTR University of Health Sciences, Hyderabad 500 095, Andhra Pradesh, India e-mail: sandeep.g.bio@gmail.com; sandeep_bme@yahoo.co.in by the human brains. Here we give a scaling factor which is variable depending on the situations for a person based on his visual memory and drawing capabilities. And then extend it to analyse his cognitive strengths, disorders and any imperfections. This model also helps in formalizing the architectural cognitive maps needed to change the scaling factor, depending on the types of visual works one performs.

Keywords Spatial knowledge \cdot Scaling factor \cdot Image representation

Introduction

The way in which the internal states of visual systems can represent the shapes of distal objects veridically by geometrical representation models are central in visual imagery. But the geometry of an object is not emplicitly present in the visual system (in the eye) (Anderson 1978). A reconstructionist approach to representation seems to be the most elucidating one in such a situation but this approach is at odds with current computational theories of representation (Barsalou 1999). Interestingly, the mechanism that accounts for the size representation under normal conditions also predicts the existence of certain kinds of size illusions (Biederman 1987; Biederman and Cooper 1991).

This makes sense because size perception should be systematically incorrect whenever representational perception is systematically incorrect. These difficulties, both theoretical and practical, are explored and a possible model is created to support this hypothesis (Bookstein 1996; Carne 1990). To account for these phenomenons we studied the scaling properties by exploring the representational views. This paper is



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mainly concerned with representations of objects under pins the process where by thing that are 'in there' give out as a distal representation using the normal drawing skills of an individual. In this way the casual relation of the representation maintained by visual systems with the reconstruction of object shapes is considered which draws parallel the notion of the subjective geometric similarity and the visual imagery (Kendall 1984).

Now consider how we can use this new active relation (note that it is directional) to describe the relations in the spatial world. First, we have to know what kinds of relations exist in the brain (Borg and Lingoes 1987). There are two basic relations: (a) spatial and (b) temporal relations. Spatial relations are between objects, and they are causally bidirectional. On the other hand, temporal relations are between events, and they are causally directional. When one event precedes the other, the reverse cannot happen simultaneously. This makes the image recollection a bit messy (when dealing with the issue of an appropriate scale or the optimum resolution of images we must keep in mind what categories of target objects we investigate) (Marr and Nishihara 1978; Edelman and Duvdevani-Bar 1997). This includes considerations regarding the scale domain in which those features are represented, as well as specific spectral or spatial properties. Before the advent of object-based classification techniques (Blaschke and Strobl 2001), there was a sharper methodological distinction between classification of entire scenes (wall-to-wall, land cover or land use type) and pattern or object recognition.

Methods

Under second order isomorphism the brain needs to find the relation between (a) external objects and (b) internal representations (Edelman 1995; Kruskal 1977). We can see that a difficulty can arise in such an interpretation; something has to perform the comparison function, but this creates an ever increasing level in a hierarchical way (i.e., higher areas judging the output relation in the lower areas). However, as Hilgetag et al. (1996) noted, it is hard to determine a strict hierarchy among cortical maps (in this case, between visual areas). Also, as Zeki (2001) suggests, integration of these information may be a nonhierarchical process. Thus, representing something and delaying the interpretation until later may not work very well. Hence we choose a slightly changed model of second order isomorphism with chorus prototypes as the basic mechanism of object identification in brain and then made our test based on these hypotheses and below are the methods discussed.

An object's representation can be activated independent of the size of the object's image on the retina (such a representation is referred to as "object-centred"), on the other hand, the object's representation is preferentially activated by a specific image size (such a representation is called as "viewer-centred") since activation depends on orientation and size relative to the viewer (Ashbridge et al. 2000). The methods used are simple drawing test for assessing the drawing skills of the subjects, but we basically concentrated on the size characteristics of the tests (a paper assessing the other features of the pictorial representations will be published soon) (Smith et al. 1997; Treisman and Kanwisher 1998). During test tasks, only one of the following spatial attributes varied: 2D orientation or size (Isabelle et al. 1999). This simple framework illustrates how the same learning algorithm and architecture can support a variety of object recognition tasks such as scaling and identification (Edelman 1999). The difference between this experiment and the segmentation was that the same object had to be clustered as the same object between images.

Results

As stated above, the mechanism is based on the chorus of prototype (which is a representational model) and hence it is limited in its implications on the spatial shaping but with some changes it can accountably explain some spatial problems like the illusions and the size constancy. It also simplifies the long standing question of shape– orientation–scale problem in spatial representations and visual performance.

The results obtained can be summarized in the following points:

- 1. The scaling factor obtained in testing, done on subjects, is found to be statistically important in assessing the spatial cognitive capabilities of the subject, though more tests are under way for proving the link conclusively.
- 2. The size information is probably represented by the S-isomorphism of the shape–space of the brain.
- 3. The scaling factors used here have its implications in elucidating the size illusion like the Ponzo illusion and the Moon illusion.
- 4. The size representations in the brain for basing the neurological studies can be evaluated. The results also shade light on the perception of the certain nonphysical parameters like infinites and parallel lines and how they are apprehended by human brain.
- 5. The inclusion of the shape of the object would require much more complicated model of representation as it includes much more complex data.

Discussions

The neural mechanisms described in this paper can only



account for simple kinds of analogies, and in some case it can even seem as simple pattern completion. A further modelling of it in graphics should be done, for explaining the shape parameters of objects (Walter and Ritter 2002). Since the data is limited a more comprehensive review of the method and its results are under way and the importance of the model becomes more apparent as it is used more extensively in the cognitive testing. A further study is need in this field.

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