A Multilayer SOM Model for Explaining Category Specific Impairments

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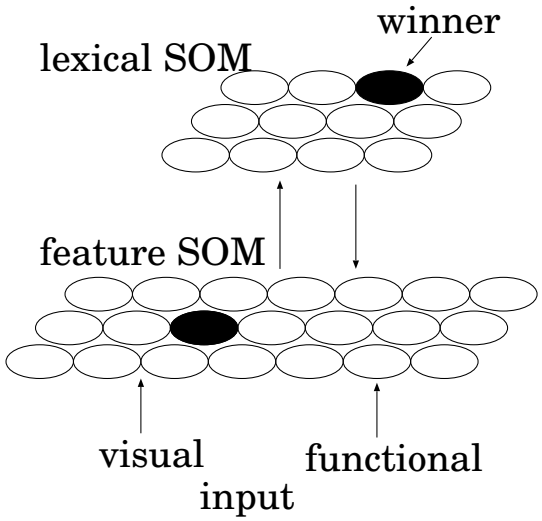
A new constitutional explanation was discussed about category specific impairments of semantic memory in terms of neural network models. Models, in general, are required to be able to deal with variability of performances of brain damaged patients with semantic memory deficits. Also, the models are required to be consistent with the facts derived from brain imaging studies and from the evidence of physiological experiments. The model proposed here may satisfy these requirements. It can provide an unified perspective.

In the literature, there are patients who cannot identify and say names of animals, on the other hand, there are other patients who have lack of knowledge about inanimate objects like hammer and brush, while they can have no difficulties to recognize other concepts. Among neuropsychological data, this double dissociation between animate and inanimate knowledge would intrigue us for considering the structure of semantic memory in the brain. So far, several hypotheses have been proposed in order to explain these category specific impairments. Warrington and McCarthy(1983) first proposed the sensory/functional hypothesis, in which each item in semantic memory would be organized based upon the knowledge of sensory and functional information. According to their explanation, animals might be distinguished by their visual features, while tools might be classified based upon how they works. Thus, if patients have regions which deal with sensory information, they may show more severe impairments about their knowledge of animals than the region related to tools.

However, category specific memory deficits could be explained by other possible hypotheses, the Hierarchical Interactive Theory (HIT) model proposed by Humphreys and Forde(2003), and the Similarity In Topography (SIT) model proposed by Simmons and Barsalou(2003), for instance. Both models would be adequate with no contradictions to neuroimaging studies and physiological evidences. However, we do not know which model is better. In addition, it might be possible to rethink another model to describe the category specific phenomena.

The model proposed here has the same hierarchy structure as HIT and SIT. Memory for recognizing objects would consist of subspaces: sensory/functional dependent information, and lexical attributes in which these knowledge spaces would be organized in a hierarchical structure. These subspaces would be interconnected.

Within a subspace, maps would be organized based upon similarities among objects through the Self Organizing Mapping (SOM) principle. This principle has proven to be useful



to draw a two-dimensional map. The winner take all circuit in the SOM would play an important role to make topographic mapping. The Hebbian learning rule was adopted to connect between subspaces after each winner was decided.

Since this model have an interactivity and a similarity based mapping, this model has the same characteristics both the HIT and the SIT model. In this point of view, this model is a natural extension of the HIT and the SIT model. It might have a more general application than the models proposed so far. In addition, this model has a computationally clear description in terms of neural networks. This model is simple, but it will be able to consider the origin of meanings as a result of both mutual connections and SOM principle. Although mathematical consideration still remains unsolved as to whether this algorithm can convergence within limitations of computational resources, this kind of formalization might help us to pigeonhole variability of semantic disorders and the structure of semantic memory.

References

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