The Role of Inhibition in a Spreading-Activation Model of Language Production. I. The Psycholinguistic Perspective

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Accepted September 23, 1992

Spreading-activation models of language production are only workable to the extent that they manage to solve the "heat death" problem, i.e., the danger that too many nodes in the network are overactive at the same time. Therefore, a delicate balance between activational and deactivational forces has to be struck. Of the three prevailing dampening mechanisms of decay, self-inhibition and other-inhibition, the latter has been selected for closer scrutiny. The key proposal of this two-part article is that activation-based models of language production cannot afford to do without an inhibitory component, in particular lateral inhibition among nodes of the same level. Psycholinguistic evidence is reviewed in an attempt to insulate inhibitory from excitatory mechanisms. Although it is difficult in normal adult language use to distinguish between the effects of excessive activation and insufficient inhibition, some patterns from language acquisition and aphasia can be shown to follow from inhibitory rather than excitatory problems, thus demonstrating the reality of inhibition. In a system of activational and deactivational forces, other-inhibition is claimed to have the excitatory mechanism of syntax as its natural opponent. It is finally argued that other-inhibition offers an explanation for some puzzling findings from the experimental literature.

INTRODUCTION

During the 1970s, comprehension models of lexical retrieval underwent a significant extension. While early experimental results were interpreted

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within an activation-only framework (e.g., Collins & Quillian, 1969; Loftus, 1973; Schvaneveldt & Meyer, 1973), later accounts were based upon excitatory as well as inhibitory mechanisms (e.g., Becker, 1980; Neely, 1977; Posner & Snyder, 1974). The reason for the incorporation of inhibition was mainly empirical. The availability of specific responses was reduced in certain unfavorable conditions as compared to a neutral condition. Delayed retrieval was rationalized in terms of the operation of an inhibitory mechanism. With the advent of connectionist frameworks in the 1980s, the concept of inhibition has received a very explicit interpretation. It is meant to describe in quantitative terms the negative effect the processing of a given item has upon the activation value of another item. At the conceptual level, it is expedient to distinguish between the static and the dynamic side of inhibition. The former is represented in terms of permanent connections that link individual processing units. These links may be of a variable strength. What has to be determined is which units are linked up in inhibitory fashion. A plausible strategy would be to assume that all those nodes which stand in a mutually incompatible relationship are inhibitorily connected. Accordingly, inhibitory connections are established, let us say, between [voiced] and [voiceless] or between /p/ and bin. However, it was soon recognized that this constraint is too powerful. While the classical interactive-activation model of McClelland & Rumelhart (1981) had inhibitory links both within levels and between levels of processing, later versions [from McClelland (1985) on] abolished vertical inhibitory links altogether and used only lateral inhibition. Thus, the nodes [voiced] and [voiceless] retained their inhibitory connection but /p/ and bin did not. This is the static aspect of the model. The dynamic aspect of inhibition is represented by the flow of information traveling along the hard-wired pathways. The amount of energy that is spread through the system is variable. It is commonly assumed to be proportional to the level of activation. That is, the more activation a node has accumulated, the more inhibition it sends out to its competitors. Inhibition can thus be said to be a function of activation and of linkage strength.

In studies on human memory, the existence and usefulness of inhibition are no longer seriously questioned. The real challenge is rather to identify the multifarious conditions under which facilitatory as opposed to inhibitory processes predominate (e.g., Blaxton & Neely, 1983; Roe-diger & Neely, 1982; Watkins & Allender, 1987). However, the role of inhibition in language production is as yet largely unclear. A survey of the pertinent models indicates that the importance attached to inhibition varies considerably from model to model. Whereas some researchers