Abstract

This paper addresses the questions of how and when lexical information influences phoneme detection in two phoneme monitoring experiments. In the first, the position of the stop consonant target (word initial, before uniqueness point, after uniqueness point, word final) and the lexical status of the target bearing item (word or nonword) were manipulated to pursue the temporal question. A contribution of the lexical level to targets in words and nonwords derived from the words) was found only when the target came in the two positions after the uniqueness point. In a second experiment, the contribution of the lexicon was made incompatible with the bottom-up evidence for targets by placing them in words where they did not belong (p: target substituted for I producing "stimuji"). No inhibitory effect of the lexical level was obtained even in cases where the target and substituted phonemes differed minimally. These results taken together indicate that the lexicon exerts its effect only after word recognition and as positive feedback suggesting strong limitations in the way in which lexical information can affect speech perception.

Introduction

No-one would dispute the claim that we recognize words on the basis of an analysis of the speech sounds of which they are composed. Controversial, at least in psycholinguistic circles, is the inverse claim that our perception of speech sounds depends upon the words they make up. In this paper, we will evaluate these claims about the relative importance of bottom-up and top-down processes mediating between the sublexical and lexical representations. To arrive at a proper description of the information flow between these two levels, we will address the questions of how and when the lexical and sublexical information sources are brought together.

To investigate these questions we used the phoneme monitoring task in which subjects are asked to detect as quickly as possible previously specified phoneme targets that appear in sentences or lists of words. Previous research [1,2,4,6,7] has shown that phoneme detection latencies are sensitive to lexical variables indicating an influence of the lexical level upon speech perception as reflected by the phoneme detection process. Our objective here is to examine empirically two opposed accounts of such lexical effects.

In autonomous models of language processing [3], it is assumed that bottom-up processes produce their output autonomously, top-down lexical information is not allowed to influence the bottom-up mechanisms responsible for phoneme perception. In order to account, nonetheless, for the presence of lexical effects in phoneme monitoring, "race models" [1,2] and "dual code models" [4] have been developed in which phoneme identification can be made on the basis of two different "outlets" or representations: a lexical and a sublexical level. In a race model account, there are two independent ways in which a phoneme target can be detected. The first target detection procedure depends upon the computation of a sublexical representation. In the second, target detection depends upon lexical access which makes available the phonological information associated with a particular accessed lexical entry. There is a race between these two processes with the one that reaches completion first providing the phoneme detection response. The presence or absence of lexical effects is explained in terms of the outcome of the race between these two independent and competing outlets.

Interactive activation models are designed to account for the integration of multiple sources of information or constraints in speech perception. The most explicit model constructed within this framework is TRACE [5]. In TRACE there are several levels of interconnected processing units corresponding to distinctive features, phonemes and words. The critical interactive aspect of this model is that word units can provide top-down feedback to phoneme units by increasing their level of activation. Hence, phoneme recognition (the moment a phoneme reaches a criterial level of activation with respect to the other phonemes) depends on both the amount of bottom-up activation from the distinctive feature level and the amount of top-down activation from the word level. Subjects responding in the phoneme monitoring task are assumed [8] to make direct and exclusive use of activated phoneme units. The presence or absence of lexical effects in phoneme monitoring is explained within the TRACE framework by varying lexical contributions to the phoneme's activation.

Although these two basic model types are radically different in nature, they make many of the same predictions and appear to be consistent with most of the data available in the phoneme monitoring literature. Given this state of affairs, it is critical to collect additional performance data that will allow us to further constrain these types of models. In particular, it is essential to determine how and when the lexical level contributes to the speech analysis, as reflected by the phoneme monitoring task.

In order to trace the time-course of lexical effects, we selected targets in four different positions with respect to the uniqueness point (UP) of the word. The UP was defined as that point at which a word's initial part is shared by no other word listed in a phonetic dictionary. Nonwords were created from these target-bearing words by changing one or more phonemes, but keeping the target's local phonemic environment as constant as possible. The differences in detection times between phoneme targets in the same position in matched words and nonwords provided an approximate measure of the lexical contribution.

Lexical effects in phoneme monitoring: Facilitatory or inhibitory?

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EXPERIMENT I

Subjects
Thirty-eight undergraduates at Nijmegen University, all native speakers of Dutch, were paid to participate in the experiment.

Materials and procedure
The test stimuli consisted of 120 words and 120 matched nonwords. Target phonemes (/p, t, k/) occurred in four different positions within target-words (word onset, before the UP, after the UP, and word offset). The nonword onset (before the nonword point, after the nonword point, and word offset). The nonword point (NPVP) is that point at which the item becomes a nonword moving from left to right, beginning towards the end.

Target-bearing items were embedded in counterbalanced lists made up of other words and nonwords not containing the target-phoneme. Twelve such lists, each containing 60 items, were created and divided into two blocks for counterbalanced presentation to the subjects. For each list, subjects were asked to detect as quickly as possible one of the three targets (specified by means of a visual display).

Results
Mean reaction times (measured from the burst of item-identification) were used as a dependent variable. Three subjects with more than 15% errors were also excluded from the analysis.

Discussion
In this experiment, we have investigated whether the lexical influence, observed to be highly facilitatory for the UP in the first experiment, can also be inhibitory when the lexical information is incompatible with the target position. The results provided no evidence for such inhibitory lexical effects, but did replicate facilitatory lexical effects. Predictions of inhibition are implicitly made in the interactive activation framework, but are excluded by the autonomous model. As a consequence, these results appear to be more compatible with the autonomous model. The absence of inhibition, although problematic for interactive models, is not excluded by the replacement (appropriate) phoneme does not show up. The strength of the bottom-up activation dominates and hides the phoneme-lexicon lexical effect. If this account is correct, then one might expect inhibitory effects to vary as a function of the strength of bottom-up activation. We are now in the process of exploring the possibility that inhibitory effects will emerge with acoustically clear targets.

The two experiments taken together suggest an asymmetry in the way lexical information can contribute to the bottom-up analysis underlying phoneme detection. The results presented here indicate that the lexicon exerts a facilitatory but not an inhibitory influence upon bottom-up processing after word recognition. Thus, these results show strong limitations in the way in which lexical information can affect phoneme processing that must be taken into account by both interactive and autonomous models.

REFERENCES