

# The Effect of Temporal Overlap on the Perception of Dichotically and Monotically Presented CV Syllables\*

Robert J. Porter<sup>+</sup>  
Haskins Laboratories, New Haven

The concern of this paper is the lag effect. This effect, first observed by Studdert-Kennedy, Shankweiler, and Schulman (1970), may be summarized as follows: if two stop consonant-vowel syllables are presented dichotically, with an onset asynchrony of 15 to 150 msec, subjects identify the temporally lagging consonant more accurately than the leading. That is, most errors are made in identifying the leading syllable of the dichotic pair. Dichotic presentation is essential for demonstrating the effect, for if the same temporally offset pairs are electronically mixed and presented to the same ear, then the leading syllable is identified more accurately than the lagging one. Studdert-Kennedy et al. suggested that the different effects for dichotic and monotic presentation might reflect the different influences of central and peripheral masking. The basis for their interpretation is diagrammed in Figure 1 for two syllables with an onset asynchrony of 75 msec. Each syllable is represented by a rectangle divided into two portions: the obliquely striped initial portion represents the location of the principle acoustic cues for the differing initial consonants; the final horizontally shaded areas represent the longer vowel portions which are the same for the two syllables. (The acoustic segmentation of consonant and vowel is intended for illustrative purposes only.)

Studdert-Kennedy et al. suggested that dichotically, at the top of the figure, the lagging syllable, which arrived centrally over a peripheral pathway separate from that of the leading, somehow disrupted the processing which had been initiated by the leading signal, information concerning the leading signal being lost as a result of this central disruption or "masking." Different factors were suggested as operating in the monotic case. Here, as is represented at the bottom of the figure, the two syllables physically overlap as they travel the same peripheral pathway. This overlap provides a sufficient condition for the peripheral masking of the lagging syllable's consonantal information by the simultaneously occurring overlapped vowel portion of the leading. Studdert-Kennedy et al. suggested that this peripheral masking of the lagging syllable by the leading overrode or precluded their central interaction and resulted in the observed advantage for the leading signal. Conceived in this way, the overlap of the signals is critically important for

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<sup>+</sup> Also University of Connecticut, Storrs.

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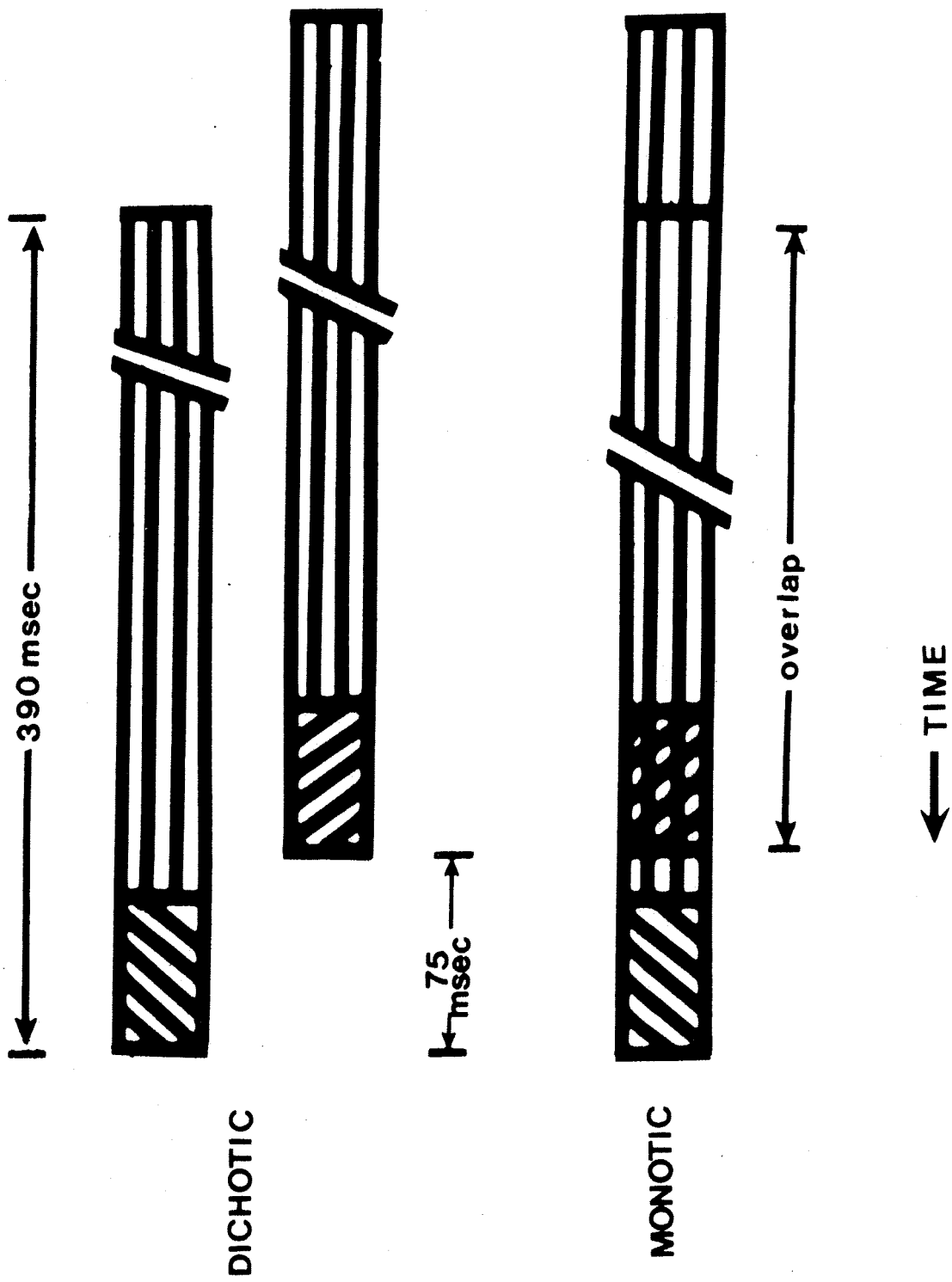


Fig. 1

demonstrating the monotic lead advantage. In the present study, the effect of eliminating the overlap was investigated by using syllables only 75 msec long and thus not overlapping at asynchronies of 75 msec or more.

Stimuli and tapes were prepared using the Haskins Laboratories computer-controlled parallel formant synthesizer. The stimuli were the six dichotic pairings of the stop-vowel syllables /ba, da, ga/. Six onset asynchronies of 0, 10, 25, 50, 75, and 100 msec were used. Two dichotic tapes were constructed: in one, the syllables were 390 msec long and thus overlapped at all asynchronies; for the second test, the syllables were 75 msec long and thus did not overlap at the two longest asynchronies of 75 and 100 msec. The 10-msec asynchrony was not included in the 75-msec syllable test. Corresponding long and short syllables were acoustically identical except for the duration of the final vowels. In each test, the dichotic pairs and the channel of the lagging syllable were appropriately counterbalanced with asynchronies. Six subjects (three males) received each dichotic tape twice on two successive days of testing. Following the dichotic tests on the second day, the subjects received each tape once with the two channels electronically mixed and presented binaurally. Pilot work had indicated that binaural presentation of the mixed channels did not yield results different from those obtained monaurally. For all tests, subjects were told to identify both consonants on each trial, guessing if necessary, and to record their responses on specially prepared answer sheets.

The results for all subjects combined are presented in Figure 2. The abscissa indicates the difference between the number of responses correct for the lagging and the number correct for the leading syllables expressed as a percent of the total number of syllables correct. Positive values indicate a lag advantage; negative values, an advantage for the leading syllable. The ordinate gives the onset asynchronies; the curve parameters are the experimental conditions.

Considering first the overall pattern of results, there is a clear separation of dichotic and binaural conditions. Dichotically, lag advantages are seen; binaurally, the leading syllable has the advantage.\*

Dichotically, there is no significant interaction between length of syllable and degree of asynchrony. The scores for the shorter syllables appear to be somewhat lower than those for the longer syllables. This difference is not, however, systematically related to the progressive reduction in overlap with increasing asynchrony.

The decrease in amount of overlap has clear effects binaurally. There is a significant interaction between length of syllable and asynchrony. Lead

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\*The effects observed are generally smaller than those obtained in previous studies. This is probably due to the higher performance levels occasioned by the higher probability of guessing the other member of the pair given that one member is correctly perceived ( $p = .5$ ). This is a consequence of there being only three tokens (as contrasted with six in previous studies). Subjects were aware of this fact and were told that the two syllables on any trial would be different.

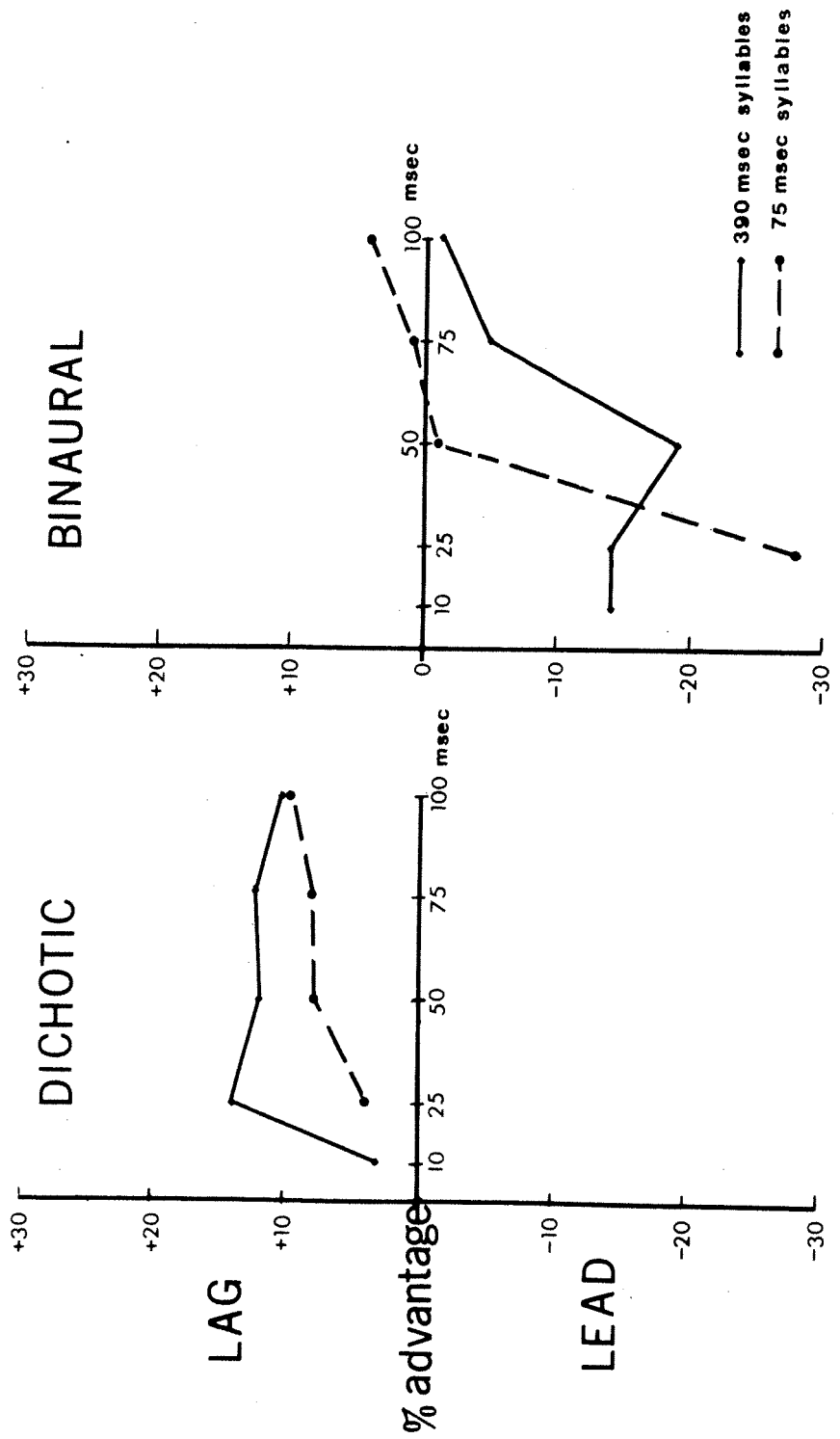


Fig. 2

advantages for the shorter syllables have essentially disappeared at asynchronies  $\leq 50$  msec ( $\leq 25$ -msec overlap), whereas the lead advantages for the longer syllables remain. A decrease in the amount of overlap would thus seem to reduce or eliminate the lead advantage seen binaurally, presumably because of the reduction in peripheral masking. These binaural results conform to subjects' postexperimental observations: with the longer overlapping syllables, only the leading one was heard clearly; with the shorter syllables, at 50, 75, and 100 msec asynchronies, both were heard. The results are perhaps not too surprising when we consider the fact that in rapid speech, consonantal information may often be temporally concatenated to nearly the degree that it is for these binaurally presented nonoverlapped short syllables.

The results do emphasize the interesting problem presented by the lag effect. Consider the short 75-msec syllables presented dichotically at 75- or 100-msec asynchrony. It is tempting to interpret the observed advantage for the lagging syllable in terms of a limited capacity of the central speech processor, that is, to suppose that the central processing initiated by the leading signal requires a certain amount of uninterrupted time in order to complete its necessary function. The untimely arrival of the lagging signal for some reason interrupts this processing, and as a consequence, information regarding the leading signal is lost. This account is not, of course, complete, since when the same temporal conditions are imposed binaurally, both syllables are processed with little difficulty. It is thus not simply the rapid temporal concatenation of information which overloads the central processor but rather the concatenation of information arriving over separate peripheral pathways. Work in progress is directed at determining why and in what way signal transmission over separate peripheral pathways places these unique constraints on central processing.

#### REFERENCE

Studdert-Kennedy, M., Shankweiler, D., and Schulman, Susan. (1970) Opposed effects of a delayed channel on perception of dichotically and monotically presented CV syllables. *J. Acoust. Soc. Amer.* 48, 599-602.