

Decision Processes in Speech Discrimination
as Revealed by Confidence Ratings

D. B. Pisoni and David L. Glanzman
Department of Psychology
Indiana University
Bloomington, Indiana 47401

Standard speech discrimination tests require the listener to make a decision about a given sequence of stimuli. For example, with the ABX test the listener is required to determine whether the third stimulus is most like the first or most like the second. This test along with several other forced-choice procedures has the excellent property that the E need not specify the dimension along which the stimuli differ, e.g., select the stimulus with the higher pitch. The typical measure of the listener's performance is the percentage of stimuli correctly discriminated. However, in recent attempts to examine the processes underlying the identification and discrimination of speech sounds, it has become apparent that the listener's task, i.e., providing just a single response, may not accurately reflect all the information that the listener may have available to him about the stimuli. For example, sometimes a listener may be quite certain that his response was correct whereas other times the listener may be very uncertain about his response. In this study we examined how listeners assign confidence ratings to discrimination judgments for a set of synthetic stop consonants. The confidence ratings obtained with both ABX and 4IAX discrimination procedures carry additional information about the stimulus properties of consonants and provide some insight into the decision processes employed in the discrimination of these speech sounds.

Decision Processes in Speech Discrimination
as Revealed by Confidence Ratings

D. B. Pisoni and David L. Glanzman

Indiana University

Bloomington, Indiana 47401

Recent work in speech perception has suggested that the perception of speech sounds may involve processes and mechanisms that are somehow different from those involved in the perception of other auditory stimuli (Liberman, Cooper, Shankweiler & Studdert-Kennedy, 1967; Stevens & House, 1972). Support for this conclusion has come from several areas of investigation including: dichotic listening, identification and discrimination experiments, and more recently, from the study of speech perception in infants. In all of these experiments listeners are asked to make a decision about a stimulus or sequence of stimuli. For example, subjects may be asked to identify stimuli into categories defined by the experimenter, or to determine whether two sounds are the "same" or "different."

Several of the current theoretical approaches to speech perception assume that decisions are made relatively late during perceptual processing and that low-level acoustic information is unavailable due to constraints placed on the organism (Eimas & Corbit, 1973; Eimas, Cooper, & Corbit, 1973).

Insert Figure 1 about here

Figure 1 shows two possible hypothetical models of the processes involved in speech und perception. Both models are identical except for where the decision component may operate. In Model 1 decisions occur relatively late in time. This model assumes that early stages of processing are obligatory and automatic, and thus not under the control of the listener. In contrast, Model 2 assumes that decisions are made at all stages of analysis. Low level acoustic information may be accessible to subjects, although this will depend on a variety of factors including: the task demands, state of the organism, and the particular criterion employed by the listener.

In the present study we examined how listeners assign confidence ratings to discrimination judgments for synthetic speech sounds. We were concerned with three basic questions. First, are the discrimination functions obtained with confidence ratings comparable to those functions obtained without confidence ratings? Second, can listeners in a speech discrimination task assign confidence ratings in a non-chance manner which is related to their observed discrimination performance? And third, do the confidence ratings provide some additional insight into the decision processes in speech sound perception?

To answer these questions we looked at discrimination functions under several experimental conditions for a set of synthetic stop consonant vowel syllables.

Method

The stimuli we used were a set of seven three-formant patterns appropriate for the initial bilabial stop series. They were produced

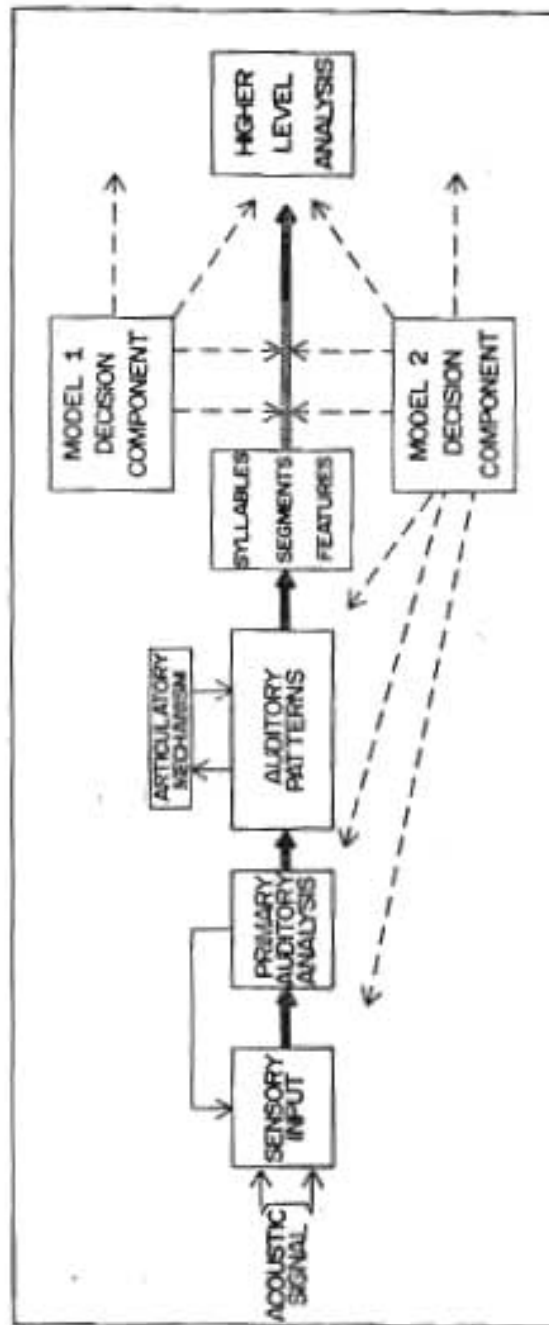


Figure 1. Outline of hypothetical model of speech perception process showing where decision component may operate.

on the parallel resonance synthesizer at Haskins Laboratories and were similar to those employed by Lisker and Abramson (1967). The seven stimuli varied in 10 msec steps along the voice onset time continuum from 0 msec VOT through + 60 msec VOT. The stimuli were recorded on magnetic tape to produce two types of discrimination tests, a standard ABX test and the 4IAX test of paired similarity (Pisoni, 1971; Pisoni & Lazarus, 1974).

Insert Figure 2 about here

The details of these two discrimination tests are shown in Figure 2. All possible pairs of stimuli one and two-steps apart along the continuum were arranged in either an ABX or 4IAX format. In the ABX test, subjects are required to determine whether the third stimulus is most like the first or most like the second. In the 4IAX test, the subject is required to determine which pair of stimuli was the same; the first or the second pair.

Eight subjects who were all undergraduate students at Indiana University were assigned to each of the two conditions of discrimination.

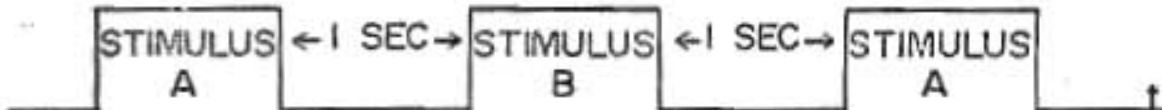
Insert Figure 3 about here

Figure 3 shows the confidence rating scale used in the discrimination tests. After making a discrimination judgment, subjects were required to rate how confident they were in their decision on a four point scale from (+++), positive my response is correct, to (-), my response represents no better than a chance guess.

Subjects were run for an hour a day on three days. Each session

DISCRIMINATION TESTS

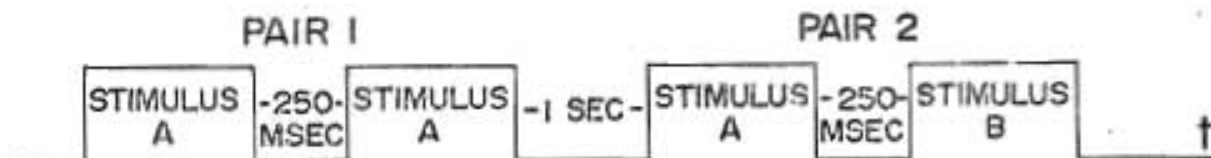
- 1) ABX TEST - PAIRS OF STIMULI ARRANGED IN TRIADS:
ABA, BAB, ABB, BAA



QUESTION: IS THE THIRD STIMULUS MOST LIKE THE
FIRST OR SECOND STIMULUS ?

RESPONSE: FIRST STIMULUS !

- 2) 4IAX TEST - TWO PAIRS OF STIMULI ARE PRESENTED
ON EACH TRIAL. ONE PAIR IS ALWAYS THE SAME AND ONE
PAIR IS ALWAYS DIFFERENT: A-A—A-B, A-B—A-A,
A-A—B-A, ETC.



QUESTION: WHICH PAIR WAS MOST SIMILAR - THE FIRST
PAIR OR THE SECOND PAIR ?

RESPONSE: FIRST PAIR !

Figure 2. Details of the two types of discrimination tests employed;
the ABX test and the 4IAX test of paired similarity.

CONFIDENCE RATING SCALE IN DISCRIMINATION

- +++ POSITIVE THAT MY RESPONSE IS CORRECT
- ++ FAIRLY CERTAIN THAT MY RESPONSE IS CORRECT
- + CAN'T DECIDE BUT THINK MY RESPONSE IS CORRECT
- RESPONSE REPRESENTS NO BETTER THAN CHANCE
GUESS

Figure 3. Confidence Rating scale used for discrimination judgments.

began with a standard identification test followed by a discrimination test.

Insert Figure 4 about here

Figure 4 shows the identification functions for the two groups of subjects.

Both groups divided the continuum into two discrete categories. It may be observed that we obtained the usual type of categorical partitioning of the continuum. The phonetic boundary is at about +30 msec VOT.

Insert Figure 5 about here

Figure 5 shows the percent correct discrimination functions for the ABX and the 4IAX tests ignoring for the moment any of the confidence rating data.

These discrimination functions are quite similar to those obtained under the usual conditions of discrimination without confidence ratings. There is a peak between phonetic categories and a trough within categories. Note that discrimination is better in the /ba/ range along the continuum than the /pa/ range, especially for the 4IAX data.

Based on only percent correct discrimination, then, our subjects show "categorical-like" discrimination of the voicing feature. But when we look at how our subjects' confidence ratings are related to observed discrimination performance, the story becomes more interesting.

Insert Figure 6 about here

CONSONANT IDENTIFICATION

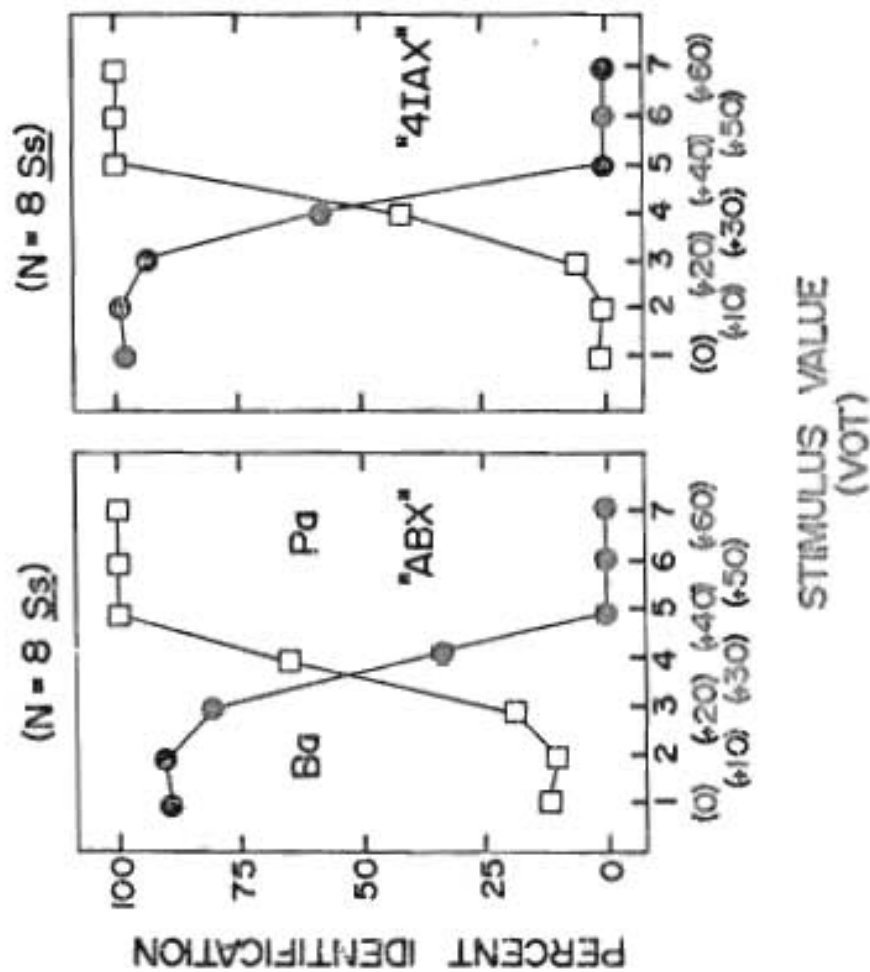


Figure 4. Average consonant identification functions for two groups of listeners.

CONSONANT DISCRIMINATION

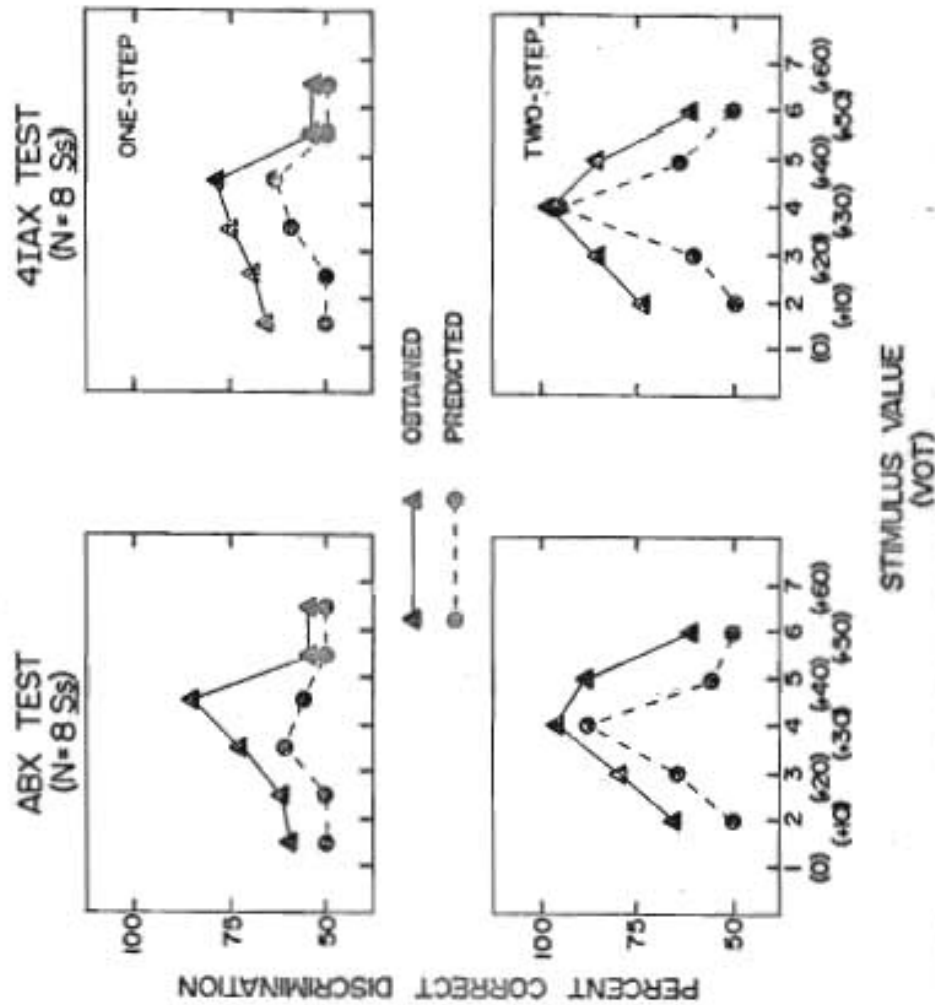


Figure 5. Average consonant discrimination functions for the ABX and 4IAX test conditions.