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ABSTRACT

Two studies investigating auditory information processing abilities of children are reported in this document. The first study analyzed the preferred specific acoustical dimension in an auditory discrimination task of preschool and sixth grade children from low and middle socioeconomic groups. Results indicated that children at both age levels do exhibit an auditory dimensional preference in a three-choice pure-tone discrimination task but that neither socioeconomic status nor age has a significant effect on dimensional preference. The second study investigated the relationship between pure-tone discrimination, as well as auditory dimensional preferences in discrimination, and linguistic discrimination across a narrow age range. Twenty-four preschool children, twelve four year olds and twelve five year olds, served as subjects. The results indicate that while auditory discrimination performance did not significantly improve with age, linguistic discrimination performance did. Together the results of these studies suggest that while auditory processing abilities do not differ between samples, linguistic discrimination performance may vary due to the increased number of structural units accessible to each memory component for the analysis-by-synthesis process. (Author/TO)

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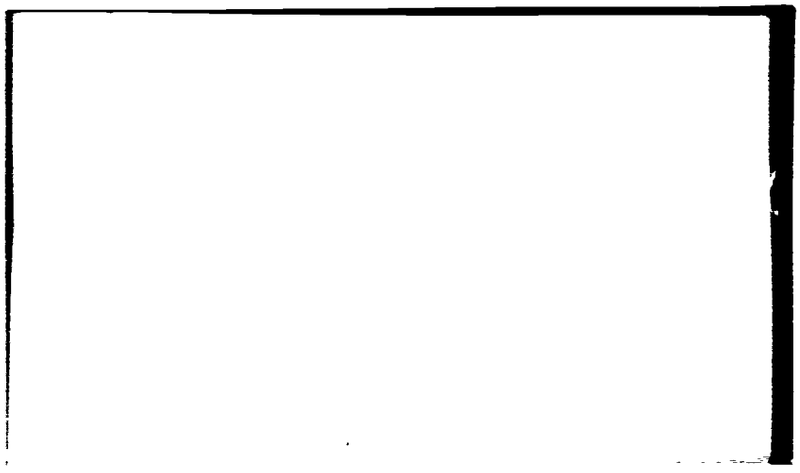

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Basic to most models of phonological development is the premise that the acquisition of phonemes progresses from easily discriminated phones to more difficult discriminations (e.g., Olmsted, 1966). Jakobson (1968) proposed that the acquisition of phonological rules follows a sequential and valid developmental course. In support of this proposition, Menyuk (1968) concluded that the production and recall of phonemes may be hierarchically arranged as a function of distinctive features. However, a basic assumption underlying most models of phonological development is that the acquisition of phonemes is dependent on the increasing ability of the child to discriminate speech sounds by the distinctive features of the language.

The few studies that have investigated children's linguistic processing and discrimination capacities have focused on performance differences as a function of socioeconomic status (SES) (Deutsch, 1964; Ryckman, 1967; Feltman, 1971). Even though SES differences have been demonstrated on some linguistic discrimination tasks, attempts at relating discrimination performance differences to other learning performance, such as reading, have been only moderately successful (Rohwer, 1970).

In other studies investigating auditory discrimination of pure-tones, the acoustical dimensions of intensity and frequency have produced differ-

ential learning rates. For middle-SES children frequency discriminations are more difficult to learn than intensity discriminations (McKee and Riley, 1962; Riley and McKee, 1963; Riley, McKee, and Hadley, 1964; Riley et al., 1967). Similarly, low-SES children are more influenced by the tonal qualities of verbal instructions and verbal reinforcement (Kashinsky and Wiener, 1969; Brooks et al., 1969).

Although these studies do not clearly demonstrate that fundamental frequency and intensity of a multi-dimensional linguistic signal directly affect the linguistic percept, they do suggest that basic components of the acoustic signal may influence auditory perception and processing. Therefore, the first part of this study addressed the possible significance of preferential attending to a specific acoustical dimension in an auditory discrimination task. Study I was based on the following hypotheses: (1) All subjects will demonstrate a consistent preference in determining the relevant acoustical dimension in an auditory discrimination task; (2) Low-SES children will tend to prefer the frequency dimension for discrimination; (3) The effect of SES on level of responding will be non-significant; (4) Dimensional preferences will be non-significantly affected by age differences, but older children will perform at significantly higher levels; (5) Younger children will respond incorrectly to conflict items requiring discrimination in the dimension opposite to their preferred dimension.

STUDY I

Method

Subjects

A total of 60 subjects (Ss), 40 preschool Ss and 20 sixth-grade Ss,

were used in the study. Twenty Ss, with a mean age of 5.5 years and an age range of 4.8 to 6.3 years, were randomly selected from a preschool in a middle-SES neighborhood. The low-SES sample, also 20 Ss with a mean age of 5.1 years and an age range of 4.9 to 5.7 years, were randomly selected from two Headstart classes. Five Ss, three Ss from the low-SES sample and two Ss from the middle-SES sample, did not complete the task, and their incomplete data were not included in the analyses.

A third sample of 20 Ss was randomly selected from a sixth-grade classroom. The age range in this sample was 11.4 to 12.3 years, with a mean age of 11.9 years.

None of the Ss were known to have any physiological hearing defects.

Stimulus Materials

The auditory dimensional preference task (ADPT) consisted of 32 three-choice pure-tone discrimination items. Twenty-four of the items involved variations in both frequency and intensity. Within an item each signal was essentially different, although two signals were of the same intensity and two signals were of the same frequency. The remaining eight items, known as conflict items, involved comparisons in a single dimension, and a correct response involved discrimination by that dimension. Four of the conflict items involved the frequency dimension, and four of the conflict items involved the intensity dimension.

Intensity values used in constructing the items were 53 dB, 65 dB, and 77 dB, and the frequency values were 500 Hz, 750 Hz, 1000 Hz, and 1500 Hz. Only adjacent values in each of the ranges were used in the construction of a particular item. The signals were produced by a Beltone audimeter (model 9D) and directly recorded on a Uher 4000 Report-L tape recorder.

Procedure and Dependent Variables

The ADPT was individually administered to each S with the Uher tape recorder equipped with Koss headphones (Model SP-3XC). The S was instructed to respond to each discrimination item by indicating which one of the three tones sounded different. The response measures obtained for each S were a frequency score, an intensity score, and an error score. The frequency and intensity scores were derived from the number of items on which each dimension was the preferred dimension used by the S for discrimination. An error score was obtained from the number of items on which neither intensity nor frequency was used as the relevant dimension for discrimination. On the basis of their performance Ss were grouped as frequency discriminators, intensity discriminators or as showing no consistent preference. Criteria for forming the three groups according to their preferred dimension for discrimination were as follows:

1. Frequency discriminators: a frequency score of above eight (chance level), and an intensity score at or below eight;
2. Intensity discriminators: a frequency score of eight or below, and an intensity score above eight;
3. No preference group: all other Ss completing the task.

Separate analyses of variance were performed on each of the three dependent measures, the frequency scores, the intensity scores, and the error scores.

Performance on the conflict items was summed for each of the two types of discrimination and constituted two additional dependent measures for each S.

Results

For the preschool groups, an analysis of variance for SES (2 levels) by preferred dimension for discrimination (3 levels) yielded a significant dimensional preference effect with both intensity ($F_{1,29} = 23.14$, $p < .001$) and frequency scores ($F_{1,29} = 34.32$, $p < .001$), but a non-significant effect with error scores. SES proved to be a non-significant effect with intensity and error scores. The significant effect of SES on frequency scores ($F_{1,29} = 18.06$, $p < .001$) was attributed to the significantly lower frequency scores for low-SES intensity discriminators by means of a Newman-Keuls Test. To determine the effect of SES on dimensional preferences, a chi-square test was performed on the obtained cell frequencies. The chi-square value obtained was non-significant at the .001 level.

To test the significance of age and dimensional preference on discrimination performance, the data from the preschool groups were combined and compared to the sixth-grade data. In the analyses of age by preferred dimension, a significant age effect was found with the frequency scores ($F_{1,49} = 16.33$, $p < .001$) and the error scores ($F_{1,49} = 33.14$, $p < .001$). However, intensity scores did not differ significantly as a function of age. Preferred dimension for discrimination was found to have a significant effect on frequency scores ($F_{2,49} = 54.69$, $p < .001$) and the intensity scores ($F_{2,49} = 68.99$, $p < .001$), but a non-significant effect on error scores. The effect of age on dimensional preference proved to be non-significant at the .001 level with a chi-square test on the obtained cell frequencies.

The analyses of variance on the conflict scores yielded non-significant effects for each of the factors of age, SES, and dimensional preference.

Discussion

Interpretations of the evidence showing SES differences have suggested that the low-SES child is deficient in auditory information processing abilities. However, the evidence from Study I suggests that low- and middle-SES children perform at similar levels in a non-linguistic information processing task. A possible explanation for the apparent discrepancy between the results of Study I and previous evidence is that nonlinguistic and linguistic processing may involve separate mediational factors.

The research in adult speech perception provides a basis for hypothesizing the development of mediational factors in the course of phonological acquisition. Several studies with adults have demonstrated the categorical nature of speech perception in stop consonant discrimination tasks (Liberman et al., 1957; Liberman et al., 1961; Pisoni, 1971). However, the continuous perception of steady-state vowels has posed some problems for theorizing about processes involved in speech perception. A model of short-term memory which accounts for differential discrimination of steady state vowels and stop consonants was proposed by Fujisaki and Kawashima (1969). According to the Fujisaki and Kawashima model, linguistic or phonetic information is processe in a phonetic component of short-term memory, and non-linguistic information is processed in an auditory component of short-term memory.

Although the auditory-phonetic memory model was developed to explain adult speech perception, the model may prove heuristically valuable in a developmental analysis of non-linguistic and linguistic discrimination. That is, auditory short-term memory may develop very early in life, as findings by Eimas et al. (1971) might suggest; whereas, phonetic short-term memory might require extensive experience with the environment due to the complexity of linguistic information storage. Even though the auditory and phonetic memory components may function separately, the evidence from studies with adults suggests that inter-related functioning may take place in some situations (Day and Wood, 1972). The degree of inter-relatedness may be quite high in the developing child in that similar mediation processes may be associated with each memory component.

Concerning mediational processes in auditory perception, the analysis-by-synthesis position (Neisser, 1967) suggests that auditory information processing is dependent on accessible structural units for analyzing and synthesizing a match to incoming information. While the structural units needed for synthesizing a match to pure-tones are basically variations in intensity, frequency, and duration, the structural units for internal linguistic synthesis are numerous and are not isomorphic with the acoustic signal (Liberman et al., 1961; Denes and Pinson, 1963). Therefore, if structural units for linguistic analysis require extensive experience for their acquisition, periods of rapid improvement in linguistic processing will not be accompanied by similar improvements in auditory processing.

A major position in this interpretation of auditory processing is that linguistic and non-linguistic information is processed in a similar way. However, different memory components, which are functionally depen-

dent on accessible structural units for internal synthesis, may be involved in linguistic and non-linguistic processing. Therefore, the second study investigated the relationship between pure-tone discrimination, as well as auditory dimensional preferences in discrimination, and linguistic discrimination across a narrow age range. Specifically the hypotheses of Study II were as follows: (1) Age will not have a significant effect on pure-tone discrimination performance; (2) Age will have a significant effect on word discrimination performance with the older group giving more correct responses; (3) A greater relationship between word discrimination and pure-tone discrimination is predicted for the younger group than for the older group.

STUDY II

Method

Subjects

Twenty-four preschool children served as Ss in the study. The age range for the twelve Ss in the four-year-old group was 3.9 to 4.3 years with a mean age of 4.1 years. The age range for the twelve Ss in the five-year-old group was 5.1 to 5.9 years with a mean age of 5.3 years. Equal numbers of boys and girls were used. Ss were randomly selected from a total population of 75 children enrolled in a preschool in a middle-SES neighborhood.

Stimulus Materials

In order to balance the effect of ABA comparisons being more difficult than ABB comparisons, two versions of the ADPT were constructed. The same signals and task items as used in Study I were used in the con-

struction of the two versions with signal position within each items being balanced. In addition, the conflict items were omitted since they yielded no significant differences in Study I. This resulted in a total of 24 items for the ADPT.

In addition to the ADPT, the Wepman Auditory Discrimination Test (WADT) (Wepman, 1958) was used in this study. Form I of the WADT was recorded on a Roberts stereo tape recorder in two versions which were balanced for ABB and ABA comparisons. Only different-word pairs were included in the task, which gave a total of 30 word pairs. Each word pair differed in one distinctive feature.

Procedures and Dependent Variables

The ADPT was administered individually following the same procedures as given in Study I.

The WADT was presented according to a procedure suggested by Rudegeair and Kamil (1969). With this modification, two different words are presented over a stereo tape recorder with external speakers. The first word was presented over the speaker to the left of the S, and the second word was presented over the speaker to the right of the S. Then the question, "Who said X?" was presented over both speakers. Ss were asked to point to the speaker that said the X word.

Four dependent measures were derived from performance on the ADPT: an intensity score, a frequency score, an error score, and a total attending score. The total attending score was obtained by summing the intensity and frequency scores for each S. The dimensional preference groups were formed by the following criteria:

1. Frequency discriminators: a frequency score above eight, and an error score below eight;
2. Intensity discriminators: intensity score above eight, and an error score below eight;
3. Neither above: intensity or frequency score above eight, and an error score above eight;
4. Neither below: intensity and frequency scores above eight, and an error score below eight.

The total number of correct responses given on the WADT was used as the fifth dependent measure for each S.

Results

An analysis of variance for age (2 levels) x dimensional preference (4 levels) was performed on each of the dependent variables. The results of these analyses yielded a significant effect for age on the WADT scores only ($F_{1,16} = 7.86$, $p < .02$). Dimensional preference in attending was a significant effect on frequency scores ($F_{3,16} = 5.49$, $p < .02$), intensity scores ($F_{3,16} = 5.84$, $p < .02$), error scores ($F_{3,16} = 5.02$, $p < .02$) and total attending scores ($F_{3,16} = 9.32$, $p < .02$). However, dimensional preference was a non-significant effect on WADT scores.

Correlational analyses were used to determine the relationship between total attending scores on the pure-tone discrimination and scores on the word discrimination task. The Pearson r obtained for the four-year-old group was .59 ($p < .05$) and the r for the five-year-old group was .26.

Discussion

The results of Study I support the hypothesis that children at both the preschool and sixth-grade levels do exhibit an auditory dimensional preference in a three-choice pure-tone discrimination task. In general, SES does not appear to be a factor affecting level of responding in the preschool child. However, the data fail to support the hypothesized SES effect on dimensional preference. Age appears to be a significant factor affecting level of responding for frequency discriminators as evidenced by the significantly higher frequency scores for the sixth-grade sample. The reason for the non-significant effect of age on level of responding for intensity discriminators remains for further study. As hypothesized, age was non-significant in affecting dimensional preference. The non-significant differences in performance on conflict items for different preference groups suggests that the most important factor in auditory processing might be acquiring a processing strategy for the task. Additional support for this conclusion may be drawn from the significantly better total performance of dimensional preferrers as compared to nonpreferrers found in Study II.

The results of Study II with Ss within a narrow age range indicate that while auditory discrimination performance did not significantly improve, linguistic discrimination performance did significantly improve. Although dimensional preference did not significantly affect linguistic discrimination performance, dimensional preferrers did score significantly higher frequency, intensity, and total attending scores.

If similar mediational processes are involved in linguistic and nonlinguistic processing, as was proposed earlier, the results of Study I

suggest that low- and middle-SES children do not differ significantly in auditory processing abilities (i.e., ability to analyze and internally synthesize auditory information). In addition, the results of Study II support the explanation offered by the auditory-phonetic memory model for differences in linguistic and non-linguistic discrimination performance. Together the results of these studies suggest that while auditory processing abilities do not differ between samples, linguistic discrimination performance may vary due to the increased number of structural units accessible to each memory component for the analysis-by-synthesis process.

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