

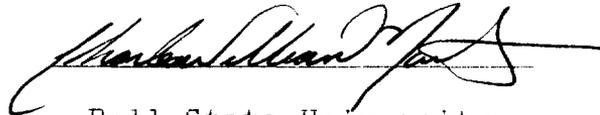
Perceptual Analysis Using a Triadic Similarity Listening Task

An Honors Thesis (ID 499)

by

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INTRODUCTION

It has become commonplace to administer speech sound discrimination tests to children exhibiting developmental sound substitutions in order to identify possible perceptual deficiencies underlying production difficulties (Locke, 1980). Research for the past several years, however, has questioned correlation between perceptual abilities as measured by speech sound discrimination tests and production abilities (Broen, et. al, 1983). Textbooks written for use in undergraduate courses in articulation and phonological disorders discuss the fact that auditory discrimination testing has been given a place in assessment procedures even though empirical data supporting the relationship between articulation and sound discrimination are conflicting (Newman, Creaghead, & Secord, 1985; Weiss, Gordon, & Lillywhite, 1987). Newman, Et. al. discuss the fact that studies have suggested that auditory discrimination abilities follow a developmental progression that current tests do not account for. Both Newman, Et. al. and Weiss, Et. al. have suggested that tests measuring internal discrimination would be more useful than some of the more commonly used tests. However, these textbooks provide no solution to the problem of accurately assessing auditory discrimination and still recommend some assessment of auditory discrimination and its use in therapy.

The following study attempts to develop a method of

assessing speech sound discrimination abilities in children that will provide useful information for therapy. Before the study can be presented, it is necessary to discuss the major theories of speech perception and the relationship between speech perception and production. In addition, an examination of the current means of assessing speech sound discrimination further illustrates the need for a more representative method. Finally, a rationale is presented for the use of a method of perceptual mapping that will present a true picture of a child's internal perceptual system.

Theories of speech perception

Opinions about the nature of speech perception have differed. Infant studies have indicated that infants as young as one month of age are able to discriminate sounds which differ by a single contrast such as voicing: ba/pa or place: ba/ga (Eimas, et al., 1971). Eimas, et al. interpret this fact as an indication that infants can process speech sounds in a linguistically relevant manner and possess "feature detectors", activated by linguistic input, which extract phonetic features from auditory patterns. According to Butterfield and Cains (1974), the most extreme interpretation of Eimas' work is that the ability to perceive phonetic stimuli is nearly completely attained in infancy. However, others have argued that this perception is not linguistically relevant as Eimas claimed. Instead, it involves a simple discrimination of sounds out of

linguistic context.

Some authors have argued that perception is facilitated by production. The motor theory of speech perception (Lieberman, et. al., 1967) exemplifies this view. The major tenet of motor theory is that speech perception is based on rules of motor production. This theory is in direct contrast with the views of Menyuk and Anderson (1969) who believe that children base productions on perceptual categories. A less extreme version of motor theory has been proposed by Schvacken (Ingram, 1976). This theory suggests that speech production can facilitate perception and cites as proof the fact that children who have mastered the production of sounds can discriminate them more quickly than children who have not mastered them. Bloom (1976), on the other hand, suggests that perception and production are two mutually dependent, but different, processes which interact as language develops.

Based on The Feature Phoneme Interaction Theory, which states that phonemes possess interrelated elements called distinctive features used in the process of phonological acquisition, Blache (1978) stated that, "While a child is producing, he/she is constantly monitoring his/her own acoustic product in comparison to the perceived cultural norm" (p.107). The "perceived cultural norm" that Blache refers to is an internal representation of sounds that may be different in each child. It is this internal representation of sounds that needs

to be represented in order to gain a clear picture of the perceptual system of a young child.

Relationship between perception and production

Before any study of speech perception can be performed, it is first necessary to establish a link between speech production and perception. This, too, has been an area of much controversy for researchers. In a study by Eilers and Oller (1975), responses on a combination production/perception experiment performed using subjects between the ages of 1:10 and 2:2, were recorded using four categories in which "+" indicated the presence of and "-" indicated the absence of. The categories were: +perception/+production, +perception/-production, -perception/-production, and -perception/+production. Much to their surprise, some responses fell into the -perception/+production category. One possible explanation for this data is that there may be occasions when production develops before perception (Edwards, 1974). Eilers and Oller suggest that a response in this category may occur as a result of a "cognitive load imposed by the discrimination task - a load which accrues only when the child is not particularly focused on a discrimination he is capable of making auditorally as evidenced by his imitative productions." Conclusions drawn as a result of this study were that while some childhood speech errors result from perceptual difficulties, there are errors for which no relationship between perception and

production can be inferred.

Winintz, et. al (1981) used the same four categories for perception/production were used in a Winitz, et.al. study (1981) which further explored the link between perception and production. They suggested that responses which fell into either the -perception/-production or the +perception/+production categories indicated that perception precedes production. Further, results of their study provided little support for existence of the -perception/+production category suggesting that responses in this category may occur simply by chance. From this study, Winitz, et al., in agreement with other investigators (Fraser, et al., 1963; Ingram 1974; Eilers and Oller, 1976), concluded that perception does indeed precede production and that, as a result, production tasks do not fully demonstrate underlying linguistic knowledge.

In a 1983 study by Broen, et al., performances of two groups of 3 year old children on both perception and production tasks for /l/, /r/, and /w/ were compared. The first group was selected on the basis that the children had normally developing articulation skills while the second group was chosen on the basis of demonstrating delays in articulatory development. Results of the production task indicated that the majority of the children in both groups misarticulated /l/ and /r/. Children in the normally developing group scored well above chance on perception task testing involving sounds they

misproduced. This was not true of the children in the articulation delayed group. There was a much greater range of performance in this group with the range including two children with no errors on the perception task and one child who performed at chance level on all contrasts. Overall, performance of this group was considerably poorer than the normally developing group. Broen et al. suggest that these findings would indicate that the relationship between development of perception and production is not necessarily a symmetrical one. Although some articulation errors may be directly linked to corresponding perceptual ones, others may not be linked. Likewise, attainments of correct perception may be a requirement for normal articulatory development, but misarticulations cannot always be blamed on poor perceptual abilities.

Assessment of speech perception

In order to assess speech perception, we typically use some sort of speech sound discrimination test (Locke, 1980). These tests, according to Locke, may be placed in two major categories: Type I and Type II tests.

The Type I test allows for a comparison of the adult surface form and the child's internal representation, and this is considered to be a necessary quality of a good speech sound discrimination test (Locke, 1980). Typically, Type I tests consist of pictures or objects, whose names are represented in

the child's receptive vocabulary, and a word presented by tape or live voice. The child must compare a sound heard with an internally represented category of sounds and decide whether or not a match has been made. The picture identification test fits into the Type I category. A problem that has been identified with the picture identification test is that it is not possible to know which sounds have been discriminated since the child may discontinue the search once an acceptable match has been made. An additional problem is that some contrasts are very difficult to represent pictorially.

Type II tests require a child to compare two adult forms. Generally, a child is asked to make a same-different judgment based on two or more syllables heard in close succession. There are three major problems with the Type II tests. First, on a same/different task in which two syllables are presented at a time, a child could conceivably answer "same" to all items. A tester, however, would not know whether this was a result of the child's inability to correctly discriminate all of the contrasts or a result of the child's inability to attend to the task or understand the instructions. Finally, Type II tests are criticized for the fact that they do not allow for a comparison of a child's internal representation with the adult form and that they do not allow for a determination of directionality of the perceptual error. These are two of the eight qualities that Locke outlines for a good test of speech sound discrimination.

A study was conducted to examine the validity among tests of speech sound discrimination which included comparisons of the results of the Wepman and Goldman-Fristoe-Woodcock (Type II test and Type I test), the Wepman and the Boston (Type II test and Type I test), and the Boston and the Goldman-Fristoe-Woodcock (both Type II tests) (Bountress, 1984). The experiment yielded very low correlations indicating that the tests may not be measuring what they claim to be measuring and that they may not be measuring speech sound discrimination in the best possible ways (Bountress, 1984).

Alternatives to these standardized tests have been suggested by Hanson (1961) and by Blache (1978). Hanson performed a simple experiment in which vowel sequences were presented to twelve year old children, three vowels at a time. The children were asked to record which of the last two vowels was more similar to the first one in the sequence. Hanson then estimated the perceptual distance between each vowel pair based on the number of times vowels had been classed together by subjects. The vowels were then arranged in a three-dimensional diagram in which similar vowels were placed closer to each other than less similar ones. Hanson claims that the diagram agrees with articulatory and acoustic vowel triangles. However, according to Kalgren, this experiment was performed in a very crude manner (Malmberg, 1968). In the 1970's similar experiments involving adults were carried out. These experiments involved having college students estimate

the similarity between two- and three-element sound series (Blache, 1978). The use of a city-block model in which multi-dimensional structures can be geometrically mapped was suggested as a way of externally representing these internal maps (Blache, 1978).

Based on the Hanson (1961) and Blache (1978) studies, a modified version of the triadic similarity task and a subsequent frequency of response analysis have been selected as means of eliciting and representing the perceptual system of young children in the following experiment.

METHODS

Subjects

The subjects were 19 children ranging in age from 4-1 to 7-1 with a mean age of 5-4. The children were enrolled at a daycare facility in Indianapolis, Indiana. They ranged in grade level from preschool to 1st grade. There were 7 female subjects (mean age, 5-3) and 12 male subjects (mean age, 5-4.) All subjects were given pure-tone hearing screenings prior to being included in the study. The screening included 500Hz, 1000Hz, 2000Hz, and 4000Hz tones presented at 20dB. According to teachers' reports, none of the children had any documented speech, language, or learning disabilities.

Stimuli

The stimulus items consisted of the 24 possible triadic combinations of /l/, /r/, /w/, and /j/. Each triad was assigned

a random number, and the triads were placed in numerical order for presentation in order to assure randomness.

The individual triads were recorded in a sound-treated room. Initially, the items were recorded through a Hydrometals Cardioid Microphone into a portable Marantz tape recorder. A slight delay was placed in between each triad. This tape was then played using an Akai CS-702D stereo cassette deck and run through a Beltone 2000 Clinical Audiometer. The first element of each triad was recorded using channels A and B of the audiometer, the second element using channel A alone, and the third using channel B alone. These switches were recorded onto another tape using the Marantz portable tape recorder. As a result, when played using a stereo tape deck, the first element of the triad played through both speakers, the second through the left speaker, and the third through the right speaker.

Conditioning

In order to condition the subjects to the triadic similarity task, two forms of conditioning were used, visual and auditory. The visual conditioning consisted of 3 items. The first sequence presented consisted of a white square placed in the middle, a white triangle placed on the left, and a white square on the right. The subjects were told to, "Point to the one that looks like the one in the middle." The next set consisted of a red triangle in the center, a red triangle on the left, and a white square on the right. The same instructions were given. The

final visual sequence consisted of a red triangle in the center, a red square on the left, and a white triangle on the right. Once again, the same instructions were given. In this case, either answer was considered correct since either one could be justified. If a subject successfully completed each of the trials, then the second training sequence was presented. This was a sequence of 3 auditory tasks using sound effects. The subject were instructed to listen to three sounds. They were told that the first sound would, "come from the middle." They were told to point to the sound (on the right or left) that sounded like the first one. For each of these triads, one of the sound effects corresponded exactly to the first one heard. If a subject successfully responded to each of the training stimuli, the triadic similarity listening task was initiated.

Procedure

For the purpose of the triadic similarity listening task, a Sony portable tape recorder with detachable speakers was used. The two speakers were placed 1 yard apart in order to clearly create the left, right, middle distinctions. The subjects were instructed to, "Listen to the three sounds and point to the one that sounds the most like the first one." Subjects were reinforced for listening carefully and responding immediately.

Results

Due to the fact that this was a relatively small sample, a qualitative analysis of the results was employed. Table I

(Appendix A) provides qualitative evidence of Blache's model for the semi-vowel system (Newman, et al., 1985) (Appendix B). If one examines pair 5, it can be seen that /ra/ is chosen over /ja/ to replace /wa/ 100% of the time. In the corresponding pair 6, it can be seen that, again, /ra/ is chosen with much more frequency than is /ja/. Once again, if one examines pair 7, it can be seen that /wa/ is chosen over /la/ to replace /ra/ 78% of the time. In the corresponding pair 8, /wa/ is chosen over /la/ to replace /ra/ 73% of the time. Finally, in pair 17, /ra/ is chosen over /wa/ to replace /la/ 52% of the time while in pair 18, /ra/ is chosen over /wa/ to replace /la/ 47% of the time. This would indicate that, for children in this age group, the perceptual distance between these sounds is small with a great degree of free variation. These examples provide qualitative evidence in support of this method of assessing the perceptual systems of children.

Discussion

The results of this experiment indicate that the triadic similarity listening task was a successful means of assessing the speech perception of young children. Children were not forced to make same or different judgments which require nothing more than simple discriminations between sound pairs since this is not what actually occurs in the process of perception (Morse, 1974). What is believed to occur is actually a much more complicated process of comparing auditory input to an internal representation of

sounds and making a suitable match or creating a new category if a suitable match cannot be made (Blache, 1978). The triadic similarity task simulated this process by presenting the child with the opportunity to hear sounds and to compare them to similar sounds in order to identify suitable matches. The fact that this experimental procedure simulated the natural process of speech perception would explain its success.

This procedure which has been used with adults (Blache, 1978) had not been attempted with very young children, but this is the group for which this information is the most useful since the sound system is still emerging. The addition of a training sequence, simplified directions, and a pointing response facilitated the use of this procedure with young children. The training sequence allowed the children to gain a complete understanding of the nature of the task and the importance of immediate responding. The use of simple directions, "Point to the sound that is like the first one," eliminated the problem of a possible misunderstanding of terminology such as same and different for which other methods have been criticized (Locke, 1980). Finally, the use of a pointing response eliminated any intervening variables such as pictures which may be unfamiliar to the child or verbal responses requiring additional processing (Locke, 1980).

It was stated in the introduction that the goal of this study was to develop a method of assessing the perceptual

abilities of young children that would provide useful information for therapy. The successful use of the triadic similarity listening task as demonstrated in this study has definite implications for therapy. In the area of assessment, the results of this study would indicate that the use of the triadic similarity task could provide valuable information about the perceptual system of a child since it identifies the dimensions an individual uses in making decisions about phonemes. In the area of treatment, the use of the triadic similarity listening task with a successive frequency of response analysis (Appendix A) would provide valuable data for clinicians. The data could be used to determine the need for enrollment into speech therapy and to help identify appropriate therapy goals. For instance, if a child's frequency of response analysis deviates considerably from those of other children in the same age group, perceptual training may be necessary in order to facilitate reorganization of the deviant perceptual system. However, if a child's frequency response analysis is similar to those of other children in the same age group, perceptual training would be contraindicated since it would appear that perception is developing in a normal manner.

With further experimentation and standardization using different sound classes and larger groups of children, and a mapping of the perceptual distance of phonemes as proposed by Blache (1978), the triadic similarity task could become a widely

used clinical tool. Standardized frequency of response charts and perceptual maps could be developed in order to externally graph the internal perceptual systems of normally developing children. These charts could be used for comparison in order to make decisions about the need for perceptual training and the selection of appropriate therapy goals. This method of identifying the dimensions used by a child when making decisions about phonemes would provide more useful information than currently used unidimensional methods of assessing perception which simply assess the perceived similarity or difference between pairs of sounds.

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production of the /-ez/ plural allomorph. Journal of Psycholinguistic Research, 10, 259-271.

APPENDIX A

TABLE 1
FREQUENCY OF RESPONSE

	A	B
1. wa-ra-la	.737	.263
2. wa-la-ra	.579	.421
3. wa-ja-la	.316	.684
4. wa-la-ja	.526	.474
5. wa-ra-ja	.100	0
6. wa-ja-ra	.263	.737
7. ra-wa-la	.789	.211
8. ra-la-wa	.263	.737
9. ra-ja-wa	.737	.263
10. ra-wa-ja	.421	.579
11. ra-ja-la	.474	.526
12. ra-la-ja	.632	.368
13. la-ja-ra	.421	.579
14. la-ra-ja	.526	.474
15. la-ja-wa	.368	.632
16. la-wa-ja	.526	.474
17. la-ra-wa	.526	.474
18. la-wa-ra	.526	.474
19. ja-wa-la	.474	.526
20. ja-la-wa	.316	.684
21. ja-wa-ra	.263	.737
22. ja-ra-wa	.632	.368
23. ja-la-ra	.158	.842
24. ja-ra-la	.684	.316

Appendix B

