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Auditory Discrimination and Phonetic Contexts in School Age Children

Mary Anne Hanner
Eastern Illinois University

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AUDITORY DISCRIMINATION AND PHONETIC CONTEXTS IN SCHOOL AGE CHILDREN

(TITLE)

BY

MARY ANNE HANNER

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I HEREBY RECOMMEND THIS THESIS BE ACCEPTED AS FULFILLING
THIS PART OF THE GRADUATE DEGREE CITED ABOVE

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DEDICATION

This thesis was completed through the continued support and encouragement of my husband, Dale, and my parents, Mr. and Mrs. Thomas Nolan. It is, in part, dedicated to them.

Mrs. Sandi Houston, a colleague and a friend, has provided me with the motivation to continue to work as a speech pathologist in the public schools since I began my career under her supervision. Because of her enthusiasm for her work and the excellent example she provided for me, this thesis is also dedicated to her.

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CHAPTER I

INTRODUCTION

Differential diagnosis of articulation defective children often reveals that there is more than a production or output deficit. The child may also have difficulty decoding the information he receives through the auditory or input channels. This problem may be manifested by difficulties in auditory discrimination of speech sounds. In 1931, Rasmus and Travis reported that speech defectives of every age level made more errors than normals on an auditory discrimination task. Aungst and Frick (1964) state that children who perform poorly on auditory discrimination tests are more likely to have articulation errors. However, Winitz and Bellerose (1967) found that in 11 of 15 studies done between 1931 and 1943 concerning differences between articulation and auditory discrimination, researchers found that as articulation errors increased, discrimination errors decreased. But these authors state that there should be a positive rather than a negative correlation if poor articulation is due to poor auditory cues. Locke (1970) reported that children did not misarticulate the same phonemic contexts that they misperceived. The research which considers the relationship between auditory discrimination and articulation abilities is inconclusive. Therefore, if a relationship exists between the perception of speech sounds and the production of speech sounds, this relationship should be verified through research.

Perhaps the research concerning the relationship between auditory discrimination and articulation ability is inconclusive because the instruments used to measure these parameters of behavior do not adequately evaluate the child's abilities because the test items are not relevant to the child's phonological or auditory experiences. Through the analysis of the Thorndike-Lorge word lists, Griffith and Miner (1973) have shown phonetic contexts rank order themselves according to their frequency of occurrence in the English language. In the same study, they found that nine of the commonly used articulation tests did not test the phonetic contexts which occur most frequently in the language. Therefore, the articulation tests are not testing phonemes in the contexts in which the child most frequently uses them. It is possible that these tests are not as relevant to the child's phonological experiences as they could be.

It is logical to assume that words which are spoken most frequently are those which are heard most frequently by the listener. Therefore, it would be assumed that the same rank order of phonetic contexts would exist for the input channel of communication as well as for the output channel or production. If one were to test auditory discrimination abilities, the most frequently perceived phonetic contexts would be of most importance in testing.

None of the authors of the most commonly used auditory discrimination tests have selected test items according to the frequency of occurrence of phonetic contexts. Words used as discrimination items for the Goldman-Fristoe-Woodcock Test of Auditory Discrimination were chosen from an undefined recognition vocabulary for children and according to ease of depiction in line drawings for the test pictures (Goldman, Fristoe, Woodcock, 1971). The items used in the Templin Picture Sound Discrimination Test were chosen on the criteria of similarity and difference of words and familiarity of the words to the subject. The basis of familiarity is not defined by the author (Templin, 1957). The items for the Templin Sound Discrimination Test are the 70 most discriminating items found after a pilot study involving 200 nonsense discrimination items (Templin, 1957). The items for the Test of Listening Accuracy in Children by Mecham and Jex were selected from the first 2000 words of the Thorndike-Lorge word lists (Mecham, 1971). The criterion by which the stimulus items were chosen from these word lists was not specified. For many years the Auditory Discrimination Test by Joseph Wepman has been used frequently by speech pathologists, psychologists and teachers to determine a child's auditory discrimination abilities. The items for this test were selected on the basis of familiarity from the Thorndike-Lorge word lists. The words chosen have membership in the same phonetic category and are of the

same length (Buros, 6th ed.). Pronovost revised the auditory discrimination test used by Mansur in a previous study to construct the Boston University Speech Sound Discrimination Test (Pronovost and Dumbleton, 1953). It is apparent that, although these tests may contain some of the most frequently occurring phonetic contexts, the test items were not chosen on that particular criterion. Further study of the actual phonetic contexts used in these tests is needed.

If relationships between articulation ability and auditory discrimination ability are to be determined, the tests used should be similar in structure and should use test stimuli with which the child has had experience. Recently, in a study by Schneider (1973), a deep test of articulation was developed which used test items selected according to frequency of occurrence of phonetic contexts. If an auditory discrimination test was developed which used phonetic contexts according to their frequency of occurrence in the English language, perhaps more conclusive comparisons between articulatory abilities and auditory discrimination abilities could be made.

One criticism of the presently used auditory discrimination tests is that these evaluations test discrimination of phonemes which the child does not misarticulate (Woolf and Rochelle, 1971). Therefore, administration of such a test does not provide implications for relevant therapy. But if deep tests of auditory discrimination and articulation were constructed using the same criteria, more accurate

correlations might be made and more implications for therapy might be derived.

Aside from the Goldman-Fristoe-Woodcock Test of Auditory Discrimination developed in 1970 and the Test of Listening Accuracy (revised in 1969), none of the other previously mentioned tests of auditory discrimination are recent in their development. It was felt that a deep test of auditory discrimination would provide a new realm to the present means of testing.

It was the purpose of this study to construct a deep test of auditory discrimination for the /r/ and /s/ phonemes. The test items were selected on the basis of frequency of occurrence of phonetic contexts in the English language. This test and a similarly constructed deep test of articulation for /r/ and /s/ were administered to public school children who have functional articulation disorders involving these phonemes.

These relevant questions were asked initially in this study:

1. Do presently used tests of auditory discrimination evaluate speech sound discriminations in phonetic contexts proportionate to their use in the English language?
2. If articulation defective children are given a deep test of articulation and a deep test of auditory discrimination for /r/ and /s/ (development of both tests being based on phonetic contexts in proportion to their occurrence in the

English language), do statistically significant relationships exist between their performances on these two tests?

3. Do correctly discriminated phonetic contexts rank order themselves similarly to their frequency of occurrence in the English language?

4. Does a statistically significant relationship exist between the articulation abilities and the auditory discrimination abilities on these tests?

CHAPTER II

REVIEW OF THE LITERATURE

Griffith and Miner (1973) applied research by George Zipf to articulatory ability and phonetic contexts. Zipf formulated what is appropriately called Zipf's Law of Abbreviation. This law states that the length of a word tends to bear an inverse relationship to its frequency (Zipf, 1935, p. 31). More simply stated, people tend to use shorter words more often than longer words. Griffith and Miner (1973) predicted that the phonetic contexts could also be applied to this law. Their research revealed that phonetic contexts were rank ordered according to their frequency of occurrence in the English language. For speech clinicians, this indicates that articulation therapy can be more efficiently planned and executed by using drill material which includes the most frequent phonetic contexts for the target phoneme. Moreover, they found that presently used articulation tests lack concurrent validity since they do not test phonetic contexts which the child uses most often. As a result of this discovery, the Griffith-Miner Test of Articulation Ability was developed to test /r/ in the most frequently occurring phonetic contexts.

As mentioned earlier, a study concerning phonetic context was done by Schneider (1973). She studied the relationships between phonetic contexts and articulation ability. The

results of her study indicate that phonetic contexts in a child's language are rank ordered according to ease of production rather than frequency of occurrence in the English language. Ease of production for the child was determined by position in the word (initial or final) and syllabic stress (accented or unaccented). This study also provides the speech pathologist with invaluable therapy implications. These are the only major studies which have been completed concerning phonetic context and frequency of occurrence in the English language. None of the previous research investigated phonetic contexts and their relationship with auditory discrimination.

The research concerning auditory discrimination and articulatory abilities is rather inconclusive. Woolf and Pilberg (1971) stated that the goal of articulation therapy is to develop sensory feedback through auditory discrimination. But they continued saying, "The relationship between auditory discrimination and articulation is inconclusive." Therefore, the most efficient way to manage therapy in order to develop sensory feedback through auditory discrimination is not defined. Kamil and Rudegeair (1972) investigated the validity of instruments used in assessing auditory discrimination because of a relationship of unknown parameters exists between articulation and auditory discrimination. Kamil and Rudegeair found that current methods of testing auditory discrimination should be modified for optimum assessment.

One such modification suggested is repeated testing in order that the child is sure of the task. Therefore, one explanation for the inconclusive results of previous research may be due to poor techniques in assessment of auditory discrimination.

There is some research which provides suggestions for ways to improve our present means of auditory discrimination assessment. The research by Kamil and Rudegeair concludes that a child should be tested more than one time to assess the child's actual abilities. The repeated testing appeared to facilitate the learning of the task to be performed and increased attention to the task. These investigators also concluded that repeated contrast pairs (bob-dod) were easier to discriminate than initial (bob-dob) or final (bob-bod) contrast pairs. However, there is no mention in this study of criterion for test items based on phonetic contexts. The authors of the Goldman-Fristoe-Woodcock Test of Auditory Discrimination deal with this problem a little differently. They have designed a training procedure at the beginning of the test. They state that this portion is included to train the child in the vocabulary of the test before the actual assessment of auditory discrimination begins. This assures the examiner that the errors are due to errors in perception rather than unfamiliarity of the test item (Goldman, et al.). Templin included the same type of training procedure in the Picture Speech Sound Discrimination Test (Templin, 1957).

Brandy (1966) criticized the then present speech sound discrimination tests because these instruments did not equate

the acoustic stimuli presented to the subject. He found that a statistically significant difference existed between presentations of live voice versus tape recorded test stimuli on auditory discrimination tests. He concluded that variability in speakers causes variability in listener performance. Of all the present tests available, only the Goldman-Fristoe-Woodcock Test of Auditory Discrimination controls for examiner variability by presenting test items on a tape recording.

Fleming (1971) presented a discussion of eight factors of phonetic contexts influencing the ability to correctly discriminate speech sounds. These are: 1) the number of features the other sounds in the context have in common with the problem sound; 2) the position of the problem sound in the context; 3) the stress and duration with which the problem sound is articulated in the contexts; 4) knowledge of the occurrence and location of the problem sound in the context; 5) the meaningfulness of the context; 6) the number of sounds and syllables in the context; 7) the number of times the problem sound occurs in the context and 8) the phonemic value of the problem sound in the contexts. She states that "the clinician should use these factors so that the subject is eventually able to recognize the presence or absence of his problem sound in the complex combinations found in his own and other's spontaneous speech." (Fleming, 1971, p. 360) This information, combined with the current research in auditory discrimination, provides the speech pathologist with valuable therapy implications.

Aungst and Frick (1964) investigated the relationship between the consistency of articulation ability and the ability to discriminate between paired auditory stimuli presented by another speaker and the ability to judge one's own speech productions as correct or incorrect. They found that the abilities tested by the paired stimuli was unrelated to the ability to judge one's own speech productions as correct or incorrect. They also found that the paired stimuli test measured an ability which is not related to consistency of articulation. Finally, it was determined than when this particular testing method was used, a significant relationship exists between the ability to judge one's own speech productions and consistency of articulation. The correlations between articulation and auditory discrimination were higher for this experiment than for any other found in the literature.

CHAPTER III

PROCEDURES

The subjects selected for this study were children with functional articulation disorders of the /r/ and /s/ phonemes. Children with the following characteristics were excluded from the sample population of this investigation: 1) those with organic involvement such as cleft palate or cerebral palsy; 2) those who stuttered; 3) those with diagnosed voice quality problems; 4) those with diagnosed language delay; 5) those in classes for the mentally retarded or gifted and 6) those with hearing losses. A population excluding these children resulted in a public school population of "average" intelligence.

All children who participated in this study were selected by the public school speech pathologist on the basis of the above criteria. The subjects were selected from grades two through six from the public school in Effingham County in Illinois. The number of subjects selected for the study was 40; 20 with a defective /r/ and 20 with a defective /s/.

To control for inter-examiner reliability, only one examiner (the author) was used. The examiner has had two year's experience in public school speech therapy and has completed 30 semester hours of graduate work in the area of speech pathology.

The frequency of occurrence of phonetic contexts in the six most common auditory discrimination tests was determined by tallying the number of times each of the phonetic contexts occurred in the test items for each test. The tests examined for phonetic contexts were: Goldman-Fristoe-Woodcock Test of Auditory Discrimination, Templin Picture Sound Discrimination Test, Templin Sound Discrimination Test, Test for Listening Accuracy in Children by Mecham and Jex, Wepman Auditory Discrimination Test and Boston University Speech Sound Discrimination Test. The phonetic contexts used as criteria for this count were the most frequently occurring phonetic contexts in the English language as determined by Griffith and Miner (1973).

The articulation tests used in the testing procedure were the deep tests which were used by Schneider (1973) for /r/ and /s/. The tests were imitation tests of articulation which were chosen because they parallel articulation therapy procedures (Schneider, 1973). The phonetic contexts determined by Griffith and Miner (1973) were used in the test. The test items are ranked according to their frequency of occurrence in the English language.

The auditory discrimination tests for /r/ and /s/ were constructed in a similar manner. The words used were chosen according to the frequency of occurrence of phonetic contexts as determined by Griffith and Miner (1973). To

standardize the examiner's presentation, the stimulus items for all portions of the testing procedure were presented on tape.

The testing procedure followed a format similar to that of Aungst and Frick (1964). These researchers did some study in the area of auditory discrimination. Their experiment was designed to compare a child's ability to discriminate his own productions and productions by another speaker. The subjects were 27 children of eight years of age who were found to have misarticulations of the /r/ phoneme. Each child was given a "deep test" of articulation to verify this misarticulation. Three auditory discrimination tests were constructed for the purpose of this research: 1) Test of Comparison in which the child compared his production with that of another speaker; 2) Test of Delayed Judgement in which the child later heard a recording of his own production and 3) Test of Instantaneous Judgement in which the child immediately judged whether the word was correct or incorrect. The Templin fifty-item auditory discrimination test was also administered to compare the results of the "traditional" auditory discrimination test.

The present study used the same testing format as the Aungst and Frick study. However, another variable, phonetic context, was added. The previously mentioned test of articulation and tests of auditory discrimination constructed

according to frequency of occurrence of phonetic contexts for /r/ and /s/ were used in this study. The same test stimuli was used for all three conditions of auditory discrimination testing. Most words selected were depictable in line drawings. Because of the low frequency of occurrence of some phonetic contexts, some non-depictable words were used out of necessity. Two Wollensak Model T-1500 tape recorders were used in this study. One recorder was needed for the Test of Instantaneous Judgement, Test of Delayed Judgement and for the presentation of the Templin Sound Discrimination Test. Two tape recorders were used for the Test of Comparison. Prior to the initiation of the testing, the examiner recorded the stimulus items for the Test of Comparison and the Templin Sound Discrimination Test. The stimulus pictures were used in the Test of Instantaneous Judgement.

The following procedures were used in testing:

1) Each child was given a deep test of articulation.

2) The examiner showed the pictures to the subject and let the subject name them. Any items that the subject failed were taught to the subject by the examiner prior to the Test of Instantaneous Judgement by use of example or sentences.

3) The subject was then asked to name the pictures or to say the stimulus word if there was not an associated picture. The subjects' responses were recorded on the tape recorder. Immediately following his response, the subject was asked to

judge whether his production was "right" or "wrong". This was the Test of Instantaneous Judgement. In this test, the subject was making a discrimination similar to that needed in a therapy situation or to monitor his own speech.

4) For the Test of Delayed Judgement, the subject listened to a play back of his own "spontaneous" productions which were recorded during the Test of Instantaneous Judgement. The child reported his judgements of these productions by saying "right" or "wrong". Once again, this type of judgement is one he must make in order to correctly monitor his speech during the carry-over and stabilization stages of articulation therapy.

5) For the Test of Comparison, the subject heard the stimulus word on one tape recorder and he immediately repeated the word. The examiner's production on the master tape and the subjects' productions were recorded on the other tape recorder. After recording the productions from the master tape and the subjects' productions, the tape was played back. The subject was asked to judge whether his production was "right" or "wrong".

6) After the subject had completed the experimental discrimination tests, he was given a Templin Sound Discrimination Test from the tape recording.

Following are the verbal directives used for each test:

Deep Test of Articulation (Griffith and Miner, 1973)
I am going to say some words. Watch me and listen very carefully. After I say a word, you say it. Are you ready? Listen, say _____.

Test of Instantaneous Judgement
I want you to name these pictures for me. Sometimes I will ask you to say a word that I don't have a picture for. After you say the word, I want you to tell me whether you said it "right" or "wrong".

Test of Delayed Judgement
Now we are going to listen to the tape recording you just made. After you hear each word, once again, I want you to tell me whether you said it "right" or "wrong".

Test of Comparison
You will hear the same words that we have been using on this tape recorder. After you hear each word, I want you to say it and it will be recorded on this tape recorder. (AFTER RECORDING IS COMPLETED) Now we will listen to that tape recording again. After you hear what I said and what you said, tell me whether yours was "right" or "wrong".

Templin Test of Sound Discrimination.
You are going to hear some silly words. Tell me if they are the "same" or "different".

The examiner recorded all subjects responses with a + for "right" and - for "wrong". After the testing was completed, the examiner listened to the two tape recordings of each subject and scored his own judgements. To determine the level of examiner reliability in judging the subject's productions, the examiner randomly selected two subjects for /s/ and two for /r/. Their recordings were re-played and the responses were scored again. The responses from each scoring were compared to determine the level of reliability.

To determine the percentage of agreement, the judgements of the examiner and the subjects were compared item by item. Aungst and Frick (1964) suggested that the percentage of agreement should reach 80%. The percentages were compared between all of the tests to determine if one circumstance is better for the subject in making judgements of discrimination.

A t-test was used to determine if a statistically significant difference exists between the subject's judgements and the clinician's judgements. The percentage of correct responses was used as data in this analysis. The level of significance was .05.

To determine the rank order or phonetic contexts, the correct discriminations for /r/ and /s/ in the Test of Comparison were tallied and percentages computed. The percentages were rank ordered from high to low. The highest percentage or the phonetic context correctly discriminated most often were ranked as the highest. This was done for each phoneme.

The rank order of percentages of phonetic contexts discriminated correctly were compared to the rank order of frequency of phonetic contexts which were determined by Griffith and Miner (1973). The statistic used was the Kendall Tau (Downie and Heath, 1970), which is a non-parametric statistic.

To determine if a relationship existed between the articulation ability and auditory discrimination ability, the correct

productions and discriminations of /r/ and /s/ were tallied and percentages of correct responses were computed. A t-test was used to determine if a statistically significant difference existed between the subjects' performance on all discrimination tests and their performance on the articulation tests. The level of significance for this t-test was .05.

CHAPTER IV
RESULTS AND DISCUSSION

INTRODUCTION

Six auditory discrimination tests were analyzed to determine their adequacy in evaluating phonetic contexts proportionate to their use in the English language. Forty children from grades two through six were selected for participation in this study. Twenty children were given a deep test of auditory discrimination for the /r/ phoneme and twenty were given a similarly constructed deep test of auditory discrimination for /s/. The test stimuli for /r/ and /s/ were selected on the criteria of frequency of occurrence of phonetic contexts in the English language. This test and a similarly constructed deep test of articulation for /r/ and /s/ were administered to the subjects who had functional disorders involving the respective phoneme. This chapter reports the results and conclusions of this study.

INTER-TEST COMPARISONS

The frequency of occurrence of phonetic contexts in the six tests of auditory discrimination was determined by tallying the number of times each of the phonetic contexts for /r/ and /s/ occurred in the test items for each test. The phonetic contexts used as criteria for this analysis were the most frequently occurring phonetic contexts in the 1000 most common English

words as determined by Griffith and Miner (1973). The results of this analysis (c.f. Charts I-XI) revealed that these auditory discrimination tests were not representative of phonetic context distributions in speech. Furthermore, assuming that the phonetic contexts spoken most often are those heard most often, these tests were not representative of phonetic context distributions in spoken auditory stimuli. It was concluded that these six tests of auditory discrimination were not phoneme specific in that they were not designed to test a child's ability to discriminate specific phonemes in auditory stimuli. The tests to not possess concurrent validity since the phonetic contexts which are tested are not those which the child must discriminate in all listening situations.

INTER-EXAMINER RELIABILITY

To determine the level of inter-examiner reliability, the examiner randomly selected two subjects for /s/ and two subjects for /r/. Their recordings from the Test of Delayed Judgement and the Test of Comparison were re-played and the responses were scored again by the examiner. The responses from each subjects scorings were compared to determine the level of examiner reliability. The following reliability levels were obtained:

1) For /r/ Subject I's scorings, the reliability level was 96.2% on the Test of Delayed Judgement and 100% on the Test of Comparison.

CHART I

FREQUENCE OF OCCURRENCE OF /r/ I/A SINGLE PHONEMES IN SIX AUDITORY DISCRIMINATION TESTS

CONTEXTS /r/ SINGLES I/A	WEPMAN AUD. DISCRIM. TEST I	WEPMAN AUD. DISCRIM. TEST II	BOSTON SOUND DISCRIMINATION TEST	TEMPLIN SOUND DISCRIM. TEST PICTURE FORM 3-5 years	TEMPLIN SOUND DISCRIMINATION TEST 6-8 years	TEST OF LISTEN ACCURACY IN CHILDREN: MECH-AM AND JEX	G-F-W TEST OF AUDITORY DISCRIMINATION QUIET	G-F-W TEST OF AUDITORY DISCRIMINATION NOISE
rI		1	3	3		1		
rɛ	2			1		8		
ri		2						
re				2	2	2	5	5
raI					1		1	1
ro					2	2		
ru						1		
ræ		2						
rʌ		2						
raU								
rɑ			3			1		
rɔ								

The number in each column indicates the frequency of occurrence of each phonetic context for the respective test.

CHART II

FREQUENCY OF OCCURRENCE OF /r/ I/UA SINGLES IN SIX AUDITORY DISCRIMINATION TESTS

CONTEXTS /r/ SINGLES I/UA	WEPMAN AUD. DISCRIM. TEST I	WEPMAN AUD. DISCRIM. TEST II	BOSTON SOUND DISCRIMINATION TEST	TEMPLIN SOUND DISCRIM. TEST PICTURE FORM 3-5 years	TEMPLIN SOUND DISCRIMINATION TEST 6-8 years	TEST OF LISTEN. ACCURACY IN CHILDREN MECHAN AND JEX	G-F-W TEST OF AUDITORY DISCRIMINATION QUIET	G-F-W TEST OF AUDITORY DISCRIMINATION NOISE
rI								
rə						1		
ro								

The number in each column indicates the frequency of occurrence of each phonetic context for the respective test.

CHART III

FREQUENCY OF OCCURRENCE OF /r/ F/A SINGLES IN SIX AUDITORY DISCRIMINATION TESTS

CONTEXTS /r/ SINGLES F/A	WEPMAN AUD. DISCRIMINATION TEST I	WEPMAN AUD. DISCRIMINATION TEST II	BOSTON SOUND DISCRIMINATION TEST	TEMPLIN SOUND DISCRIMINATION PICTURE FORM 3-5 years	TEMPLIN SOUND DISCRIMINATION TEST 6-8 years	TEST OF LISTEN. ACCURACY IN CHILDREN: MECHAN & JEX	G-F-W TEST OF AUDITORY DISCRIMINATION QUIET	G-F-W TEST OF AUDITORY DISCRIMINATION NOISE
ɛr						2	5	5
ɪr		2					6	6
ɔr								
ar	2	2		3		6		
or						7	2	2
ur								
ær								
aɪr								
aʊr						1		

The number in each column indicates occurrence of the phoneme in a test item.

CHART IV

FREQUENCY OF OCCURRENCE OF /r/ I/A BLENDS IN SIX AUDITORY DISCRIMINATION TESTS

CONTEXTS /r/ BLENDS I/A	WEPMAN AUD. DISCRIM. TEST I	WEPMAN AUD. DISCRIM. TEST II	BOSTON SOUND DISCRIMINATION TEST	TEMPLIN SOUND DISCRIM. TEST PICTURE FORM 3-5 years	TEMPLIN SOUND DISCRIMINATION TEST 6-8 years	TEST OF LISTEN. ACCURACY IN CHILDREN: MECHAN AND JEX	G-F-W TEST OF AUDITORY DISCRIMINATION QUIET	G-F-W TEST OF AUDITORY DISCRIMINATION NOISE
pr						1		
tr				2		4		
gr			1	1		2		
br			1	4		6		
fr		1	1					
dr				1				
str				3				
kr			1			2		
θr	1	1		4		1		
spr				3				

The number in each column indicates the frequency of occurrence of each phonetic context for the respective test.

CHART V

FREQUENCY OF OCCURRENCE OF /r/ F/A BLENDS IN SIX AUDITORY DISCRIMINATION TESTS

CONTEXTS /r/ BLENDS F/A	WEPMAN AUD. DISCRIM. TEST I	WEPMAN AUD. DISCRIM. TEST II	BOSTON SOUND DISCRIMINATION TEST	TEMPLIN SOUND DISCRIM. TEST PICTURE FORM 3-5 years	TEMPLIN SOUND DISCRIM. TEST 6-8 years	TEST OF LISTEN. ACCURACY IN CHILDREN: MECHAN & JEX	G-F-W TEST OF AUDITORY DISCRIMINATION QUIET	G-F-W TEST OF AUDITORY DISCRIMINATION NOISE
rt		2						
rd				1		3		
rm						4		
rk	2							
rs				1		3		
rd								
r[illegible]								
rn						3		
rt								

The number in each column indicates the frequency of occurrence of each phonetic context for the respective test.

CHART VI

FREQUENCY OF OCCURRENCE /S/ I/A SINGLES IN SIX AUDITORY DISCRIMINATION TESTS

CONTEXTS /s/ SINGLES I/A	WEPMAN AUD. DISCRIM. TEST I	WEPMAN AUD. DISCRIM. TEST II	BOSTON SOUND DISCRIMINATION TEST	TEMPLIN SOUND DISCRIM. TEST 3-5 years	TEMPLIN SOUND DISCRIMINATION TEST: 6-8 yrs.	TEST OF LISTEN. ACCURACY IN CHILDREN: MECHAM & JEX	G-F-W TEST OF AUDITORY DISCRIMINATION QUIET	G-F-W TEST OF AUDITORY DISCRIMINATION NOISE
si				1		1	1	1
sɪ	1	1				5		
se		1		1	4		2	2
sɛ						1		
sæ	1	1		1		2	2	2
sɔ	1	1						
so				1		5		
su			1	1				
sʌ		1						
sɝ						3		
saɪ						2	2	2
saʊ						1		
sɔɪ								

CHART VII

FREQUENCY OF OCCURRENCE /s/ I/UA SINGLES IN SIX AUDITORY DISCRIMINATION TESTS

CONTEXTS /s/ SINGLES I/UA	WEPMAN AUD. DISCRIM. TEST I	WEPMAN AUD. DISCRIM. TEST II	BOSTON SOUND DISCRIMINATION TEST	TEMPLIN SOUND DISCRIM. TEST 3-5 yrs.	TEMPLIN SOUND DISCRIM. TEST 6-8 yrs.	TEST OF LISTEN. ACCURACY IN CHILDREN: MECHAN & JEX	G-F-W TEST OF AUDITORY DISCRIMINATION QUIET	G-F-W TEST OF AUDITORY DISCRIMINATION NOISE
sɛ								
so								
sɚ								
sə								

The number in each column indicates the frequency of occurrence of each phonetic context for the respective test.

CHART VIII

FREQUENCY OF OCCURRENCE OF /s/ F/A SINGLES IN SIX AUDITORY DISCRIMINATION TESTS

CONTEXTS /s/ SINGLES F/A	WEPMAN AUD. DISCRIM. TEST I	WEPMAN AUD. DISCRIM. TEST II	BOSTON SOUND DISCRIMINATION TEST	TEMPLIN SOUND DISCRIM. TEST PICTURE FORM 3-5 yrs.	TEMPLIN SOUND DISCRIMINATION TEST: 6-8 yrs.	TEST OF LISTEN. ACCURACY IN CHILDREN: MECHAM & JEX	G-F-W TEST OF AUDITORY DISCRIMINATION QUIET	G-F-W TEST OF AUDITORY DISCRIMINATION NOISE
is	1							
Is						5		
es			4		2			
ɛs								
æs	1	1	4	2		3		
as								
ɔs					1			
us								
ʌs	2	2						
aIs			1			2		
aUs			1	2		1		
ɔIs								

The number in each column indicates the frequency of occurrence of each phonetic context for the respective test.

CHART IX

FREQUENCY OF OCCURRENCE OF /s/ I/A IN BLENDS IN SIX AUDITORY DISCRIMINATION TESTS

CONTEXTS /s/ BLENDS I/A	WEPMAN AUD. DISCRIMINATION I	WEPMAN AUD. DISCRIMINATION II	BOSTON SOUND DISCRIMINATION TEST	TEMPLIN SOUND DISCRIM. TEST PICTURE FORM 3-5 yrs.	TEMPLIN SOUND DISCRIMINATION TEST 6-8 yrs.	TEST OF LISTEN. ACCURACY IN CHILDREN: MECHAM & JEX	G-F-W TEST O AUDITORY DIS CRIMINATION QUIET	G-F-W TEST O AUDITORY DIS CRIMINATION NOISE
sp								
spl								
spr				3				
sk								
skw								
st			3	4		1		
str				2				
sm								
sn								
sl				2		2		
sw				2				

The number in each column indicates the frequency of occurrence of each phonetic context for the respective test.

CHART X

FREQUENCY OF OCCURRENCE OF /s/ F/A BLENDS IN SIX AUDITORY DISCRIMINATION TESTS

CONTEXTS s/s BLENDS F/A	WEPMAN AUD. DISCRIMINATION TEST I	WEPMAN AUD. DISCRIMINATION TEST II	BOSTON SOUND DISCRIMINATION TEST	TEMPLIN SOUND DISCRIM. TEST PICTURE FORM 3-5 yrs.	TEMPLIN SOUND DISCRIMINATION TEST 6-8 yrs.	TEST OF LISTEN. ACCURACY IN CHILDREN: MECHAN & JEX	G-F-W TEST OF AUDITORY DISCRIMINATION QUIET	G-F-W TEST OF AUDITORY DISCRIMINATION NOISE
sk								
st	3		3			2		
ns						1		
nst								
ls								
rs				1		3		
ps								
ts				1		6		
ks			4	6		2		
kst								

The number in each column indicates the frequency of occurrence of each phonetic context for the respective test.

CHART XI

FREQUENCY OF OCCURRENCE OF /s/ F/UA BLENDS IN SIX AUDITORY DISCRIMINATION TESTS

CONTEXTS /s/ BLENDS F/UA	WEPMAN AUD. DISCRIM. TEST I	WEPMAN AUD. DISCRIM. TEST II	BOSTON SOUND DISCRIMINATION TEST	TEMPLIN SOUND DISCRIM. TEST PICTURE FORM 3-5 yrs.	TEMPLIN SOUND DISCRIMINATION TEST 6-8 yrs.	TEST OF LISTEN. ACCURACY IN CHILDREN: MECHAM & JEX	G-F-W TEST OF AUDITORY DISCRIMINATION QUIET	G-F-W TEST OF AUDITORY DISCRIMINATION NOISE
ns						1		
st								

The number in each column indicates the frequency of occurrence of each phonetic context for the respective test.

2) For /r/ Subject II's scorings, the reliability level was 98.1% on the Test of Delayed Judgement and 94.3% on the Test of Comparison.

3) For /s/ Subject I's scorings, the reliability level was 94.3% for the Test of Delayed Judgement and 96.2% for the Test of Comparison.

4) For /s/ Subject II's scorings, the reliability level was 92.5% for the Test of Delayed Judgement and 96.2% for the Test of Comparison.

Analysis of these levels of reliability indicated that the examiner was able to score the student's productions on the Test of Delayed Judgement and the Test of Comparison with a high degree of agreement and accuracy.

COMPARISON OF PRODUCTION AND PERCEPTION

In order to test the relationship between these childrens' performance on the deep tests of auditory discrimination and their performance on the deep test of articulation, a t-test was used. Each subject's score for this comparison was the percentage of correct responses on each deep test. An alpha level of .05 was required for statistical significance. The results for /r/ and /s/ are shown in Table I:

TABLE I
COMPARISON OF STUDENTS'
PRODUCTION AND PERCEPTION SCORES FOR /r/ AND /s/

PHONEME	COMPARISON	t-SCORE
/r/	STIJ vs. DAT	1.65
	STDJ vs. DAT	0.41
	STC vs. DAT	0.77
	CTDJ vs. DAT	3.86*
	CTC vs. DAT	3.63*
/s/	STIJ vs. DAT	2.53*
	STDJ vs. DAT	1.80
	STC vs. DAT	2.05
	CTDJ vs. DAT	2.31*
	CTC vs. DAT	3.97*

STIJ - Students' Judgements on the Test of Instantaneous Judgement
STDJ - Students' Judgements on the Test of Delayed Judgement
STC - Students' Judgements on the Test of Comparison
CTDJ - Clinician's Judgements on the Test of Delayed Judgement
CTC - Clinician's Judgements on the Test of Comparison
* - t-score is significant at the .05 level

The implications from this statistical analysis were that a statistical difference does not exist between the students' performance on the Deep Test of Articulation and his ability to judge his own speech under all condition used for making these judgements with one exception. The exception was the students' judgements on the Test of Instantaneous Judgement for /s/. This exception cannot be explained from the information revealed in this study and awaits further research in the area of auditory discrimination in children. In all other comparisons, the students' ability to judge his own productions of the respective phoneme was not significantly different from his ability to produce the respective phoneme.

In this study, the tests of auditory discrimination involved the following tasks: 1) The Students' Test of Instantaneous Judgement (STIJ) involved the child making an immediate judgement as to the accuracy of his production of the respective phoneme. 2) In the Students' Test of Delayed Judgement (STDJ), the child heard a tape recording of his production from the Test of Instantaneous Judgement and made a judgement as to whether the production was correct or incorrect. 3) In the Students' Test of Comparison, the child compared his productions of the respective phoneme to that of the clinician and made a judgement concerning the accuracy of his production. 4) The Clinician's Test of Delayed Judgement (CTDJ) involved the clinician listening to the child's productions on tape and

making a judgement of accuracy in the production of /r/ and /s/. 5) In the Clinician's Test of Comparison (CTC), the clinician listened to the tape of her productions and the children's productions and made a judgement concerning the accuracy of each child's response.

The t-test analysis of the production-perception relationship revealed that a significant difference existed between the child's performance on the Deep Test of Articulation and the clinician's judgements of the child's performance on the tests of auditory discrimination (CTDJ and CTC.) The mean score for the clinician's judgements were significantly higher than the scores for the child's performance on the Deep Test of Articulation. This was interpreted to mean that the clinician perceived differences in the child's performance that the child did not perceive. Since the clinician had been trained to hear errors which the child had not been trained to hear, this was not a remarkable discovery. The high level of inter-examiner reliability supported the findings of this statistical analysis.

The t-test uses only the group mean to determine if a statistically significant difference exists between two groups of data. However, from a practical standpoint, the group mean may be distorted by one or two extreme scores. Therefore, it was felt that the individual scores should be examined. The following comparisons were made for the /r/ phoneme:

1) In comparing the students' judgements on the Test of Instantaneous Judgement (STIJ) and the Deep Test of Articulation, it was found that the group mean for perception exceeded the group mean for production. Only seven of twenty children scored higher on the Deep Test of Articulation than on the Test of Instantaneous Judgement (STIJ). This comparison of individual scores supported the comparison of the group means. This indicated that the children perceived fewer errors under this condition of judgement than they produced on the Deep Test of Articulation.

2) In comparint the students' Test of Delayed Judgement (STDJ) and the Deep Test of Articulation, the group mean for perception exceeded the group mean for production. Ten of twenty children scored higher on the Deep Test of Articulation than on the Test of Delayed Judgement (STDJ). However, the magnitude of the scores on the Deep Test of Articulation was not great enough to exceed the group mean of the Test of Instantaneous Judgement (STDJ). Again, the children perceived fewer errors under this condition of judgement than they produced on the Deep Test of Articulation.

3) When the group means of the students' Test of Comparison (STC) and the Deep Test of Comparison were compared, it was found that the group mean for the students' Test of Comparison (STC) exceeded the group mean for the Deep Test of Articulation. Ten of twenty children scored higher on the Deep Test of Articulation than on the Test of Comparison (STC) which indicated that the children perceived less errors under this

condition of judgement than they produced on the Deep Test of Articulation.

4) In comparing the clinician's Test of Delayed Judgement (CTDJ) group mean and the group mean for the Deep Test of Articulation, it was found that the mean for production exceeded the group mean for perception. Fourteen children received higher scores on the Deep Test of Articulation than on the clinician's Test of Delayed Judgement (CTDJ). This comparison of individual scores supports the comparison of group means. This finding indicated that in the judgement of the clinician, the children produced fewer errors on the Deep Test of Articulation than on the Test of Delayed Judgement.

5) When the clinician's Test of Comparison (CTC) and the Deep Test of Articulation group means were compared, it was found that the group mean for production exceeded the group mean for perception. In examining the individual scores, it was found that thirteen of twenty children scored higher on the Deep Test of Articulation than on the clinician's Test of Comparison (CTC). This finding supported the comparison of the group means as used in the t-test.

The following comparisons were made for the /s/ phoneme:

1) In comparing the students' Test of Instantaneous Judgement (STIJ) and the Deep Test of Articulation group means, it was found that the perception group mean exceeded the group mean for production. In examining the individual scores, it was found that only five of twenty children scored higher on the Deep Test of Articulation than on the

students' Test of Instantaneous Judgement. This supported the comparison of the group means and indicated that the children perceived fewer errors under this condition of judgement than they produced on the Deep Test of Articulation.

2) When the group means for the students' Test of Delayed Judgement (STDJ) and the Deep Test of Articulation were compared, it was found that the group mean for perception exceeded the group mean for production. Only nine of twenty children scored higher on the Deep Test of Articulation than on the students' Test of Delayed Judgement. This finding supported the comparison of the group means which were used in the t-test. This indicated that the children perceived fewer errors under this condition of judgement than they produced on the Deep Test of Articulation.

3) In comparing the group means for the students' Test of Comparison and the Deep Test of Articulation, it was found that the group mean for perception exceeded the group mean for production. Only eight of twenty children scored higher on the Deep Test of Articulation than on the students' Test of Comparison. This finding supported the group mean comparison used in the t-test. This finding also indicated that the children perceived fewer errors under this condition of judgement than they produced on the Deep Test of Articulation.

4) When the group means for the clinician's Test of Delayed Judgement (CTDJ) and the Deep Test of Articulation were compared, it was found that the group mean for perception

exceeded the group mean for production. This finding supported the comparisons of the group means with only seven of twenty children scoring higher on the Deep Test of Articulation than on the clinician's Test of Delayed Judgement. Again this comparison indicated that the clinician perceived fewer errors under this condition of judgement than on the Deep Test of Articulation.

5) In comparing the group means for the clinician's Test of Comparison (CTC) and the Deep Test of Articulation, it was found that the group mean for perception exceeded the group mean for production. Only two of twenty children scored higher on the Deep Test of Articulation than on the clinician's Test of Comparison. This comparison supported the comparison of group means and indicated that the clinician perceived fewer errors under this condition of judgement than on the Deep Test of Articulation.

In summary, it was determined by comparing individual scores with group means that the group means were characteristic of the individual scores and no distortions were noted.

COMPARISON OF STUDENTS' AND CLINICIAN'S JUDGEMENTS

To determine the percentage of agreement between the clinician's judgements and the students' judgements on the Test of Delayed Judgement and the Test of Comparison, an item by item comparison was made for each testing condition. The results are shown in Table II:

TABLE II
COMPARISON OF CLINICIAN AND STUDENTS ON
TEST OF DELAYED JUDGEMENT AND TEST OF COMPARISON FOR /r/ AND /s/

Phoneme	Test Used for Comparison	Percentage of Agreement
/r/	Test of Delayed Judgement	63.7%
/r/	Test of Comparison	66.1%
/s/	Test of Delayed Judgement	79.34%*
/s/	Test of Comparison	85.46%*

* Indicates that the percentage of agreement approaches or exceeds the level suggested by Aungst and Frick (1964).

It is concluded that the students and the clinician agreed more frequently on the accuracy of the productions of /s/ than on the productions of /r/. This documented the clinical observation that children are not proficient in monitoring their own productions of /r/. This finding also supported the finding of Daugherty (1974) that all sounds may not be discriminated in the same manner. Since the level of agreement increased for both phonemes on the Test of Comparison, it was concluded that this circumstance was better for the student in making judgements of his own productions.

To determine if a statistically significant difference existed between the subjects' judgements and the clinician's judgements, a t-test was used. An alpha level of .05 was required for statistical significance. The percentage of correct responses for the students and clinician was used for this analysis. The results of this analysis are shown in Table III:

TABLE III
t-SCORES FOR /r/ AND /s/

PHONEME	TEST USED FOR COMPARISON	t-SCORE
/r/	Test of Delayed Judgement	2.49*
/r/	Test of Comparison	2.71*
/s/	Test of Delayed Judgement	0.39
/s/	Test of Comparison	0.79

* Indicates significance at the .05 level.

The results of this analysis indicated that the students' and clinician's judgements for /r/ differed significantly while the judgements for /s/ did not. The comparisons of production and perception support the findings of the comparison of students' and clinician's judgements of the two phonemes and the conclusion of Daugherty (1974). Once again, it can be said that this research documents the clinical observation that children cannot proficiently monitor their productions of /r/. It is apparent that /r/ and /s/ are two very different phonemes and that children monitor them with differing degrees of accuracy. The implication for the speech pathologist is that therapy which is successful remediation for a defective /r/ may not be the optimal therapy for remediation of a defective /s/.

In comparing group means of the students and the clinician, the following results were found:

1) The group mean for students' judgements on the Test of Delayed Judgement exceeded the group mean for the clinician's judgements. The clinician judged six students' productions

better than the students judged the productions themselves.

2) The group mean for students' judgements on the Test of Comparison exceeded the group mean for clinician's judgements. The clinician judged six students' productions better than the students judged the productions themselves.

These comparisons of group means and analysis of individual scores indicated that the individual scores followed a pattern which would yield such a group mean.

RANK ORDER OF CORRECTLY DISCRIMINATED PHONETIC CONTEXTS

To determine if correctly discriminated phonetic contexts rank order themselves similarly to their frequency of occurrence in the English language, the non-parametric Kendall-Tau statistic (Downie and Heath, 1970) was used to compare the rank orders of the data to rank order of frequency of occurrence of phonetic contexts as determined by Griffith and Miner (1973). The results of these comparisons are shown in Table IV:

TABLE IV

COMPARISON RANK ORDER OF PHONETIC CONTEXTS

PHONEME	DISCRIMINATION TEST	KENDALL-TAU VALUE
/ singles		
I/A	Students' Test of Instantaneous Judgement	.46
I/UA	Students' Test of Instantaneous Judgement	-.41
F/A	Students' Test of Instantaneous Judgement	.07
/ blends		
I/A	Students' Test of Instantaneous Judgement	0.00
I/UA	Students' Test of Instantaneous Judgement	.51
F/A	Students' Test of Instantaneous Judgement	-.04
/ singles		
I/A	Students' Test of Delayed Judgement	0.00
I/UA	Students' Test of Delayed Judgement	-.41
F/A	Students' Test of Delayed Judgement	-.22
/ blends		
I/A	Students' Test of Delayed Judgement	.07
I/UA	Students' Test of Delayed Judgement	.41
F/A	Students' Test of Delayed Judgement	-.45

TABLE IV (cont.)

PHONEME	DISCRIMINATION TEST	KENDALL-TAU VALUE
/r/ singles		
I/A	Students' Test of Comparison	-.06
I/UA	Students' Test of Comparison	.33
F/A	Students' Test of Comparison	.20
/r/ blends		
I/A	Students' Test of Comparison	.05
I/UA	Students' Test of Comparison	.41
F/A	Students' Test of Comparison	-.09
/r/ singles		
I/A	Clinician's Test of Delayed Judgement	.60
I/UA	Clinician's Test of Delayed Judgement	0.00
F/A	Clinician's Test of Delayed Judgement	.17
/r/ blends		
I/A	Clinician's Test of Delayed Judgement	.26
I/UA	Clinician's Test of Delayed Judgement	.81
F/A	Clinician's Test of Delayed Judgement	.46
/r/ singles		
I/A	Clinician's Test of Comparison	1.00*
I/UA	Clinician's Test of Comparison	0.00
F/A	Clinician's Test of Comparison	.37
/r/ blends		
I/A	Clinician's Test of Comparison	.51
I/UA	Clinician's Test of Comparison	.81
F/A	Clinician's Test of Comparison	-.31
/s/ singles		
I/A	Students' Test of Instantaneous Judgement	.26
I/UA	Students' Test of Instantaneous Judgement	1.00*
F/A	Students' Test of Instantaneous Judgement	.35
/s/ blends		
I/A	Students' Test of Instantaneous Judgement	.65
F/A	Students' Test of Instantaneous Judgement	.28
F/UA	Students' Test of Instantaneous Judgement	1.00
/s/ singles		
I/A	Students' Test of Delayed Judgement	0.00
I/UA	Students' Test of Delayed Judgement	0.00
F/A	Students' Test of Delayed Judgement	0.00
/s/ blends		
I/A	Students' Test of Delayed Judgement	.23
F/A	Students' Test of Delayed Judgement	.21
F/UA	Students' Test of Delayed Judgement	0.00
/s/ singles		
I/A	Students' Test of Comparison	.32
I/UA	Students' Test of Comparison	.67
F/A	Students' Test of Comparison	.69
/s/ blends		
I/A	Students' Test of Comparison	.03
F/A	Students' Test of Comparison	.06
F/UA	Students' Test of Comparison	0.00
/s/ singles		
I/A	Clinician's Test of Delayed Judgement	.12
I/UA	Clinician's Test of Delayed Judgement	.78
F/A	Clinician's Test of Delayed Judgement	.47

TABLE IV (cont.)

PHONEME	DISCRIMINATION TEST	KENDALL-TAU VALUE
/s/ blends		
I/A	Clinician's Test of Delayed Judgement	-.12
F/A	Clinician's Test of Delayed Judgement	-.14
F/UA	Clinician's Test of Delayed Judgement	1.00*
/s/ singles		
I/A	Clinician's Test of Comparison	0.00
I/UA	Clinician's Test of Comparison	.26
F/A	Clinician's Test of Comparison	.07
/s/ blends		
I/A	Clinician's Test of Comparison	.14
F/A	Clinician's Test of Comparison	-.45
F/UA	Clinician's Test of Comparison	0.00

* Indicates perfect correlation

The results of this analysis show that with four exceptions a statistically significant relationship does not exist between the rank order of the correctly discriminated phonetic contexts and the rank order of the phonetic contexts' frequency of occurrence in the English language. The rank orders are shown in Tables V through XIV. The following exceptions were found in this analysis:

1) A perfect correlation was found between the rank order of I/A /r/ single phonetic contexts on the clinician's Test of Comparison and the rank order of the frequency of occurrence of phonetic contexts in the English language.

2) A perfect correlation was found between the rank order I/UA /s/ single phonetic contexts on the students' Test of Instantaneous Judgement and the rank order of the frequency of occurrence of phonetic contexts in the English language. This was felt to be due to the small number (4) of phonetic contexts in the group.

3) A perfect correlation was found between the rank order of F/UA /s/ blend phonetic contexts on the Students' Test of

TABLE V
RANK ORDER OF CORRECT DISCRIMINATIONS OF /r/
STUDENT'S RESPONSES ON TEST OF INSTANTANEOUS JUDGEMENT

PHONETIC CONTEXT	RANK
I/A SINGLES	
rɪ	1.5
ri	1.5
ro	4.0
rʌ	4.0
rɑ	4.0
rɛ	6.0
raʊ	7.0
raɪ	8.5
ræ	8.5
re	10.0
ru	11.0
rɔ	12.0
I/A BLENDS	
dr	1.0
pr	2.5
θr	2.5
spr	4.0
gr	5.0
tr	7.5
br	7.5
fr	7.5
kr	7.5
str	10.0

PHONETIC CONTEXT	RANK
I/UA SINGLES	
rʊ	1.5
ro	1.5
rʊ	3.0
F/A SINGLES	
ɛr	1.5
ær	1.5
aɪr	3.0
ar	4.0
ɔr	6.0
or	6.0
ur	6.0
ɪr	8.0
aʊr	9.0
I/UA BLENDS	
tr	1.0
pr	2.5
dr	2.5
F/A BLENDS	
rθ	1.0
rk	2.5
rdʒ	2.5
rd	4.0
rt	6.5
rm	6.5
rs	6.5
rtʃ	6.5
rn	9.0

TABLE VI
RANK ORDER OF CORRECT DISCRIMINATIONS OF /r/
STUDENT'S RESPONSES ON TEST OF DELAYED JUDGEMENT

PHONETIC CONTEXTS	RANK
I/A SINGLES	
raʊ	1.0
ri	3.5
raɪ	3.5
re	3.5
ræ	3.5
ra	6.0
rɪ	7.5
rʌ	7.5
ro	9.0
rɛ	10.5
rɔ	10.5
ru	12.0
I/A BLENDS	
tr	1.5
spr	1.5
pr	3.5
gr	3.5
dr	6.0
str	6.0
θr	6.0
kr	8.0
fr	9.0
br	10.0

PHONETIC CONTEXTS	RANK
I/UA SINGLES	
ro	1.0
rɪ	2.5
rə	2.5
F/A SINGLES	
aɪr	1.0
ɪr	2.5
ur	2.5
ɛr	5.5
ar	5.5
or	5.5
ær	5.5
aʊr	8.0
ɔr	9.0
I/UA BLENDS	
tr	1.0
pr	2.0
dr	3.0
F/A BLENDS	
rs	1.0
rdʒ	2.0
rk	4.0
rn	4.0
rtʃ	4.0
rt	6.0
rd	7.0
rθ	8.0
rm	9.0

TABLE VII
RANK ORDER OF CORRECT DISCRIMINATIONS OF /r/
STUDENT'S RESPONSES ON TEST OF COMPARISON

PHONETIC CONTEXTS	RANK
I/A SINGLES	
ri	1.0
re	4.0
raɪ	4.0
ræ	4.0
rʌ	4.0
ra	4.0
ro	8.0
raʊ	8.0
rɔ	8.0
rɛ	10.0
rɪ	11.0
ru	12.0
I/A BLENDS	
tr	1.0
gr	4.5
br	4.5
dr	4.5
str	4.5
θr	4.5
spr	4.5
pr	9.0
fr	9.0
kr	9.0

PHONETIC CONTEXTS	RANK
I/UA SINGLES	
rɪ	1.0
ro	2.0
rɵ	3.0
F/A SINGLES	
ɛr	1.0
ar	3.0
or	3.0
aɪr	3.0
ur	5.5
ɜr	5.5
ɪr	7.0
aʊr	8.0
ɔr	9.0
I/UA BLENDS	
tr	1.0
dr	2.0
pr	3.0
F/A BLENDS	
rk	1.0
rθ	2.0
rd	3.5
rdʒ	3.5
rs	5.5
rtʃ	5.5
rt	7.0
rm	8.5
rn	8.5

TABLE VIII
RANK ORDER OF CORRECT DISCRIMINATIONS OF /r/
CLINICIAN'S RESPONSES ON TEST OF DELAYED JUDGEMENT

PHONETIC CONTEXTS I/A SINGLES	RANK
rɛ	1.5
ri	1.5
rɪ	3.5
re	3.5
raɪ	5.5
ræ	5.5
rʌ	7.5
raʊ	7.5
ro	9.5
ra	9.5
rɔ	11.0
ru	12.0

I/A BLENDS	
pr	1.5
θr	1.5
tr	4.0
gr	4.0
kr	4.0
dr	6.0
br	7.5
spr	7.5
str	9.0
fr	10.0

PHONETIC CONTEXTS I/UA SINGLES	RANK
rɪ	1.0
ro	2.0
rə	3.0

F/A SINGLES	
ɚr	1.0
ɪr	2.0
ɛr	3.5
aɪr	3.5
ar	5.5
ur	5.5
ɔr	7.5
or	7.5
aʊr	9.0

I/UA BLENDS	
pr	1.0
tr	2.0
dr	3.0

F/A BLENDS	
rd	1.0
rs	2.0
rt	4.5
rk	4.5
rθ	4.5
rn	4.5
rm	8.0
rdʒ	8.0
rtʃ	8.0

TABLE IX
RANK ORDER OF CORRECT DISCRIMINATIONS OF /r/
CLINICIAN'S RESPONSES ON TEST OF COMPARISON

PHONETIC CONTEXTS I/A SINGLES	RANK
rɛ	1.0
rɪ	2.5
re	2.5
ri	4.0
ræ	5.5
raʊ	5.5
raɪ	8.0
ro	8.0
rʌ	8.0
ra	10.0
rɔ	11.0
ru	12.0

I/A BLENDS	
pr	2.5
tr	2.5
gr	2.5
dr	2.5
kr	5.5
θr	5.5
str	7.5
spr	7.5
br	9.0
fr	10.0

PHONETIC CONTEXTS I/UA SINGLES	RANK
rɪ	1.0
ro	2.0
rə	3.0

F/A SINGLES	
ɪr	1.0
ɛr	2.0
ar	3.0
ɛr	4.5
aɪr	4.5
ɔr	6.5
or	6.5
ur	8.5
aʊr	8.5

I/UA BLENDS	
pr	1.0
tr	2.0
dr	3.0

F/A BLENDS	
rs	1.0
rdʒ	2.0
rk	4.0
rn	4.0
rtʃ	4.0
rt	6.5
rd	6.5
rθ	8.0
rm	9.0

TABLE X
RANK ORDER OF CORRECT DISCRIMINATIONS OF /s/
STUDENT'S RESPONSES ON TEST OF INSTANTANEOUS JUDGEMENT

PHONETIC CONTEXTS	RANK
I/A SINGLES	
sɛ	1.5
sɔ	1.5
so	3.5
saU	3.5
sʌ	5.5
saI	5.5
sI	8.5
si	8.5
sæ	8.5
sɔI	8.5
su	11.0
sɚ	12.5
se	12.5
I/A BLENDS	
sp	2.5
sk	2.5
spr	2.5
sl	2.5
sm	5.5
spl	5.5
str	8.0
sn	8.0
sw	8.0
st	10.0
skw	11.0

PHONETIC CONTEXTS	RANK
I/UA SINGLES	
sɛ	1.5
so	1.5
sɚ	3.0
sə	4.0
F/A SINGLES	
aIs	1.5
ʌs	1.5
ɛs	5.0
es	5.0
æs	5.0
as	5.0
aUs	5.0
Is	8.5
ɔIs	8.5
is	10.5
ɔs	10.5
us	12.0
os	13.0
F/A BLENDS	
ns	1.0
st	3.5
rs	3.5
ks	3.5
ps	3.5
nst	7.0
ls	7.0
kst	7.0
sk	9.0
ts	10.0
F/UA BLENDS	
ns	1.0
st	2.0

TABLE XI
RANK ORDER OF CORRECT DISCRIMINATIONS OF /s/
STUDENT'S RESPONSES ON TEST OF DELAYED JUDGEMENT

PHONETIC CONTEXTS I/A SINGLES	RANK
sæ	2.5
sʌ	2.5
sɔI	2.5
saI	4.5
se	4.5
sI	7.0
si	7.0
sɔ	7.0
sɚ	10.0
so	10.0
su	10.0
saU	12.5
sɑɹ	12.5

PHONETIC CONTEXTS I/UA SINGLES	RANK
sɚ	1.0
so	2.0
sə	3.0
sɛ	4.0

F/A SINGLES	
aIs	1.5
ʌs	1.5
es	4.0
æs	4.0
ɔIs	4.0
Is	6.0
ɛs	9.0
is	9.0
os	9.0
us	9.0
aUs	9.0
ɔs	12.5
as	12.5

I/A BLENDS	
spl	1.0
sp	3.0
spr	3.0
sl	3.0
str	6.0
skw	6.0
sw	6.0
sk	8.5
sn	8.5
st	10.0
sm	11.0

F/A BLENDS	
kst	1
st	2.5
ks	2.5
rs	4.5
nst	4.5
ns	7.0
sk	7.0
ps	7.0
ls	9.0
ts	10.0

F/UA BLENDS	
ns	1.5
st	1.5

TABLE XII
RANK ORDER OF CORRECT DISCRIMINATIONS OF /s/
STUDENT'S RESPONSES ON TEST OF COMPARISON

PHONETIC CONTEXTS I/A SINGLES	RANK
so	1.0
sɛ	2.0
sɪ	5.5
si	5.5
saɪ	5.5
sɔ	5.5
su	5.5
saʊ	5.5
sæ	9.0
sʌ	10.5
sɔɪ	10.5
sɚ	12.5
se	12.5

I/A BLENDS	
sp	1.5
spl	1.5
str	3.0
sm	6.0
spr	6.0
sn	6.0
sl	6.0
sw	6.0
sk	9.5
skw	9.5
st	11.0

PHONETIC CONTEXTS I/UA SINGLES	RANK
sɚ	1.0
sə	2.5
so	2.5
sɛ	4.0

F/A SINGLES	
is	1.5
aɪs	1.5
ɪs	5.0
es	5.0
æs	5.0
ʌs	5.0
aʊs	5.0
ɛs	9.5
ɔs	9.5
os	9.5
ɔɪs	9.5
us	12.0
as	13.0

F/A BLENDS	
rs	2.5
ks	2.5
sk	2.5
kst	2.5
st	6.0
nst	6.0
ps	6.0
ls	8.0
ns	9.5
ts	9.5

F/UA BLENDS	
ns	1.5
st	1.5

TABLE XIII
RANK ORDER OF CORRECT DISCRIMINATIONS OF /s/
CLINICIAN'S RESPONSES ON TEST OF DELAYED JUDGEMENT

PHONETIC CONTEXTS I/A SINGLES	RANK
sɔɪ	1.0
sɛ	3.0
sɪ	3.0
se	3.0
si	7.0
sɝ	7.0
sɔ	7.0
saʊ	7.0
sæ	7.0
sʌ	11.0
saɪ	11.0
so	11.0
su	13.0

PHONETIC CONTEXTS I/UA SINGLES	RANK
sə	1.0
sɚ	3.0
sɛ	3.0
so	3.0

F/A SINGLES

aɪs	1.0
is	2.5
ɔɪs	2.5
ɪs	6.0
ɛs	6.0
es	6.0
ɔs	6.0
aʊs	6.0
æs	9.0
ʌs	10.5
us	10.5
as	12.5
os	12.5

I/A BLENDS

sp	1.0
sm	3.0
sl	3.0
sw	3.0
spl	5.0
spr	6.0
st	8.0
str	8.0
sn	8.0
sk	10.0
skw	11.0

F/A BLENDS

sk	1.0
rs	2.5
ks	2.5
st	5.0
nst	5.0
ps	5.0
ns	7.5
ls	7.5
kst	9.0
ts	10.0

F/UA BLENDS

ns	1.0
st	2.0

TABLE XIV
RANK ORDER OF CORRECT DISCRIMINATIONS OF /s/
CLINICIAN'S RESPONSES ON TEST OF COMPARISON

PHONETIC CONTEXTS	RANK
I/A SINGLES	
saɪ	1.5
saʊ	1.5
sɛ	4.5
si	4.5
sɔ	4.5
sɚ	4.5
so	8.0
su	8.0
sɔɪ	8.0
sɪ	10.5
sɝ	10.5
sʌ	12.5
se	12.5
I/A BLENDS	
sp	2.0
str	2.0
spr	2.0
sn	4.5
sl	4.5
st	7.0
spl	7.0
sw	7.0
sm	9.0
sk	10.0
skw	11.0

PHONETIC CONTEXTS	RATE
I/UA SINGLES	
sɔ	2.0
sɚ	2.0
so	2.0
sɛ	4.0
F/A SINGLES	
aɪs	1.5
aʊs	1.5
ɪs	5.5
æs	5.5
is	5.5
ɔs	5.5
ʌs	5.5
ɔɪs	5.5
ɛs	10.0
es	10.0
os	10.0
us	12.0
as	13.0
F/A BLENDS	
st	2.5
rs	2.5
ls	2.5
ps	2.5
sk	5.5
nst	5.5
ns	7.5
ks	7.5
kst	9.0
ts	10.0
F/UA BLENDS	
ns	1.5
st	1.5

Instantaneous Judgement and the rank order of frequency of occurrence of phonetic contexts in the English language. This was felt to be due to the small number (2) of phonetic contexts in the group.

4) A perfect correlation was found between the rank order of F/UA /s/ blends on the clinicians' Test of Delayed Judgement and the rank order of the frequency of occurrence of phonetic contexts in the English language. This was felt to be due to the small number (2) of phonetic contexts in the group.

CURRENT FINDINGS COMPARED TO CONCLUSIONS OF AUNGST AND FRICK

Aungst and Frick (1964) found that the traditional tests of auditory discrimination such as the Templin Sound Discrimination Test were not related to the consistency of articulation. In the present study, it was found that a statistically significant difference existed between the students' performance on the Deep Test of Articulation for /r/ and the Templin Sound Discrimination Test. The t-score was 3.57 which was significant at the .05 level which was required for significance. A comparison of the students' individual scores revealed that 16 of 20 children scored higher on the Templin Sound Discrimination Test than on the Deep Test of Articulation for /r/. This finding compared favorably to the group means which were used in the t-test. A comparison of the students' performance on the Deep Test of Articulation for /s/ and the Templin Sound Discrimination Test did not reveal a statistically significant difference. The t-score was 1.94 which was not significant at the .05 level which was required for significance. In comparing individual scores, it was

found that 15 of 20 children scored higher on the Templin Sound Discrimination Test than on the Deep Test of Articulation. However, the magnitude of score differences was not great enough to constitute a significant difference. The implication from this statistical analysis is that when the variable of phonetic context is added to the research design of Aungst and Frick, the relationship between the students' performance on the Deep Test of Articulation and the traditional test of discrimination does not remain consistent.

Aungst and Frick concluded that the ability to discriminate between paired auditory stimuli presented by another speaker was unrelated to the ability to judge one's own speech productions as correct of incorrect. To determine if this conclusion was true in the present study, a t-test was computed to compare the students' judgements on the Test of Instantaneous Judgement and Test of Delayed Judgement to the Templin Sound Discrimination Test. The students' percentage of correct discriminations was the score used for each test in this analysis. An alpha level of .05 was required for statistical significance. The results of this analysis are shown in Table XV:

TABLE XV
COMPARISON OF STUDENTS' TEST OF INSTANTANEOUS JUDGEMENT AND TEST OF DELAYED JUDGEMENT TO TEMPLIN SOUND DISCRIMINATION TEST

PHONEME	COMPARISON	t-SCORE
/r/	STIJ vs TSDT	2.62*
	STDJ vs TSDT	3.59*
/s/	STIJ vs TSDT	0.84
	STIJ vs TSDT	0.13

STIJ-Students' Test of Instantaneous Judgement
STDJ-Students' Test of Delayed Judgement
TSDT-Templin Sound Discrimination Test
* Indicates significance at the .05 level of significance

Since the Templin Sound Discrimination Test performance was significantly different from the performance on the Test of Instantaneous Judgement and the Test of Delayed Judgement for /r/ but not for /s/, it was again concluded that the conclusions of Aungst and Frick are not consistent when the variable of phonetic context is added to the research design. The finding that /r/ and /s/ are discriminated differently was supported once again in the findings of this comparison.

CONCLUSIONS

1) Six auditory discrimination tests were analyzed to determine if the tests evaluate speech sound discriminations in phonetic contexts proportionate to their use in the English language. It was concluded that these six tests of auditory discrimination are not phoneme specific since they were not designed to test a child's ability to discriminate specific phonemes in auditory stimuli. Furthermore, the tests do not possess concurrent validity since the phonetic contexts which are tested are not those which the child must discriminate in all listening situations.

2) In comparing production-perception relationships, it was found that a close relationship existed between the students' performance on the Deep Test of Articulation and his ability to judge his own speech under all conditions for making these judgements. This comparison also revealed that the clinician perceived differences in the child's performance that the child did not perceive. However, this is not a unique discovery since the clinician had been trained to hear errors which the child had not been trained to hear.

3) In comparing students' and clinician's judgements of /r/ and /s/, it was concluded that the students and the clinician agreed more frequently on the accuracy of the productions of /s/ than on the accuracy of the productions of /r/. This finding is supported by the findings of Alcorn, Griffith and Miner (1974) which revealed that in a comparison of defective

productions of /r/ and /s/, the /r/ stimuli were less acceptable to the listeners than the /s/ stimuli. Perhaps there are more allophonic differences in the distortions of /r/ than in the distortions of /s/ which would account for this difference in acceptance. However, in the scope of this research, such a question cannot be answered.

4) A t-test was used to statistically compare students' and clinician's judgements on all tests of auditory discrimination. It was found that a statistically significant difference existed between the students' and clinician's judgements of /r/. However, this difference did not exist for /s/.

5) Noting the discrepancies between /r/ and /s/ throughout this study, it was concluded that these are two different phonemes which children perceive with varying degrees of accuracy. In testing the auditory discrimination skills of adults, Daugherty (1974) found the same discrepancies between these two phonemes. Therefore, the remediation techniques used for /r/ may not necessarily be the optimal techniques for /s/ since the child perceives these phonemes differently.

6) In comparing the rank order of correctly discriminated phonetic contexts of /r/ and /s/ with the rank order of frequency of occurrence of phonetic contexts of /r/ and /s/ as determined by Griffith and Miner (1973), it was found that a statistically significant relationship did not exist between the two rank orders.

7) The significance of the sixth conclusion would infer that in this study the comparison of production and perception rank orders revealed that they are not highly related nor significant. However, this area of research does need further investigation since other studies such as Aungst and Frick (1964) and Travis and Rasmus (1931) did indicate significance between perception and production.

8) The findings of this research were compared to the conclusions of Aungst and Frick (1964) since this research design was developed by them. Consistently, it was found that the results of Aungst and Frick did not remain consistent when the variable of phonetic contexts was added to the research design.

CHAPTER V
SUMMARY AND CONCLUSIONS

SUMMARY

It was the purpose of this study to construct a deep test of auditory discrimination for the /r/ and /s/ phonemes which tested these phonemes in the most frequently occuring phonetic contexts in the English language. Forty children were tested under three conditions of auditory discrimination. Of these children, twenty had defective productions of /r/ and twenty had defective productions of /s/. Six presently used tests of auditory discrimination were analyzed to determine the frequency of occurrence of the most frequent phonetic contests as determined by Griffith and Miner (1973). The six tests of discrimination were: Goldman-Fristoe-Woodcock Test of Auditory Discrimination, Templin Picture Sound Discrimination Test, Templin Sound Discrimination Test, Test for Listening Accuracy in Children by Mecham and Jex, Wepman Auditory Discrimination Test and Boston University Speech Sound Discrimination Test.

This study was designed to answer the following questions:

1. Do presently used tests of auditory discrimination evaluate speech sound discriminations in phonetic contexts proportionate to their use in the English language?
2. If articulation defective children are given a deep test of articulation and a deep test of discrimination for /r/ and /s/ (development of both tests being based on the phonetic

contexts in proportion to their occurrence in the English language), do statistically significant relationships exist between their performances on these two tests?

3. Do correctly discriminated phonetic contexts rank order themselves similarly to their frequency of occurrence in the English language?

4. Does a statistically significant relationship exist between the articulation abilities and the auditory discrimination abilities?

The six tests of auditory discrimination were analyzed by tallying the number of times each of the phonetic contexts occurred in the test items for each test. The phonetic contexts used as criteria for this analysis were the most frequently occurring phonetic contexts as determined by Griffith and Miner (1973).

Forty children with functional articulation disorders of the /r/ and /s/ phonemes were selected for this study. Children with the following characteristics were excluded from the sample population in order to select a public school population of "average" intelligence:

1) those with organic involvement; 2) those who stuttered; 3) those with diagnosed voice quality problems; 4) those with diagnosed language delay; 5) those in classes for the mentally retarded or gifted and 6) those with hearing losses. These children were selected from grades two through six in the public schools of Effingham County, Illinois.

The deep tests of articulation used to evaluate the children's articulatory abilities were those used by Schneider (1973) for /r/ and /s/. The auditory discrimination tests for /r/ and /s/ were similarly constructed according to frequency of occurrence of phonetic contexts as determined by Griffith and Miner (1973). All test items were presented on tape to standardize the examiner's productions.

The testing procedure followed the format used by Aungst and Frick (1964) with the added variable of phonetic context. The following procedures were used:

1) Each child was given a deep test of articulation for his respective error phoneme.

2) The examiner trained the child in naming the test pictures.

3) The subject was asked to name the pictures and his response was tape recorded. Immediately following his response, the subject was asked to judge whether his production was "right" or "wrong" for this Test of Instantaneous Judgement.

4) For the Test of Delayed Judgement, the subject listened to a play-back of his "spontaneous" productions which were recorded during the Test of Instantaneous Judgement. The child reported his judgements of these productions as "right" or "wrong".

5) For the Test of Comparison, the subject heard the stimulus word on one tape recorded and he immediately repeated the word. The examiner's production on the master tape and the subjects' productions were recorded on a second tape recorder. After

recording the productions from the master tape and the subjects' productions, the tape was replayed. The subject was asked to judge whether his production was "right" or "wrong".

6) After the subject had completed the experimental discrimination tests, he was given a Templin Sound Discrimination Test from a tape recording.

To determine the percentage of agreement between the clinician and the students, the judgements were compared item by item. The percentages were compared between all of the tests to determine if one circumstance was better for the subject in making judgements of discrimination. A t-test was used to determine if a statistically significant difference existed between the subject's judgements and the clinician's judgements. For all t-tests, an alpha level of .05 was required for significance. To determine the rank order of phonetic contexts, the correct discriminations for /r/ and /s/ from all the experimental tests of discrimination were tallied and percentages computed. The percentages were ranked from high to low. This was done for each phoneme tested. To determine if the rank order of percentages of phonetic contexts discriminated correctly were comparable to those determined by Griffith and Miner (1973), the non-parametric statistic of rank order correlations, the Kendall-Tau, was used. To determine if a relationship existed between the articulation ability and auditory discrimination ability, the correct productions of /r/ and /s/ were tallied and percentages were computed. These percentages were used as data for a t-test with the alpha level for significance being .05.

CONCLUSIONS

The following conclusions were drawn from this study:

1) Six auditory discriminations tests were analyzed to determine if the tests evaluate speech sound discriminations in phonetic contexts proportionate to their use in the English language. It is concluded that these six tests of auditory discrimination are not phoneme specific since they are not designed to test a child's ability to discriminate specific phonemes in auditory stimuli. Furthermore, the tests do not possess concurrent validity since the phonetic contexts which are tested are not those which the child must discriminate in all listening situations.

2) In comparing production-perception relationships, it was found that a close relationship existed between the students' performance on the Deep Test of Articulation and his ability to judge his own speech under all conditions for making these judgements. This comparison also revealed that the clinician perceived differences in the child's performance that the child did not perceive. However, this is not a unique discovery since the clinician had been trained to hear errors which the child had not been trained to hear.

3) In comparing students' and clinician's judgements of /r/ and /s/, it was concluded that the students and the clinician agreed more frequently on the accuracy of the productions of /s/ than on the accuracy of the productions of /r/. This finding is supported by the findings of Alcorn, Griffith and Miner (1974) which revealed that in a comparison of defective productions of /r/ and /s/, the /r/ stimuli were

less acceptable to the listeners than the /s/ stimuli. Perhaps there are more allophonic differences in the distortions of /r/ than in the distortions of /s/ which would account for this difference in acceptance. However, in the scope of this study, such a question cannot be answered.

4) A t-test was used to statistically compare students' and clinician's judgements on all tests of auditory discrimination. It was found that a statistically significant difference existed between the students' and clinician's judgements of /r/. However, this difference did not exist for /s/.

5) Noting the discrepancies between /r/ and /s/ throughout this study, it was concluded that these are two different phonemes which children perceive with varying degrees of accuracy. In testing the auditory discrimination skills of adults, Daugherty (1974) found the same discrepancies between these two phonemes. Therefore, the remediation techniques used for /r/ may not be the optimal techniques for /s/ since the child perceives these phonemes differently.

6) In comparing the rank order of correctly discriminated phonetic contexts of /r/ and /s/ with the rank order of frequency of occurrence of phonetic contexts of /r/ and /s/ as determined by Griffith and Miner (1973), it was found that a statistically significant relationship did not exist between the two rank orders.

7) The significance of the sixth conclusion would infer that in this study the comparison of production and perception

rank orders revealed that they are not highly related nor significant. However, this area of research does need further investigation since other studies such as Aungst and Frick (1964) and Rasmus and Travis (1931) did indicate significance between perception and production.

8) The findings of this research were compared to the conclusions of Aungst and Frick (1964) since this research design was developed by them. It was found that the results of the Aungst and Frick (1964) did not remain consistent when the variable of phonetic contexts was added.

IMPLICATIONS FOR FURTHER RESEARCH

At the completion of this research concerning phonetic contexts and auditory discrimination skills, it was revealed that many research questions remained to be answered. The following implications for further research were suggested:

1) The allophonic differences of /r/ and /s/ should be further investigated under conditions of phonetic context variables. This was suggested since differences which are unexplainable exist between a child's ability to discriminate correct productions of /r/ and /s/.

2) Since children perceive /r/ and /s/ differently in a discrimination task, their ability to produce the two phonemes should be investigated under conditions of phonetic contexts. The purpose of this research would be to determine if children produce /r/ and /s/ with differing degrees of accuracy under identical testing or remediation techniques.

APPENDIX A
DEEP TEST OF ARTICULATION FOR /r/
(Griffith and Miner, 1973)

SINGLES

I/A		I/UA		F/A	
1. rich	/rI /____	1. Henry	/rI /____	1. bear	/ɛr/____
2. red	/rɛ/____	2. several	/rɛ/____	2. clear	/ir/ ____
3. real	/ri/ ____	3. railroad	/ro/____	3. war	/ɔr/ ____
4. race	/re/____			4. car	/ar/ ____
5. ride	/raI/____	SCORE	/3	5. four	/or/ ____
6. road	/ro/ ____			6. sure	/ur/ ____
7. room	/ru/ ____			7. carry	/ær/____
8. ran	/ræ/____			8. tire	/aIr/____
9. run	/rʌ/____			9. hour	/aUr/____
10. round	/raU/____				
11. rock	/ra/____			SCORE	/9
12. wrong	/rɔ/____				

SCORE /12

BLENDS

I/A		I/UA		F/A	
1. press	/pr/ ____	1. provide	/pr/____	1. art	/rt/ ____
2. trade	/tr/ ____	2. country	/tr/____	2. hard	/rd/____
3. grow	/gr/ ____	3. hundred	/dr/____	3. farm	/rm/____
4. break	/br/ ____	SCORE	/3	4. dark	/rk/____
5. free	/fr/ ____			5. horse	/rs/____
6. draw	/dr/____			6. large	/rdʒ/____
7. string	/str/____			7. north	/rθ /____
8. cross	/kr/____			8. born	/rn/____
9. three	/θr/____			9. march	/rtʃ /____
10. spread	/spr/____			SCORE	/9

SCORE /10

APPENDIX B
AUDITORY DISCRIMINATION TEST FOR /r/
TEST ITEMS

SINGLES

I/A		I/UA		F/A	
1. ring	/rI/	1. strawberry	/rI/	1. bear	/ɛr/
2. record	/rɛ/	2. several	/rə/	2. ear	/ir/
3 read	/ri/	3. railroad	/ro/	3. corner	/ɔr/
4. rake	/re/			4. car	/ar/
5. ride	/raI/	SCORE	/3	5. four	/or/
6. rope	/ro/			6. your	/ur/
7. ruler	/ru/			7. tire	/aIr/
8. rat	/ræ/			8. hour	/aUr/
9. run	/rʌ/			9. carry	/ær/
10. round	/raU/				
11. rock	/ra/			SCORE	/9
12. wrong	/rɔ/				
SCORE	/10				

BLENDS

I/A		I/UA		F/A	
1. present	/pr/	1. provide	/pr/	1. heart	/rt/
2. tree	/tr/	2. country	/kr/	2. yard	/rd/
3. grass	/gr/	3. children	/dr/	3. arm	/rm/
4. bridge	/br/	SCORE	/3	4. dark	/rk/
5. fruit	/fr/			5. horse	/rs/
6. dress	/dr/			6. large	/rdʒ/
7. straw	/str/			7. north	/rθ/
8. cross	/kr/			8. horn	/rn/
9. three	/θr/			9. march	/rtʃ/
10. spring	/spr/			SCORE	/9
SCORE	/10				

APPENDIX C
DEEP TEST OF ARTICULATION FOR /s/
(Schneider, 1973)

SINGLES

I/A		I/UA		F/A	
1. cent	/sɛ/ ____	1. person	/sə/____	1. kiss	/Is/____
2. sick	/sɪ/ ____	2. officer	/sə/____	2. yes	/ɛs/____
3. sun	/s /____	3. necessary	/sɛ/____	3. space	/es/____
4. seat	/si/ ____	4. also	/so/____	4. pass	/æs/____
5. size	/saI/____			5. peace	/is/____
6. sir	/sɚ/ ____	SCORE	/4	6. loss	/as/____
7. say	/se/ ____			7. ice	/aIs/____
8. saw	/sɔ/ ____			8. us	/ʌs/____
9. soon	/su/ ____			9. possible	/as/____
10. so	/so/ ____			0. close	/os/____
11. south	/saU/____			11. produce	/us/____
12. sat	/sæ/ ____			12. house	/aʊs/____
13. soil	/sɔI/____			13. voice	/ɔIs/____
SCORE	/13			SCORE	/13

BLENDS

I/A		F/A		F/UA	
1. stick	/st/ ____	1. best____	/st/	1. perhaps	/ps/ ____
2. speak	/sp/ ____	2. dance___	/ns/	2. next	/kst/____
3. strong	/str/ ____	3. its ____	/ts/	3. silence	/ns/ ____
4. sky	/sk/____	4. horse___	/rs/	4. forest	/st/ ____
5. small	/sm/____	5. box____	/ks/	SCORE	/4
6. spring	/spr/___	6. ask ___	/sk/		
7. explain	/spl/___	7. against__	/nst/		
8. square	/skw/__	8. else_____	/ls/		
9. snow	/sn/____	SCORE	/8		
10. sleep	/sl/____				
11. sweet	/sw/___				
SCORE	/11				

APPENDIX D
AUDITORY DISCRIMINATION TEST FOR /s/

SINGLES

I/A		I/UA		F/A	
1. seven	/sɛ/	1. salute	/sə/	1. kiss	/ɪs/
2. six	/sɪ/	2. survey	/sɚ/	2. dress	/ɛs/
3. sun	/sʌ/	3. necessary	/sɛ/	3. race	/es/
4. see	/si/	4. also	/so/	4. glass	/æs/
5. sign	/saɪ/			5. geese	/is/
6. circle	/sɝ/	SCORE	/4	6. cross	/ɔs/
7. sailor	/se/			7. ice	/aɪs/
8. saw	/sɔ/			8. bus	/ʌs/
9. sea	/so/			9. possible	/as/
10. soup	/su/			10. close	/os/
11. south	/saʊ/			11. juice	/us/
12. sandwich	/sæ/			12. house	/aʊs/
13. soil	/sɔɪ/			13. voice	/ɔɪs/
SCORE	/13			SCORE	/13

BLENDS

I/A		F/A		F/UA	
1. star	/st/	1. nest	/st/	1. silence	/ns/
2. spoon	/sp/	2. fence	/ns/	2. forest	/st/
3. straw	/str/	3. United States	/ts/	SCORE	/2
4. skirt	/sk/	4. horse	/rs/		
5. small	/sm/	5. box	/ks/		
6. spring	/spr/	6. mask	/sk/		
7. splash	/spl/	7. against	/nst/		
8. squirrel	/skw/	8. else	/ls/		
9. snake	/sn/	9. perhaps	/ps/		
10. sleep	/sl/	10. next	/kst/		
11. swing	/sw/	SCORE	/10		
SCORE	/11				

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