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The Relationship Between Changes in Articulatory Performance and Changes in Oral Sterognostic Ability in Children

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THE RELATIONSHIP BETWEEN CHANGES IN ARTICULATORY PERFORMANCE AND CHANGES IN ORAL STEREOGNOSTIC ABILITY IN CHILDREN

by
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This thesis submitted by Arlene A. Smolak in partial fulfillment of the requirements for the Degree of Master of Arts from the University of North Dakota is hereby approved by the Faculty Advisory Committee under whom the work has been done.

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ABSTRACT

The purpose of this study was to investigate the relationship between changes in oral stereognostic ability and changes in articulation proficiency in elementary-school children. The subjects for this investigation were seventeen normal-speaking children, with a mean age of seven years four months, and seventeen articulatory-defective children, with a mean age of seven years three months.

All of the subjects were administered the Arizona Articulation Proficiency Scale: Revised (AAPS) (Fudala, 1970) and a test of oral stereognosis twice in the 1977 school-year--both prior and subsequent to a period of articulation treatment with the speech-defective group. The interval between the measures was eight weeks.

The oral stereognostic task consisted of the subject identifying ten geometric shapes placed successively in his mouth by pointing to corresponding shapes presented visually before him.

Results of the study did not support former research which found a relationship between oral stereognostic ability and articulation proficiency.

The experiment failed to demonstrate that an improvement in oral stereognostic ability accompanied the refinement of articulation skills which occurred in the speech-defective group. A significant relationship was not found between oral stereognostic ability and severity of articulation defectiveness in either test situation in the

speech-defective group. A moderate correlation was found between age, grade, and oral stereognosis in the pre-test situation; however, the results of the post-test failed to demonstrate such a relationship. The experiment failed to show any significant difference between sexes on either the task of oral stereognosis or on the AAPS within either the normal-speaking group or the speech-defective group, in either test situation. No significant difference was found between the pre-test and post-test performance by the speech-defective subjects on the AAPS.

It could not be concluded from the results of this study that oral sensory perceptual processes develop as a result of articulation refinement. However, the low correlation observed between pre-test and post-test oral stereognostic performance by the normal-speaking subjects and speech-defective subjects raises question as to whether the oral stereognostic measure used in this study was a reliable research tool. Therefore, further research, to identify the nature of the interactions which underlie oral sensory perception and to determine the function of oral stereognosis as a component of articulation, is recommended.

CHAPTER I

INTRODUCTION AND REVIEW OF LITERATURE

Until recently, relatively little attention has been given to the potential role of oral sensory feedback in articulation production. The purpose of the present investigation was to determine the relationship between changes in oral stereognostic ability, a measurement of oral sensory perception, and changes in articulation proficiency in elementary-school children. The study involved the comparison of performances of children having defective articulation and children having normal speech on oral stereognostic and articulation tasks both before and after a period of speech therapy had intervened with the speech defective group.

Since this study was concerned with articulation and sensory processes, it was important to draw upon information gathered by other explorations dealing with the various sensory processes within the oral cavity and their relationship to articulation.

The speech production system is composed of effector, sensory, and control units all of which work jointly to activate, monitor, and control the movements which ultimately result in the audible end products of speech (Wolfe and Gouilding, 1973).

The effector unit operates to produce the interacting spatio-temporal articulatory movements requisite for speech.

Fundamental to these coordinated actions is the sensory information processed within the sensory unit of the speech mechanism (Wolfe and Gouilding, 1973). The development of the motor patterns of speech are related to the efficiency with which this sensory information is integrated with the motor activity. The function of integration is performed by the control unit. Articulation proficiency in speech is the result of the successful interaction of sensory information and motor activity.

Fucci and Robertson (1971) explain the existence of this sensori-motor interaction as requisite to articulatory skill; the child uses the sensory information accompanying his speech patterns until he perceives them as similar to those of the adult. These utterances are reinforced, habituated, and stabilized in subsequent practice. In the aforesaid model of articulation acquisition, there is the involvement of the sensory operations of audition, propioception, and taction.

Until recent years, much attention had been given to the role of audition as the primary sensor unit as illustrated by the Fairbanks model (McDonald, 1964). There has been a limited amount of research concerning the sensory processes of propioception and taction and their application to articulatory development (Blahauvietz, 1968). These channels of feedback had been regarded as secondary to the auditory sensory system in speech production. More recently, however, studies have resulted in an increased awareness of the part played by the propioceptive and tactile senses in monitoring speech.

Auditory alterations on speech output was the subject of a study by Ringel and Steer (1963). They reported that the use of masking noise alone did not significantly impair articulation in normal-speaking subjects. Van Riper and Irwin (1958) have suggested that the role of oral sensation may be more vital to feedback processes in the perception of articulation than audition once the speech patterns have been established. Van Riper (1972) describes propioceptive feedback as the most important control for monitoring speech after babyhood. Even with normal audition, a person may remain unaware of his articulatory-defective speech once propioception has been established as the primary monitoring channel.

In the study of a seventeen-year-old female with marked impairment of orosensory functions, MacNeilage and Rootes (1967) demonstrated the relative importance of propioceptive-tactile feedback. Even in the absence of motor damage, and even with normal information from the auditory modality, the patient was still unable to produce even moderately intelligible speech. The investigators concluded that the articulation disorder was the consequence of the somesthetic deficit.

McCroskey (1958) attempted to demonstrate the importance of tactile feedback to speech by studying the effects on speech of the imposing of sensory nerve blocks of the oral mechanism. He found that the injection of local anesthesia in and around the oral area of his subjects resulted in significant alterations in their otherwise normally-articulated speech. Further investigations in the area of oral region anesthetization was conducted by Ringel and Steer (1963). They too found speech articulation to be severely affected by sensory nerve blocks. Similar findings in further exploration of the effects of oral tactile alterations on speech output were reported by Ringel and Fletcher (1967) and Ringel and Putnam (1976).

In general, alterations of normal speech-related oral tactile perceptions result in speech output disturbance (Ringel and Ewanowski, 1965). Since decreased levels of articulatory performance is a consequence of alterations in oral tactile perception, it would seem that the normal development and maintenance of articulation presupposes adequate sensory functioning. Some sources of disordered articulation may be related to some oral somesthetic disturbance alone.

Due to the important clinical implications inherent to this orosensory-motor relationship, a number of investigations have developed procedures for the assessment of tactile perception of the oral cavity. One such procedure is oral stereognosis. Locke (1968, p. 1259) quotes Woodford (1964) in defining oral stereognosis as:

> . . . the faculty of perceiving the three-dimensional qualities (shape) of objects examined orally and of identifying them, while any inability to perform this task represents astereognosis regardless of where the deficit lies or whether it's organic or functional.

Oral stereognosis, then, requires peripheral, tactile, and kinesthetic receptors and a minimum level of motor involvement (Locke, 1968). It is, thus, conceived that motor and sensory development underlie both speech and oral stereognosis. Hence, astereognosis may be indicative of some deficit in either the motor or sensory units in the development and refinement of articulation.

It has been demonstrated that oral stereognosis varies with both speech intelligibility and severity of articulation disorder. Blahauvietz (1968) conducted a study in which two groups of children, a normal-speaking control group and a speech-defective experimental group, were required to perform a task designed to measure lingual stereognostic ability. Results of the experiment showed a significant relationship between the subject's lingual stereognostic ability, and the defectiveness of the subject's speech.

Ringel and Steer (1963), Ringel and Scott (1968), and Ringel et al. (1970) also studied the comparative oral stereognostic abilities of articulatory-defective speakers and normal speakers. The former group consistently made a larger average number of errors and was more variable in performance than the latter group. In addition, the average number of errors increased with the severity of the articulation problem. Thus, the articulatory-defective speakers had less success than their normal counterparts in average oral stereognostic performance.

Most of the studies in the area of oral sensory perception have involved the use of "functional" articulation-defective speakers as experimental subjects. Nevertheless, the experiments using defective speakers with organic pathologies (nervous system and oral structure) have obtained similar results. Creech and Wertz (1973) compared the performance of a group of dysarthric subjects with normal speakers and discovered an inferior oral-stereognostic ability in the former group. The authors thus concluded a definite relationship between articulation proficiency and oral stereognostic ability.

Investigators have also pursued the relationship between oral stereognosis and the acquisition of speech articulation. Locke (1968) compared oral sensory perception and articulation learning in two groups of young children. Results showed that children with good oral stereognosis were better able to learn speech sounds strange to their native language, and English phones, than were children with poor oral stereognosis.

Similarly, in a study comparing speech sound stimulability and oral form discrimination tasks, Sommers, Cox, and West (1972) reported that those children with poor oral stereognosis obtained lower stimulability scores than did normal speakers with good oral stereognosis.

The findings of these studies give evidence, then, of oral stereognosis as an important subskill in the refining of articulation. Conceivably, therefore, oral sensory perception facilitates articulation refinement.

An investigation conducted by Ringel and Bishop (1973) supported such a relationship between oral stereognosis and articulation acquisition. The oral sensory acuity and discrimination abilities of an orally-educated and orally-oriented deaf group were tested and compared to those of manually-educated and manually-oriented deaf subjects and to normal-hearing subjects. It was found that although the oral-deaf group made a greater percentage of errors than the normal-hearing group, the two groups did not differ greatly in error rates. On the other hand, the manual-deaf group made nearly three times as many errors as the oral-deaf group, demonstrating much poorer oral stereognostic ability. The oral discrimination deficiency of the deaf subjects, poorest in the manual-deaf group, indicates a deficit in some underlying ability which seems important for the acquisition of speech articulation. This deficit would seem to be sensory in nature.

The performance deficiencies may be interpreted as a function of insufficient practice in using speech skills.

These findings are especially significant to the interrelationship of oral sensory perception and articulation. Both the normal-hearing and orally-educated deaf individuals had proceeded through the comparatively normal development of the integration of oromotor and orosensory activity in speech articulation acquisition. Ringel and Bishop (1973) speculated that the manually-educated deaf individuals had not practiced speech and, thus, had not developed this orosensori-motor integration. Consequently, they demonstrated a perceptual deficit owing to inferior oral stereognostic performance.

It appears, from the above findings, that not only is the ability to develop and refine the fine motor movements of speech contingent, to a great extent, on orosensory perceptual ability, but also oral discrimination ability is dependent upon the acquisition of the fine motor movements of articulated speech and subsequent practice of the skill.

The important question is in the exact nature of the relationship between oral sensory perception and articulation acquisition. Do the development and maintenance of normal speech exist in a cause-effect relationship with oral sensory perception or are they interdependent skills related to other factors such as perceptual skill development or neurological maturation?

Locke (1968) suggested that articulation development terminates long before the underlying sensory processes have completed maturation. Nevertheless, one accompanies the other in the process of development.

Regarding articulation development and oral sensory perception as parts of a total system, one might hypothesize that were the termination of articulation refinement premature, and, therefore defective, the sensory processes would, in turn, be incomplete due to their mutual interdependence. If such a hypothesis of interdependence were to be correct, successful attempts at articulation refinement would witness an improvement in oral discrimination ability.

The purpose of the present study was to explore the existence of such a co-occurrence by assessing the comparative articulation and oral stereognostic skills of a speech articulation-defective group and a normal-speaking group of subjects, both before and after a period during which the speech-defective group received speech therapy for articulation errors.

To meet the purpose of this investigation, the following questions were asked:

1. What relationships exist among the variables used in this study: Pre-test and post-test administrations of the Arizona Articulation Proficiency Scale (AAPS) (Fudala, 1970); pre-test and post-test administrations of the oral stereognostic task; sex, grade, and age of the subjects; and groups to which the subjects were assigned?

2. What differences exist between the January testing of the AAPS and the March testing?

3. What differences exist between the January testing of the oral stereognostic task and the March testing?

CHAPTER II

PROCEDURES

The articulation and oral sterognostic skills of each subject were tested twice during the 1977 academic year: Once in January and then eight weeks later, in March. The experimental group received treatment for articulation defects during the interval between testing periods. The results of the articulation and oral sterognostic evaluations of the expermental and control groups were then subjected to statistical analysis.

Subjects

The subjects included a normal-speaking control group and a speech-defective experimental group. Each group consisted of seventeen children who were enrolled in the Dryden District Elementary Schools, Dryden, Ontario, Canada. The normal-seaking subjects ranged in age from five years three months to eleven years six months, with a mean age of seven years four months. The speech-defective subjects ranged in age from five years one month to eleven years seven months, with a mean age of seven years three months. Subjects selected were required to meet the following criteria:

1. As identified by public school and/or health records, observations by the clinician, and articulation testing results, the

child must have an articulation defect with no known organic cause for inclusion in the experimental group.

2. As identified by public school and/or health records, observations by the clinician, and articulation testing results, the child must have normal speech articulation for inclusion in the control group.

3. Each experimental subject must have a score below 92.5 on the _AAPS_.

4. Each control subject must have a score of 100.0 on the _AAPS_.

5. According to public school and/or health records, the child must have normal oral-structural relationships, no present or past sensory or motor disturbances, and normal intellectual capacity.

6. The age of each subject must fall within the range of 5.0 to 12.0 years.

7. Each experimental subject must be matched with his control subject in terms of school environment, sex, and age within a range of three months.

Articulation and Oral Stereognosis Evaluation

Each subject received articulation and oral stereognosis assessment. In each case, administration of the articulation test preceded that of the oral stereognosic test. The picture form of the _AAPS_ was the speech articulation test used in this investigation. Potential subjects were given an _AAPS_ score and classified in either the control or experimental group, or were eliminated from the study if they did not meet the criteria. Following the articulation testing, the oral stereognostic test was administered to the selected subjects. The test of oral stereognosis involved an oral form discrimination task which required the subject to match intraorally presented objects with an identical set of ten forms presented visually. The stimulus items were replications of the ten three-dimensional forms described by Ringel and others (1970). They were of clear plexiglass and of four geometric classes: triangular, rectangular, oval, and concave (Appendix 1). The shapes were fabricated such that they measured three millimeters in thickness and ranged from one to two centimeters in diameter. A small hole was drilled in each item and nylon thread attached as a safety measure.

The stimulus forms were presented successively to each subject. For each individual, the order or presentation of each item was randomized. Throughout each experimental session, the subject was not allowed to touch the stimulus materials with his hands. He was instructed to open his mouth. The experimenter then placed a stimulus form in his mouth. The forms were shielded from the subject's vision by the experimenter's cupped hand. Each subject was encouraged to explore the shape of the object by orally manipulating it in any way he preferred. He was allowed to keep it in his mouth for five seconds. Upon removal of the item from his mouth, the subject was referred to an identical set of shapes and required to identify the corresponding shape by pointing. The instructions given to the subject were informal but similar to those used by Locke (1968, p. 1261):

> We have small forms like these. . . . The form will be put in your mouth for you to feel with your tongue. You may move it in your mouth in any way you like but don't look at it. After feeling it with your tongue and mouth, point to the . . . form you think you have in your mouth. Take as much time as you like and guess if you are not sure.

Each stimulus form corresponded with a number on a score sheet (Appendix 2). The score sheet was used to record correct or incorrect identification of the shapes by the subject.

When all the individuals had been tested, the total number of shapes correctly identified, and the total number of shapes incorrectly identified were determined for each subject. The AAPS scores and the oral stereognostic scores were then subjected to statistical analysis.

CHAPTER III

RESULTS AND DISCUSSION

The purpose of the present study was to investigate the relationship between changes in oral stereognostic ability and changes in articulation proficiency in elementary-school children.

Seventeen children with normal speech and seventeen children with defective articulation were administered tests of articulation and oral stereognosis twice in the school year--both before and after a period of articulation treatment with the speech-defective group. The interval between the measurements was eight weeks.

The data collected from the oral stereognosis and articulation measures were variously grouped and analyzed on the basis of the questions posed in this study:

1. What relationships exist among the variables used in this study: Pre-test and post-test administration of the Arizona Articulation Proficiency Scale (AAPS) (Fudala, 1970); pre-test and post-test administrations of the oral stereognostic task; sex, grade, and age of the subjects; and groups to which the subjects were assigned?

2. What differences exist between the January testing of the AAPS and the March testing?

3. What differences exist between the January testing of the oral stereognostic task and the March testing?

Raw scores on the individual measures consisted of the test scores derived on the AAPS and the number of shapes out of a possible ten, correctly identified by the control and experimental subjects, in the pre-test and post-test situations. These scores are presented in Appendices 3 and 4.

The data collected from the two measures were variously grouped and analyzed to investigate relationships and differences between the performance of the experimental and control groups.

The performance of the two subject groups on the two testing conditions in the pre-test and post-test situations was compared using Pearson-product-moment correlation coefficients to determine the relationships which existed among the variables. Table 1 presents the correlation coefficients for all controlled variables.

Both pre-therapy and post-therapy subject performance on the AAPS were highly correlated with the group to which each subject was assigned (pre-test: $r = .87$; $p < .05$, and post-test: $r = .80$; $p < .05$). Since articulation performance was the basis for group assignment, this was to be expected.

Subject performance of the pre-test oral stereognostic task was moderately correlated with age ($r = .51$; $p < .05$), indicating that older subjects scored higher than younger subjects. The post-test, however, was not indicative of such a relationship ($p > .05$).

There was a moderate correlation between the pre-test oral stereognostic task and grade ($r = .41$; $p < .05$). This is supportive of the correlation between pre-test oral stereognosis and age, since age is highly correlated with grade ($r = .95$; $p < .05$).

TABLE 1

MATRIX OF CORRELATIONS FOR ALL VARIABLES

	Variable							
Variable	Sex	Group	Age	Grade	January AAPS	March AAPS	January Stereognosis	March Stereognosis
Sex		0.00	0.2	0.14	0.16	0.15	0.22	0.30
Group			0.0	0.00	0.87[a]	0.80[a]	0.16	0.23
Age				0.95[a]	0.11	0.07	0.51[a]	0.31
Grade					0.13	0.08	0.41[a]	0.33
January AAPS						0.96[a]	0.18	0.17
March AAPS							0.18	0.17
January Stereognosis								0.31
March Stereognosis								

Note: Lower half of matrix omitted

[a]$p < .05$ ($r \geq .34$)

The correlations between the articulation and oral stereognostic scores were not significant in either test situation ($p > .05$). Nor was there a significant relationship between the groups to which the subjects were assigned on the basis of their articulation performance and their performance on the oral stereognostic task in either test situation ($p > .05$). These results indicate that oral stereognostic performance cannot be meaningfully predicted from performance on measures of articulation proficiency. Nor are the results supportive of the converse, i.e., oral stereognostic performance is not reflective of articulation competence.

The possibility of oral stereognostic and articulation differences between sexes within either group in both test situations was then considered. The AAPS scores and oral stereognostic scores of the male and female subjects in both groups are shown in Appendices 5 and 6.

Tables 2 and 3 present the means of the raw scores obtained by the two subject groups on the pre-test and post-test measures of articulation and oral stereognosis.

An analysis of covariance procedure was used to compare the performance of the speech defective subjects and the normal-speaking subjects on the measures of articulation and oral stereognosis to determine whether a significant difference existed between the scores of the two groups.

Results of the analysis of covariance by the method of fitting constants for group and sex with the AAPS scores are shown in Table 4.

TABLE 2

THE MEANS OF THE RAW SCORES OBTAINED BY THE TWO SUBJECT GROUPS ON THE AAPS PRE-TEST AND POST-TEST

	Pre-Test	Post-Test
Control-Male	100.00	100.00
Control-Female	100.00	100.00
Experimental-Male	83.19	88.27
Experimental-Female	90.06	92.06

TABLE 3

THE MEANS OF THE RAW SCORES OBTAINED BY THE TWO SUBJECT GROUPS ON THE STEREOGNOSTIC PRE-TEST AND POST-TEST

	Pre-Test	Post-Test
Control-Male	4.788	4.788
Control-Female	4.125	4.000
Experimental-Male	4.333	4.222
Experimental-Female	3.500	2.875

Inspection of Table 2 reveals that the performance of the experimental female subjects in both pre-test and post-test administrations of the AAPS exceeded that of the experimental male subjects. In the pre-test, the females scores a mean of 90.06 while the males scored a mean of 83.19. In the post-test, the mean score of the experimental female subjects on the AAPS was once again higher than that of the male experimental subjects. The females scored a mean of 92.06 while the males scored a mean of 88.27. The results of the analysis of covariance presented in Table 4 showed, however, that the performance of the females on the AAPS was not significantly different from that of the males. The analysis of covariance procedure resulted in an F score of 0.398. An F score of 4.17 was needed for significance at the .05 level of confidence.

TABLE 4

SUMMARY TABLE FOR THE METHOD OF FITTING CONSTANTS IN THE ANALYSIS OF COVARIANCE FOR GROUP AND SEX ON THE AAPS

Source of Variation	df	SS	MS	F
Sex	1	1.196	1.196	0.398
Group	1	8.595	8.595	2.859
Interaction	1	1.551	1.551	0.516
Within	29	87.183	3.006	
Total		97.382		

Table 3 presents the means of the raw scores obtained on the oral stereognostic pre-test and post-test for the subject groups. Inspection of the table reveals that in both test situations, the performance of the males in both subject groups exceeded that of the females. In the pre-test the normal-speaking males performed better than the normal-speaking females (Mean of males = 4.788; Mean of females = 4.125). The post-test revealed a decrease in stereognostic score means for both males and females although the male score mean remained higher than that of the females (Mean of males = 4.778; Mean of females = 4.000).

Similar findings were shown in the performance of the experimental male and female subjects on the oral stereognostic tasks. In the pre-test, the speech-defective males performed better than the females (Mean of males = 4.333; Mean of females = 3.500). In the post-test, the males in the experimental group again exceeded the experimental females in mean score (Mean of males = 4.222; Mean of females = 2.875). Once again, a decrement in stereognostic mean scores occurred for both male and female subject groups. Overall, however, the mean scores of the males in both subject groups exceeded those of the females in oral stereognostic performance.

Results of the analysis of covariance by the method of fitting constants for group and sex with the oral stereognostic scores are shown in Table 5.

TABLE 5

SUMMARY TABLE FOR THE METHOD OF FITTING CONSTANTS IN THE ANALYSIS OF COVARIANCE FOR GROUP AND SEX ON THE ORAL STEREOGNOSTIC TASK

Source of Variation	df	SS	MS	F
Sex	1	6.310	6.310	2.155
Group	1	4.025	4.025	1.374
Interaction	1	0.587	0.587	0.200
Within	29	84.927	2.929	
Total	32	95.504		

Inspection of Table 5 reveals that the combined control and experimental male subjects did not perform significantly better than the female subjects on the oral stereognostic task. The analysis of covariance procedure resulted in an F score of 2.155. An F score of 4.17 was needed for significance at the .05 level of confidence.

The significance of the difference in mean scores of the AAPS pre-test and post-test which were obtained by the experimental group was determined by t test analysis. The results of the t test procedure are presented in Tables 6, 7, and 8.

TABLE 6

MEANS, STANDARD DEVIATIONS, DEGREES OF FREEDOM AND t-VALUE OF THE PRE-TEST AND POST-TEST OF THE AAPS FOR THE EXPERIMENTAL GROUP

	Pre-Test	Post-Test	t-Value
Mean	90.06	87.142	1.371
Standard Deviation	5.09	5.400	
Degrees of Freedom	32	32	

With 32 degrees of freedom, a t-value of 2.04 or greater is needed for significance at the .05 level of confidence.

The difference between the mean scores of the pre-test and post-test administration of the AAPS for the experimental group was 2.65 (Table 6). Analysis of the difference between the means yielded a t-value of 1.367 which was not significant at the .05 level of confidence.

TABLE 7

MEANS, STANDARD DEVIATIONS, DEGREES OF FREEDOM AND t-VALUE OF THE PRE-TEST AND POST-TEST OF THE AAPS FOR THE EXPERIMENTAL FEMALES

	Pre-test	Post-test	t-value
Mean	90.06	92.063	1.83
Standard Deviation	2.62	1.370	
Degrees of Freedom	14	14	

With 14 degrees of freedom, a t-value of 2.15 or greater is needed for significance at the .05 level.

TABLE 8

MEANS, STANDARD DEVIATIONS, DEGREES OF FREEDOM AND t-VALUE OF THE PRE-TEST AND POST-TEST OF THE AAPS FOR THE EXPERIMENTAL MALES

	Pre-Test	Post-Test	t-value
Mean	83.19	88.278	1.65
Standard Deviation	6.50	7.000	
Degrees of Freedom	16	16	

With 16 degrees of freedom, a t-value of 2.12 or greater is needed for significance at the .05 level.

The difference between the mean scores of the pre-test and post-test administrations of the AAPS for the experimental female subgroup was 2.003, resulting in a t-value of 1.826, which was not significant at the .05 level of confidence (Table 7).

The difference between the mean scores of the pre-test and post-test administrations of the AAPS for the experimental-male subgroup was 5.088 (Table 8). This difference resulted in a t score of 1.65 which also was not significant at the .05 level of confidence.

Although the post-test mean was higher, the experiment failed to establish any significant difference between the pre-test and post-test performance of the experimental group on the AAPS. This suggests that the interval between pre- and post-test periods should have been longer.

The oral stereognostic stimulus items were replications of those used in other studies (Appendix 1).

> They are known to represent a wide range of absolute identifiability and were selected to insure the multiple occurrence of items characterized by some gross geometric descriptions and differing essentially in some (undefined) size characteristic (Ringel et al., 1970).

Upon the oral and visual presentation of an item, the task of the subject was to determine whether the items were in the same shape category and to estimate the relative sizes of the two items. A judgment involving two items of different shape was referred to as a between-class comparison. A judgment involving two items of similar shape but different size was referred to as a within-class comparison.

The response errors of the control and experimental groups were arranged according to between-class and within-class types and were analyzed for four subject groupings. The experimental group was divided into two subgroups: Those subjects with AAPS scores below 89.0 in the pre-test situation were assigned to A_1. A_2 consisted of those subjects whose AAPS scores were equal to or greater than 89.0 in the pre-test situation. The two remaining groups used in the analysis were the control group and experimental group (total).

The findings in conjunction with the results are presented in Tables 9, 10, and 11. The means and standard deviations for the four groups on the error scores are presented in Tables 9 and 10.

TABLE 9

THE MEANS AND STANDARD DEVIATIONS OF BETWEEN-CLASS AND WITHIN-CLASS ERRORS FOR NORMAL-SPEAKING AND ARTICULATION-DEFECTIVE SUBJECTS ON THE ORAL-STEREOGNOSTIC PRE-TEST

	Between-Class Error			Within-Class Error	
Subject Group	N	Mean	Standard Deviation	Mean	Standard Deviation
Control	17	3.47	1.98	2.00	1.62
Experimental	17	3.06	1.56	2.82	1.29
A_1	8	2.75	1.39	3.25	1.49
A_2	9	3.33	1.73	2.44	.88

It can be seen from Tables 9 and 10 that the subject groups and sub-groups differ in the number of between-class and within-class errors. In the pre-test, the control group produced more between-class errors and less within-class errors than the experimental group and the less severe articulatory-defective speakers (A_2) produced a greater mean number of between-class errors than the more severe articulatory-defective speakers (A_1). However, the results of the post-test were not compatible with those of the post-test. In the post-test situation, the mean number of between-class errors and within-class errors increased as a function of severity of articulation deficiency. The experimental group as a whole produced more errors of both types than the control group. In both the pre-test and post-test situations, the more severe articulatory-defective speakers (A_1) produced a greater mean number of within-class errors than the less severe articulatory-defective speakers (A_2).

TABLE 10

THE MEANS AND STANDARD DEVIATIONS OF BETWEEN-CLASS AND WITHIN-CLASS ERRORS FOR NORMAL-SPEAKING AND ARTICULATION-DEFECTIVE SUBJECTS ON THE ORAL STEREOGNOSTIC POST-TEST

	Between-Class Errors			Within-Class Errors	
Subject Group	N	Mean	Standard Deviation	Mean	Standard Deviation
Control	17	2.59	1.77	2.88	1.58
Experimental	17	4.12	1.73	3.41	.86
A_1	8	4.63	1.77	2.50	.93
A_2	9	3.67	1.58	2.22	.83

To assess the significance of the differences in the mean number of errors of both types for the subject groups and subgroups, t test analysis was applied to the data. The summary of the t tests are presented in Table 11.

The only significant differences among the mean number of between-class and within-class errors were those which existed between the control group and the experimental group in the post-test situation. The t test analysis of the between-class and within-class errors yielded t-values of 2.55 and 2.54 respectively which were significant at the .05 level of confidence. The experimental group made significantly more errors of both types than did the control subjects on the post-test.

TABLE 11

SUMMARY OF t TESTS FOR THE SIGNIFICANCE OF THE DIFFERENCES IN THE MEAN NUMBER OF BETWEEN-CLASS AND WITHIN-CLASS ERRORS FOR NORMAL-SPEAKING AND ARTICULATION-DEFECTIVE SUBJECTS ON THE ORAL STEREOGNOSTIC PRE-TEST AND POST-TEST

	Pre-test t-value		Post-test t-value	
Group Comparison	Between-class	Within-class	Between-class	Within-class
Control vs. Experimental	.71	1.64	2.55[a]	2.54[a]
A_1 vs. A_2	.75	1.33	1.15	.65

[a]t with 32 d.f. at .05 level = 2.05

A second analysis of the data compared the mean number of errors made on between-class and within-class pairs within each group and subgroup. Tables 9 and 10 show that there was a greater number of between-class errors produced than within-class errors in all but two cases. In the pre-test, the more severe articulatory-defective speakers (A_1) produced more within-class errors than between-class errors. In the post-test situation, the experimental group as a whole produced more within-class errors than between-class errors.

Table 12 presents a summary of the t test analysis for the differences in mean number of errors for the between-class and within-class comparisons.

TABLE 12

SUMMARY OF t TESTS FOR THE SIGNIFICANCE OF THE DIFFERENCES IN THE MEAN NUMBER OF ERRORS WITHIN THE SUBJECT GROUPS AND SUB-GROUPS FOR BETWEEN-CLASS AND WITHIN-CLASS ERROR COMPARISONS

Group Comparison	Pre-test t-value	Post-test t-value
Control: between-class vs. within-class	.86	.18
Experimental: between-class vs. within-class	.17	.52
A_1: between-class vs. within-class	.35	1.51
A_2: between-class vs. within-class	1.13	1.10

With 32 degrees of freedom for the comparison of between-class error and within-class error pairs within the control and experimental groups, a t-value of 2.04 was needed for significance at the .05 level of confidence. With 14 degrees of freedom for the comparison of error pairs within the A_1 subgroup, and with 16 degrees of freedom for the comparison of error pairs within the A_2 subgroup, t-values of 2.15 and 2.12, respectively, were needed for significance at the .05 level.

Thus, inspection of Table 12 reveals that none of the mean differences between between-class error and within-class error pairs were statistically significant.

CHAPTER IV

SUMMARY AND CONCLUSIONS

The purpose of the present study was to investigate the relationship between changes in oral stereognostic ability and changes in articulation proficiency in elementary school children.

Seventeen normal-speaking children, with a mean age of seven years four months, and seventeen articulatory-defective children, with a mean age of seven years three months, were administered tests of articulation and oral stereognosis twice during the 1977 school year--both prior and subsequent to a period of articulation treatment with the speech-defective group. The interval between the measures was eight weeks.

On the basis of the various statistical measures used in this exploration of relationships between oral sensory perception and articulation skills, the following results were observed:

1. The low correlation between pre-test and post-test oral stereognostic performance by the normal-speaking subjects and speech-defective subjects ($r = .31$, $p < .05$) leads to doubt whether the oral stereognostic measure, used in this study, is a reliable research tool. It also calls into question other research which measured oral stereognostic ability in this way. This unsatisfactory level of reliability may be due to the complexity of the stimulus items which

perhaps were not within the perceptual capabilities of the subjects, or it may be a function of the task procedure of comparisons which did not limit itself to the modality in question but instead was a matter of intersensory (oral-visual) matching.

2. Neither a time period of eight weeks nor the combination of speech therapy and time resulted in an improvement in performance on the task of oral stereognosis by the normal-speaking group and speech-defective group. Because an improvement in performance on the oral stereognostic task did not accompany a refinement of articulatory skills, as measured by the AAPS, within the speech-defective group, it seems questionable that the acquisition of successful articulatory speech patterns facilitates increased levels of oral sensory perceptual ability.

3. The experiment failed to show a significant relationship between the subjects' oral stereognostic ability and the defectiveness of their speech as measured by the AAPS, in either the pre-test or post-test situation. The results seem to indicate that measurements of oral form discrimination are not predictive of articulation proficiency, nor is articulatory competence predictive of oral stereognostic ability.

4. The experiment suggests the possibility that oral stereognostic ability is developmental. The experiment failed to show a significant relationship between oral stereognostic ability and age in the post-test situation. However, the moderate correlation between age, grade, and oral stereognosis in the pre-test situation does seem to suggest that levels of oral sensory perceptual ability increase as a function of age. Older subjects tended to perform better on the oral

stereognostic task than younger subjects. This relationship may be due to maturation. The older subjects may be more proficient in stimulus exploration due to superior motor abilities that permit easier manipulation of stimulus items. The relationship may be due, also, to factors such as more mature motivational attitudes or attention and retention span.

5. The experiment failed to show any significant difference between sexes on the task of oral stereognosis and on the AAPS within either the normal-speaking group or speech-defective group, in either the pre-test or post-test situation.

6. The experiment failed to show a significant difference between the pre-test and post-test performance by the speech-defective subjects on the AAPS. The results seem to indicate that the refinement in articulation skills, which occurred within the speech-defective group, in the eight-week interval, was not significant.

Thus, the results of the present study did not support the research of prior investigations which found a relationship between articulation performance and oral stereognostic ability.

Because of the questionable reliability of the oral stereognostic task, it could not be concluded that oral sensory perceptual processes develop as a result of the acquisition and practice of the successful motor placements and movements of speech articulation.

Recommendations for Further Research

It is recommended that, in the future, similar research continue in the effort to identify the exact nature of the interactions which underlie oral sensory perception, and, to determine the function of oral stereognosis as a component of articulation.

The following suggestions are offered for further research:

1. A study to clearly establish the reliability or levels of reliability of any measure of oral stereognostic ability should precede use of that measure in any future study and should be considered when evaluating previous studies.

2. Similar studies utilizing a larger number of subjects in each group are recommended.

3. Similar studies utilizing older subjects are recommended.

4. Similar studies might utilize experimental subjects with a greater range of severity of defectiveness of articulation.

5. In similar studies, a greater interval of time between pre-test and post-test measurements is recommended.

6. In the future, researchers might consider limiting stimulus item comparisons to the intraoral modality.

APPENDIX 1

ORAL STEREOGNOSTIC SHAPES

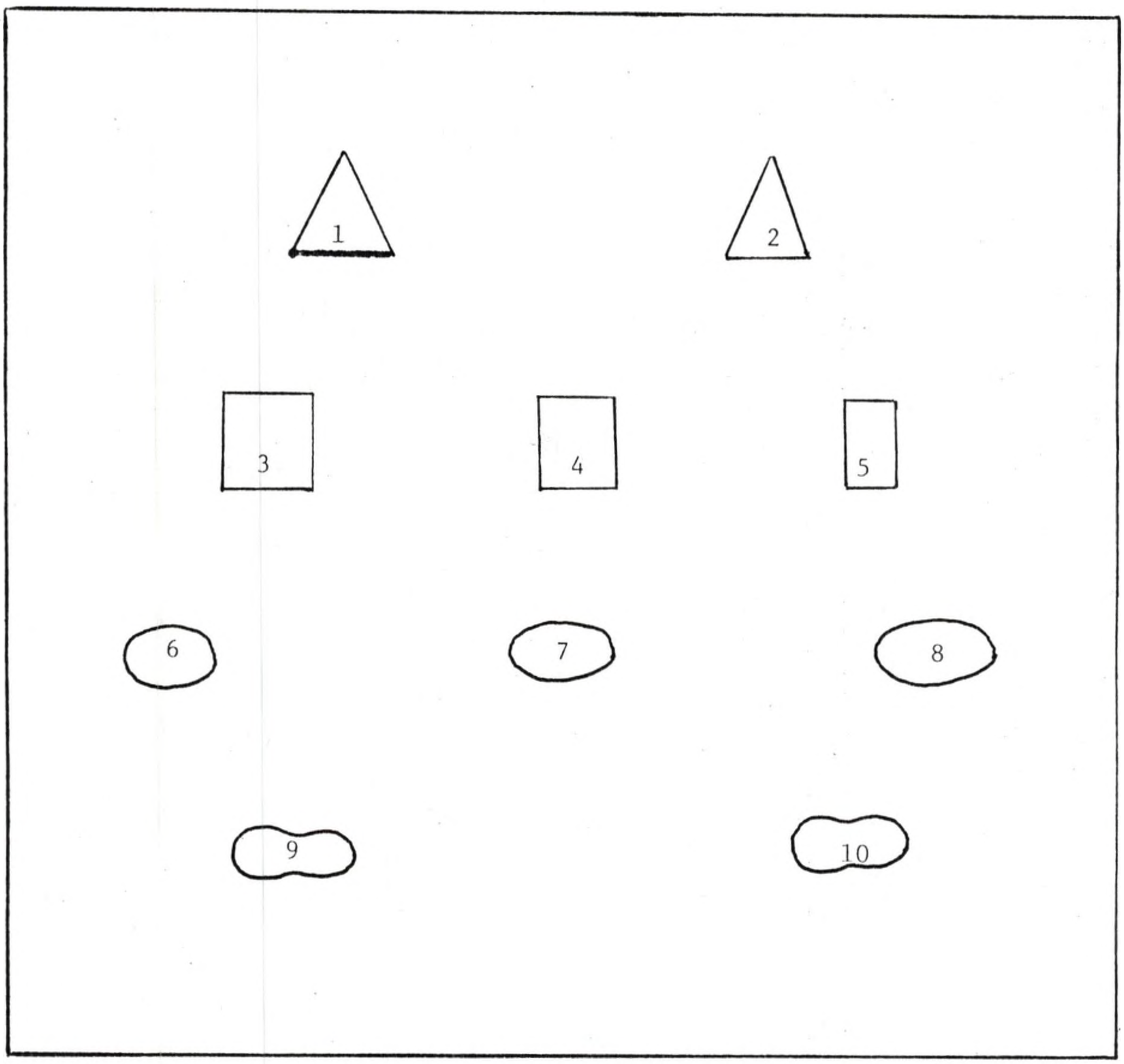

Fig. 1.--Oral Stereognostic Shapes.

APPENDIX 2

ORAL STEREOGNOSTIC TEST SCORE SHEET

Name ______________________

Age __________ Grade ______________

School ______________________

Teacher ______________________

	Correct	Incorrect
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

APPENDIX 3

ARTICULATION AND STEREOGNOSTIC TEST SCORES FOR THE PRE-TEST SITUATION

TABLE 13

ARTICULATION AND STEREOGNOSTIC TEST SCORES FOR THE PRE-TEST SITUATION

Control		Experimental	
Articulation	Stereognostic	Articulation	Stereognostic
100.0	1	84.0	2
100.0	1	91.5	4
100.0	7	85.5	4
100.0	4	91.5	1
100.0	4	89.0	4
100.0	5	85.5	5
100.0	3	83.0	5
100.0	2	71.0	3
100.0	5	89.0	3
100.0	6	89.5	7
100.0	4	91.5	3
100.0	5	84.5	3
100.0	5	88.5	4
100.0	7	90.5	2
100.0	5	92.0	6
100.0	6	88.0	6
100.0	6	91.5	5
Means			
100.0	4.471	87.412	3.941

APPENDIX 4

ARTICULATION AND STEREOGNOSTIC TEST SCORES FOR

THE POST-TEST SITUATION

TABLE 14

ARTICULATION AND STEREOGNOSTIC TEST SCORES FOR THE POST-TEST SITUATION

Control		Experimental	
Articulation	Stereognostic	Articulation	Stereognostic
100.0	1	90.0	2
100.0	2	93.5	4
100.0	4	93.0	4
100.0	5	92.5	1
100.0	3	91.5	5
100.0	6	87.5	3
100.0	5	90.5	5
100.0	6	71.0	4
100.0	4	92.0	4
100.0	6	90.0	3
100.0	8	92.5	1
100.0	6	85.0	5
100.0	4	90.5	1
100.0	1	92.5	3
100.0	5	93.5	5
100.0	3	93.0	5
100.0	6	92.5	6
Means			
100.0	4.412	90.06	3.58

APPENDIX 5

CONTROL GROUP AND EXPERIMENTAL GROUP *AAPS* SCORES BY SEX

TABLE 15

EXPERIMENTAL GROUP AAPS SCORES BY SEX

Pre-test			Post-test	
Male	Female		Male	Female
85.5	84.0		93.0	90.0
89.0	91.5		91.5	93.5
85.5	91.5		87.5	92.5
83.0	89.0		90.5	92.0
71.0	89.5		71.0	90.0
84.5	91.5		85.0	92.5
88.5	90.5		90.5	92.5
88.0	92.0		93.0	93.5
91.5			92.5	
		Means		
83.19	90.06		88.28	92.06

Note: Each male and female control group subject received an AAPS score of 100.0 in both the pre-test and post-test situations. Therefore, the control group AAPS scores have not been presented in table form.

APPENDIX 6

CONTROL AND EXPERIMENTAL STEREOGNOSTIC SCORES BY SEX

TABLE 16

CONTROL GROUP STEREOGNOSTIC SCORES BY SEX

Pre-test		Post-test	
Male	Female	Male	Female
7	1	4	1
4	1	3	2
5	4	6	5
3	5	5	4
2	6	6	6
5	4	6	8
5	7	4	1
6	5	3	5
6		6	
Means			
4.778	4.125	4.778	4.0

TABLE 17

EXPERIMENTAL GROUP STEREOGNOSTIC SCORES BY SEX

Pre-test		Post-test	
Male	Female	Male	Female
4	2	4	2
4	4	5	4
5	1	3	1
5	3	5	4
3	7	4	3
3	3	5	1
4	2	1	3
6	6	5	5
5		6	
Means			
4.333	3.5	4.222	2.875

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