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An Investigation of Oral Stereognosis and Articulation in Sighted and Blind Children

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AN INVESTIGATION OF ORAL STEREOGNOSIS AND ARTICULATION IN SIGHTED AND BLIND CHILDREN

by

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in Sighted and Blind Children

by

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The purpose of this investigation was to determine if a significant difference exists between oral stereognosis skills of blind and sighted children. The possibility of a relationship between oral stereognosis and articulation was also explored in both the sighted and blind populations. A group of twenty-four blind and a group of twenty-four sighted subjects between the ages of seven and twenty were divided into subgroups of those having normal speech and those with defective articulation. There were twelve subjects in each subgroup. A 20-item test of oral stereognosis (NIDR forms) was administered to each subject and error scores taken.

Results of the study indicate that no significant difference exists between the oral stereognosis abilities of sighted and blind subjects. A significant difference was found to exist at the .01 level between oral stereognosis scores of normal speakers and articulatory impaired speakers. This difference was also found to be significant between the blind subgroups but not between the sighted subgroups.

(71 pages)

INTRODUCTION

In conducting speech therapy, a speech pathologist often finds it necessary to instruct a client in proper positioning of the articulators in order to achieve correct production of a phoneme. This method of instruction is dependent upon the client's awareness of his oral structures and his ability to manipulate them in response to either a verbal command or a visual model. Such a procedure requires, on the part of the client, the utilization of oral kinesthetic or tactual feedback, audition, and/or vision.

When conducting speech therapy with a blind client it is obviously not possible to utilize the visual channel. Therefore, the other two modes of instruction must be relied upon to a greater degree. The blind person must be able to learn to make a correct sound through the use of auditory discrimination and oral tactile-kinesthetic cues. In 1972, members of a clinical team from the Utah State University Department of Communicative Disorders found some difficulty in using the latter method of instruction when conducting therapy with blind children at the Utah State School for the Blind. Many of these children experienced difficulty responding to even simple tongue placement commands.

Such observations raised some questions as to whether or not this seeming deficiency in oral perception was indicative or an overall disruption of oral sensation and whether or not this was characteristic of the blind population as a whole.

At the time of this writing, no published research could be found which has dealt directly with this question. This study will attempt to assess the oral sensory abilities of blind children as compared to sighted children.

There has been, recently, a growing body of research literature concerning the contribution of oral sensory feedback to articulatory proficiency. The general indication seems to be that a positive relationship may exist between oral sensation and articulation, although the research is somewhat contradictory at this point. This study will have incorporated into its design a means of determining whether any difference exists between oral sensory perception, as measured by a modified test of oral stereognosis, of children with normal speech and those with defective articulation.

A further consideration will be whether the blind population demonstrates a difference in oral sensory perception of normal speakers and articulatory impaired speakers.

The comparing function refers to the process whereby the messages coming back from the motor are matched against a predetermined standard pattern of some sort. When the actual feedback fails to correspond with the desired feedback, corrective measures are immediately taken.

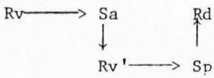
Fairbanks (1954) and Mysak (1949) both discuss the speaking system as one which has at least the rudiments of a closed cycle or servosystem. Such a system employs feedback of the output to the place of control, comparison of the output to the input, and manipulation of the output-producing device that will cause the output to have the same functional form as the input. The system performs its task when, by these means, it produces an output that is equal to the input times a constant.

Fairbanks (1954) describes the speech servosystems as being comprised of a control unit, effector unit and sensor unit. The effector unit is comprised of a motor, a generator and a modulator. These are analogous to the respiratory, vibratory and resonating structures, respectively. The effector unit is responsible for producing the output, or speech. The sensor unit has three parts labeled sensor 1, 2, and 3. Sensor 1 is the primary receiver of the acoustic stimulus, the ear. Sensor 2 and sensor 3 symbolize the tactile and proprioceptive end-organs, which supply data about the mechanical operation of the effector. The sensor unit relays its data to the controller unit in the form of feedback signals. The controller unit is an automatic device that issues specific orders to the effector. It is here that the feedback signal is compared with the intended signal and any correction is made in orders being sent to the effector unit.

Lane (1965) describes still another theory of speech perception, called the motor theory, which maintains that articulatory movements and their sensory feedback mediate between the acoustic stimulus and the perception of speech. The observed sequence of events in a speech-perception episode can be represented as in this diagram.

Rv ——> Sa ——> Rd

Rv, a vocal response, generates an acoustic stimulus, Sa, which leads to a discriminative response, Rd. According to the motor theory of speech perception, the following diagram shows the expanded sequence of events.



The acoustic stimulus leads to a covert, articulatory response, Rv', whose proprioceptive feedback, Sp, leads to the discriminative response.

In addition to the mechanical aspects of speech production, Van Riper and Irwin emphasize the importance of the learning process in this complex behavior of speech:

> At first [a child] must compare the self-hearing of his own utterance with the sounds that come from his parents' mouths. If they match and he is rewarded, the kinesthetic or tactual echoes or messages from his tongue position at that moment tend to become vivid and important. Soon the kinesthetic or tactual feedback is sufficiently stabilized to serve as the dominant control for speech, and the ear feedback, though still present, takes a secondary role. (Van Riper and Irwin, 1958, pp. 109-110)

In each of these explanations of the speech process, one element which stands out as being essential to its proper functioning is feedback, both auditory and tactile-kinesthetic. Konigsmark, referring to feedback, states:

> There is a sensory flow back to the central nervous system, probably indicating the position of all of the structures related to speech, allowing other centers as the cerebellum to project the necessary impulses for a smooth flow of motor activity. Speech is also modified by hearing the spoken words, matching the output to that which is desired. (Konigsmark, 1970, p. 3)

Inasmuch as all the subjects used in the present study were judged as having normal hearing, the auditory channel of feedback will not be discussed to the extent that will tactile-kinesthetic feedback. Van Riper and Irwin (1958) and also McCall (1969) have found through their studies that the role of kinesthesia and tactile sensation in the oral cavity seem to be more vital to the feedback process in the perception of articulatory placement than audition, once speech patterns have been established.

Oral Stereognosis

A number of investigators have studied the tactile sensory system as an important element in the speech feedback network and have devised various ways of testing oral sensation and perception, one of which is oral stereognosis. Stereognosis is defined by Ruch and Patton (1965) as being an appreciation of the form of objects by palpations without the aid of vision. This definition was given in reference to manual exploration of objects, but Arndt et al. (1970) suggest that "oral stereognosis" be the term used to refer to the faculty of identifying objects through oral exploration. Thompson (1969) defines oral stereognosis as the faculty of perceiving the nature of objects on the basis of tactile-kinesthetic sensations from the oral cavity, particularly the tongue. Woodford (1964) defines oral stereognosis more specifically in stating that it is the ability to identify objects by perceiving the three-dimensional qualities (shape) of objects examined orally.

Tests of oral stereognosis

Several versions of oral stereognosis tests, or tests of oral form-identification have been developed and used. Tests developed by various investigators have differed in number and type of forms used as well as the exact nature of the task required of subjects. The test found to be most often used was a 20-item test described by Shelton, Arndt and Hetherington (1967) which uses forms standardized by the National Institute of Dental Research (NIDR).

McDonald and Aungst (1967) conducted a study using a set of five three-dimensional forms.

Aungst (1965) also used a 25-item test which was comprised of the twenty NIDR forms and the set of five three-dimensional forms.

Ringel, Burk, and Scott (1970) and McDonald and Aungst (1970b) utilized a shortened 10-item test in which the ten test stimuli were drawn from the 20-item NIDR forms.

Related tests

Though the most common method of assessment of oral sensory abilities has been that of oral form recognition (Ringel, 1970b), there have been numerous other tests developed to evaluate various aspects of oral sensation and perception.

Fairbanks and Bebout (1950) developed a duplication of tongue position task in which the subject was required to extend the tongue to a stop plate ten times in succession, then attempt to duplicate the distance with the tongue without the stop plate in place. A measurement of maximum length of tongue protrusion and tongue force, measured by pressing the tongue against an apparatus, were also included. This particular test was judged by Rutherford and McCall (1967, p. 190) to have a "lack of a priori relevance to the act of speaking" and was therefore eliminated from their test battery.

Two-point discrimination is a frequently used procedure for assessing oral awareness. Ringel and Ewanowski (1965) utilized an oral two-point esthesiometer, which is described by Ringel (1970a), to determine two-point thresholds. The subject is presented with two stimulus points on various areas of the oral region. The probe tips are presented with successive increments or decrements in distance between them. The subject is instructed to indicate whether he felt one or two stimulus points. Other studies utilizing two-point discrimination have been conducted by Grossman (1964) and Rutherford and McCall (1967).

Numerous and varied procedures, less prevalent, have been used by researchers for the assessment of tactile sensitivity of the oral region. Grossman, Hattis, and Ringel (1965) have used nylon filaments and also, for the determination of oral tactile threshold, an electromechanical force transducer. Arndt et al. (1970) used a pressure aesthesiometer to test tongue tip pressure sensitivity. Ringel, Saxman, and Brooks (1967) did a study concerning mandibular kinesthesia in which they took measures of the magnitude of change in mandibular positioning that were necessary for the perception of such change. McDonald and Aungst (1967) reported on a study which utilized several measures of oral sensation and perception. One test included in this battery was designed to measure the subject's ability to differentiate between weights presented in the mouth. Tactile localization, another test in the battery, was assessed by touching the subject with a wisp of cotton and with the end of an applicator stick at various oral locations. Each subject was asked if he had been touched and if so, to locate the area. Oral-texture discrimination was assessed through the use of three plastic discs with different textured surfaces. The discs were presented successively in pairs, and the subject was asked to indicate which of the pair seemed to be rougher. Ringel and Fletcher (1967) also conducted a study assessing oral-texture discriminating abilities. Tactile pattern recognition and kinesthetic pattern recognition were two tests used by Rutherford and McCall (1967). Grossman (1967) developed a test of electrical stimulation to serve as a wherewithall of the mouth. Fucci (1972) conducted an investigation which tested for threshold responses to vibrotactile stimulation on both oral and nonoral regions.

Validity of tests

Research concerning the role that oral sensory feedback plays in relationship to speech is still relatively new and development of testing instruments to evaluate this relationship is still in its early stages. Observations of some studies "seem to raise an important question about the adequacy of present measures for evaluating the input from oral sensory end organs which aids in control of the movements by which articulate speech is produced." (McDonald and Aungst, 1970a, p. 395)

There has also been some problem with finding a significant relationship between several of the oral perception tests developed. Williams and LaPointe (1972) found no significant relationships between intraoral form recognition and interdental-thickness discrimination or between interdental-weight discrimination and interdental-thickness discrimination. However, a significant ($p<.05$) inverse relationship was found between intra-oral form identification and interdental-weight discrimination. Those who were able to detect very small differences in weight interdentally also performed very well at recognizing shapes in the mouth. Williams and LaPointe hypothesized that the reason for correlation or lack of correlation in this study may have to do with sensory substrata and location of the place where judgment is made or common sensory networks.

Another study conducted by Williams and LaPointe (1971b) found no significant ($p<.05$) correlations between tasks of oral stereognosis, lingual light-touch detection and lingual two-point discrimination. These researchers suggest that this lack of correlation may reflect procedural error in their study. They state:

> That the measures are unrelated seems unlikely, for in order to correctly identify a form intra-orally one must first be aware of its existence within the oral cavity and secondly, with many geometric shapes the recognition of two points such as the separate points of a star is a prerequisite to recognition of the form. (Williams and LaPointe, 1971b, p. 842)

Considering several of the test instruments presently developed and researched McDonald and Aungst (1967, p. 219) seem to agree that "as a measure of oral sensory function, form identification in the mouth (oral stereognosis) seems to be more promising than two-point discrimination, weight perception, localization or texture discrimination."

Sensory acuity of oral regions

Testing of the oral region has shown that the oral cavity does not demonstrate uniform sensitivity. Certain regions of the oral cavity are more capable of making perceptual evaluations than others, and different stimuli depend on different oral regions for their successful evaluation (Ringel, 1970b). In general, research in two-point discrimination indicates that the front of the mouth is more sensitive than its posterior regions and that increased discriminability exists at the midline of the structure. The tongue tip was found to be significantly more discriminate to two-point stimulation than any other oral structure studied (Ringel and Ewanowski, 1965). However, the tongue blade is capable of more accurate texture judgements than the tongue tip and lips (Ringel and Fletcher, 1967). Grossman, Hattis and Ringel (1965) reported that the lip exhibited more sensitive tactile thresholds than the incisive papilla. Arndt, Elbert and Shelton (1970) observed that fewer forms were identified when explored by the lips alone than the entire oral cavity and tongue. This seems to indicate that oral form recognition is a skill for which lingual sensitivity and manipulation are paramount. The results of studies which have tested various parameters of oral sensitivity indicate that the progression from maximal to minimal discrimination involves the lingual, labial and palatal structures in that order, and that the lingual region rivals the fingertip in relative sensitivity (Ringel and Ewanowski, 1965).

Oral Sensation and Articulation

It has been observed that a significantly high incidence of lingual agnosia occurs among speech defective populations (Palmer, Wurth and Kincheloe, 1963). Considering the important role the tongue plays in oral sensation, one might wonder if there exists a relationship between oral sensitivity and speech articulation.

This is a question that is presently receiving increased attention from researchers. A great number of studies associated with this question have been done but no conclusive answer has yet been found. The general indication seems to be that a relationship does exist between oral sensory perception and articulation. Weinberg, Liss and Hillis (1970, p. 350) state that "the production of normal speech requires the spatial and temporal regulation of the movement patterns of the articulators." McDonald (1964) and Van Riper and Irwin (1958) hypothesize that accurate oral sensory information about these movement patterns is essential for the production of normal speech.

Disordered articulation

A number of investigators have attempted to explore the relationship between oral sensitivity and articulation by comparing normal speakers with articulatory-defective speakers on various tests of oral perception and discrimination. Studies conducted by Moser, LaGourgue, and Class (1967), Ringel, Burk and Scott (1970), Ringel et al. (1970) and Weinberg, Lyons and Liss (1970), indicated that articulatory-defective speakers have more difficulty on tests of oral form recognition than do their normal-speaking controls. This has been demonstrated for children as well as adults (Ringel et al., 1970).

Class (1956) also found a significant relationship between oral stereognosis and disordered articulation. Results of a study run by Fucci and Robertson (1971) indicated that subjects considered to have "functional" articulation disorders made fewer and proportionately different types of correct responses in tasks of oral form discrimination than were made by a comparable group of normal speakers.

Aungst (1965) conducted a study involving kindergarten and first grade pupils in which only a slight association between articulation proficiency and oral stereognosis ability was found. While the correlations were low, the correct production of some speech sounds (e.g., /r/ and /θ/) appeared to be more closely associated with oral stereognosis ability than correct production of other speech sounds (e.g., /s/ and /l/). Weinberg, Liss and Hillis (1970) explored these findings further by comparing oral, visual, and manual form identification in /r/ defective and normal speaking junior and senior high school students. It was found that speakers with /r/ sound misarticulation were significantly ($p<.05$) less proficient in oral form perception than the normal speaking control sample.

Fucci (1972) used vibrotactile stimulation to test for threshold responses to both oral and nonoral regions with a group of normal speaking adults and a group with "functional" articulation speech defects. Results of the study indicated that the normal-speaking subjects, in general, demonstrated more sensitive oral-tactile thresholds to vibratory stimulation than the "functional" articulation-defective subjects. The normal-speaking subjects and articulation-defective subjects, in general, did not show consistent differences with respect to nonoral sensitivity to vibratory stimulation. This lack of a consistent difference in nonoral sensory performance provides support for the contention that differences in tactile sensitivity between normal speakers and those with articulation defects, if present at all, are not necessarily throughout the entire body.

A study by Ringel, Burk and Scott (1970) demonstrated that measurements of oral form discrimination can differentiate between degrees of articulatory proficiency that have been previously established by independent means. Thus, children and adults with mild articulatory problems make more errors than normals, but significantly fewer errors than speakers with more severe articulation problems.

Contrary to these findings, two investigations were found that failed to demonstrate clear relationships between articulatory performance and oral-form skill. Moser, LaGourgue and Class (1967) report on an exploratory study done by Jack Kile in which no significant difference was found between the scores obtained by normal speakers and speakers with articulatory disorders. Arndt, Elbert and Shelton (1970) also failed to find any significant differences.

Class (Moser, LaGourgue and Class, 1967) made an interesting finding with regard to a speech disorder other than articulation. It was found that a group of stutterers made significantly (5 percent level) poorer oral form recognition scores than normal speakers. In addition, these stutterers did not differ significantly in oral form recognition scores from speakers with articulation problems.

Oral training therapy

Some researchers have explored the possibility of using oral form recognition training as a therapeutic tool in articulation remediation. Locke (1968) found that children with inaccurate oral perception were less able to learn new consonant articulations than children with accurate oral perception. These results seem to suggest that efficient oral perception facilitates articulation learning.

Wilhelm (1971) converted a test of oral form recognition into an instrument for use in oral training. Results of a study using this instrument indicated that oral form recognition training when combined with repeated articulation testing resulted in improved articulation.

Contrary to these findings, Shelton, Willis and Johnson (1973) found that oral form recognition training did not influence articulation and that no articulation improvement resulted. Results also showed that oral form recognition skill (oral stereognosis) did not appear to improve with training. These researchers, therefore concluded that oral form recognition training, such as used in this study, could not be considered a suitable treatment for disordered articulation. Although "research shows that articulation and oral sensation are related ... such a relationship does not indicate that manipulation of one variable is an effective means for influencing the other" (p. 530).

Sensory Evaluation of Pathological Speakers

Oral stereognosis has also been utilized in assessing sensory abilities in pathological speakers. Class (Moser, LaGourgue and Class, 1967) evaluated twenty cerebral palsied individuals, representing various types of the disorder, using six geometric forms in seven different sizes. It was found that the individuals with cerebral palsy were significantly (1 percent level) less adept at making identifications than the normal control group of speakers.

Solomon (1965) reported that in a group of athetoid patients, form recognition was positively correlated with ratings of chewing and drinking ability and with articulation scores.

A battery of tests was designed by Rutherford and McCall (1967) to measure five different types of oral sensory discrimination. This test battery was administered to a group of seventeen cerebral palsied subjects and their controls. The cerebral palsied group was comprised of eight spastic quadriplegics and nine athetoid quadriplegics, all having neuromuscular dysfunction which affected their speech. The cerebral palsied group, as a whole, had significantly poorer tactile acuity on the tongue tip than the control group. The spastic quadriplegics also did poorer on kinesthetic pattern recognition than both the control group and the athetoid quadriplegic subjects.

Ringel (1970a) conducted a study in which he assessed the oral sensory abilities of subjects with muscular dystrophy who exhibited concurrent speech difficulties. On a test of two-point discrimination these subjects demonstrated greater limen values than the normal subjects. This finding may be indicative of inferior oral perception in the dystrophic group. Ringel's findings seem to concur with his hypothesis that disorders of oral tactile perception may be related to disorders of oral motor activities. Mullendore and Stoudt (1961) found that muscular dystrophied persons exhibited slower oral diadochokinetic movements, numerous articulation errors, a lack of ability to sustain phonation, reduced vocal energy, and vocal quality disturbances.

Hochberg and Kabcenell (1967) tested oral stereognosis of twelve cleft palate adults. They found that on tests of both surface alteration and shape alteration of forms cleft palate individuals demonstrated significantly inferior oral sterognostic ability than normal adults. Contrary to these findings, Mason (1967) found no apparent perceptual deficit for the task of oral form identification within cleft lip and palate populations. He also found no apparent relationship between test score and cleft type.

Studies of Persons with Sensory Pathologies

Several researchers have collected extensive data on individual cases of persons with congenital sensory deficits. Such case studies can provide insight into the role of oral sensation and perception as it relates to such skilled motor acts as speech.

Bosma, Grossman and Kavanagh (1967) reported on two similar cases with oral sensory deficits. Both these patients' speech was described as minimally intelligible with consonant production being severely impaired. Both patients were able to perceive light touch throughout the oral area but were almost totally unable to perform on tasks of oral form recognition.

With one of these patients, Rootes and MacNielage (1967) took electromyograms of the oral area and made a phonetic analysis of the patient's speech. They also investigated the relationship between speech perception and production with a series of seven speech perception tests. Test results provided evidence that "production and perception are interrelated, namely in front vowels and voiced stop consonants" (p. 317).

Chase (1967) also discussed this same patient with regard to the relationship between oral motor function and motor deficits. This patient was evaluated by Chase at age seventeen years. She displayed many neurological abnormalities including some in the oral cavity. Speech motor activity was not normally developed. Two-point discrimination was impaired for the lips with a marked inability to organize movements of the lips and tongue. Protrusion and deviation of the tongue from right to left anterior to the teeth was impossible. The patient produced primarily vowel sounds but with the aid of speech therapy had developed minimally-intelligible speech. A neurological examination failed to reveal much evidence for primary disturbance of motor function. A possible answer to the question as to how, if at all, such motor deficits are related to sensory deficits is suggested by Chase. In accordance with the closed-loop theory of the speaking system, previously discussed in this paper, Chase suggests that "if there is inadequate sensory feedback information to perform accurate error detection, there will be corresponding inaccuracies in motor output" (p. 306).

Artificially induced sensory deficiencies

One approach to delineating the role of sensory mechanisms in speech has been the use of nerve-block anesthesia to artificially and temporarily induce sensory deficiencies in the oral cavity. A study by Schliesser and Coleman (1968) validates the use of oral anesthesia to eliminate oral tactile sensation as a means of feedback. It was found that tactile sensation can be eliminated from the oral cavity by means of oral anesthesia without significantly interfering with the motor aspects of speech.

Of several studies which were examined (McCroskey, 1958; McCroskey, Corley and Jackson, 1959; Schliesser and Coleman, 1968; Ringel and Steer, 1963), all the investigators seemed to agree that speech under conditions of oral sensory deprivation by anesthetization remains highly intelligible. This was true even when sensory deprivation was combined with auditory masking (Gammon et al., 1971; Ringel and Steer, 1963).

It is interesting to contrast this finding with the observations made concerning the speech of the patients with sensory system pathologies. Their speech was described as only minimally intelligible. Ringel (1970b), in discussing this difference, points out that the anesthetized persons have had normal oral sensory experiences in the past and during the acquisition of language while the patients with the sensory pathology have never experienced normal sensation in the mouth, or at a different level. "It does appear that in the short term sense, the speech producing mechanism is capable of maintaining a high degree of integrity in the presence of an interruption in its usual sources of information." (Ringel, 1970b, p. 198)

In spite of the fact that speech does remain intelligible under conditions of oral anesthesia there are reports of certain alterations in speech that do take place when the oral cavity is deprived of normal sensation. Gammon et al., (1971) observed the speech of normal speaking subjects under three different experimental conditions: 1) with white noise masking 2) with local anesthesia of the oral cavity 3) with masking and anesthesia. It was found that articulation of consonants suffered most under conditions of oral sensory deprivation. Vowel production was not affected by any condition of feedback deprivation. Vocal quality declined most in the combined condition and next under tactile feedback deprivation.

Scott and Ringel (1971a) investigated the effect of oral sensory deprivation on articulation through the use of nerve-block injections. Articulatory changes were found to be largely nonphonemic in nature and included the loss of retroflexion and lip rounding gestures. Less closed fricative constrictions and retracted place of articulation was also noted.

Scott and Ringel (1971b) compared the speech of dysarthric and experimentally sensory deprived (sensory nerve-block anesthetization) speakers. The purpose of this study was to determine whether motor dysfunctions and sensory dysfunctions result in distinctive articulatory patterns. In general, the types of errors were found to be different. These results were said to emphasize the unique contribution of information from peripheral oral receptors in the control of ongoing speech.

Although most studies have used the nerve-blocking procedure to achieve states of oral-region sensory deprivation, a technique of topical anesthetization has also been used (Ringel and Steer, 1963).

This method seems to have only a minimal effect on speech accuracy. Ringel and Steer found that the use of nerve-block anesthesia resulted in significantly more articulation errors than under the experimental conditions of topical anesthetization of the oral region, or binaural masking, or a combination of both.

The Blind Child

Definition of blindness

The most widely used definition of blindness, applied largely for legal purposes, describes a person as blind if he has:

> ... central visual acuity of 20/200 or less in the better eye, with correcting glasses; or central visual acuity of more than 20/200 if there is a field defect in which the peripheral field has contracted to such an extent that the widest diameter of visual field subtends an angular distance no greater than 20 degrees. (Lowenfeld, 1973, p. 30)

This definition does not cover the important factor of near or reading vision.

A report by the American Medical Association (1955) in the Section on Ophthalmology discusses visual efficiency as including visual acuity at a distance and near vision, as well as such factors as visual fields, ocular motility, binocular vision, adaptation to light and dark, color vision and accommodation. The relationship between Snellen measurements of visual acuity for distance and the percentage of visual efficiency is shown in Table 1 (A.M.A. Committee Report, 1955).

Causes of blindness

There are many causes of visual impairments, such as anomalies and diseases of the eyeball, cornea, lens, retina, optic nerve, and

Table 1. Central visual acuity for distance and corresponding percentage of visual efficiency

Snellen measure of central visual acuity	Percentage of visual efficiency
20/20	100
20/40	85
20/50	75
20/80	60
20/100	50
20/200	20

uveal tract. It would serve no practical purpose to give the latest available figures on causes of blindness among school children because they date back to a survey made during the school year 1958-1959 (Lowenfeld, 1973). In addition, current statistics on the causes of blindness would be heavily distorted by two pathological factors: retrolental fibroplasia (RLF) and maternal rubella. RLF, an eye disease which was diagnosed in 1942, was rampant in the United States and elsewhere between 1949 and 1954. In the latter year medical research ascertained that the major cause of this disease was the administration of high concentrations of oxygen over prolonged periods of time to prematurely born infants. As a consequence of this finding, the epidemic character of RLF is now controlled. Cohen (1966) found that out of a group of 48 blind test subjects which were involved in his study, 85 percent of them had blindness caused by RLF.

Rubella (German measles) contracted by women in their first trimester of pregnancy produces blindness in many children, as well as other abnormalities. Rubella epidemics occur in six to seven year cycles; the last one, between 1964 and 1966, resulted in an estimated

30,000 cases of defective children (Lowenfeld, 1973). A vaccine for German measles is presently available and it can be hoped that it will be effectively applied to prevent any future epidemic and its resulting abnormalities.

The blind multiply-handicapped

In many cases the blind child is faced with not only a visual disability but other associated or resulting problems.

The years beginning with the 1950's were characterized by a decisive increase in not only the number of visually handicapped children but also blind children with additional handicapping conditions. This was primarily due, as previously discussed, to RLF and maternal rubella. Lowenfeld (1969) reports of a study made in 1968 in the state of California, in which 45 percent of visually handicapped children in educational facilities were found to be multi-handicapped, that is, having another additional "marked" handicapping condition. Dauwalder (1964) reports a figure of 24.5 percent of blind children being multi-handicapped.

However, one must be very careful when determining if additional handicaps, such as mental retardation, are existent in the blind child. Elonen and Zwarensteyn (1964, p. 600) stress that "one of the most universally accepted misconceptions regarding blind children is that their development in all areas is necessarily slower than that of the sighted child." They go on to explain that these children, referred to as the "deviant blind" may so resemble the distrubed seeing child that they are often thought to be autistic or brain damaged. Often when in addition to either of these features, their performance level does not approximate their chronological age level, the child is considered retarded. Rather than retarded it has been observed that deviant patterns of the deviant blind child are more typically uneven or unusual than simply retarded.

Norris, Spaulding, and Brodie (1957) emphasize that any direct comparisons of the development of young blind and sighted children must be made with caution because of the multiplicity of factors involved. There are also the limitations of the instruments for testing both groups of children which must be considered.

Mobility and motor skills

The visual impairment in and of itself does not retard motor development; however, there are important indirect influences which may and often do retard development. These influences include the etiology of the visual impairment, which may also contribute to the presence of concomitant physical disabilities; lack of opportunity because of parental overprotection, neglect, and misunderstanding of needs; inability to acquire skills naturally because of deficient imitative learning; delayed development because of lack of the visual stimulation that may be necessary to learn certain skills (Lowenfeld, 1973).

Elonen and Zwarensteyn (1964) emphasize that lack of opportunity may be a very important factor contributing to the fact that over-all achievement by blind children in the area of motor development is not equal to normal. It is pointed out that too often the blind child is confined to a bed, playpen or other small restricted areas. Even when the child is out of the crib he is usually placed in an area cleared of all objects and obstacles leaving no sources of stimulation. Even when some objects are within reach of the child, he is not motivated to go after them since he cannot see them.

Norris, Spaulding, and Brodie (1957) found that in blind children, delayed mastery appears most significantly in certain types of motor response, with fine motor coordination developing easily only after wide experience in gross motor activity. Skill in fine motor coordination was found to usually develop at a later age in blind children than for sighted children.

A study conducted by Bottrill (1968) showed no difference in the learning ability of blind and sighted individuals on location learning, an important element of locomotion.

Elonen and Zwarensteyn (1964) stress that when compensatory experiences and motivation are provided for the blind child, his achievement can reach normal limits.

Tactile-proprioceptive skills. For a long time it was believed that the blind are automatically compensated for the loss of one sense by increased effectiveness of their other senses, such as hearing and touch. Scientific investigations of comparative sensory thresholds do not confirm this assumption (Hayes, 1941). There is, however, no doubt that blind people who must rely on nonvisual sensory data learn to make better use of their other senses. For example, a blind person who reads Braille must rely more on the sense of touch than a sighted person who relies on vision to read. "Any higher efficiency of the blind in interpreting the sensory data perceived, must be the result of attention, practice, adaptation, and increased use of the remaining facilities." (Lowenfeld, 1973, p. 36)

The results of a study by Ewart and Carp (1963) also failed to confirm the theory of compensatory development of the other senses, especially tactile and proprioceptive, in the blind. No difference was found in tactual recognition of form between sighted and blind subjects.

Stellwagen and Culbert (1963) conducted a study to determine if any differences existed in the ability of blind and sighted subjects to manually discriminate between various textures. No significant difference in mean performance of the two groups were found.

An investigation concerning tactile-kinesthetic perception of straightness in blind and sighted subjects was conducted by Hunter (1954). It was found that the blind, both as individuals and as a group were significantly finer in their judgements and more consistent. Hunter explained these results in terms of the more highly developed organization of the blind's tactile-kinesthetic perception.

Speech and language. Spoken language is an essential constituent of human growth and development, especially for the blind child. A major portion of what the congenitally blind ever know about their world comes to them through the medium of the human voice (Cutsforth, 1963). The ability to communicate efficiently is also particularly important to the blind. Stinchfield (1944) points out that the seeing infant learns early to "speak with his eyes," attracting attention with

However, if tension over the presence of the handicapping condition makes it impossible for the parent to enjoy his child and react normally to him, the child may not receive the feedback conducive to language growth (Lowenfeld, 1973).

If language is to have meaning, words must be filled with the ingredients of concepts, thoughts, ideas and emotions. Thought emerges from experience. Rich experiences and rich language growth go hand in hand. If the child's visual horizon is severely restricted, a number of experiences are not available to him. Unless experiences are brought within the area of his sensory perception, his language development may show deficiencies.

Faulty articulation in the blind may be related to the fact that one of the channels of speech feedback, vision, is nonoperant. The child without sufficient vision to observe lip movement and facial expression has only the auditory pattern as a basis for his verbal imitations. This limitation may result in misarticulation of certain sounds, particularly if the child has any problems in auditory discrimination.

Research is not in full agreement as to whether or not speech and language deviations are more frequent among children who are blind than among those who are sighted. An investigation by Eisenstadt (1955) found no significant differences in speech performance between blind and sighted children, except in the area of voice. Brieland (1950) reported that the speech of blind subjects was not found to be inferior to the speech of sighted subjects, although the sighted group did exhibit a significantly higher rate of speech. A study by Norris, Spaulding, and Brodie (1957), which utilized items dealing with language taken from Cattell Infant Intelligence Scale showed no retardation and even some acceleration of language development in the blind children's group.

Hypotheses

The following hypotheses are considered in this investigation:

Oral stereognosis scores of the blind population are significantly poorer than those of the sighted population.

Oral stereognosis scores of children with defective articulation are significantly poorer than the scores of those with normal speech.

A significant difference exists between the oral stereognosis scores of blind subjects with articulation errors and the scores of blind subjects with normal speech.

The null hypotheses posed with regard to these statements are:

There is no significant difference between the oral stereognosis scores of the blind population and the sighted population.

Children with defective articulation and children with normal speech do not differ significantly on a test of oral stereognosis.

No significant difference exists between the oral stereognosis scores of blind subjects with articulation errors and blind subjects with normal speech.

METHODS AND PROCEDURES

Subject Selection

A total of forty-eight subjects were involved in this study. Twenty-four of these subjects were visually handicapped persons drawn from the Utah School for the Blind. Twenty-four were normally sighted persons drawn from public schools in Cache County and Logan City school districts. Both the sighted group and the blind group were each divided into subgroups; those with normal articulation and those with defective articulation. All four subgroups consisted of twelve subjects each.

Criteria for acceptance into the blind group required that the subject be classified as legally blind, which indicates visual acuity of 20/200 or less after correction. Both totally and partially blind subjects were involved. Only those subjects who were blind from birth or within the first two years of life were accepted for this study.

Classification in the defective articulation category required that the subject be presently enrolled in speech therapy and judged by the speech pathologist, on the basis of standardized testing results, to exhibit defective articulation.

Other general criteria for acceptance as a subject in the study were as follows:

1. Within the age range of 7-20 years.
2. No severe intellectual deficits.
3. Hearing judged to be within normal limits.

4. No observable abnormal oral deviations.

5. No known sensori-motor disturbances.

Both male and female subjects were involved in the study. However, this variable was not controlled for since the findings of Arndt, Elbert, and Shelton (1970) indicate no difference in performance between male and female subjects on oral form recognition.

An effort was made to control for the variable of age since research indicates that age facilitates performance in oral form discrimination (Ringel, 1970b; Weinberg, Lyons, Liss, 1970). McDonald and Aungst (1967) have shown that ability to identify forms in the mouth improves with age until midadolescence, remains stable in young adults, and deteriorates in old age. The point to which this ability improves and then levels off is set at approximately eight years of age by Arndt et al. (1970). In order to minimize the effect of age on test results, selection criteria for age was set at 7-20 years, and an effort was made to keep the age means of each group similar.

Testing Instrument

A set of twenty plastic three-dimensional geometric forms were used to assess the oral stereognostic skills of the subjects. This particular set of forms was standardized by the Oral Pharyngeal Development Section, National Institute of Dental Research. Each form has an approximate breadth of one-half to three-fourths inch and a thickness of one-eighth inch. The sets to be used for oral exploration were mounted on plastic handles three inches long to prevent possible swallowing of the form by the subjects.

One set of forms was mounted on a 9 x 7 sheet of plastic to provide a three dimensional response board. This alteration of the usual test materials, as described by Shelton, Arndt and Hetherington (1967), which require visual matching of the forms to drawings, was necessary so that it could be administered to blind subjects. Matching of the oral forms was accomplished through manual, rather than visual, exploration of the response board. The forms were arranged in four rows of five forms using the same placement as used by LaGourgue (Moser, LaGourgue, and Class, 1967), and Weinberg, Lyons, and Liss (1970). A representation of the response board can be found in Appendix F.

Equipment utilized in this study for test administration included:

1. 20-item National Institute of Dental Research (NIDR) Test of Oral Stereognosis (two sets).
2. Response board of mounted NIDR forms.
3. Score sheets and pencil.
4. Stop-watch.
5. Iodine-based disinfecting solution (Wescodyne).
6. Containers and other materials for disinfecting.
7. Screen to hide test materials from subject's view.
8. Card with outlines of forms corresponding in arrangement to response board and numbered according to number on corresponding oral form.
9. Examiner's instruction card.
10. Blindfold.

Reliability studies on this particular 20-item test of oral stereognosis have been completed by Arndt, et al., (1970). Their findings show this to be a reliable test for the age groups being examined in this study.

Standardization procedures have been done and normative data collected and compiled on a similar 35-item test using multiple-choice type response stimuli (Arndt, Elbert, and Shelton, 1970). In reviewing the literature, no report of normative data being established on this 20-item version of the test could be found.

In the case of many predictor tests, determining validity simply involves the definition and measurement of a single criterion. However, in the case of the oral form-identification test, there is no single validating criterion available. To assess the validity of this test, a series of interrelated experiments must be performed. Each experiment should test hypotheses derived from present conceptions of what it is that is being measured. Validation of an oral stereognosis test would involve demonstration that the test permits predictions that are compatible with knowledge about stereognosis. This requires information beyond that gained by use of the test itself (Shelton, Arndt, and Hetherington, 1967).

Test Administration

Testing procedures were the same for all four groups. Both blind and sighted subjects were blindfolded to control for differing degrees of blindness and to provide identical testing conditions for all subjects. After being blindfolded each subject was given approximately, but not limited to, one minute to familiarize himself with the response board by manual exploration. This was done to allow the subject to orient himself to the arrangement of the board and therefore decrease the time it might take to locate the matched choice. After feeling the shapes on the response board, the subject was given the following instructions:

> I have some more shapes that are on handles. I am going to put one in your mouth at a time for you to feel with your tongue. You may move it around with the handle to help you feel it with your mouth. Don't feel it with your hands. After feeling the form with your tongue and mouth, feel the board with your hands and find the shape that you think is just the same as the one you have in your mouth. You can keep the form in your mouth while you look for the same one on the board with your hands. When you think that you have found the right one, put your finger on it and tell me "This one." Take as much time as you need and guess if you're not sure--but you only get one choice. Do you have any questions?

Each of the twenty test items were presented randomly, one at a time, with the same random order being used for each subject. All test materials were kept behind a screen until the subject was blindfolded. To make the task less dependent on memory, simultaneous oral examination of the form and manual examination of the response board was encouraged. Each form was cleaned and disinfected after each use. No time limit was placed on the matching of each form, but response times were kept with a stop-watch by the examiner for use in data analysis. Timing began with the oral presentation of the form and

and terminated when the matched choice on the response board was indicated. Only one response to each form was allowed. The subjects were encouraged to guess if they were not sure. No feedback was given the subjects as to the correctness or incorrectness of their responses. Occasional encouragement or instructions were given when the subject demonstrated a decrease in attention to the task or a lack of understanding of the task. When such comments were necessary, they were indicated on the score sheet.

Scoring

Performance on the test was recorded by the examiner on a score sheet designed especially for this study (Appendix D). Each identification was recorded as correct or incorrect. The number designation of each choice made from the response board was also indicated next to the item number of the form being presented orally. Response times for individual test items were recorded on the score sheet to the nearest half-second. A test score for each subject was determined by the total number of incorrect responses resulting in an Error Score.

RESULTS

The sample populations to be studied were divided into two main groups with each having two subgroups; the sighted group being divided into those with articulation errors (S_a), and those with normal speech (S_n), and the blind group including those with articulation errors (B_a), and those with normal speech (B_n). Each subgroup was comprised of twelve subjects. For purposes of statistical analysis, the subjects were also grouped according to whether they had normal speech or dis-articulate speech, regardless of visual acuity. A complete description of each subgroup can be found in Table 2.

Table 2. Group description

Group	N	Boys/girls	Mean age	Age range
B_a	12	7/5	12-1	7-6 to 19-2
B_n	12	3/9	12-6	9-10 to 16-4
S_a	12	7/5	10-0	8-1 to 14-3
S_n	12	4/8	10-11	8-0 to 14-4

Initially, it needed to be determined if the four sample subgroups were, in fact, drawn from different populations. A Kruskal-Wallis one way analysis of variance resulted in an acceptance of the null hypothesis at the .05 level of significance. This indicates that all four sample subgroups cannot be assumed to be drawn from different populations.

At the time of performance each child's response to each of the twenty test stimuli was scored as correct or incorrect. A response time for each item of the test was also recorded. Response time was determined as the time from which the stimulus was placed in the child's mouth till he made the required response, "This one."

Each child was then given a total error score by totaling all incorrect responses. A total response time was obtained for each child by adding the response times of all twenty test items. A mean error score and range of error scores for each group and subgroup was recorded (Tables 3 and 4). The entire blind group received a mean error score of 9.58 with subgroup B_a having a mean error score of 12.0 and subgroup B_n a mean error score of 7.16. The entire sighted group received a mean error score of 9.79 with subgroup S_a having a mean error score of 10.83 and subgroup S_n a mean error score of 8.75. The individual error scores of each child are found in Appendixes B and C.

Table 3. Oral stereognosis scores of groups

Group	Mean error score	Range
Blind	9.58	1-20
Sighted	9.79	3-18
Normal speech	7.95	1-14
Disarticulate speech	11.41	3-20

Table 4. Oral stereognosis scores of subgroups

Group	Mean error score	Standard deviation	Range
B_a	12.0	4.60	3-20
B_n	7.16	3.21	1-12
S_a	10.83	3.73	3-18
S_n	8.75	2.86	4-14

A comparison of the mean error scores of the entire blind and the entire sighted group was made using the Mann-Whitney U test for large samples. The value of z was found to be .577 which has a probability of p = .2843. Since this p is larger than α = .01 the null hypothesis of no significant difference between these two groups was accepted.

Using the same statistical method it was found that a significant difference does exist between the group of normal speakers, both blind and sighted, and the articulatory impaired, blind and sighted speakers. Tabular values show that $z \geq 3.03$ has a one-tailed probability under the null hypothesis of $p < .0012$. Since this p is smaller than $\alpha = .01$ the null hypothesis was rejected in favor of the research hypothesis.

Further statistical analysis tested the third research hypothesis of whether oral stereognosis shows any relationship to articulation in the blind population. The Mann-Whitney U one-tailed test was used to compare the mean error score of subgroup B_a to subgroup B_n with B_n being the better mean score. The critical value of U at the .01 level of significance was 31, and the computed value of U was found to be 29.

Since U is less than 31, the null hypothesis was rejected, indicating a significant difference in mean error scores of the two subgroups.

In order to analyze the source of the difference in performance on the oral stereognosis test which was found between the normal speaking group and the articulatory impaired group, further comparisons of the four subgroups were made. The Mann-Whitney U one-tailed test was run on each of the six possible combinations of two subgroups.

At the .05 level, no significant difference was found between the following subgroup combinations: B_a and S_a, S_n and S_a, B_n and S_n. Although the latter group, blind with normal speech and sighted with normal speech, showed no significant difference at the .05 level, the computed U of 45 did approach the critical value of 42 at this level.

A significant difference was found at the .025 level but not the .01 level between the B_a and S_n subgroups. A comparison of the B_n and S_a subgroups also showed a difference significant at the .025 level. In each case, the computed U was 37 and the critical value of U at the .025 level was also 37.

Response times for each subgroup can be found in Table 5. No statistical analysis other than mean response time for each group was computed. Both blind subgroups had faster response times than the sighted subgroups. The fastest mean response time was recorded by the blind subgroup with normal speech and the slowest mean time by the sighted subgroup with normal speech.

Table 5. Response times of subgroups

Subgroup	Total response time	Mean response time
B_n	73 min. 42 sec.	6 min. 9 sec.
B_a	90 min. 18 sec.	7 min. 32 sec.
S_n	116 min. 57 sec.	9 min. 45 sec.
S_a	98 min. 47 sec.	8 min. 14 sec.

DISCUSSION

A major consideration of this investigation was whether blind children would perform as well as sighted children on a test of oral stereognosis. It was found that oral stereognosis does not differ significantly between the sighted and blind populations. Further analysis of the scores of the four subgroups showed that the blind, normal speaking subgroup did not have significantly poorer scores than the sighted, normal speaking subgroup. Though the blind, articulatory imparied subgroup had a poorer mean score than the sighted, articulatory impaired subgroup, this difference was again not significant. It therefore can be concluded that any observed deficiency in the oral perception of a blind child cannot be solely attributed to his blindness. Reduced oral sensation, as measured by this test of oral stereognosis cannot be considered as a characteristic of the blind population as a whole.

Results of this study concur with other research findings which indicate a significant positive relationship between oral stereognosis and articulatory proficiency. It was found that children with articulation errors did significantly poorer on the 20-item test of oral stereognosis than did those children with normal speech. This finding lends strength to the servosystem theory of speech which states that feedback, whether auditory or tactile proprioceptive, plays an important role in the monitoring and production of speech output.

A third finding of this investigation is that this relationship between oral stereognosis and articulation is also found in the blind population. Results showed that blind children with normal speech did significantly better on this test of oral stereognosis than did blind children who exhibited articulation errors.

Though a significant difference was found between the scores of the entire group of normal speakers and the entire group of speakers with articulation errors, the difference between the scores of the sighted, normal speech subgroup and the sighted, disarticulate subgroup was not found to be significant. Since this difference was found to be significant between the blind, normal speakers and the blind, articulatory impaired speakers, it would seem to imply that oral sensation contributes more to articulatory skill in the blind population than in the sighted population.

However, the writer is hesitant about making such an interpretation of these test results due to a possible problem concerning external validity of this subgroup's test scores. Testing conditions were less optimal for the sighted, normal speaking subgroup than for the other subgroups. This was the last group of the study to be evaluated and therefore testing took place in the late spring, just prior to dismissal of school for summer. Four of the subjects were tested on a day when school closing activities were taking place. More difficulty was experienced with this subgroup than with others in keeping the child attentive to the task. Therefore, some of this subgroup's test scores may not be as valid as would be desired. Retesting was impossible due to the unavailability of test subjects.

According to the results of this investigation, the deficiencies in oral awareness suspected by the team from Utah State University

Department of Communicative Disorders, in a group of blind articulatory impaired children cannot be attributed to their blindness.

Such deficiencies could be associated with a number of other variables. The sample of blind children tested did not necessarily include the group in which the difficulties were observed. All children having any hearing deficits or known neurological or intellectual impairments were eliminated from the investigation. Any one of these or other yet unspecified variables could have been associated with the disruption of oral perception noted in the observed group of blind children.

In examining the mean response times recorded by each of the subgroups, it can be seen that the blind children, as a whole, performed the task of oral form-identification faster than did the sighted children. Speaking in reference to response times of tactile stimulation to the tongue Siegenthaler (1965, p. 388) states:

> It is reasonable to assume that an organism which operates on a servosystem principle tends to rely on those sensory channels which are most efficient (make the greatest contribution to the control of output) for the set of environmental and internal conditions present. Among other aspects of efficiency, a sensory modality should facilitate rapid reaction when responding to a stimulus, i.e., reaction time is an important indicator of efficiency of a feedback channel.

Williams and LaPointe's (1971a) findings seem to corroborate Siegenthaler's statement. It was found through their investigations that a subject's performance tends to be inversely related to response time.

Taking into consideration the preceding findings and the results of this study in terms of response times, it would appear that the oral tactile-proprioceptive feedback system was functioning more efficiently for the blind group than for the sighted group.

These results become more meaningful when it is considered that one of the major channels through which the blind child is accustomed to exploring his world is through manipulation of objects, while the sighted child's primary channel of exploration is vision. Through repeated use and reliance upon this tactual sense, the blind child may have learned to make better, more efficient use of this avenue of learning. The sighted child who has relied primarily on vision may be less able to efficiently utilize his tactual sense when suddenly deprived of the use of sight. This is not to say that the blind child has a more sensitive or acute sense of touch but only that he is more practiced at making identifications through this channel and therefore may utilize it more efficiently.

When the mean response times of the two blind subgroups were compared, it was observed that the normal speaking subjects had a faster mean response time than the articulatory defective speakers. This would appear to indicate that the tactile-proprioceptive feedback channel was functioning more efficiently for those speakers with normal speech than for those with defective articulation within the blind group. However, this relationship did not hold true in the sighted group. The sighted, normal speakers had a slower mean response time than the sighted speakers with articulation errors. Such results may be due to a problem encountered with the sighted, normal speakers concerning testing conditions. Test conditions were not optimal for a portion of this subgroup, and therefore, response times for these subjects may have confounded the overall times of the sighted, normal speech subgroup.

Non-statistical comparisons of response times appear to indicate a possibility that proprioceptive feedback functions more efficiently in the blind group than in the sighted group, and that normal speakers, at least within the blind group, appear to have more efficient proprioceptive feedback systems than speakers with defective articulation. However, further research is needed in this area before anything more than speculative statements concerning such relationships can be made.

Limitations

Though a substantial relationship between articulation and oral stereognosis has been suggested by this investigation, a cause and effect relationship cannot be assumed. Further research would be necessary before such an assumption could be made.

The sample population in this study was rather limited, and the possibility that differing results might be obtained from a larger sample population cannot be ruled out.

The population from which the sample of blind subjects was drawn was somewhat restricted since they were all enrolled in the same educational institution for the blind. This school draws its pupils from a relatively limited geographical area.

A fourth limitation, previously discussed, deals with the problem of testing conditions or circumstances, particularly those associated with the group of sighted subjects with normal speech. It was felt that, due to the circumstances under which they were tested, some of the subjects may not have performed to the best of their ability.

Implications

Results of this investigation indicate that the use of oral tactile-kinesthetic cues may be used as effectively in the remediation of defective articulation with blind children as with sighted children.

Further implications of this study, in the words of Fucci and Robertson (1971, p. 714), lie in the possibility that

> The therapeutic procedures for articulation disorders which are considered to be 'functional' in nature might be further studied as to the appropriateness of such procedures. Utilization of an oral-tactile approach may be more suitable as a rehabilitative model.

Ringel et al. (1970, p. 9), raised a question which is also raised by this investigation. "If skills measured by the oral-form discrimination tasks do in fact underlie articulation, can articulatory proficiency be improved directly by training with appropriate orotactile discrimination tasks?" In addition, would such methods yield similar results in both the blind and sighted populations? These questions are ones which need further research before they can be answered.

SUMMARY

Twenty-four blind subjects and twnety-four sighted subjects were categorized into subgroups according to articulatory proficiency. The two blind subgroups were composed of twelve subjects with normal speech and twelve subjects with articulation errors. The sighted group was divided in a similar manner with twelve in each subgroup.

Each subgroup was administered a 20-item test of oral stereognosis using the NIDR forms. Scores were statistically compared using the Mann-Whitney U to determine whether any differences in oral stereognostic ability exist between the blind and sighted populations. The same statistical analysis was used to determine if any relationship existed between oral stereognosis and articulation.

It was determined that at the .05 level of significance there was no difference between the scores of the blind subjects and the sighted subjects. However, a significant difference did exist at the .01 level between the oral stereognosis scores of normal speakers and articulatory impaired speakers.

This indicates that some relationship does exist between oral stereognosis and articulation, but oral perception does not differ in the sighted and blind populations.

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APPENDIXES

Appendix A

Individual Descriptions of Blind Group

Table 6. Blind, normal speech subgroup

Student	Sex	Age		Cause of blindness	Degree of visual loss
101	F	9-10	Birth	Rotary Nystagmus	Partial
102	F	11-10	Birth	Cerebral Hemorrhage	Partial
103	F	10-1	Birth	Atrophy of Optic Nerve	Partial
104	M	10-4	Birth	RLF	Total
105	F	11-3	Birth	Congenital abnormality	Partial
106	F	12-6	Birth	Strabismus	Partial
107	F	12-9	Birth	Retinal pigmentary degeneration	Partial
108	M	13-3	1-6	Retino Blastoma	Total
109	F	11-11	Birth	Congenital cataracts	Partial
110	M	16-2	10-0	Retino Blastoma	Total
111	F	14-2	Birth	Astigmatism Nystagmus	Partial
112	F	10-4	Birth	(not in records)	Partial

Table 7. Blind, disordered articulation subgroup

Student	Sex	Age	Onset of blindness	Cause of blindness	Degree of visual loss
201	F	17-7	Birth	(not in records)	Total
202	F	11-0	Birth	Maternal Rubella	Partial
203	M	12-10	Birth	Prenatal Problems	Total
204	M	19-2	Birth	RLF	Total
205	F	13-7	0-6	Anoxia due to cord prolapse	Partial
206	M	7-6	0-4	Optic Atrophy	Total
207	F	10-1	Birth	RLF	Total
208	M	8-11	Birth	Prenatal maternal disease	Partial
209	M	10-10	Birth	Maternal Rubella	Partial
210	M	10-2	Birth	Damage to Occipital Lobe during delivery	Total
211	F	10-1	2-9	Pressure on brain due to Hydrocephalic condition	Total
212	M	12-9	Birth	Undeveloped Optic Nerve	Partial

Appendix B

Individual Scores of Blind Group

Table 8. Sighted, normal speech subgroup

Student	Oral stereognosis error score	Total response time
101	9	5 min. 24 sec.
102	11	5 min. 4 sec.
103	12	5 min. 13 sec.
104	8	9 min. 32 sec.
105	7	5 min. 59 sec.
106	2	6 min. 49 sec.
107	8	2 min. 57 sec.
108	3	14 min. 59 sec.
109	7	4 min. 28 sec.
110	1	2 min. 44 sec.
111	9	5 min. 11 sec.
112	9	5 min. 22 sec.

Table 9. Sighted, disordered articulation subgroup

Student	Oral stereognosis error score	Total response time
201	9	6 min. 12 sec.
202	12	13 min. 4 sec.
203	5	5 min. 39 sec.
204	3	11 min. 39 sec.
205	14	2 min. 52 sec.
206	15	7 min. 8 sec.
207	20	12 min. 58 sec.
208	12	5 min. 39 sec.
209	9	4 min. 3 sec.
210	16	6 min. 31 sec.
211	14	5 min. 5 sec.
212	15	9 min. 28 sec.

Appendix C

Individual Scores of Sighted Group

Table 10. Normal speech subgroup

Student	Oral stereognosis error score	Total response time
301	10	7 min. 40 sec.
302	14	11 min. 22 sec.
303	7	12 min. 43 sec.
304	8	7 min. 36 sec.
305	7	5 min. 20 sec.
306	11	6 min. 5 sec.
307	11	9 min. 50 sec.
308	8	7 min. 10 sec.
309	4	15 min. 55 sec.
310	11	11 min. 43 sec.
311	4	7 min. 50 sec.
312	10	13 min. 43 sec.

Table 11. Disordered articulation subgroup

Student	Oral stereognosis error score	Total response time
401	3	15 min. 19 sec.
402	9	5 min. 38 sec.
403	16	7 min. 33 sec.
404	9	5 min. 47 sec.
405	13	9 min. 5 sec.
406	9	8 min. 2 sec.
407	10	5 min. 55 sec.
408	12	7 min. 49 sec.
409	9	9 min. 30 sec.
410	10	4 min. 29 sec.
411	18	9 min. 20 sec.
412	12	10 min. 20 sec.

Appendix D

Score Sheet

NAME____________________ DATE________________

VISUAL STATUS________________ TIME________________

SPEECH STATUS________________ EXAMINER________________

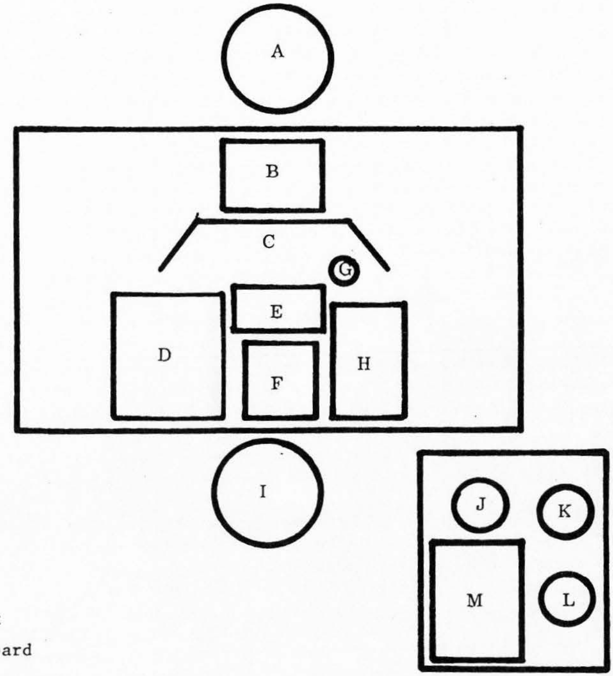
AGE__________ SEX________ ERROR SCORE________________

Presented Form (oral)	Matched Form (Tactile)	Time
#1		
#2		
#3		
#4		
#5		
#6		
#7		
#8		
#9		
#10		
#11		
#12		
#13		
#14		
#15		
#16		
#17		

Comments:

Appendix E

Set-up of Test Materials



A. Subject

B. Test board

C. Screen

D. Test forms (in order of presentation)

E. Form number reference card

F. Instruction card

G. Stop watch

H. Score sheet

I. Examiner

J. Soapy water

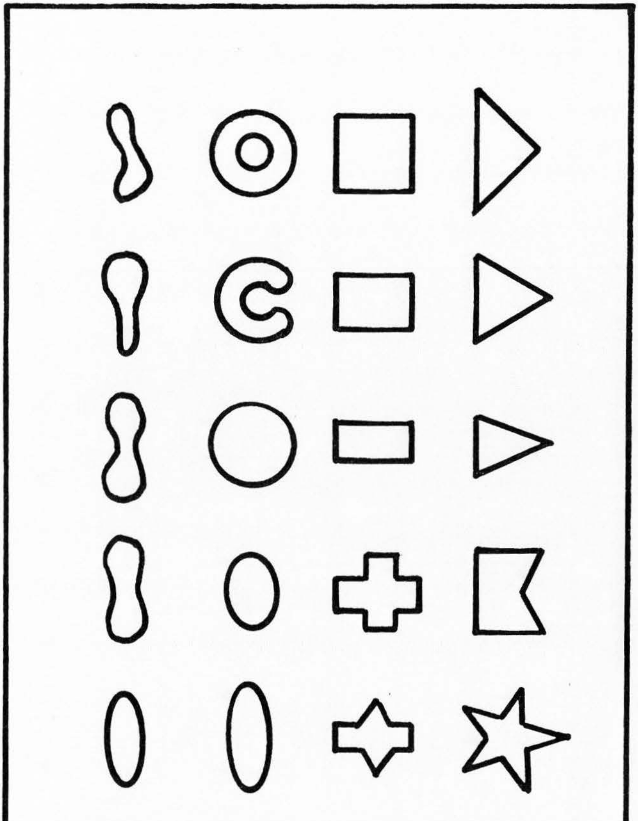
K. Rinse water

L. Wescodyne solution

M. Drain mat for sterilized test forms

Appendix F

Representation of Response Board



Appendix G

Information Concerning the Acquisition and Preparation of Test Materials

I. NIDR test forms

Address: Wilkes Precision Instrument Co.
5706 Frederick Avenue
Rockville, Maryland 20850

Phone: 301-881-8130

Price: twenty form set - $8.50 (no handles)
twenty form set - $13.00 (with handles)

II. Sterilization solution - Wescodyne

Address: West Chemical Products
990 South 6th West
Salt Lake City, Utah

Phone: 801-355-7431

Price: $7.45 per gallon

Preparation: To 1 gallon cold water, add 18 cc Wescodyne. Soak instruments in solution for five to ten minutes. Shake off excess liquid and place form directly in the mouth.

VITA

Mariette Johnson Milbrandt

Candidate for the Degree of

Master of Science

Thesis: An Investigation of Oral Stereognosis and Articulation in Sighted and Blind Children

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