ORAL FORM DISCRIMINATION AND ALTERNATE ARTICULATORY MOTION RATE IN THE CEREBRAL PALSIED

ROSHNI RAJ

Reg.No.M9013

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TO my little spastic friends

Who taught me the joy of living

CERTIFICATE

This is to certify that the Dissertation entitled: ORAL FORM DISCRIMINATION AND ALTERNATE ARTICULATORY MOTION RATE IN THE CEREBRAL PALSIED is the bonafie work in partial fulfilment for second year M.Sc., (Speech and Hearing) of the student with Reg. No.M9013.

Dr.(Miss) S.Nikam,
Director,
All India Institute of
Speech and Hearing
Mysore-6.

CERTIFICATE

This is to certify that the Dissertation entitled: ORAL FORM DISCRIMINATION AND ALTERNATE ARTICULATORY MOTION RATE IN THE CEREBRAL PALSIED has been prepared under my supervision and guidance.

Shyamala K. C

(Dr. Shyamala Chengappa)
Guide.

DECLARATION

This Dissertation entitled: ORAL FORM DISCRIMINATION AND ALTERNATE ARTICULATORY MOTION RATE IN THE CEREBRAL PALSIED is the result of my own study, undertaken under the guidance of Dr. Shyamala Chengappa, Lecturer, Speech Pathology Department, All India Institute of Speech and Hearing, Mysore, and has not been submitted earlier at any University for any other Diploma or Degree.

Mysore

1992

Reg. No. M9013

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INTRODUCTION

A major consideration of research workers in speech science and speech-language pathology has been to attempt to describe and explain the manner in which the human speech system operates. "System" is used here to refer to the interacting and interdependent components of a functional unit that is only partially accessible to direct observation (Attanasia, 1987). Speech, a motor act, consists of complex ballistic movements (Bosma, 1967). Unlike many motor activities, speech requires a complex blend of actions in synchrony to produce even the simplest response (Kelso, Tulier, and Harris, 1983). Sensory-motor integration is a necessary condition for normal speech production.

As the complexity of the speech system does not allow completely direct observation of its operations, models have been developed by a number of investigators as a means of representing what might be the nature of the system and how it functions (Lee, 1950; Lashley, 1951; Fairbanks, 1954; Leiberman, et al. 1962; 1967; Eilenberg, 1973; Kent, 1973).

Many models have employed the concepts of servosystem theory. Though servosystem models differ from one another along several dimensions, they all share the view that speech production is monitored and controlled by feedback of different stimuli via sensory information received from peripheral receptors (Kramer, 1972; Ringel, 1970). Sensory feedback as described in servosystem models, is provided by the auditory, oral-tactile and oral kinesthetic-proprioceptive pathways (Fairbanks, 1954; Kramer, 1972; MacNeilage, 1970).

A number of researchers have attempted to investigate the importance of feedback control by studying what happens to speech when sensory feedback is altered or manipulated. The literature describing the effects of delayed auditory feedback on speech for example, indicates that when individuals speak under DAF, speech is disrupted along one or more of the dimensions of rate, fluency and articulation (Fairbanks, 1955, Fairbanks and Guttman, 1958; Lee, 1950; Webster and Dormen, 1971), The finding of speech disruption is often interpreted as confirmation of the need for auditory feedback to monitor and control speech production and as validation of the servosystem theory in general.

While studies in auditory feedback have been used to support the validity of servosyatem theory, most models ascribe some function to oral tactile and oral kinesthetic-preprioceptive feedback (Ringel, 1970; Kramer, 1972). Whether it be speculative or emperieal, the research that is available in oral tactile and oral kinesthetic-proprioceptive feedback, suggests that these two feedback mechanisms may be atleast as important as auditory feedback in guiding speech production (Van Riper and Irwin, 1958; Henke, 1970; MacNeilage, 1970; Perkell, 1969).

Research concerned with oral sensation has indicated that oral tactile and oral kinesthetic-proprioceptive feedback deficiencies can disturb speech production especially articulation. Studies by Wilson (1960) and Ringel (1970) for example have included observations of individuals with sensory pathologies and descriptions of speech production in persons who have experienced experimentally induced oral sensory deficiencies. Since oral feedback does not function adequately in such cases, it would appear that servosystem control of speech is implicated thereby contributing to disturbances in speech.

Thus, several researchers who have studied servosystem theory view that speech production is monitored and controlled by auditory, oral tactile and oral kinesthetic-proprioceptive feedback and that disturbances in any of these sensory channels can impair speech.

Speech and language clinicians often rely on tactile and kinesthetic cues during articulation therapy as oral sensory and kinesthetic feedback play a role in monitoring articulation gestures. Hence investigation of the relationship between oral sensory function and articulation skills has potential clinical implications according to some investigators.

Oral sensory ability is found to be depicted in articulation proficiency. Information relating to the ability of a person to make judgements of object shape upon oral presentation may provide insight into the nature of oral sensory mechanisms which are believed to underlie the speech monitoring system.

The ability to perceive the nature or form of objects placed in the mouth via the oral tactile sensory system has been termed as oral stereognosis (Ringel, House, Burk, Dolinsky and Scott, 1970). Stereognostic ability has been recognized as an important indicator of nervous system integrity (Forster, 1962; Ringel, Burk and Scott, 1970).

Oral form discrimination test has been found to be the Most efficient test available for evaluating oral stereognosis (Lass, et al. 1972; McDonald and Aungst, 1967).

It has been suggested that there may be a relationship between oral stereognosis and articulation, specifically that oral form discrimination errors may increase as a function of severity of articulation disorder (Ringel, House, Burk, Dalinsky and Scott, 1970), The results of a number of studies involving children of the clinical population support this hypothesis, however there are others which have failed to support the existence of such a relationship. Moser, LaGourgue and Class (1967) reported a study in which no significant difference was found between oral form identification of normal and articulation disordered subjects.

The lingual ability haa long been considered by speech pathologists to be of major relevance to the prodoction of normal and deviant speech. Inability to manipulate the tongue rapidly enough or precisely enough to make the refined movments necessary for adequate articulation has been attributed to insensitivity, weakness, poor co-ordination, paralysis, sluggishness, clumsiness, or lack of adaptation.

Many studies have been done measurin lingual perfor-mance in its various aspects such as tongue protrusion, tongue strength, pattern reproduction, position reproduction, tactual pressure perception, lingual form perception and diadochokinetic ability. The latter aspect, the diadochokinetic ability or alternate articulatory motion rate is a performance which is quantifiable. Hence as assessment of the client's oral motor skills is typically a part of the articulatory evaluation, such as that in Dysarthria.

Dysarthria is an articulation problem caused by neuro-muscular disability. A lesion of the central or peripheral nerveus systams that involves the pathways subserving the speech mechanism may result in dysarthria (Darley, Aronson and Brown, 1969). Dysarthrias are caused by a paralysis, weakness or incordination of the speech musculature and these could be clinically encountered in children such as those in cerebralpalsy and adults as in Parkinsonism. The most significant characteristic of dysarthric speech is reduced intelligibility (Tikofsky and Tikofaky, 1964) and in the cerebral palsied population such speech is often referred to as "Cerebral palsied speech" and frequently characterized as slurred, thick and laboured. It often involves disturbances is respiration, phonation, articulation, resonance and prosody. Thus if the areas used in speech are affected, there will be interference with the movements for speech and a resulting dysarthria.

Cerebral palsy is by nature a movement disorder, so movement variables such as rate, range, direction and co-ordination should figure prominently in the evaluation of individuals with this communicative handicap. Yet these variables have received little direct attention and the relationship between oral sensory-motor skills and articulation Skills in cerebral palsy remains inconclusive.

Need for the study:

Studies investigating the oral sensory-motor ability of cases with speech disorders are scarce. Results of various studies regarding the relationship between oral sensory ability and motor speech proficiency have not always been in agreement. Studies on oral stereognostic tests and alternate articulatory motion rate on cerebral palsied subjects using Indian population are nil. Hence the present study was planned. The investigation was intended to answere the following questions.

1. Is there a difference between normal subjects and cerebral palsied subjects in terms of oral form discrimination ability?
2. Is there a difference between normal subjects and cerebral palsied subjects in terms of alternate articulatory motion rate?
3. Is there a ralationship between oral form discrimination ability and alternate articulatory motion rate in the groups of normal and cerebral palsied children studied?

Implications of the study:

1. The present study may serve to add to the fund of knowledge regarding oral form discrimination ability and alternate articulatory motion rate in the cerebral palsied population and also dysarthria in cerebral palsy.
3. It may be useful in developing diagnostic and prognostic tests is clinical population.
3. It may be useful for standardization of normative data on the two taske used in the present study.
4. These two tests may serve to identify a subgropp if any, in the clinical population.

Definitions used in the present study:

1. Oral form discrimination ability (OFD): ability to identify discriminate and judge two three-dimensional geometric forms of objects as "same" or "different" when they are placed intraorally.
2. Lingual alternate articulatory motion rate (AAMR): The rate of the ability of the tongue to move in co-ordination with other articulators to accomplish rapid, repetitive articulatory movements.
3. Cerebral palsy (CP): It may be defined as a motor dysfunction secondary to central nervour system damage to the organism before, during or shortly after birth. It may also be defined as a nonprogressive neuromuscular disorder characterized by paralysis, weakness, inco-ordination or any other aberration of motor function due to malfunction of the motor centres of the brain.
4. Spasticity: It is the most common type of cerebral palsy, wherein there is an exaggerated contraction of muscles when subjected to stretch and is clinically manifested by hyperactive deep reflexes, hypertonicity and clonus.
5. Athetosis: is another form of cerebral palsy characterized by uncontrollable, jerky, irregular twisting movements of the extremities. There Movements may be intentional, non-intentional or constant uncontrollable involuntary reactions.

REVIEW OF LITERATURE

Oral sensory function is related to the oral motor proficiency (McDonald and Aungst, 1967). The perception of motion of articulators for speech production is a synthesis of different sensations principally tactile and kinesthesis. Patton (1942) stated that the kinesthetic and proprioceptive senses are of basic importance in learning speech and without them, the conditioned reflex of speech would probably never be established nor maintained. Diltman (1955) felt that proprioception is fundamental to speech at any stage of development. He stressed that all Speech involves muscle activity and all muscle activity involves proprioception.

Importance of feedback systems for speech:

According to Perkell (1969)'s view of the articulation system, vowels are produced through the action of a slow extrinsic tongue muscle network under the primary influence of acoustic and myotactie feedback. Consonant production, on the other hand, is thought of as being produced by the combined function of the fast-acting intrinsic, as well as the slower extrinsic muscle systems and is regulated by intraoral air pressure and tactile feedback.

Ladefoged (1967) has also hypothesised that consonants depend more on oral sensory feedback while the production of vowels depends more on auditory monitory.

MacNeilage (1970) while discussing the sequencing of articulatory movements, refers to the results of oral stereognosis studies as evidence that persons "can integrate complex pattern of tactile and motor information to make accurate judgements of the spatial characteristics of the stimulus objects". He speculates further that "it is likely by such integration of motor information with concurrent tactile and other somesthetic and kinesthetic information and (auditory information) the language learner builds up an internalized spatial representation of the oral area" thus facilitating articulation.

In discussing the development of articulation, Milisen (1966) has stated that closed circuit feedback system serves primarily as a monitor of self-generated speech sounds.

Ringel (1970) contends that motor patterns are modified and restructured in accordance with information received from peripheral sensory sources.

Another example of the role that proprioceptive feedback might play in the control of speech activities is contained in the neuro-anatomic and physiologic studies by Kirchner and Wyke (1964, 1965). Their investigations have revealed that the larynx is equipped with two distinct intrinsic mechano-receptor reflex by the articulator system and the myotactic system. These systems clearly play a part in the continues and precise adjustment of muscle tone during phonation.

Kawamura (1965) supports the presence of a sensory control mechanism for motor activity. According to him, the motor control of the jaw muscles is primarily a function of sensory processes originating within the temperomandibular joint.

Perkins (1977) opinionates that any disruption in the speech output implies a disruption of auditory, tactile or Kinesthetic feedback.

Hardcastle (1976) suggests that tactile feedback provides information to the central nervous system (CNS) about localization of contact, about onset of timing and about degree of pressure after the event has taken place. Proprioception conveys information about positioning of the articulations and about rate of movement. It provides predictive information and also information during the event. Proprioceptors (kinesthetic receptors) are therefore, faster acting than tactile receptors. But both are important for the ongoing monitoring of speech production.

Effect of disturbed sensation on speech production and Monitoring:

According to Perkins (1977), any disruption in auditory, tactile or kinesthetic feedbacks exhibits a disruption in speech output. The role of these feedbacks has been studied by artificially inducing sensory disruption.

Disturbed auditory feedback: Aa early as 1949, Hanley and Draegart noted that while speaking in the presence of noise. loudness of voice was directly influenced by the noise and its intensity.

Lee (1950) and Black (1951) were the first to report delayed auditory feedback (DAF). According to tham, when a normal speaker's output was fed back to his ears, after a short delay of about l/5th of a second, marked breaks in fluency occured. The most obvious effects of speech were slowening of speech, increase in intensity with pitch raise and a serious disturbance in the speech pattern.

Smith (1962) observed that those subjects who performed most successfully under DAF were probably able to ignore for the most part, the non-synchronized sounds of speech and to control their speech mainly by somesthetic feedback signals.

The importance of feedback systems was stressed by Van Riper (1971) who implied that information about the speech output is returned to the central integrating mechanism through tactile, kinesthetic and auditory sensors. The feedback returns through multiple bilateral channels (air, bone, tissue, tactile, kinesthetic etc) and is processed at many levels in the central nervous system, a situation where distortion of signals could possibly take place. Since speech demands an incredibly precise synchronization of simultaneous and successive bilateral motor responses, such disturbance could produce asynchrony and lead to speech defect.

Many investigators observed articulatory errors disturbances in speech rate and rhythm, and in vocal intensity under DAF conditions (Rawnsley and Harris,(1954);Coblens and Agnelle (1965); Fairbanks and Guttnam (1958); Peters (1954); Dolch (1954).

Others have found DAF to have a facilitative effect on Speech production (Chase, 1958; Gruber, 1965).

Besides the studies dealing with the role of auditory feedback system in monitoring speech, there have been numerous studies emphasizing the role of tactile and kinesthetic feedbacks in monitoring speech production. These have been studies on normals in whom sensory disruption was artificially induced, through the tactile and kinesthetic senses. Oral anaesthetization studies have mainly employed 3 methods (1) Topical anaesthesia to oral region; (2) Nerve block anaesthesia.

The technique of nerve-block anaesthesia for studying speech production was first used by McCroskey (1950, 1958). He conducted two experiments which involved disturbing tactile-Kinesthetic feedbacks during speech. He observed that anaesthetization of articulators produced significant disturbances in articulation mostly in the form of substitution errors.

Klein (1963) studied speech by disturbing auditory, tactile feedbacks separately and both in combination. Topical anaesthesia was used to disrupt the tactile feedback which resulted in articulatory changes.

Effects of tactile and auditory alterations ware studied by Ringel and Steer (1963) on thirteen females with normal speech and hearing, for their effect on different aspacts of speech output. Binaural masking with wideband noise was used to disturb auditory feedback. Topical and Block anaesthesia were used to disturb tactile and kinesthetic feedbacks. When a combination of masking noise and anaesthesia was used, significant articulation impairment was noted as compared to either condition of anaesthesia or noise alone. Analysis of Speech after anaesthesia revealed a significant increase in average peak level of speech. Topical anaesthesia had no effect. A significant increase in phonation/time ratio was noted in both masking and nerve block anaesthesia conditions. Articulation was most severely affected by nerve block anaesthesis or in combination with masking noise. The type of misarticulation was mainly distortion. The difference in mean syliable duration between nerve block condition and control and topical anaesthesis condition was found to be very large, but failed to reach statistical significance. It was concluded that significant alterations in average peak level, articulation and rate variability occur under conditions of altered tactile sensations. Effects of multiple sensory disturbances were cumulative in nature for certain speech output variables.

Ladefoged (1967) tested five subjects under a control and three experimental conditional (1) Binaural masking noise; (2) Topical anaesthesia of the surface of lips; tongue and roof of the mouth and (3) Combination of (1) and (2). He concluded that auditory feedback is necessary for vowel production while consonant production was dependent on tactile and kinesthetic feedbacks.

Sussman (1970) conducted a study to determine the role of tactile feedback in tongue movement control. He used a tongue motion photo cell transducer for tracking tongue move—ments under topical anaesthesia. It was found that reduced tactile modality resulted in poor tracking efficiency of the tongue, despite the presence of normal auditory visual and kinesthetic feedbacks. He concluded that tactile modality is important in spatially and temporally guiding the tongue movements. He speculated that, this finding supported the contention that the exteroceptive touch endings of the tongue contributed to the mediation of position and movement as was pointed out earlier by Carleton (1938)and Weddell and his associates (1940). According to his findings, the intelligible speech even with local anaesthesia can be reasoned out, that a slight shift in the place of articulation due to loss of fine articulatory maneuvers may still maintain a basic core of intelligibility. This explains the findings of Ringel and Steer (1963) that topical anaesthesia produced no considerable effect on speech intelligibility.

Mason (1971) studied the effect of sensory deprivation on oral stereognostic ability on thirty normal subjects. Oral stereognostic score did not appear to be affected by right unilateral mandibular block anaesthesia. Bilateral mandibular block anaesthesia appeared to be critical and more effective in breakdown of oral perception.

Scott and Ringel (1971a) did a spectral analysis and phonetic transcription of the words spoken with and without nerve-block anaesthesia of two normal adult males. Results showed that place and manner of articulation were affected by stop consonants. Fricatives were noticed to retain their manner of production but they were characterized by less close constriction and a retracted place of constriction. A slight tendency toward a more neutral configuration during vowel production was noticed. Nasality was not altered. The high frequency energy sequence of high frequency sounds (for eg /s/) were considerably diminished under nerve-block anaesthesia.

Gasmon and his associates (1971) studied articulation and stress/juncture under oral anaesthesia and masking noise. Eight college students were studied under three experimental conditions (1) binaurai auditory masking, (2) tactile nerve block anaesthesia, and (3) combination of (1) and (2). The analysis of results revealed that in none of the three conditions were the stress and juncture disrupted. Consonantal articulation suffered more in condition (2) and (3) than in (1) as reported by many of the earlier studies. Feedback regarding the articulatory shape, area of contact and pressure of contact appeared to be important for consonant production.

The effect of labial sensory deprivation in articulation of bilabial sounds was studies by Putnam and Ringel (1972) by using a combination of nerve-block anaesthesia and photography on a normal adult female. It was found that during experimental condition lip movement was less accurate and less extensive, the production of bilabials was incomplete and appeared unilabial. A lack of accurate monitoring of the intra-buccal air pressure of or /p/ resulted in fricative sound which was not noticed for /b/ or /m/ production. No relative change in the production of single initial /p/ /b/ or /m/ under anaesthesia was attributed to unaffected mandible leading to a passive motor system in which the lower lip is moved up and down from the upper lip.

Horii et al. (1973) studied the acoustic characteristics of speech under anaesthetization on an young adult. Analysis of results revealed reduction of natural frequency spectral components, decreased rate of utterance and prolongation of voice syllabic nuclei and a higher and more variable fundamental frequency.

Burke (1975) estimated the effects of topical anaesthetization on gross oral functioning using atest of oral stereognosis on ten normal subjects. Results revealed a significant increase in number of errors after anaesthetization. The tests also included oral diadocokinetic ratio consisting of repetition of syllables and syllabic combination of puh/tuh/kuh as quickly and as accurately as possible for two, five second periods. A series of 't' tests conducted on these data revealed no significant changes in mean repetition rate after anaesthetization for either individual syllables or the syllable sequence. These results were similar to those obtained by a few previous workers (Locke, 1968; schlissear and Coleman, 1968 and suggest that the local anaesthesia did not produce any gross impairment in motor functioning inspite of a gross reduction in oral sensory feedback.

Prosek and House (1975) studied changes in intraoral air pressure and consonant duration in subjects with sensory deprivation due to anaesthesia. Four young adults with normal speech and intact oral structures were asked to read 20 bisyliabic words, first ia isolation and then in sentences. A list of 13 sentences were also read which provided a wide variety of allophonic variation of the stop consonants under study. The findings of the study were that the characteristic carriage of the tongue shifted posteriorly, the rate of speech was slower and misarticulation of consonants were present in anaesthesia condition. In addition, the consonants were produced with slightly greater intra oral air pressure.

Burke (1975) conducted a study to demonstrate any existing relationship between DAF susceptibility and selected auditory perceptual and oral sensory ability. Subjects with high and low susceptibility to DAF were chosen and tested for their dependence on auditory oral sensory feedback. Auditory masking, whispering and local anaesthesia were used individually and in combination to achieve a reduction in one or more feedback channels. Subjects were tested for their ability in oral diadochokinetic rate and oral stereognosis under oral anaesthesia. Results revealed that reduction of either auditory or oro-sensory feedback had so differential effect on speech with high and low susceptibility to DAF.

Putnam and Ringel (1976) studied speech production with and without nerve block anaesthetization by using cine radiography to study the behaviour of lips tongue and mandible. The study was conducted on two normal subjects. Frame by frame measurements of lip protrusion, tongue position and jaw placement were chosen for selected stops, glides fricatives and vowels in the speech sample, comparison of the measurements between the normal and nerve block conditions ravealed (1) reduction in context appropriate lip protrusion and loss of precision in lip closure activity more noticeable for the upper than the lower lip (2) a reduction in the precision of tongue articulation particularly on contacts for lingua-alveolar and lingua-velar consonants, apical retroflexion on glides and steady state postures for lingual palatal fricatives and vowels and (3) noticeable alterations in inferior and superior jaw position Which symmetrically closed to the maxilla for bilabial consonant closure and often reduced or extended in excursion for vowels and other consonants.

Siegel et al. (1977) studied the effect of oral anaesthetization on the speech of a normal female adult. The tasks included diadochokinesis, imitation of unfamiliar Swedish phonemes, production of one, two, three and four syllable words and of two prose passages. On diadochokinetic tasks, the rate of response was found to be lowered after the anaesthetization. The subject who was "error less" on oral stereognosis test before anaesthetization could not detect the presence of the form in her mouth with anaesthetization. Intelligibility was disturbged. Smallest percentage of error for 3 syllable word and greatest percentage of errors for complex passage was noticed on analysis of articulation. Imitation of unfamiliar words was also affected under anaesthesia. In summary, the talker's performance varied as a function of speech tasks.

The relative significance of tactile kinesthetic feedback in children developing speech was studied by Daniloff et al. (1977). They studied the effect of acute oral anaesthetization on speech of young children and found that children's speech was somewhat more affected by sensory deprivation than that of comparable adults. The investigators concluded that it is likely that once a speech sound is mastered by children, they display adult like motor control patterns when challenged by oral sensory daprivation.

The studies reviewed so far indicate that a disruption in oral sensory feedback brings about gross changes in oral motor function but minimal disturbances in speech intelligibility. A basic requirement of sensory deprivation is that it must decrease tactile-kinesthetic feedback without affecting the motor system. However, the recent work by various investigators have revealed that there is usually an involvement of motor fibres also (Bordan et al. 1973, as cited by Siegel et al. 1977).

Methods for evaluation of oral sensory motor function: Measures of oral sensitivity

Many attempts have been made to accurately evaluate oral sensory functions. The tests measures were either in the form of sensory acuity or sensory discrimination. Attempts were made to correlate these measures with speech proficiency.

Same of the methods used to measure oral sensitivity are mentioned below:

Grossman (1967) used nylon filaments of varying diameters to test oral tactile discrimination..

Rutherford and McCall (1967), McCall (1969) found that normal and dysartrhic subjects could be successfully differentiated using tactile acuity as a test for oral sensory acuity. Tactile acuity has bean operationally defined as the ability to detect a groove engravad on a smooth plastic piece. Normal acuity was found to be 1.5 mm. The kinesthetic pattern recognition test requires the subject to first trace a pattern cut into a plastic piece with the tongue. He is then asked to point to the picture of the pattern he traced.

Studies have also been conducted to evaluate the ability of the oral cavity to assess the object size. Dellow et al. (1970) investigated the oral assessment of plastic cylinder size while Lapointe et al. (1973) investigated the subject's ability to assess the sine of holes of various diameter instructing the subject to match the intra orally presented hole with visual display.

Willams and Lapointe (1974) davised an instroment and procedure for measuring discrimination of samll deviation from the vertical and horizontal orientation of a groove engraved in a plastic disc. The subjects were required to make judgements of the groove's angular relationsip to the vertical and horizontal axes by tracing the groove with the tongue.

Ringel et al. (1967) devised mandibular Kinesthesia test as another measure to evaluate oral sensitivity. They defined mandibular kinesthetic difference limen as the change in mandibular positioning which was necessary for the perception of such changes as measured by the Vernier calipers. It was observed that as the size of the oral aperture increased, proportionately smaller difference limens were noticed.

Tests have also been devised to measure oral vibro-tactile sensation (Grossman, 1970). Vibro-tactile threshold was found to be an accurate measure of oral sensation.

Studies have been conducted by varying several variables in vibro-tactile threshold measurement. Some of the variables studied are the psychophysiological method of adjustment (Fucci and Hall, 1971), frequencies to which the tongue is sensitive (Telage at al.l972; Fucci, 1972; Hall et al, 1972) effect of auditory masking (Fucci at al. 1977) etc.

he complexity of the instrument used to measure vibro-tactile sensitivity makes it difficult for one to use it in determining oral sensory function. The two point discrimination test is simpler.

The two point discrimination threshold has been considered to be an index of a basic discriminatory process (Rush, 1951). Classically it had been the index of tactile spatial discrimination. The two paint discrimination limen ia measured as the smallest separation of two points that can be perceived as two points rather than one. This test has been uasd to differentiate normal and defective speakers (Rutherford and McCall, 1967).

Lingual two point difference limen has been studied by several investigators. A majority of them reported that assymmetry on right and left sides of selected oral structures exists (Ringel and Ewanowski, 1965; Harikin and Banks, 1967; McCall and Morgan, 1971; Lass et al. 1972; Lass and Park, 1973). They also concluded that the tip of the tongue is more sensitive and that two point difference limen varies from site to site. Controversial findings were reported by McNutt (1975).

Oral stereognostic measures

These measures deal with the ability to recognize and discriminate three dimensional form of objects intra-orally. Oral form recognition and oral form discrimination are the two most widely used tests.

Oral form recognition test: Here the subject is required to identify the form of a 3D geometric plastic object placed in his oral cavity from a set of visually presented forms or their pictures visual cues are avoided. Many sets of forms have been developed, each set varying in number, shape and size. The twenty forms developed at National Institute of Dental Research - NIDR (Shelton et al. 1967), 5 3-dimensional forms produced by speech and hearing clinic of pensylvania

State University and NIDR (McDonald and Aungust, 1967); 16 forms in Nuttall test of oral stereognosis (Thompson, 1970) are some of them.

Shelton (1967) developed the NIDR-20 forms for oral stereognosis test. The forms ware geometric and some irregular and mounted on handles.

The findings from studies employing these tests have bean inconsistent. Some of these tests have failed to differentiate normals and speech defectives probably because of the inter-sensory nature of the oral form recognition task (Ringel, 1968). Hence another test - the oral form discrimination test was developed which elimianted the participation of the visual channel.

Oral form discrimination test: It was developed by Ringel at al. (1968). The test stimuli consisted of 10 forms representing a wide range of item difficulty and confusion. This was selected from NIDR-20 forms and were categorized into 4-geometric groups - triangular rectangular, oval and biconcave. The pairing of the forms resulted in "within class" (forms of similar shape but different size) and "between class"(forms of different Shapes) stimulus pairs. Totally 55 pairs were used along with 10 pairs selected randomly for reliability check. The subject was required to indicate if a pair of stimuli was "same" or "different" when placed consecutively in the mouth. He found that it was possible to differentiate normals and misarticulation group with the help of this test.

Ringal advocated OFD test as a better tool for testing oral stereognosis. He Sound that a positive relationship existed between "between class" (different geometric shapes and sizes) discrimination skills and articulatory proficiency. Thus "within-class" and "between-class comparison task appears to evaluate performance at different levels of discrimination. Performance on "within class" (similar shapes but different sizes) appears to be independent of speech function. For better diagnosis Ringel et al (1976) suggested the use of between claas pairs of forms.

<u>Variables studied in oral stereognostic measures:</u>

Variables affecting oral stereognostic scores have been studied such as those related to form size and thickness of stimuli. Other variables related to subjects such as age, sex, education, memory and time required for identification affected OFR. Some researchers even compared performance on various tests.

Class (1966) studied the effect of variation in size of stimuli. The six geometeric forms varied in size from 1/8" to 1/2" in maximum height and width dimensions. The findings indicated that sizes 1/4", 3/16" and 1/8" were increasingly difficult to identify and needed more time.

William and Lapointe (1971) studied the variables related to form such as form size and thickness and other variables such as age, sex, education and time required for identification affecting oral form recognition. Subjects of the study were grouped into different age levels ranging from 20-29 years, 30—39 years, 40-49 years and 50-69 years. Results revealed that a heirarchy of difficulty for shape existed with the smallest in size most difficult to identify. Age levels were suggested as an important variable in the performance of CFR task, while sex and education were not found to be significant variables. An inverse relationship was found between the time taken for identification and scores obtained.

Lapointe aad Williams (1971) conducted another study to find the effect of 3 attachment condition - stainless steel orthodontic wire attachment, nylon monofilament line attachment and no attachment upon oral sensory scores.

Thompson (1970); Torrance and Beasley (1975) investigated performance of a subject on different tests of oral stereognosis. They found that five forms developed by Pensylvania State University was the most difficult, followed by NIDR-20 and then Nuttall test.

Williams and Lapointe (1971) administered (1) Ten form test of oral stereognosis (2) Test of light and (3) two point discrimination test on 25 adults and found no significant relationship among the 3 measures.

Thompson (1970) compared the performance en the oral stereognostic and articulation tests under conditions of increasing oral sensory deprivation. Results revealed a positive relationship between articulation and oral stereognostic skills. Fewer errors on oral stereognostic test but more articulation errors were observed on placement of palatal shield.

Fitch et al (1973) conducted a study to find the relationship between lingual motor performance and oral form identification. The correlation obtained was not statistically significant.

Cannetta (1977) investigated the decrease in oral perception ability with increasing age. OFD test was administered to subjects ranging in age from 20 to 70 years. The mean scores indicated a gradual decline in the performance but no significant difference between any two age groups between 20-60 years was found.

Lass et al. (1972) conducted 4 experiments with normal adults to determine the effect of several variables on OFD test. They concluded that (1) simple repetition of the test did not improve subjects OFD scores (2) feedback information regarding correctness of the subject's responses did not Significantly affect performance (3) the presence or absence of handles did not influence the scores. (4) the location of the forms in the oral cavity ie in front or back of the mouth, affected the scores. Fewer errors were committed When the forms were placed oathe tip of the tongue.

Williams and Lapointe (1972) explored the relationship between the OFR interdental thickness discrimination and interdental weight discrimination. No significant Relationship was found between them.

Effect of memory on performance of OFD task was studied by Lass and Clay (1971), They administered OFD test to 30 normal admits under two conditions. (1) No delay condition where the pair to be discriminated was placed simultaneously in the oral cavity; and (2) delay condition where an interval of 5 seconds was allowed between successive presentation of the two forms. The investigators did not impose any time limit on the exploration of each form. Better performance in delay condition was noted. Exploration of the form in the midline did not seem possible when the forms ware placed in the mouth simultaneously.

Results of the study done by Yairi and Cavaness (1975) on 60 subjects was in agreement to the previous study (Lass, and Clay, 1971). In addition, they observed that simulat-neous presentation resulted in more between class errors than within class errors while the converse was observed in the group who were given successive presentation.

Effect of therapy on oral stereognostic scores has also been studied. Orally trained deaf children were tested for OFR ability. These children had their training in oral language from the age of two years. Children's ability in passive (with tongue stationary) and active (explore with tongue) lingual recognition of the form was evaluated. Deaf children were able to identify geometric shapes passively better than their hearing peers, but performed no better when exploring the shapes actively. They reasoned that deaf children who are taught orally gave greater attention to oral speech and they depend on fewer cues (Weiss and Skalbeck, 1975).

Ruscello and Less (1977) administered OFR test before, during aad at the end of speech therapy. Though no progressive improvement across the three testing period was noticed, their scores on these tests did improve from first to third testing period.

Bishop et al (1973) compared the OFD abilities of manually trained deaf subjects with normals and with orally trained subjects. The 2 groups of deaf children differed on oral form discrimination test but not on manual discrimination with the hands. This suggested that poorer performance on the OFD test by manually trained deaf children was not due to generally cognitive deficiency.

An important variable studied in oral stereognostic test is age. McDonald and Aungst (1967) noted that the performance on OFD task improved as function of age upto midteens and decreased markedly in geriatric group. They noted that the levelling of the growth curve nearing midteens seemed to parallel the completion of growth of the oral and facial structures.

To study developmental pattern and sax differences in OFD Skill Mani (1978) studied sixty normal children of both sexes of the ages 5, 7, 9, 11 and 13 years. It was concluded that (1) OFD ability increased as a function of age upto 13 years, however the increase was not a uniform gradual increase but a stepwise increase (2) sex differences were not present in the development of OFD across the age levels studied.

Shalini (1979) studied OFD skill as a function of age and sex in children of ages 6, 8, 10, 12 years and found that (1) OFD skills increase as a function of age in even-age group children. This improvement was found to be uniformly gradual except with a slight reduction in ability at 12 years of age which is not statistically significant (2) sex diferences were not present in the group studied and (3) no significant interaction effect of age and sex was noticed in the development of OFD ability in 'even-age' group Children.

Kumin et al. (1984) studied the relationship of oral stereognostic ability to age and sex of children. A battery of items testing oral stereognostic ability was individually presented to 168 Children, 12 boys and 12 girls at each of the seven age levels from 4-5 to 11-12. Age was significantly related to oral stereognostic scores, older subjects scored significantly higher than the younger subjects. Sex was also significant, girls scored higher than boys. The interaction of age and sex was not significant.

Apart from measures of oral sensitivity there are other measures to assess integrity of oral motor function.

Measures of oral motor skills:

The evaluation of motor speech integrity usually encompasses several types of speaking tasks. One major traditional component of most motor speech evaluations is oral diadochokinetic tasks ie tasks requiring rapid repetition of /p^/, /t^/ and /K^/ in mono-, bi-, and trisyllabic combinations. The measure most commonly derived and quantitatively applied from oral diadochokinesis is alternate motion rate (AMR) or alternate articulatory motion rate (AAMR) or maximum repetition rate (MRR). It refers to the maximal number of syllable repetitions per unit time.

AMR are diadochokinetic rate is established either with a "count by time" procedure where the examiner counts the number of syllables spoken in a given period of time or a "time by count" procedure where the examiner notes the time required to produce a designated number of syllables. Performance is them compared to normative data. The syllables most frequently used to assess AMR are /pʌ/, /tʌ/, /kʌ/ in isolation and the sequences /pʌtʌ/, /tʌkʌ/ and /pʌkʌ/ and /pʌtʌkʌ/ or their voiced counterparts.

Siegel and his associated (1977) speculate that oral speech tasks such as diadochokinesis reflect sensory deprivation. Such diadochokinetic tasks give indirect evidence concerning the Status of motor system. Diadochokinetic tasks place the articulatory system under stress by requiring rapid and coordinated articulation of syllable. Hence, the effects of sensory deprivation are most readily revealed by tasks of this sort than reading and spontaneous speech production. They concluded that the importance of oral sensory feedback increases as the speech tasks become more demanding.

Studies of oral sensory-motor skills in the clinical population:

Orosensory perception and articulatory proficiency have been investigated in persons with normal as wall as defective speech using a variety of measurement technique. The literature relevant to this will reviewed under two sub-headings.

(i) Studies on oral stereognosis

(ii) studies concerning the evaluation of motor speech integrity using oral diadochokinetic tasks or alternate articulatory motion rate.

Studies of oral stereognostic tests on clinical population include:

i) studies on subjects diagnosed as functional disorders

ii) studies on subjects with structural anomalies

iii) studies on subjects with no structural anomalies.

Studies in each of the above category will be reviewed under two sections:

1) Studies with adults serving as subjects.

2) Studies with children serving as subjects.

1. Studies with adults serving as subjects:

Studies with cases diagnosed as having functional disorders

The speech problems which are considered to be functional may show an etiological oral sensory disturbance. The recent research evidences in the area of tactile feedback has given us interesting facts regarding the etiology of so called 'functional speech disorders'. Stuttering and cases with mis-articulation mainly come under this type of functional disorder.

Jensen et al. (1975) while studying oral sensory perceptual integrity of stutterers tested intra oral form recognition, labial and lingual 2 point discrimination, interdental intra oral weight discrimination and interdental thickness discrimination. They chose stutterers and normal speakers who were matched for age, sex, race and education as subjects for the study. They found no difference between stutterers and normal speakers in oral sensory perceptual integrity. The investigators pose that the result may be so because they were not successful in testing oral sensation and perception during the act of speaking.

Oral sensory ability in stutterers was evaluated using the technique of oral anaesthetization (Hutchinson and Ringel, 1975 Manohar et al. 1975; and Devraj, 1978). Hutchinson and Ringel (1975) anaesthetized the oral region of a group of stutterers using a series of nerve block injections. The subjects were asked to deliver a talk. The investigators found that there was increased dysfluency and they attributed this to unchecked emergence of dysfluency pattern Which is preprogrammed.

However, the above findings were contraindicated by Manohar et al. (1975) and Devraj (1978. Manohar et al. (1975) studied 3 stutterers under 4 conditions, viz. (1) base rate (2) 105 dB SPL masking noise (3) lingual anaesthesia and (4) masking noise and lingual anaesthesia. All these conditions involved reading and spontaneous speech sessions. They analyzed repetition and eye-blink responses. They reported improved fluency in their cases under tongue anaesthesia.

Devraj (1978) studied the speech sample of a stutterer after lip and palate anaesthetization separately. He found that there was substantial reduction in stuttering under palatal and labial anaesthesia and that labial anaesthesia produced more reduction in stuttering than palatal anaesthesia. On the basis of the study the investigators concluded that stuttering may be due to disturbance in tactile and kinesthetic feedback.

Disordered articulation may reflect a basic oral sensory disability. Various studies suggest that there may well be a group of speakers with defective oral motor function as poor articulation whose motor dysfunction is associated with defective oral sensory abilities. Literature on articulatory disorders suggest that normal development and maintenance of articulation presupposes, to some degree, the adequacy of gross and specific motor and sensory functioning within the oral region.

Fairbanks et al. as early as 1950, studied minor subtle organic deviations in functional disorders of articulation. They evaluated the rate of movement of oral structures and found that speakers with functional misarticulations were no inferior to normal speakers. Although differences were noticed, they failed to be statistically significant.

Ringel and Scott (1968) administered OFD test to articulation defective subjects and normals. The articulatory defective subjects were judged free of oral structure anomalies and reported no past or present history of sensory and/or motor defects. Articulatory defective subjects were further divided into 2 groups (1) Mild misarticulation (a_1) and (2) Moderate misarticulation (a_2) groups.

The findings of the study indicated that on the average normal speaker produced significantly fewer errors than the total articulatory defective group and its subgroup. In addition, the 2 articulatory defective subgroups differed significantly in their average performance. Subjects in subgroup a_2 made greater average number of mistakes compared to subgroup a_1.

A study done by Kingston and Rosenthal (1987) however failed to support the proposal that OFD tests differentiate among degrees of articulatory proficiency.

Studies on subjects with oral structure anomalies:

Subjects with cleft lip or palate fall into this group. These subjects may also present congenital anomalies of sensory endorgans and/or their central connections. Also, epositioning of tisues by various surgical procedures may diminish the oral sensory inputs. Therefore, studies have been conducted on cleft palate subjects to test their ability in oral stereognosis.

Hochbergs and Kabanell(1967) administered oral stereognosis test to 12 cleft palate adults and 13 normals. The sample was heterogenous with respect to age, type and the extant of cleft, type of management, speech proficiency and other associative disabilities. Subjects who wore prosthsetic aids were tested with and without the aid.

Significantly poor scores were demonstrated by cleft palate subjects. It was noted that the subjects with prosthesis performed significantly better than those without it. The older cleft palate subjects performed significantly better than the younger cleft palate subjects. Similar findings were reported by Andrews (1973).

Andrews (1973) compared the perforamnce of cleft palate group with non-cleft palate subjects on a test of oral form discrimination. Subjects age range from 6-29 years. He also tried to relate the results of the cleft palate group to the type of cleft and the adequacy of articulation.

Oral form discrimination test was administered to both the groups. Normals performed significantly better than the claft subjects. The number of errors on the orosensory test were similar for patients with bilateral, left unilateral and isolated palatal clefts. The cleft palate subjects who had fewer articulation errors had almost the same scores on OFD test as did normals. The mean number of errors on OFD test for poor articulation group was significantly greater than for either non-cleft group or the cleft palate group with relatively good articulation.

Pressel and Hechberg (1974) studied OFD with 60 surgically repaired cleft palate speakers and 60 normal subjects. The study revealed no sensory perceptual deficit in cleft palate speakers contrary to Andrew's (1973) findings.

Studies on subjects with no oral structural anamolies:

This group includes investigations on aphasics, apraxics, dysarthrics, cerebral palsied individuals. Levine (1965) studied 27 normal and 27 aphasic subjects. He compared them for oral stereognostic perception. Each subject was asked to point to the tracing on the paper which corresponded to the form in the mouth. Aphasics made three times more errors than the normal subjects. The findings of Guilford and Hawk (1968) fall in the similar lines.

Rosenbek et al. (1973) administered 3 oral sensitivity tests to three groups of subjects, (1) thirty adults with cortical lesion (2) Ten aphasic adults without apraxia and (3) thirty normals serving as control. The test battery consisted of the follwing:

(1) Oral form discrimination test (Ringel et al. 1968). The patient was blindfolded and 2 geometric forms differing either in shape or size were placed in his mouth successively. The subjects task was to judge whether the 3 forms were same or different.

(3) Two point discrimination test: An esthesiometer was used to obtain the 2 point discrimination threshold on the tongue tip and the blade.

(3) Mandibular kinesthesia test (Ringel et al. 1967): The subject had to judge Whether a series of seven mouth openings were greater than or less than a standard mouth opening.

The finding of the study was that the first group had significantly greater difficulty on all the 3 tests. Further, severity of apraxia was found to be significantly related to the performance on all the 3 tasks. Rosenbek (1970) reported similar findings with apraxia having direct relationship with oral sensory difficulties. Studies in agreement with the above havebeen reported by Teixeira et al. (1974) and Lunn and Russel (1978).

Twenty subjects diagnosed as cases of cvA formed experimental group and six months formed the control group. Subjects is experimental group were categorized as dysarthric, aphasic and apraxizc using Johnson-Darler test. Results revealed that normals had performed better on oral stereognostic recognistion tests than any of the clinical group and that apraxixs scored significantly lower in comparison to other groups (Teixeira, Defran and Nichols, 1974).

Lunn and Russel (1978) administered oral form discrimination test to 16 post CVA dyspraxics . This study was done in order to validate Luria's (1977) hypothesis that OFD would be associated with afferent form than efferent form of dyspraxia. The reaslts were in agreement with earlier findings where oral stereognostic scores have been found to correlate with severity of dyspraxia. However, unlike the findings of Rosenbek (1973), the study indicated that oral stereognostic scores are more closely correlated to the particular type of dyspraxia, which predominantly shows errors of substitution. This would add evidence to the model proposed by Lurie (1977) that abnormalities in Kinesthetic feedback may be involved in patients suffering from afferent kinesthetic dyspraxia, the locus of lesion probably being in the area of secondary zone of post central gyrus.

Deutsch (1981) sought to explore the relationship between site of cortical brain lesion, oral form identification scores and a severity measure of the disordered speech output in speech apraxic subjects. Oral form identification scores were obtained for 9 anterior and 9 posterior LH brain lesion subjects exhibiting speech apraxic behaviour and aphasia. Oral form identification scores did not differ significantly for the 2 subject groups. The oral form identification deficit was unrelated to the severity of speech apraxia. It was concluded that oral form identification deficits are most probably not causally related to motor speech programs-ing problem nor should such deficits in this population be viewed as a valid indicator of cortical sensory dysunction.

Other than apraxic and aphasic, dysarthrics have also been tested for oral stereognostic ability (Creech and Wertz, 1973). 20 dysarthric patients were matched for age and sex with 20 control subjects. Oral sensation and perception tests consisted of the oral form discrimination test, 2 point discrimination test and mandibalar kinesthetic test used by Rosenberk et al (1973). A tape having 10 minutes sample of imitative and spontaneous speech was rated for intelligibility on a seven point rating scale by experienced speech pathologists.

The results indicated that the scores of the dysarthric group were significantly lower than that of the control group on all the three tests. However, Creech and Wertz (1973) could find no relationship between oral sensitivity and speech intelligibility.

The results of the above studies reveal that patients with neurological disorder have deficit in oral stereognosis. This deficit might or might not be the cause for the speech problem.

Scott and Ringel (1971b) compared the speech samples obtained from individuals with motor disability and individuals with sensory disruption due to anaesthesia. The subjects consisted of 6 dysarthric adults and 2 normal adults with nerve block anaesthesia. Subjects read 11 spondee words. Phonetic transcription and wideband spectogram analysis revealed several differences between the two groups. The authors concluded that motor and sensory dysfunctions result in a variety of defective articulatory patterns.

Among those with no oral structural anomalies the oral sensory perception Skills of hearing impaired persons have been studied to a limited extent. (Moser, LaGourge and Class 1967; Bishop, Ringel and House, 1972, 1973; Braverman, 1974). When auditory input is reduced absent or distorted, as it is for the hearing impaired, tactile-kinesthetic feedback may be an important factor in the development and maintenance of articulatory accuracy. Articulation errors and intelligibility of rated speech of 75 hearing-impaired adults were compared to their errors on atest of orosensory perception. When subscores on each of the tests were compared, several significant relationship were present between articulatory proficiency and orosensory perception. These results the authors feel may be useful in the development of appropriate strategies for use by speech-language pathologists working with the hearing-impaired (Lieberth and Whitehead, 1987).

<u>Studies with children serving as subjects:</u>

Ringel et al. (1970) studied the application form discrimination tests on children with various degrees of misarticulation. Sixty children, 30 males and 30 females constituted experimental group. All were receiving speech therapy. Degrees of functional misarticulation ranged from mild to severe. A control group also was chosen consisting of 60 normal children. The findings revealed that subjects with articulatory defect made more errors on the OFD task than did the subjects with normal speech. There was a clear tendency for errors to increase as a function of severity of articulation defect. Children demonstrated move difficulties than adults with OFD.

The data from the 120 children were compared to data contributed by adults in the earlier study (Ringel, Burk and

Scott, 1968). In general, it was found that (1) OFD errors increased as a function of severity of articulation deficit and (2) normal subjects commited fewer errors on the tasks than those with articulatory deficit (3) children had more difficulties than adults with the OFD task.

Fucci and Robertson (1971) studied 10 normal speakers and 10 misarticulating subjects (with no gross abnormality of oral structures nor any history of sensory motor deficit) with respect to oral stereognisis ability using the forms developed by NIDR. The results revealed that subjects considered to have functional, misartlculation made fewer and Proportionately different types of correct responses when compared to normal speakers. The investigators concluded that the term "functional" may not be appropriate for speakers having articulation disorder such as those found in their experiment.

Sommers et al (1972) studied the performance of 70 Children with 3 degrees of articulation proficiency in an OFD task. The 3 groups of children included subjects with superior articulation, subjects with deviant articulation and subjects with articulation defect. Their findings were in agreement with that of Ringel et al. (1970).

Mason (1967) studied oral stereognosis in 42 children and adults with palatal or labial clefts; between the age range of 6 to 45 years. They were air tested on an oral form recognition task for recognition of 20 plastic geometric shapes. The results revealed no perceptual defect within the cleft lip and palate group. Surgical or prosthetic intervention did not appear to affect oral stereognostic scores. Mason concluded that congenital anamely was not always accompanied congenital sensory oral defect.

Rutherford and McCall (1967) studies a group of 17 cerebral palsied subjects and 11 controls matched for mental age. Five tests of orofacial senssation and perception included. Tactile acuity test. Tactile localization, tactile pattern recognition, kinesthetic pattern recognition, two point discrimination. The results revealed that the cerebral palsied group performed significantly poorer than the normal group in only three /tasks: ie, tactile acuity, kinesthetic pattern recognition and twe-point discrimination. Athetoids and normals showed significantly better performance then spastics on kinesthetic pattern recognition test and no significant differences were found between athetoid and normal subjects.

Chase (1967) (studied a girl with congenital sensory pathology. Sucking and swallowing difficulties along with drooling were present in infancy. Clumsiness in fine movement and problem in coordination were reported. At seventeen years of age, the subject was again examined for neurological deficit. Protrusion, lateral tongue movements and coordinated movements of the oral structures were impaired. Smell and taste sensations were normal but there was absence of pain in the oral cavity and absence of gag reflex. Sensory examination revealed marked impairment in localization of point stimulation and two -point discrimination on the face and lips though normal on the extremities. Manual stereognosia was markedly impaired though general motor ability was within the normal limits. A marked impairment was seen when visual feedback was eliminated. Speech intelligibility was low even after speech therapy, the subject's speech was limited to the production of vowels.

Similar case study was reported by Bloomer (1967), the case was diagnosed as having cranial nerve palsy with weak-0 ness of the muscles of the tongue, jaw aad pharynx at eight years of age. An oral stareognostic tact administered at the age of 10 years revealed that the subject was not able to distinguish even the most dissimilar plastic forms. Abnormally low oral diadochekinetic rate was noticed. The case was diagnosed as a case of oral dysdiadochokinesis with astereognosis.

Solomon (1965) investigated the relationship between several measures of oral perception, ratings of chewing, drinking ability and a measure of articulatory skills in athetoid children. He administered five tests of oral sensory function namely form discrimination, weight perception, texture discrimination, 2 point discrimination and tactile localization. His results suggested a marked association between these oral motor abilities and ability to identify forms in the mouth. A similar relationship between articulatory ability (as on Tamplin-Darley's Afticulation Test) and other motor abilities was suggested by a high positive correlation between these measures (McDonald and Aungst, 1967).

Studies on alternate motion rate:

Speech is a dynamic process that requires the precise coordination of the oral musculatures. During ongoing speech production, fine muscle movements of the lips, tongue, palate and jaw constantly alter the dimensions of the oral cavity. Because speech is a motor act researchers have explored the relationship between articulatory skills and motor coordination investigating performance on general motor tasks as well as oral and facial motor tasks.

Studies focusing on the relationship between general motor skills and articulatory abilities have yielded inconsistent and inconclusive results. Investigators have examined populations of different ages and with different types of speech disorders and have assessed different motor skills on both a formal and informal level (Bilto, 1941; Reid, 1947; Prins, 1962; and Jenkins and Lohr, 1964). Most of this research was conducted prior to 1965. Because individuals with articulation problems have not shown to also have significant retardation in general motor development, Anther research has not been generated.

Alternate notion rate or the rate of diadochokinesis can be taken as an indication of the speed of change from inhibition to stimulation of antagonistic muscles. This speed of change may be called the speed of the reciprocating synapses of the CNS. A test of diadochokinesis of the articulators is a measure of the maximum rate at which the reciprocating synapses of the CNS may function for speech uses.

Diadochokinesis normally increases during childhood. Hence one of the determiners of the diadochokinetic rate is the degree of maturation. Disease of the CNS, however, apparently slows up the rate of diadochokinesis, when a disturbance of the CNS causes stuttering speech, general sluggishness of the muscles of the face and mouth and other muscles which are involved in the production of speech is noted.

West's experimentation as quoted by Russel and Jenkins (1941) is illustrative of some results of certain disorders of the CNS. He observed that sluggishness of muscles disappeared after a cure of the lesion. These observations seemed to indicate that there is a close connection between certain types of disorders of the CNS and dysphemia. In order to determine whether this observation was significant in diagnosing stuttering patients it was necessary to discover whether there were non-pathological, significant differences between stutterers and nonstutterers in the speed of performing diadochokinetic movements. The objective of Weat's experimental work was to discover the differencs between stutterers and non-stutterers in diadochokinetic movement. Results of his study showed that normal males showed a greater speed of variation than the normal females and there were overlapping of rates for these diadochokinatic movements made by the stuttering and non-stuttering groups. Out of the 39 stutterers, 11 overlaped the normals in their ratea and this overlapping occurad in the lower quartile of the normals and upper quartile of the stutterers. The figures for the females showed that the overlapping was such that name of the stutterers rates fell within the range of the middle 50% of the normal group. These observation seemd to indicate that a slow rate of diadochokinetic movement of the jaw and brow ".... is either a cause of or is related to a cause of dysphemia". The results of West, seemed to indicate that the diagnosis of a speech disorder in any given case, especialiy if dysphemia is thought to be present should include a neurological test based on diadochokinetic movements.

Aa per Jenkin's (1941) study -

1. There seemed to be an increase in the rate of diadochokinesis of the jaw from the age of 7 to the age of 18.
2. There seemed to be greater possibility that there is a difference in speed of this movement for successive ages than there is that there is a difference in speed between the sexes of the same age.
3. There seemed to be no correlation with age after the age of 17.
4. Practically all subjects seem to produce their maximum rate for this diadochokinetic movement during the first 10 seconds.
5. Stutterers seemed to show a slower rate of diadochokinesis of the jaws than do the nonstutterers.

Prins (1962) compared normal and misarticulating children on different motor abilities. The variables selected were motor tasks consisting of equilibratory coordination, tandum walking, non-equilibratory coordination, pellet and bottle test and oral diadochokinesia. The diadochokinesis involved rapid, alternating articulation of /pʌtʌkʌ/ and the number of repetitions in a duration of 5 seconds. Results revealed poorer scores in the group with misarticulations on all motor tasks and auditory abilities tested.

Jenkins and Lohr (1964) evaluated children with severe misarticulations and normals on Oseretsky tests of motor proficiency (Doll, 1946), which tested general dynamic and static coordination, motor speed, simultaneous voluntary movements, execution of movements in speech and accuracy limits. They found that Children with severe misarticulations had more difficulty in motor proficiency than the normals.

Dworkin (1978, 1980) studied lingual tongue strength and lingual AAMR in children with unimpaired speech and those with frontal lisps. Results revealed that unimpaired Speakers exhibited significantly greater tongue strength and faster AAMR than their lisping counterparts. These findings were said to challenge the original diagnosis of functional lisping.

In a study undertaken by Dworkin and Culatta (1985), the primary purpose was to determine whether there were any signs of structural and/or neuromuscular aberrations in the speech mechanisms of children who were previously diag-noted as having functional articulation disorders.

Their study consisted of 20 subjects in the control group and 24 subjects in the experimental group previously diagnosed as having functional articulation disorder. Chief criterion for such a diagnosis being the subject's ability to pass an oral mechanism secreening examination. Assessment battery consisted of articulation tests (sounds in words subtest of the Goldman-Fristoe test of articulation, 1969). AAMR (Syllable /p^/ /t^/ /k^/ were used to assess labial and lingual AAMR), tongue strength(was assessed using a cutom-designed semiconductor strain guage transducer, sensi-tive to direct-compression forces) and oral mechanism examina-tion (appraised using a Dworkin-Culatta oral mechanism exami-nation D-C0ME, 1980), Results indicated that there was no significant differences between the groups on any of the measures made (ie. tongue strength, AAMR and OME).

These results also appeared compatible with the findings of various clinical researchers that oral structural and neuromuscular abnormalities do not necessarily distinguish Children with articulation disorders from those with unimpaird speech(Guyette aad Diedrich, 1981; Powers, 1971; Shelton et al. 1966; Williams et al. 1981). However , these results do not seem to lend support to previous reports that children with (so called) functional articulation disorders have significantly weather tongues, slower AAMR and more volitional oral movement difficulties than their normally articulating counterparts (Dworkin, 1978; 1980).

A few studies of AAMR have been done on the clinical population of cerebral palsy. Research along these lines started as early as is She 1940s.

Heltmen and Peacher (1943) have suggested that they call "voiced movements" as being of particular value in diadochokinetic exercises for spastic children. They studied 102 spastics for rate of repetitive movements of (1) opening and closing the jaw, (2) opening and closing the lips with and without voice and (3) movements of the tongue to the ruge palatinum and down, with and without voice. They found that mean rates of lip and tongue movements were significantly greater with than without voice.

Data reported by Byrne (1959) and Irwin (1957) on CP children showed that, in general voceless sounds are more frequently misarticulated in the initial position than their voiced cognates. Therefore, the production of the voiceless syllable /p∧-t∧-k∧/ may have been more difficult for the CP subjects than the voiced syllables /b∧//d∧/ and /g∧/.

Hedges (1955) studied the relationship of 3 repetitive speech movements to speech understandibility among 60 individuals with spastic and athetoid types of CP. Rates of repetition of syllables /pʌ/, /tʌ/ and /kʌ/ were used as measures of an individuals ability to open and close the mouth, raise the tip of the tongue and elevate the back of the tongue respectively. Ratings of speech understandability were made for each subject by a panel of trained judges. Hedges reports a significant relationship between the diadochokinetic rates of (1) the mandible and lip movement (3) tongue-tip movement and (3) lingua palatal movement and understandability. Hedges made the assumption that the ability to perform certain repetitive speech movements of the articulators was a valid measure of the ability to perform certain respectitive nonspeech movements of the same structures

In a study done by Hixon and Hardy (1964), they investigated the relationships among (1) speech defectiveness (2) Rates of repetition of certain consonant vowel syllables and (3) rates of repetitive nonspeech movements of the speech articulators in agroup of 50 CP children and which 25 Children were spastic quadriplegics and 25 athetoid quadriplegics.

The results of the study warrant the following tentative conclusions:

(a) The neurophysiological mechanism which speech movements of the articulators may be dissimilar from those which evoke nonspeech movements of the same structures.

(b) An adequate evaluation of Restricted mobility of the speech articulators which is related to speech problems associated with CP cannot be accomplished by the use of nonspeech movements of those structures.

(c) Speech movements of the articulators can be used te accomplish an adequate evaluation of restricted motility of the speech articulators in CP children.

(6) Remedial therapy procedures which employ speech activities of the articulators may be much more efficient than those procedures which employ nonspeech movements of those structures.

(e) Restruction of mobility in the posterior portion of the tongue may exert important influence on the production of speech in CP children.

There were others however like Yoss and Darley (1974) who were more interested in identifying behaviours that might distinguish "developmental apraxia of speech" from functional articulation disorders. Included in their study were 30 Children with moderate to severe articulation difficulties of unknown origin and a matched group with unimpaired speech Results indicated that children with articulation disorders exhibited significantly greater difficulty than their normally speaking counterparts on nonspeech acts such as –

a) Volitional oral movement control of the tongue and lips.

b) Fine motor coordination and alternating movements of the
extremities and tongue

c) Sequences of volitional oral movements and

d) Auditory perception and sequencing tasks.

Additionally, several of the articulation disordered children exhibited speech behaviours that will also considered by Yoss and Darley to be characteristic of developmental apraxia of speech. These included - (a) slower than normal AAMR (b) Transpositions during sequential syllable reptitions and (c) Prosodic insufficiencies stash as prolongations, repetitions and additions during contextual speech.

Contradictory findings were reported by Williams, Ingham and Rosenthal (1981) in their replication of Yoss and Darley's (1974) study with the aim of distinguishing developmental apraxia of speech from functional articulatory deficits. Included in their study were 30 children with moderate to severe articulation errors and a matched control group. Their results differed from those of Yoss and Darley. Comparable analysis of the data failed to identify developmental apraxia of speech characteristics in the articulation disordered Children.

In their review of developmental apraxia of speech, Guyette and Diedrich (1981) challenged the validity of many studies that found organic correlates of articulation disorders.

They concluded that "neurological soft signs, poor non-speech oral movement skills and poor AAMR and can occur with developmental apraxia of speech but are by no means necessary or sufficient conditions of this disorder." They also suggested that such conditions may be observed in children with functtional articulation disorders, apraxia of speech or even normal articulation skills. Earlier, Shelton et al. (1966) found that both normally speaking children and those with articulation disorders exhibited difficulties with toague elevation and tongue wiggling tasks conclusions were that these tasks by themselves were not sufficient to identify the underlying causes of articulation disorders.

Some investigators have studied oral sensation and oral motor skills together in the clinical population by using tasks such as the oral form discrimination task and alternate articulatory motion rate (McNutt, 1977; Shyamala, 1980),

McNutt (1977) investigated the performance of functional misarticulation group in terms of misarticulated sounds on the oral stereognosis test. He hypothesized that specific perceptual motor abilities exist in children who product different articulatory errors. The subjects included 15 normal children, 15 children with /r/ misarticulation and 15 children with /s/ misarticulation. The tests adminstered were (1) 2 point discrimination test to measure peripheral and cortical abilities related to discrimination process (2) oral from discrimination test to measure peripheral and central integrating process (Chusid and McDonald, 1967) (3) Oral motor abilities by finding performance on alternate motion rate of the tongue. It was found that children who misarticulated /s/ were found to have comparably normal performance tasks that tested different oral sensory abilities but were found to be deficient in both oral sensory tasks and alternate motor abilities.

Shyamala (1980) evaluated the oral sensory and motor abilities of 64 subjects on 2 tasks. Oral form discrimination test (Ringel, 1968) and lingual alternate articulatory motion rate (Darley, Aronson and Brown, 1975; Winitz, 1969; McNutt, 1977). Subjects consisted of normal speakers, cases with stuttering and misarticulations. The subject's ages ranged from 13 to 25 years.

Results revealed that the normals and subjects with Speech problems differed remarkably in terms of OFD and AAMR. The subjects with speech problems demonstrated lesss efficient sensory ability than normals and deficient oromotor ability. The stutterers and speakers with misarticulations did not differ in terms of oral sensory ability or oral motor ability. There was a negative correlation between the 2 sets of scores obtained among normals ie lesser the number of errors on OFD, the greater the AAMR and vice-versa.

As is evident from the review of literature, there are not many studeis regarding oral sensory and motor skills in the cerebral palsied population and hence there still remains a derth of information regarding this issue. The present study aimed specifically at exploring the oral sensory motor skills of this population. Two experimental tasks viz. (1) oral form discrimination task and (2) the alternate articulatory motion rate ware chosen to examine this issue.

METHODOLOGY

The study was undertaken is order to investigate the differences between performance of normal speakers and cerebral palsied speakers on two experimental tasks viz. (1) Oral form discrimination task (OFD) and (2) Alternate articulatiory motion rate (AAMR).

Subjects: A total of 35 subjects were used for the study Group-I consisted of 39 normal sapkers and group II consisted of 15 cerebral palsied speakers. The subjects ages ranged from 4 to 12 years. All had Kannada as their mother-tongue.

Table-1: Table showing the distribution of subjects.

	Group-I Normals.	Group-II Cerebral Palsied
Number	20	15
Mean age	8.2 years	8.6 years
Male	12	9
Female	8	6

Group-I: This group consisted of 20 normal speakers. All the subjects were screened for hearing, speech and intelligence. The subjects were selected based on the following criteria.

1) Should have normal hearing (a hearing threshold not exceeding 20 dB HL ISO 1969).
2) Should present no observable or reported oral structural or functional anomali as or neurological problems.

3) Should have an intelligence quotient of over 95 (as screened on any one of the tests for intelligence at All India Institute of Speech and Hearing).

Group-II: Consisted of 15 subjects from the cerebral palaied population with severity ranging from mild to moderate. 12 were spastic and 3 were athetoid in the cerebral palsied group. The number was restricted to the availability of cases according to the criteria of selection. The criteria of selection were:

1. The subjects should have nromal hearing (hearing threshold not exceeding 20 dB HL ISO 1969).
2. Should have an average intelligence with IQ more than 80 as screened by a clinical psychologist.

The study consisted of two experiments (1) OFD test (2) AAMR. All the subjects underwent both the experiments.

Experiment - I : OFD test

The test was administered in a quiet room with no distractions.

Materials: The stimuli used in the task were 8 geometric forms, the test forms drawn from a pool of twenty item set developed at the National Institute of Dental Research (McDonald and Aungst, 1967). These forms were made of inert, white plastic material. They included four geometric shapes: Triangle, Rectangle, Oval and biconcave. They were of two different sizes - email and big. The forms and their dimensions are given in Appendix-I. The oral discrimination forms, were mounted on handles to avoid the risk of the subject swallowing the form. The handles also permitted the investigator to freely manipulate the form in the oral cavity.

Each of the forma were numbered (1 to 8) and were grouped into four geometric categories: triangle, rectangle, oval and biconcave. The two forms in each geometric category were paired with each form in the other geometric categories. Thus a total of 24 pairs were obtained wherein each stimulus pair was used only once in the test (For eg. Use of the pair 2-3 did not permit use of the pair 3-2). Eight more pairs were obtained and added to the twenty four by pairing each of the farms with themselves (For eg. 6-6, 4-4, 2-2 etc.). Thus a total of 32 pairs were used for test administration. Four pairs selected at random from the total number of pairs were included to check reliability. A fifty percent test retest reliability was required for the subjects to be included in the study.

Instructions to the subject: The subject was seated comfortably on a Chair towards the right aide of the investigator and was instructed as follows:

"Do you see these forms here? I am going to blindfold you and put one of them in year mouth. I will have it there for 5 seconds during which time you can move it around within your mouth, with your tongue and feel it. Then, I am going to take it away and place another one in your mouth for 5 seconds. This second form may be the same or different in terms of size and/or shape. After I remove it, you will have to tell me whether both of them were "same" or "different". If you have any doubts, you can ask me".

The doubts were clarified and trials for familiarization were given if necessary.

Procedure: The subject was blindfolded and the forms were presented successively. A form of the stimulus pair was placed in the subject's mouth and the subject was permitted to manipulate it orally in his/her mouth for 5 seconds, after which, it was removed. The second form of the stimulus pair was placed ia the mouth and again the subject was permitted to manipulate it orally for 5 seconds. After removing the second form, the subject was required to indicate whether the two items of the pair were "same" or "different". An interval of 5 seconds between each stimulus presentation was maintained.

The responses of the subjects ware recorded in a data sheet, the format of which is shown in tabular form-2. Time limits were strictly maintained using a stop watch. After each discrimination the forms were sterilized using an antiseptic lotion (Dettol).

Scoring: Each error was given a score of zero and each correct response was given a score of one. Total number of correct responses were scored for each subject. The scoring procedure was similar to that used by Mason (1967) and Moser et al (1967). The total score did not include the scores obtained in items chosen for reliability cheek.

Tabular Form-2: The data sheet used in the present study.

Sl.No. Name: Age: Sex:

Mother tongue Group-I

Group-II

Sl.No.	Stimuli pairs	Response	Sl.No	Stimuli pairs	Response
1	1-6		19	1-8	
2	1-4		20	1-5	
3	1-1		21	1-7	
4	2-7		22	2-6	
5	2-5		23	1-3	
6	2-3		24	2-6	
7	8-8		25	2-4	
8	3-8		26	2-2	
9	3-6		27	3-7	
10	3-3		28	3-5	
11	4-6		29	2-5	
12	3-5		30	4-8	
13	4-7		31	4-4	
14	4-5		32	5-8	
15	6-7		33	5-6	
16	5-7		34	6-8	
17	6-6		35	7-7	
18	8-8		36	4-5	

Experiment - II :AAMR Test

Each subject was evaluated in a quiet room without any distractions.

<u>Materuaks:</u> A Philipa tape-recorder (Model 15AM125/00S was used for recording the response of the subject. A voiced trisyllabic combination of /bʌdʌgʌ/ was used to record the AAMR. The trisyllable /bʌdʌgʌ/ was used because (1) its production involved both front and back of the oral cavity (2) the use of all voiced phonemes permitted the maximum number of repetitions before exhausting the air supply (McNutt, 1977).

<u>Instructions to the subjec:</u> The subject was seated in front of the microphone of the tape-recorder and was instructed as follows:

"This is a test to find out how fast you can speak accurately. Take a deep breath and start repeating /bʌdʌgʌ/ as fast and as many times as you can. Whenever you run out of breath, stop take a deep breath and start again. Start when I say "start" sad continue doing so until I say "stop". If you have any doubts, please ask me".

Doubts were clarified and demonstration of the task was given.

<u>Procedure:</u> The subjects were instructed to take a deep breath before beginning and to continue repeating the trisyllabic sequence as fast and as long as possible. The AAMR of each subject was recorded. The duration between a deep inspiration

and expiration as indicated by the stoppage of repetitions, was considered as one breath group. The subjects were stopped after the third sequence of repeating the trisyllable for a full expiration.

Scoring: The data for analysis included the number of syllable repetitions in the first five seconds of the first, second and third breath groups. The analysis over time was dene to permit increasing fatigue of prolonged voluntary periodic contractions of muscles (Seyffarth, 1962; McNutt, 1977).

The investigator and another post-graduate student served as two judges in evaluating the number of syllables repeated for five seconds in each of the three breath groups. Each breath group was evaluated thrice by both the judges to ensure intratester and inter-tester reliability. The averaged number of syllable repetitions for 5 seconds were determined and compared for the two groups.

RESULTS AND DISCUSSION

The results of the two experimental tasks were analyzed to find out:

1. The difference between the normal subjects and cerebral palsied subjects in terms of oral form discrimination ability.
2. The difference between the normal subjects and cerebral palsied subjects in terms af alternate articulatory motion rate.
3. The relationship between OFD ability and AAMR in the normals and CP children studied.

Experimental task - I: The means and standard deviations of the correct responses scored on OFD task was computed for each group. A series of 't' tests (Guilford, 1965; Carrett and Woodworth, 1966) were computed to determine the significance of difference between means.

Comparison of perforamnce of normals and cerebral palsied subjects on OFD task.

Table-3: The comparison of normals and cerebral palsied subjects in terms of correct identification on OFD task.

	Normals	C.P
Number	20	15
Mean	26.05	20.8
Standard Deviation	3.64	4.46

The means and standard deviations for the 2 groups are shown in Table-3. It was found that the mean performance of the normal subjects was better than that of the cerebral palsied subjects. The variability in performance of the cerebral palsied subjects on the OFD task was more than normals. The difference between the two means was found to be significant on computation of 't' value.

Thus, in the OFD task there is a difference in performance between the normal subjects and the cerebral palsied subjects, the normals being superior to the cerebral palsied subjects in terms of OFD ability. This finding is in agreement with the study by Rutherford and McCall (1967) who reported that the cerebral palsied group performed significantly poorer than the normal group on tasks of orofacial sensation and perception. Similar findings in dysarthrics was reported by Creech and Wertz (1973).

Comparison of spastic and athetoid subjects on OFD task:

Although it was not the main focus of the study and though the number of spastics and athetoids in Group-II was limited, an attempt was made to compare their performance on the OFD task.

Table-4 : Comparison of spastic and athetoid subjects in terms of correct identification on OFD task

	Spastics	Athetoids
Number	12	3
Mean	18.6	23

As shown in the table, the mean performance of athetoids on the OFD task was better than the normals.

Experimental Task-II: The means, standard deviations and 't' values were computed four AAMRs (in terms of syllables/5 seconds) for the 2 groups.

Table-5: Comparision of normals and cerebral palsied subjects on AAMR (Syllables/5 seconds)

	Normals	CP
Number	20	15
Mean	30.3	12.6
Standard Deviation	5.93	6.39

As seen in Table-5, the mean AAMR is higher in normals than in the cerebral palsied groups. The difference between the means of the two groups was found to be statistically significant at .01 level. Greater variability was found in Group II (CP) than in Group-I(Normals). Thus, it was found that the cerebral palsied group was poorer than the normals in terms of alternate articulatory motion rate.

Comparison of spastic and athetoid subjects on AAMR:

Table-6: Performance of spastic and athetoid subjects on AAMR (syllables/5 seconds).

	Spastics	Athetoid
Number	12	3
Mean	12.6	8.33

It was found that the mean performance of the spastic subjects was better than the athetoids on the AAMR task.

However, since the subgroup of spastic and athetoid subjects is very small, no generalization can be made in this study regarding the performance oa the above experinental task.

The results of the present study were also analysed to find out if there is a relationship between OFD ability and AAMR in the normals and the cerebral palsied groups. The two sets of scores obtained on the experimental tasks were compared to find out if performance on one task correlated with performance on the other. The 't' teat was computed to find out if the correlation was statistically significant. The correlation between the two sets of scores was not found to be statistically significant for either of the groups Group-I: r = .28 and Group-II, r = 0.35). Thus good performance in one task did not necessarily mean that the subject would perform equally well on the other task.

While age was not a variable investigated in the present study it was observed that the younger children in the present age-group studied made more errors on the OFD task. This finding falls in line with previous studies by Mani (1978) and Snalini (1979) that there is an improvement in performance on the OFD task with age. The younger subjects also demonstrated poorer performance on the AAMR task compared to the older children in the age group studied (Table-7) and this may probably reflect on neuromuscular maturity or lack of it.

Though these two tests may not be useful together as a test battery for cheeking oral sensory and motor skills, each of these tests, it is suggested, may prove to be Valuable in contributing to our evaluation and therapeutic efforts regarding oral sensory perception and oral motor skills in the clinical population.

Normals				Cerebral palsied			
Sl.No.	Age	OFD	AAMR	Sl.No.	Age	OFD	AAMR
1	5	19	17	1	4	9	3
2	5	22	21	2	5	16	6
3	6	19	22	3	6	17	7
4	6	23	24	4	7	18	7
5	6	23	24	5	7	19	9
6	7	24	27	6	7	20	8
7	7	24	28	7	8	21	9
8	8	25	30	8	8	21	10
9	8	26	30	9	8	23	15
10	8	26	31	10	9	22	16
11	8	27	33	11	9	25	15
12	8	27	33	12	10	24	17
13	8	28	33	13	10	24	18
14	9	27	34	14	11	26	23
15	9	28	36	15	12	27	26
16	10	29	36				
17	11	30	36				
18	11	30	36				
19	12	32	36				
20	13	32	39				

Table-7: OFD scores and AAMR across ages.

SUMMARY AND CONCLUSIONS

The present investigation was undertaken in light of the continuing search and need for answers regarding the possible relationship between oral sensory-motor efficiency and speech proficiency. This study sought to explore the oral sensory and motor abilities of 35 subjects (20 normals and 15 cerebral palsied) in the age range of 4-12 years.

The subjects were tested on two tasks: Oral form discrimination test (Ringel, 1968) and Lingual alternate articulatory motion rate (Darley, Aronson and Brown, 1975; Winitz, 1969; McNutt, 1977).

The OFD test consisted of 32 stimulus pairs of 3 plastic forms belonging to 4 geometric categories. When the pairs of stimuli were prsented successively in the mouth, the subjects were required to indicate whether the two forms were "same" or "different". The correct responses were scored.

The alternate articulatory motion rate (AAMR) test required the subject to repeat rapidly the trisyllabic combination /bʌdʌgʌ/ for 5 seconds durations of 3 breath groups. The averaged number of syllables repeated for 5 seconds in each of the 3 breath groups recorded were subjected to statistical analysis.

The findings of the study were as follows:

1. There is a significant difference between the normal subjects and cerebral palsied subjects performance on the OFD task. The normals were superior to the cerebral palsied subjects in terms of OFD ability.
2. On the AAMR task, depressed performance in lingual motor skills was observed in the cerebral palsied group.
3. Performance on one experimental task did not correlate significantly with performance on the other task for both the groups.

Suggestions, and Recommendations for further research:

1. It is suggested that the OFD task can be used there-peutically to heighten oral sensory awareness to improve the child's sensory awareness of his articulators.
2. Therapeutic emphasis on AAMR tasks may improve articula-tory skills by sensitizing the subjects to the place and number of contacts by the articulators.
3. The same study can be conducted on a large population.
4. The complexity of the OFD test can be increased by varying the shapes of the forms, so as to make it more sensitive in evaluating the adult age group.

5. Other clinical populations can be studied and their performance can be compared using the tests employed ia the present study.
6. The use of these two tests as prognostic indicators of articulation improvement for the clinical population can be evaluated.
7. The normative data for these two tests can be established.

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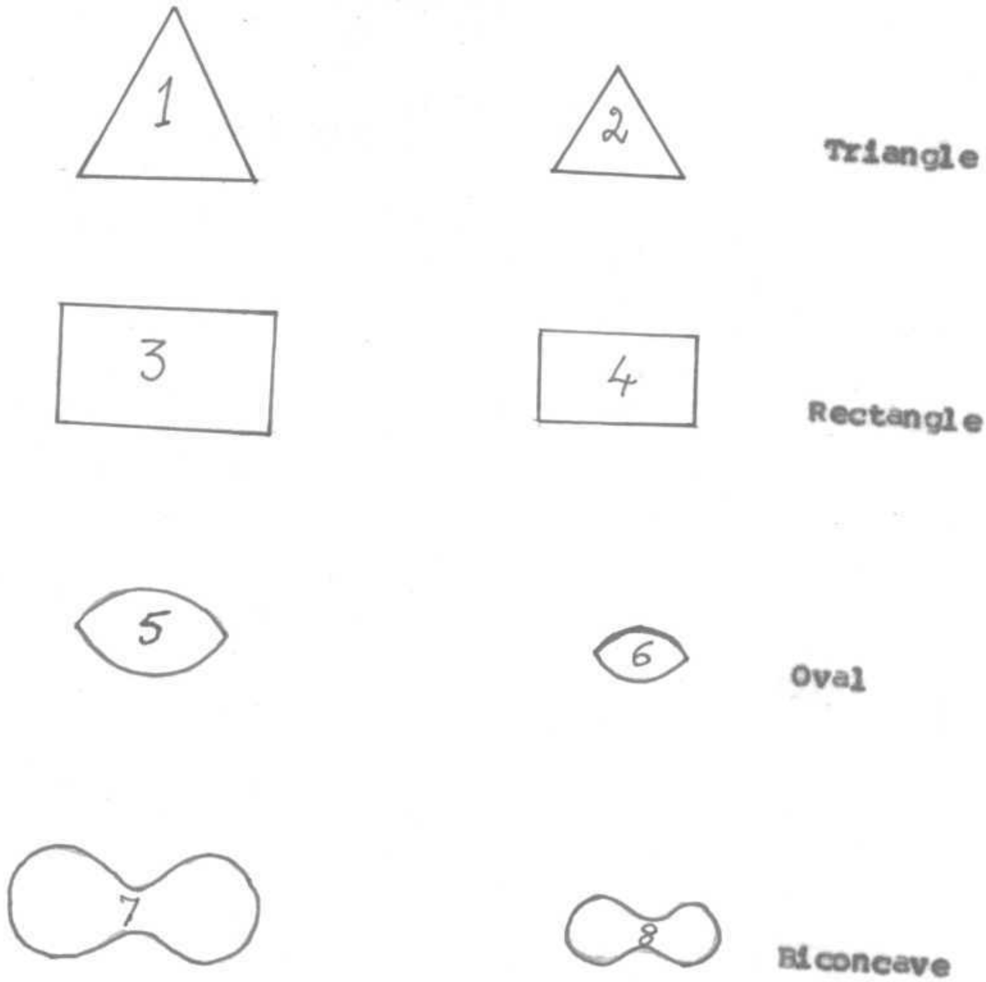
APPENDIX



The eight geometric forms drawn from the pool of NIDR-20 forms.