Oral Sensory and Motor Skills in Normals and a Clinical Population.

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CERTIFICATE

This is to certify that the dissertation entitled "Oral sensory and motor skills in normals and a clinical population" is the bona fide work in part fulfilment for MSc in Speech and Hearing of the student with Register No. 8

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CERTIFICATE

This is to certify that this dissertation has been prepared under my supervision and guidance.

Guide

DECLARATION

This dissertation is the result of my own study undertaken under the guidance of Mr. N.P. Nataraja, Lecturer in Speech Pathology, All India Institute of Speech and Hearing, Mysore, and has not been submitted earlier at any University for any other diploma or degree.

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CONTENTS

CHAPTER I

INTRODUCTION

> "Oral sensory and perceptual integrity are important feedback components needed for the regulation and refinement of oral motor patterns necessary for normal speech (Bosma 1967)

In the oral area there la an intimate interaction of sensory and motor function, essentially an autocommunication for speech production. Speech, a motor act, consists of complex ballistic movements (Bosma 1967). The role of sensory and perceptual experiences in developing and regulating oral motor performance is currently being studied with greater emphasis (Ringel 1970). Disturbances in oral sensory perception have been found to be associated with disturbances in speech output. There are indications supporting the view that oral sensory function is related to the oral motor proficiency (McDonald and Aungst 1967). But the nature of oral sensory abilities and their contributions to various motor activities including speech production is still inconclusive.

Speech production has been explained on the basis of a servo-model, with the advent of Weiner's (1948) theory of cybernatics, various hypothetical models were proposed. Those by Fairbanks (1954), Mysak (1966) are the most widely cited models of speech production. These models emphasize the closed-loop system of tactile, kinsesthetic and proprioceptive feedbacks in monitoring the ongoing speech production. Role of sensory feedbacks has been stressed by many (Patton 1942, Diltman 1955,), Lieberman 1957, Smith 1962, Millsen 1966, Henke 1967, Ringel 1970, Van Riper 1971, Hardcastle 1976).

Effect of disturbed oral sensory system on speech production and monitoring has been widely investigated. Any disruption in auditory, tactile or kinesthetic feedbacks exhibits a disruption in speech output (Perkins 1977).

several studies have investigated sensory disruption by artificially inducing it (Lee and Black 1951, smith 1962, Coblens and Agnello 1965, Fairbanks and Gutiman 1958, McCroskey 195O, 1956; Ringel and Steer 1963; Ladefoged 1967; Scott and Ringel 1971, Gammon et al 1971; Mason 1971; Putnam and Ringel 1972, 1976; Leanderson and Persson 1972; Horii et al 1973; Prosek and House 1975; Burke 1975, Gerald et al 1977). Effects of oral anaesthesia have been reported to be maximum disruption of consonants minimally affecting intelligibility (Ringel and Steer 1963, Hutchinson and

Ringel 1975).

Role of tactile and klnesthetlc sensory abilities have also been studied in disordered speech (Class 1956, Levine 1965, Solomon 1965, Rutherford and McCall 1967; Chase 1967; Bloomer 1967, Rootee and McNeilage 1967, Mason 1967; Hochbeig and Kabcenell 1967, Guilford and Hawk 1968; Ringel and scott 1968; Rosenbek 1970, 1973; Ringel et al 1970; Fucci and Robertson 1971; Sommore et al 1972; Creech and Herts 1973; Teixeira et al 1974; Pressel and Hoclhberg 1974; Jensen et al 1975; Cohen and Hanson 1975; Hutchinsen and Ringel 1975; Kanohar et al 1975; Guitar 1975; McNutt 1977; Lum and Russel 1978; Devraj 1978).

Investigations on speech disordered group included both organic and functional cases.

Articulation and fluency aspects have been found to be mainly disturbed in speech production (Lee 1950, Black 1951; Coblens and Agnello 1965; Fairbanks and Guttman 1958; Peters 1954, Dolch 1954, Class 1956; Bloomer 1967; Creech and Werts 1973; Ringel and Scott 1968; Ringel et al 197O; Fucci and Robertson 1971; Sommors et al 1972; Jensen 1975; Kelly 1977, Manohar et al 1975; Hutchinsen and Ringel 1975, McMutt 1977, Devraj 1976). Speech problem was also found to be associated with oral sensory deficiency (Rutherford and McCall 1967; Bloomer 1967; Chase 1967; Lavine 1965; Guilford and Hawk, 1968; Rosenbek 1970, 1973; Creech and Herts 1973; Teixeiro 1974; Lum and Russel 1978; Andrew. 1973; Class 1956; Ringel and Scott 1968; Ringel et al 1970; Fucci and Robertson 1971; Sommors et al 1972; Kelly and McNutt 1977). Motor abilities have also been studied in cases of functionally speech disordered group (Perkins 1975; Anderson 1923; Cross 1936; Wesphal 1933; Bilto 1941; Carlson 1946, Strother 1936; Kriegman 1943; Kopp 1946; Spriesterbach 1940; Finklestien and weisberger 1954, Cooper and Allen 1977, Fairbanks et al 1950; Prins 1962, Jenkins and Lohr 1964, Yossand Darley 1974; McNutt 1977).

The reports about the sensory-motor ability have been controversial in cases with speech disorders. A battery of tests are used to Measure oral sensory ability. The commonly cited ones are tests of tactile acuity, texture discrimination localisation, pattern recognition, two-point discrimination, vibrotactlle sensitivity and oral stereognostic tests (Rutherford and McCall 1967; Fucci and Robertson 1972; McDonald and Aungst 1967; Ringel et al 1970; Ringel and Ewanowski 1965).

Oral stereognosis is the faculty of perceiving the nature of objects on the basis of tactile, kinesthetic sensations from the oral cavity particularly the tongue (Thompson 1970). such an ability As required for speech production aa a normal speaker should develop the ability to integrate spatial representation of his oral cavity. Oral form discrimination ability has been cited aa important for speech production (Ringel 1968, 1970). Articulation proficiency and oral stereognosis have been reported to be cloaely related (Class 1966).

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

Variables involved in oral form discrimination include the stimulus variables like size and shape of forms, retention time, inter-stimulus interval (Lass et al 1972; Lass and Clay 1973; Torrans end Beasley 1975, Lapointe and Williamson 1971) the subject variables like sex, intelligence and linguistic factors (Mani 1978; Shalini 1979).

Oral sensory ability is found to be depicted in articulation proficiency. Various articulation tests have been used in connection with this. Articulatory notion rate is considered to be an important and diagnostic tool in evaluating speech proficiency (Darley, Aronson and Brown

1975; Winitz 1969; McNutt 1977).

Need for the study

Studies have revealed controversial findings regarding the relationship between oral sensory ability and motor speech proficiency, variables like sex and age have not received much attention, studies investigating the oral sensory-motor ability of cases with speech disorders are scarce. Studies on stutterers and subjects with misarticulations dealing with sensory-motor ability using Indian population are very few. Hence, the present study intended to answer the following questions:-

1. Is there a difference between normal male and female subjects in terms of oral fora discrimination ability and alternate articulatory motion rate?

2. Is there a difference between the normal group and a functionally speech disordered group on oral form discrimination ability and alternate articulatory motion rate?

3. Is there a difference between stutterers and subjects with misarticulations in terms of oral form

discrimination ability and alternate articulatory action rate?

Purpose of the study

The purpose of the study is to test the following hypotheses:

1. There is no difference between normal male and female subjects in terms of oral form discrimination ability.

2. There is no difference between normals and subjects with speech problems in terms of oral form discrimination ability.

3. There is no difference between normals end stutterers in terms of oral form discrimination ability.

4. There is no difference between normals and subjects with misarticulations in terms of oral form discrimination ability.

5. There is no difference between stutterers and subjects with misarticuiatlons in terms of oral form discrimination ability.

6. Thare is no difference between normal male and female subjects in terms of alternate articulatory motion rate.

7. There is no difference between normals and subjects with speech problems in terms of alternate articulatory motion rate.

6. There is no difference between normals and stutterers in terms of alternate articulatory motion rate.

9. There is no difference between normals and subjects with misarticulations in terms of alternate articulatory motion rate.

10. There is no difference between stutterers and subjects with misarticulations in terms of alternate articulatory motion rate .

Limitations of the study

1. Only limited number of subjects were selected.

2. It was not possible to include more number of female subjects.

9. The clinical population included subjects with

stuttering and misarticulatlona only.

4. Limited age range was considered.

Implications

1. This study may add to the present status of literature regarding oral form discrimination and artlcu-latory action rates of normals, stutterers and subjects with misarticulations.

2. It may be useful in developing diagnostic and prognostic tests in clinical population.

3. It may be uaeful for standardization of normative data on the two tasks used in the present study.

Definitions used in the present study

Oral form discrimination ability: Ability to identify, discriminate and judge two, three-dimensional geometric forms of objects as "same" or "different" when they are placed intraorally.

Lingual alternate articulatory motion rate: The rate of the ability of the tongue to move in coordination with other articulators to accomplish rapid, repetitive articulatory movements.

stuttering: It is defined as the disruption in the fluency of verbal expression which is characterized by involuntary, audible or silent repetitions and prolongations in the utterance of short speech elements namely: sounds, syllables and words of one syllable.

Misarticulation: Phonemes are said to be misarticulated when they are perceived as omitted, substituted or distorted.

CHAPTER II

REVIEW OF LITERATURE

> "speech, the epitome of skilled movements, requires exquisite sensory feedback of oral motor functions"
>
> - Perkins 1977

Speech is a actor act of uttering speech sounds. "Speaking involves three processes:Phonation, articulation-reaonance and speech-flow. Phonatory processes are basic to production of voice; Articulatory-resonatory processes are basic to production of different sounds of speech; speech-flow processes are basic to prosody (stress inflection and rhythm) to pronunciation (arranging sounds in proper sequence), to rate and to the fluency with which sounds are initiated and joined together" (Perkins 1977).

speech consists of complex ballistic movements. Senaory-motor integration is a neceaaary condition for normal speech production. The role of sensory and perceptual experiences in developing and regulating oral Motor performance is currently being studied with greater emphasis (Ringel 1970). Investigations of the nature of oral-sensory abilities and their contributions to various actor activities including speech production is not yet conclusive.

But there are indications supporting the view that oral sensory function is related to the oral motor proficiency (McDonald and Aungst 1967).

The perception of action of articulators for speech production is a synthesis of different sensations principally tactual and kinesthesis. It has been reported that the infant of five or six months, constantly exposed to the simultaneous auditory-tactile-kinesthetic-vibratory feedbacks from his own vocal Mechanism, is forming rudimentary auditory motor associations and by eight or nine months learns to reproduce many of the sounds he hears in environmental speech. However, little is known of the senaory discriminations the infant must learn, if he is to perfect the movement patterns of apeech. Based on the current knowledge of speech physiology, Rutherford and McCall (1967) postulated five types of sensory discriminations in the least, which might be needed in order to learn the different motor patterns for phonemes. They are: location of tactile contact between articulators; size or configuration of the area of tactile contact; direction of movement of the articulators; rate of movement of the articulators and extent of movement or present location in space articulators.

Speech as a servo mechanism: Feedback refers to the process by which the output signals are sent back to the "Central system", and speech is controlled by feedbacks.

Speech production as a motor act has been explained on the basis of cybernatics, science of automatic control, weiner (1948) extended principles of cybernatics to biological systems. With the advent of his theory of cybernatics, various hypothetical models have been proposed (Fairbanks (1954) and Mysak (1966)). These advocate the closed feedback loops as the essential Monitoring system for speech production. Any disruption in the monitoring system might lead to speech disturbances (Fairbanks 1954; Mysak 1966; Metshell 1973; Hollien 1975). Closed feedback loop systems differ in comparison with the open feedback loop systems in that they are error sensitive, error-measuring, self-adjusting and goal-directed closed mechanisms.

Fairbanks (1954) presented one of the most widely cited models of speech production highlighting the sensory monitoring needed for motor activity. His model includes an effector unit, a sensor unit, a storag unit, a mixer and a comparator unit. According to the model, the output information that is fedback is matched against the input patterns in the storage component.

The mixer or controller regulating Mechanism changes the instructions to effector system, thus altering the output to reduce the future errors. The exteroceptive (auditory) and proprioceptive (somesthetic) informations are fedback for comparison with the intended output. in this model, the rate of change of the effective driving signal is caused to vary with the magnitude of the error signal, when the error signal is large the corrective change is also rapid and it becomes progressively slower as the error signal is reduced.

The model proposed by Mysak (1966) also makes use of the closed loop system. The sensory informations are fedback. The sensory informations of errors in speech performance are fedback to the closed loop machine thereby affecting automatic corrections. Mysak (1966) views the speech system as a closed, multiple-loop system containing feed-forward, feed-back and external loops. His servomodel includes the receptor, integrator, transmitter, effector and sensor units. The speech system is complex with minor control loops operating within main loops or large overall control systems. The system has two outputs, the speech content and the speech product. Error-free speech content and error-free speech output indicate total positive feedback. Lieberman (1957) has patented a model of phonological perception in which speech production and perception are considered as two aspects of the same process. This motor theory observes that the acoustic stimulus leads to a covert articulatory response and the proprioceptive feedback leads to a discriminative event which has been called "perception". Lieberman and his associates (1961) speculate "in the course of long experience of a Speaker (and listener), the articulatory movements connected with speech sounds and sensory feedbacks (or more likely the corresponding neurological processes) become part of the perceiving process, mediating between the acoustic stimulus and its ultimate perception.

Smith (1962) proposed a similar model known as "neurogeometric" theory aiming at an operational approach. According to this theory the sensory control of speech is primarily an intrinsic neural process, the characteristics of which are determined by the basic senaorl-neuromotor mechanisms of perceptual-motor integration.

Van Riper (1971) also stresses the importance of feedback systems in implying 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 actor responses, such disturbance could produce asynchrony and lead to speech defect.

Hole of feedback in development and control of speech production:

Patton (1942) stated that the kinesthetic and proprioceptive senses are of basic importance in learning speech and without thaw, the conditioned reflex of speech would probably never be established nor maintained.

Diltman (1965) 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.

It is commonly accepted that speech is initially built upon proprioceptive sensations that come from reflexive activities such aa sucking, swallowing, vomiting, yawning and others (McDonald and Aungst 1967). Henke (1967) suggested that proprioceptive feedback provides the mechanisms whereby the timing or rate of articulatory activity is accomplished. He cited an example of production of a stop consonant in which ongoing activity waits until contact between articulators (closure) ia attained and then uses awareness of this happening, presumably through proprioceptive feedback, as a trigger for further articulatory activity.

Perkell (1969) views the speech production mechanism as composed of "two neuromuscular systems with different behavioural characteristics responding in general to different feedback". In his 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 myotactic 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 pleasure and tactile feedback.

Ladefoged (1967) has also hypothesized that the production of vowels depends more on auditory monitoring than do the consonants which depend more on oral sensory feedback. MacMeilage (1970) while discussing the sequencing of articulatory movements, refers to the results of oral-stereognosis studies as evidence that persons "can integrate complex patterns 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.

Milisen (196$) in discussing the development of articulation 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 resources.

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 systems, one, a phasic reflex system which is driven from rapidly adapting receptors located in the capsules of the laryngeal joints (the articular system) and the other, a tonic servo reflex system which is driven from slowly adapting receptors embedded within the mascles themselves (the myotactic system). These systems clearly play a part in the continuous and precise adjustment of muscle tone during phonation.

The work of Kawamura (1965) on the mandibular musculature also 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 temporomandibular joint.

Van Riper (1971) remarking on the servo-model observed that there are many possible sources of distortion in the feedback systems used to monitor speech. Perkins (1977) opinionates that any disruption in the speech output implies a disruption of auditory, tactile or kinesthetic feedback.

Hardcastle (1976) summarizing what is known about the activity suggests that tactile feedback provides information to the central nervous system 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. Proprloceptors (kinesthstic 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:

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

As early as 1949, Hanley and Draegart noted that while speaking in the presence of noise, loudness of voice is directly influenced by the noise and it increases.

Delayed auditory feedback (DAF) was first reported by Lee (1950) and Black (1951). According to them, when a normal speaker's output was fedback to his ears, after a short delay of about l/5th of a second, marked breaks in fluency oceured. The most obvious effects of speech were slowarlng of speech, increase in intensity with pitch raise and a serious disturbance in the speech pattern. Lee (195O) reported that a subject might atop completely or if he attempts to maintain normal speech rate with DAF, he would begin to stutter by repeating syllables especially those with fricative sounds such as "sh" and "ch". He did not offer an explanation for the individual differences in critical time data needed on his five subjects, smith (1962) observed that theae different forms of adapting to feedback delay indicate that speech control is somewhat more flexible than Lee (1950) implied and that aural Monitoring is not necessarily a higher level of control than somesthetic Monitoring. The subjects, who performed most successfully under DAF were probably able to ignore for the most part, the non-aynchronized sounds of speech and to control their speech mainly by somesthetic feedback signals.

Rewnsley and Harris (1954) observed prolongation of vowels and Coblena and Agnello (1965) observed prolongation of glides and continuant sounds under DAF. In addition, DAF resulted in apeech disturbances like increased articulatory errora, longer duration, greater SPL and higher fundamental frequency.

Pairbanka and Cuttman (1956) obaerved apeech under DAP and noted articulatory diaturbencea aa direct effect and lncreaaa in vocal SPL aa indirect effect.

Petera (1954) found that speech rate increeaed when epeaker'B voice waa accelerated and fedback to hla own eara through air-conduction.

Dolch (1954) alao reported that feedback acceleration in combination with the feedback being transmitted to the eare at 180^{o} out of phase to the signal emitted at the mouth lead to harshness of voice, an increase in intensity and slowering of rate of speech.

Chase (1958) found that it was possible to repeat the speech sounds more number of times in a 5-second period under DAF than in a 5-second period under control conditions, when 20 subjects were tested, fifteen of them repeated the sound /b/ for 2-7 times acre under delay than under no delay conditions. It was concluded that there was a facilitating effect on the circulation and re-circulation of speech sounds under DAF.

Gruber (1965) observed that, under DAF, normal speaking individuals can be taught to "beat the machine" by concentrating on their tongue and lip movements and also by becoming aware of the proprioceptive feedbacks.

While the few studies mentioned above deal with the role of auditory feedback system in monitoring speech, there have been numerous studies accentuating the role of tactile and kinaesthetic feedbacks in monitoring speech production. There have been studies on normals in whom sensory disruption was artificially induced, through the tactile and kinesthetic senses. Oral anaesthetization studies have mainly employed 2 methods (1) Topical anaesthesia to oral region; (2) Nerve block anaesthesia.

Ringel and Steer (1963) studied the effects of tactile and auditory alterations, on thirteen females with normal speech and hearing, for their effect on different aspects of speech output. Binaural masking with wideband noise was used to disturb auditory feedback. Topical and block anesthesia 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. There was significant increase in phonation/time ratio in both masking and nerve-block anaesthesia conditions. Articulation was moat severely affected by nerve-block anaesthesia or in combination with masking noise. The type of misarticulation was mainly distortion. The difference in mean syllable duration between nerve-block condition and control and topical anaesthesia 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.

McCroskey (1950, 1958) was first in using the technique of nerve-block anaesthesia for studying speech production.

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.

Klien (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.

Ladefoged (1967) tested five subjects under a control and three experimental conditions: (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). The results revealed that the condition (3) produced disorganized yet intelligible speech, condition (2) resulted in labial sound misarticulations. Difficulty in producing /s,z/, /t,d/ and /l/ along with pitch and nasality changes were noted in condition (1). 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 call transducer for tracking tongue movements 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 end-inga of the tongue contributed to the mediation of position and movement as earlier pointed out 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 alight shift in the place of articulation due to loss of fine articulatory maneuvers may still maintain a baaic core of intelligibility. This explains the findings of Ringel and steer (1963) that topical anaesthesia produced no considerable effect on speech intelligibility.

Spectral analysis and phonetic transcription of the words spoken with and without nerve-block anaesthesia were studied by Scott and Ringel (1971 a) on two normal adult males. The results showed that place of articulation and manner of articulation were affected for 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 alight 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 example /s/) were considerably diminished under nerve-block anaesthesia.

Articulation and stress/juncture production were studied under oral anaesthesia and masking noise by Gammon and his associates (1971). Eight college students were studied under three experimental conditions: (1) binaural 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 previous studies. Feedback regarding articulatory shape, area of contact, and pressure of contact appeared to be important for consonant production.

Putnam and Ringel (1972) studied the role of sensory feedback on the lip by using a combination of nerve-block anaesthesia and photography, on a normal adult female. The effect of labial sensory deprivation in articulation of bilabial sounds was studied. 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 for /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 /h/ 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.

Leanderson and Persson (1972) studied the EMG activity of facial muscles during speech, of ten normal adults with and without nerve-block anaesthesia. No perceptible difference in speech was found before and after anaesthetization but the most consistant finding was a general increase in the amount of pre-speech background activity and in particular, in the amount of articulatory activity. Theae EMG changes in afferent activity may be accounted for, by a disturbed positional sense. To compensate for this disturbance, the control of articulatory activity which la normally unconaciously done, may be referred to a higher level of central nervous system under this condition.

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

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 end tested for their dependence on auditory or 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 diadokokinetic rate and oral stereognosis under oral anaesthesia. Results revealed that reduction of either auditory or oro-sensory feedback had no differential effect on speakers with high and low susceptibility to DAF.

Four young normal adults were studied by Prosek and House (1975) for changes in intra-oral air pressure and consonant duration in subjects with sensory deprivation due to nerve-block anaesthesia. The findings revealed that the characteristic movement of the tongue shifted posteriorly, the rate of speech was lower and misarticulation of consonants were present under anaesthetic condition, slightly greater intra-oral breath pressure was observed in the production of consonants.

The behaviour of lips, tongue and mandible during speech production with and) without nerve-block anaesthetization was studied by Putnam and Ringel (1976) on two normal subjects. Cine-radiography was used and 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 revealed (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-allveolar and lingua-velar consonants, apical retroflection 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.

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

Burke (1975) estimated the effects of topical anaesthetization on gross oral functioning using a test of oral stereognosis on ten normal subjects. Results revealed a significant increase in number of errors after anaesthetization. The tests also included oral diadokokinetic rates 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; Schlisser 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.

Siegel et al (1977) studied the effect of oral anaesthetization on the speech of a normal female adult.

The tasks included diadokokinesis, imitation of unfamiliar Swedish phonemes, production of one, two three and four syllabie words and of two prose passages, on diadokokinetic 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 disturbed. Smallest percentage of errors for two 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. Spectrographic and perceptual analysis of the speech produced during sensory deprivation revealed: (1) children's speech was same what more affected by sensory deprivation than that of comparable adults. (2) Consonants and vowels were equally affected in terms of error rate. Apical, dental and other abstract consonants were greatly affected. (3) The older children revealed a slowing of speech rate, an exaggeration of VOT and similar other behaviours, to compensate for the loss of oral sensation. The results indicate no strong differences between the children of varying age. 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 deprivation.

studies conducted on children are relatively few, since a procedure to altar or disrupt tactile-kinesthetic feedback in children without the use of painful injection is not yet developed (Frick 1964).

The studies reviewed so far indicate that a disruption in oral sensory feedback brings about gross changes in oral motor function but minimal disturbance in speech intelligibility. A basic requirement of sensory deprivation la 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 fibers also (Borden et al 1973, as cited by siegel and his associates 1977).

Siegel and his associates (1977) speculate that oral speech tasks such as diadokokinesis reflect sensory deprivation. Such diadokokinetic tasks give indirect evidence concerning the status of motor system. Diadokokinetic tasks place the articulatory system under stress by requiring rapid and co-ordinated articulation of syllables. Hence, the effects of sensory deprivation are Host readily revealed by tasks of thia sort than reading and spontaneous speech production. They concluded that the importance of oral senaory feedback increases as the speech tasks become more demanding.

Role of tactile and kinesthetic feedback in disordered speech:

The studies on role of tactile and kinesthetic feedback in speech and language defective population with organic pathology includes studies on cleft palate subjects (with defective oral structures), aphasics, apraxics and dysarthrics with no oral structural analies.

The cleft palate subjects may present congenital defects of oral sensory receptors and/or their higher centres, surgical intervention for the closure of the cleft may also alter the oral sensation and motor functioning and hence speech production.

Hochbergs and Kabcenell (1967) studied oral stereognosis on twelve cleft palate adults and normal subjects of varying age, extent of the cleft and therapeutic measures. significantly poorer scores were demonstrated by cleft palate subjects. It was seen that subjects belonging to older age group and those with palatal prostheses obtained better scores than the subjects of younger age group and those without palatal proatheaee.

Andrews (1973) studied subjects with and without palatal cleft in the age range of 6-29 years. An oral form discrimination test was administered on 39 cleft palate subjects and same number of matched normal subjects. It was noted that normal subjects performed significantly better than cleft palate subjects. The number of errors on the oroaensory test were similar for patients with bilateral or unilateral or isolated palatal clefts. Cleft palate speakers with fewer articulation errors had nearly the same acorea as normals on the oral-form discrimination task. The mean number of errors on oral form discrimination teat for poor articulation group was significantly greater than for either non-cleft palate subjects or the cleft palate group with relatively good articulation.

A few studies on oral sensory motor functioning of cleft palate speakers include children as well.

Mason (1967) studied oral stereognosis in 42 children and adults with palatal or labial clefts; between the age range of six to fortyfive years. They were all tested on an oral form recognition task for recognition of twenty plastic geometric shapes. No tine limit was imposed for the subject to explore the forms in the mouth. 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 anamoly was not always accompanied by congenital sensory oral defect.

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

Though the cleft palate subjects exhibit asymmetry in maxillary arch, abnormal tongue posture and abnormal nasal resonance affecting speech production. There have been controversial findings with regards to oral sensory functioning. However, the limited number of studies mentioned here should not be considered conclusive, since the results may not be comparable as the groups were heterogenous with respect to different variables like age, duration of prosthetic use and/

or speech therapy or surgical intervention.

studies on subjects with no oral structural anamoly includes investigations on aphasics, aproxies, dysarthrics, cerebral palsied individuals.

Levine (1965) studied oral stereognostic perception in 27 normal and 27 aphasic subjects. Each subject was required to recognise the tracing on the paper which corresponded to the form in the mouth. Aphasics made three times wore errors than the normal subjects.

The finding of Guilford and Hawk (1966) confirmed the above results.

Rosenbek et al (1973) studied oral sensitivity in 3 groups of subjects: 30 adults with cortical lesion and apraxia, 10 aphasics without apraxia and 30 normals. The sensitivity measures included (1) oral farm discrimination test (Ringel et al 1968). (2) Two point diacrimination test. (3) Mandibular kinesthesia test (Ringel et al 1967). The findings revealed that subjects with cortical lesion demonstrated significantly greater difficulty on all the three tests, severity of apraxia was found to be significantly related to the performance on all the three tasks.

Rosenbek (1970) reported similar findings with apraxia showing direct positive relationship with the oral sensory abilities.

Teixeira et al (1974) studied 20 subjects with cerebrovascular disorders and 6 normal subjects. Subjects in the experimental group consisted of dysarthrics, aphasics and apraxics. The findings revealed that apraxics scored significantly lower in comparison to other groups and normals performed better on oral stereognostic recognition tests than any of the clinical group.

An oral form discrimination test was administered to 16 subjects with dyspraxia following CVA by Lum and Russel (1978). The study evaluated Luria's (1977) hypothesis that oral discrimination would be associated with afferent form than an efferent form of dyspraxia. The results of this study were found to be in agreement with earlier findings that oral stereognosis had a direct relationship with severity of dyspraxia. The study also indicated that oral stereognostic measures are more closely related directly to the particular type of dyspraxia predominantly exhibiting errors of substitution. These support the model proposed by Luria that abnormalities in kinesthetic feedback may be involved in patients with afferent kinesthetic dyspraxia.

the locus of lesion probably being in the area of secondary zone of post central gyrus.

Creech and Wertz (1973) studied dysarthrics for oral stereognostic ability. 20 dysarthrics with 20 matched normal subjects were studied. Oral sensation and perception tests consisted of the oral form) discrimination test, two point diacrimination test and mandibular kinesthesic test as used by Rosenbek at al (1973). samples of imitative and apontaneous speech were rated for intelligibility on a seven point rating scale. The results indicated that the dysarthric group scored significantly lower than the control group on all of the three tests. Creech and wertz (1973) could find no relationship between speech intelligibility and oral sensation.

Rutherford and McCall (1967) studied a group of 17 cerebral palsied subjects and 11 controls matched for mental age. five tests of orofacial sensation 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 normal group in only three tasks: i.e., tactile acuity, kinesthetic pattern recognition and two-point discrimination. Athetoids and normal showed significantly better performance than 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 co-ordination were reported. The subject again was examined at seventeen years of age for neurological deficit. The examination revealed absence of pain in the oral cavity. Protrusion, lateral tongue movements and coordinated movements of the oral structures were impaired, smell and taste sensations were normal but gag reflex was absent. 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 stereognosis was markedly impaired. Though general motor ability was within normal limits. A marked impairment was seen when visual feedback was eliminated. Even after speech therapy the subject's speech was limited to the production of vowels. speech intelligibility was very low.

Bloomer (1967) reported a similar case study. His subject demonstrated a speech problem attributed to the muscular incoordination of oral structures especially the tongue. The case was diagnosed as having cranial nerve palsy with weakness of the Muscles of the tongue, jaw and pharynx at eight years of age. Even after intensive speech therapy her speech remained almost completely un-intelligible. Misarticulations in the form of substitutions tad omissions were seen. Incoordination of phonatory and articulatory movements was observed. An oral stereognostic test 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 diadokokinetic rate was noticed. The case was diagnosed as a case of oral dysdiadokokinesis with astereognosis.

Similar findings were reported by Rootes and McNeilage (1967) on studying a sixteen year old girl with impairment in somesthetic perception and motor function. The investi-gators administered a series of tests of speech perception and production. Comprehension of speech was intact. But speech was highly unintelligible, inspite of normal amount of oral muscle activity during speech production.

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 identification, weight perception, texture discrimination, 2-point discrimination and tactile localization. His reaulta suggested a marked association between theae oral motor abilities and ability to identify forme in the mouth. "A similar relationship between articulatory ability (as on Templin-Darley's Articulation Test) and other motor abilities was suggested by a high positive correlation between these measures" (McDonald and Aungst 1967).

These studies reveal that the quality of oral sensory function may be related to the quality of oral motor proficiency depicted by articulatory proficiency.

Oral sensory and motor behaviours of stutterers:

Van Riper (1971) emphasizes the role of tactile and kinesthetic feedback in the development of stuttering by stating that a child who develops stuttering fails to make an appropriate transfer in speech monitoring from the auditory channel to the proprioceptive channels. He has also reported that stutterers speak more fluently while whispering and completely fluent when pantomining speech.

improvement in fluency in stutterers under delayed auditory feedback may be due to forced transference of speech rhythm control to a more matured or less loaded tactile, kinesthetic sensor (Mysak 1976). The disordered rate and rhythm may occur because of problems in the auditory sensor or in the tactile-kinesthetic sensor.

other evidences supporting an active role of tactile and kinesthetic feedback in stuttering include the finding that stutterers do not stutter or stutter lets with the use of electrolarynx which requires a high degree of conscious articulation in the pantomining movements (Mackenzie 1966); Laryngectomized stutterers who learn oeaophageal speech do not show any stuttering probably because of careful articulation to compensate possible loss in the acouatic features of oesophageal speech (oldrey 1953; Irving and Webb 1961, Van Riper 1971). There are some stutterers who stutter even under whispering and silent reading (Ratna and Nataraja, 1975). Rarity of stuttering in congenitally deaf and laryngectomees emphasize the role of somesthesia in monitoring of ongoing speech (Van Riper 1973).

All these findings indicate that the feedback systems other than audition play an important role in the development and maintenance of stuttering. The speech problem of stuttering which is usually considered to be "functional" may show an etiological oral sensory disturbance.

Class (1956) found that lingual form perception studied with respect to the time required for lingual form perception, the differences in ability for lingual form perception varied in the four experimental groups studied consisting of 20 cerebral palsied, 20 stuttering, 20 misarticulating and 20 normal subjects. It was found that subjects with stuttering and misarticulations were less adept and inferior at the task than normals, stutterers and speakers with misarticulation were not significantly different from each other (Moser 1967).

Jensen et al (1975) studied oral sensory perceptual integrity of stutterers using oral form recognition test, labial and lingual two-point discrimination, interdental, intraoral weight discrimination and interdental thickness discrimination tests. They found no differences between stutterers and normal speakers in oral sensory perceptual integrity. The investigators concluded that the result might have been so because they were not successful in testing oral sensation and perception during the act of speaking.

Cohen and Hanson (1975) studied the inter-sensory integrating ability of stutterers. A task involving matching of auditory-temporal (tapping) patterns with visual-spatial (dot) displays was administered. They found stutterers to be deficient in the task and concluded that stutterers present some specific neurological dysfunction which interferes with their ability to perform efficiently in receptive-expressive functions. The inter-sensory-integration and speech production were found to be correlated.

studies were conducted using the technique of oral anaesthetization to evaluate the oral sensory ability in stutterers under sensory deprivation.

Hutchinson and Ringel (1975) anaesthetized the oral region of a group of stutterers using a series of nerve block injections and evaluated speech production under this condition. They found that there was increased dyafluency under sensory deprivation. They offered explanation that stuttering increases as a result of organismic stress (as evidenced by Brutten and Shoemaker 1967); stutterer may learn to reduce the frequency and severity of stuttering. This refinement would require peripherial feedback which would be lost under oral senaory deprivation leading on to more severe form of stuttering. They found an increase in stuttering in terms of prolonged articulatory postures and hence decreased rate.

They also hypothesized that if reduction in stuttering were to be seen under oral sensory deprivation, it would indicate the inability of the stutterer to monitor the articulatory events of the block hence showing that stuttering was within the peripheral framework; conversely, if no marked change in stuttering occured under oral sensory deprivation, it would Mean that oral sensory information plays no significant role in the control of stuttering.

Manohar et al (1975) studied three stutterers under four conditions. (1) base rate; (2) 105 dB SPL masking noise; (3) lingual anaesthesia and (4) masking noise and lingual anaesthesia in combination. They evaluated reading and spontaneous speech under all these conditions and analysed repetitions and eye blink responses only. They found maximum fluency under tongue anaesthesia. They concluded that each of the above mentioned condition seems to decrease stuttering and increase fluency.

Guitar (1975) investigated the relationship between decrease in stuttering frequency and reduction of electrical activity at each muscle site of speech organs using analogue electromyographic feedback. One of the subjects showed greater decrease in stuttering frequency when feedback was associated with lip site. Another subject showed greater decrease in stuttering when feedback was given both from laryngeal and lip sites. It was concluded that stuttering may be due to distorted feedbacks at different parts concerned with speech production.

Devraj (1976) studied the speech sample of a stutterer after lip and palatal anaesthetization separately. The results revealed that there was substantial reduction in stuttering under labial and palatal anaesthesia. And labial anaesthesia produced more reduction in stuttering than palatal anaesthesia. The investigator concluded that stuttering may be due to disturbance in tactile and kinesthetic feedbacks.

The theory that stuttering is based on an organic predisposition of a neuromuscular nature has stimulated a large amount of research on the motor abilities of stutterers which have not been conclusive. A stutterer's speaking rate la affected by duration of his pauses between phrases, duration of his stuttering block and by his articulatory rate. Articulatory rate has a powerful effect on stuttering and must be specified in any description of a stutterer's speech (Perkins 1975).

The motor proficiency of stutterers has been evaluated both for general motor abilities and oral motor abilities in speech production. The majority of the studies have investigated inter-sensory-motor coordination. On testa of eye-hand coordination, Anderson (1923), Cross (1936), Wesphal (1933) found no differences between stutterers and non-stutterers. On the other hand, Bilto (1941) and Carlson (1946) found stutterers inferior to normal speakers on similar tests.

On the speed of repetitive manual movement test, stutterers were found inferior by Cross (1936), west (1929) and Rotter (1938) while strother (1936) and Kriegman (1943), closely matching their subjects with respect to age, sex, handedness and skills of rhythm discrimination found stutterers slightly though not significantly, superior to non-stutterers. Palmer and Oeborn (1940) found stutterers and non-stutterers equal in strength of the tongue. On speed of repetitive movements of the tongue, lips, jaw, stutterers were found slower than right handed normal speakers by Cross (1936). Spriesterbach (1940) observed no differences between the control and experimental groups on a similar test. Kopp (1946) found stutterers extremely deficient in general physical coordination as measured by the Oseretsky tests of motor proficiency.

Finkelstien and weisberger (1954) found that stutterers did not differ from non-stutterers on Oseretsky tests of motor proficiency consisting of tests of general bodily coordination. They concluded that if a general lack of neuromuscular integration underlied stuttering it would not be noticed on this particular series of tests.

Cooper and Allen (1977) studied the time control accuracy of ten normals and tan stutterers. The speech sample comprised repetition of sentences, paragraphs and nursery rhymes and a finger tapping task as a control. Temporal accuracy was measured. Results suggested that there is a wide range of timing abilities even among the normal speakers; on most of the experimental tasks normal speakers are more accurate timers than stutterers. These results suggested that there is a defect in the speech motor output in stutterers.

Sensory and motor behaviours of speakers with mis-articulations:

Normal development and maintenance of articulation pre-supposes to some degree the adequacy of gross and specific sensory-motor functioning of the oral region. Some sources of disordered articulation may reflect a basic oral sensory disability.

Ringel and Scott (1966) studied articulation-defective speakers and normal speakers using oral form discrimination test. The group with misarticulations consisted of nine females and eighteen males with no gross abnormalities of the oral structures nor any history of sensory and/or motor defects. The normal speaking group consisted of sixteen females and four males. The findings of this study revealed that on the average normal speakers produced significantly fewer errors than the articulatory defective group. The mild and moderate miaarticulation groups differed significantly in their average performance in that the moderate misarticulation group made more errors compared to mild miaarticulation group.

Rlngel et al (1970) studied the application form discrimination tests on children with various degrees of miaarticulation. sixty children, thirty males and thirty 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 sixty normal children. The findings revealed that subjects with articulatory defect made more errors on the oral form discrimination 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 more difficulties than adults with the oral form discrimination.

Fucci and Robertson (1971) studied ten normal speakers and ten misarticulating subjects (with no gross abnormality of oral structures nor any history of sensory motor deficit) with respect to oral stereognosis ability using the forms developed by NIDR. The results revealed that subjects considered to have functional misarticulation 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.

Sommors et al (1972) studied the performance of seventy children with three degrees of articulation proficiency in an oral form discrimination task. The three 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).

Kelly (1977) studied the lingual vibro-tactile thresholds of thirty normal and thirty functionally misarticulation children. All the children had normal hearing with no history of neurosensory or neuromotor disturbance. Misarticulations were analyzed in terms of distinctive features and phonemic scores on Templin Darley diagnostic test of articulation. Lingual sensitivity was determined on the anterior midline region of dorsum of the tongue at 125, 250 and 500 Hz. The analysis of the results revealed that lingual sensitivity is significantly reduced in children with misarticulation. But reduced sensitivity did not appear to be related to the articulatory phonemic errors or to the pattern of distinctive features errors. These findings are in agreement with results of the study by Fucci and Robertson (1971).

McMutt (1977) investigated the performance of functional misarticulation group in terms of misarticulated sounds on the oral stereognosis teat. He hypothesised that specific perceptual motor abilities exist in children who produce different articulatory errors. The subjects included fifteen normal children, fifteen children with /r/ misarticulation and fifteen children with /s/ misarticulation. The tests administered were (1) two-point discrimination test to measure peripheral and cortical abilities related to discrimination process (Ruch 1965). (2) Oral form 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 on tasks that tested different oral sensory abilities but were found to be deficient in oral alternate motion rate of the tongue. Children who misarticulated /r/ sound were found to be deficient in both oral sensory tasks and alternate motor abilities.

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.

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 mia-articulations were no inferior to normal speakers. Although differences were noticed, they failed to be statistically significant.

Brine (1962) compared normal and misarticulating children on different motor abilities. The variables selected were motor tasks consisting of equilibratory coordination, tandem walking, non-equilibratory coordination, pellet and bottle test and oral diadokokinesis. The diadokokinesis involved rapid, alternating articulation of /pʌtʌkʌ/ and the number of repetitions in a duration of 5-secs. Resulte 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.

In a study of children with developmental dyspraxia, Yoss and Barley (1974) found impaired facility for rapid alternating movements in children with misarticulations of /s/ or /r/.

The varying results of these investigations may be attributed to the heterogeneity of the population studied, the size of the samples chosen and the wide variability seen in the pathological group itself.

Clark (1974) emphasizes the importance of tactile and kinesthetic feedbacks in speech facilitation techniques for the speech handicapped which are becoming increasingly necessary.

The studies reviewed so far indicate that oral sen-aory ability and actor proficiency might be related.

Methods for evaluation of Sensory-motor function

Various measures have been used to evaluate oral sensory-motor integration. Oral sensitivity measures have taken the form of either sensory activity or sensory dis-crimination which were thereforth correlated with speech proficiency.

Grossman (1967) uaed nylon filaments of varying dia-meters to test oral tactile stimulation. Tactile stimulation of various oral and non-oral sites on 4 women and two men between 35-40 years of age were investigated. The oral sites included incessive papilla, the dorsal surface of the tongue tip and upper and lower lips. Two extra-oral sites were also chosen. The filament was placed on the test site with a s m a l l bent and the subject was to indicate whether he/she felt it or not. The upper lip was found to be significantly more sensitive than any of the other sites. The lower lip and tongue did not differ in sensitivity being significantly wore sensitive than the oral and extra oral aides.

Tactile acuity la another test for oral sensory acuity. It can be determined by evaluating the ability to detect a groove engraved on a smooth plastic surface. Normal threshold of acuity was found to be 1.5 mm. Tactile motor abilities can be assessed by measuring the tactile acuity. Another test for kinesthetic pattern recognition requires the subject to trace a pattern cut into a plastic piece with the tongue and to recognize the pattern traced among a series of similar looking pictures. Normal and dysarthric subjects could be successfully differentiated using these tests (Rutherford and Mccall 1967, McCall 1969).

Studies to evaluate the ability of oral cavity to assess the object size have been carried out (Dellow et al 1970). Dellow and hie associates investigated the oral assessment of plastic cylinder size and found that subjects overestimated the size and the errors were significantly greater than those produced by manual comparison alone.

Lapointe et a1 (1973) investigated the subject's ability to assess the size of holes of various diameter instructing the subject to match the intra orally presented hole with visual display. Here also there was a tendency for over-estimation of the size.

Williams and La Pointe (1974) devised an instrument and procedure for measuring discrimination of small deviation from the vertical and horizantal orientation of a groove engraved in a plastic disc. The subjects were required to make judgements of the groove's angular relationship to the vertical and horizantal axes. lo males and 1O females were blindfolded and instructed to trace the groove with the tongue and report the position of groove as vertical, horizantal or angled to the right of vertical or angled to the left of the vertical. Subjects performed better on horizantal plane than in vertical plane condition. No sex difference was found in terms of the number of errors.

mtra-oral texture discrimination waa etudled by Ringel and Fletcher (1967) in 24 normal adults. The oral-apatio temporal discrimination waa hypotheeiaed to be related to textural discrimination. 6 plecea of cloth varying in coaraeneaa aerved aa the atimuli, preaented to selected oral and extra-oral site. The results revealed characteristic pattern of response for the structural sites with respect to the texture of the stimuli.

Mandibular Kinesthesia test is another oral sensitivity Measure (Ringel et al 1967). Mandibular kinesthetic difference listen was defined by Ringel and his associates as the change in mandibular positioning which was necessary for the perception of such changes, as messured by a vernier calipers. The results revealed that as the size of the oral operture increased, proportionately smalier difference listens were noticed.

The tests for measuring vibro-tactile sensation and two point discrimination are the most widely used tests for oral sensitivity evaluation.

Geldard (1940) was the first investigator to demonstrate that vibro-tactile stimuli could be used successfully to assess central and peripheral tactile processes. Grossman (1970) noted that vibratory stimuli share same central nervous system pathway as touch and involve high level perceptual judgements similar to speech. Vibro-tactile threshold is an accurate measure of oral sensation according to him.

Studies investigating vibro-tectile threshold have included several variables like the psychophysiological Method, frequency and others. Fucci and Hall (1971) studied the vibro-tactile sensation on 5 male and 5 female adults. Thresholds were determined by psychophysiological method of adjustment, on oral and non-oral sites. Results revealed that there was a significant difference in threshold for tongue and palmar surface.

Telage and his associates (1972) attempted to provide normative data regarding the vibro-tactile sensitivity of tongue for 110 normal adult speakers at 200 and 400 CPS. The range of frequencies to which the tongue was most sensitive was selected and the lowest vibro-tactile thresholds were obtained in the range of 300-400 CPS. Threshold for all speakers were obtained at 200 CPS to 400 CPS using method of limits (Hall et al 1972). Comparison of thresholds at the test frequencies showed a lower mean sensitivity at 400 CPS than at 200 CPS.

Fucci et al (1977) investigated oral sensory changes in 30 subjects with disrupted auditory feedback. Lingual vibro-tactile thresholds at frequencies 123, 250 and 500 Hz were determined from the tongue surface, under auditory masking. No effect of auditory masking was noticed on lingual sensory ability.

The complex instrumentation for measuring vibrotactile sensitivity makes it difficult to be used as a routine clinical test for oral sensory function. The two point discrimination test is simpler.

The measure of two point discrimination threshold is considered to be an index of a basic discriminatory process (Ruch 1951). It has been an index of tactile-spatial discrimination. The two-point discrimination limen is measured as the smallest separation of two points that can be perceived as two points rather than one and it has been used to differentiate between normal and defective speakers (Rutherford and McCall 1967).

Mccall and Morgan (1971) studied 25 adults for asymmetry in two-point difference limen on tongue margins on both left and right tides. Modified vernier calipers was used to determine the threshold. Variation in force and tongue dryness were controlled. A significant difference limen value between right and left margins of the tongue was evident. The study, like many other studies, revealed that asymmetry on right and left sides of selected oral structures exists (Ringei and Ewanowskl 1965; Harikin and Banks 1967; Lass et al 1972; Lass and Park 1973). The investigators concluded that the tip of the tongue was most sensitive and two-point difference limen varies from site to site.

McNutt (1975) reported that children show no significant asymmetry in two point difference linen, between the right and left sides of the tongue. Adults showed varying results, some showing asymmetry in the form of a decrease in sensitivity on one side of the tongue. He attributed the assymetry differences between adults and children to changes in the central nervous system rather than to changes of peripheral sensory mechanisms. McNutt (1979) studied the magnitudes and patterns of two-point difference limens (DL) of the tongue in children with and without misarticulations. The results revealed that increased size and abnormal pattern of lingual two-point limens were associated characteristically with misarticulations of particular sounds.

The oral stereognostic measures deal with the ability to recognise and discriminate three dimensional form of objects intra-orally. The two most widely used tests involve oral form recognition and oral form discrimination.

Oral form recognition test consists of three dimensional geometric plastic forms. The subject is required to identify the form kept in his oral cavity from a get of visually presented forms or their pictures. Visual cues are avoided.

Several sets of forms each set varying in number, shape and size have been developed. Some of then are twenty forms developed at National institute of Dental Research - NIDR (shelton et al 1967); 5 three 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).

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

The effect of variation in aize of stimuli has been studied by Class (1966). The findings indicated that sizes 1/4", 3/16" and 1/8" were increasingly difficult to identify and needed more time, significant effect on performance was not noticed for size above 1/4".

William and La Pointe (1971) studied the variables related to forms such as aize and thickness and other variables such as age, sex, education and time required for identification affecting oral form recognition. The results revealed that a hierarchy of difficulty in recognizing shapes among the twelve test forms of varying shapes exiated. But there was no linear relationship between the size of the stimuli and the performance. The forms. smallest in size, were found to be the most difficult to identify. Age levels were suggested as an important variable in the performance on the oral form recognition test, sex and education were not found to be significant variables. Time was found to be an important variable as an inverse relationship was found between the time taken for identification and the scores obtained.

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.

William and La Pointe (1971) studied the relationship between oral form recognition test end lingual touch sensitivity test on twentyfive adults. A ten form test of oral stereognosis, a test of light touch and the two point discrimination tests were administered. The results revealed no significant relationship among the three measures.

The relationship between lingual motor performance and oral form identification was studied by Fitch et al (1975). However, no conclusions could be drawn.

Canetta (1977) investigated the decrease in oral perceptual ability with increasing age. subjects between 20-70 years of ape were studied using an oral form recognition test. The mean scores indicated a gradual decline in the performance but no significant difference between any two age groups was found between 20-60 years of age. significant decrement in scores was noticed from younger age to old age of 70 years. But subjects in their 6O's did not deviate significantly from performance level of young adults. It was concluded that no appreciable decline of oral perception was found until the age of 70 years.

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

Oral form discrimination test was developed by Ringel et 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 categorised 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 is same or different when placed conaecutively in mouth. He found that it was possible to differentiate normals and misarticulation group with the help of this test.

Variables affecting oral form discrimination scores were studied by Lass and his associates (1972). They concluded that (1) subject's oral form discrimination skills did not improve with simple repetition of the test. (2) significant effect on performance was not noticed when feedback information concerning the correctness of the subject's responses were given. (3) The scores were not affected by the presence or absence of handies. (4) The location of the forms in the oral cavity, i.e., in front or back of the mouth, affected the scores. Fewer errors were made when the forms were placed on the tip of the tongue.

The relationship between the oral form recognition, interdental thickness discrimination and interdental weight discrimination were explored by Williams and La Pointe (1972). for interdental form discrimination the subject had to make "same" or "different" Judgements for a series of blocks presented in pairs, one at a time, between the upper and lower central incisors. For thickness variation discrimination a standard block and another block varying in thickness were presented. similarly, blocks with variation in weight were used for interdental weight discrimination. No significant relation between the three tests were found.

Effect of memory on performance of oral form discrimination task was tested on normal adults (Lass and Clay 1971). The investigators administered oral form discrimination test to their subjects under (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. Better performance in delay condition was noted. Exploration of the form in the midline did not seem possible when the forms were placed in the mouth simultaneously.

Yairy and Caaness (1975) investigated effect of time factor on 60 normal female adults grouped into two of thirty each. Oral form discrimination test was administered to both groups with a difference. The presentation of forms to one group waa one at a time with 5 secs., interval and for another group focus were presented simultaneously. The exploration time was limited to 7 seconds. The results were the same as that of previous study by Lass and Clay (1971). In addition, they observed that simultaneous presentation resulted in more 'between-class' errors than within class errors and the converse was observed in the group who were given successive presentation. The normal speaking subjects with simultaneous presentation of forms showed oral stereognostic response pattern similar to articulatory defective speakers.

in children, oral sensitivity measures most widely used ate vibro-tactile sensation and two-point discrimination (Longer 1974, Kelly 1977, McNutt 1975).

Oral atereognostlc measures used in children include oral form recognition and oral form discrimination tests.

Fucci and Robertson (1971) studied normal and children with misarticulations on oral form discrimination task. The effect of several variables were analyzed. The results revealed that the two groups of children differed on oral stereognostic tasks. There was a great amount of variability within and between the two groups in terms of within-class and between-class responses; tongue tip and tongue blade were more sensitive sites in the oral region.

Oral form recognition test was also administered to orally trained deaf children by weiss and Skalbeck (1975). Children's ability in passive (with tongue stationary) and active (exploration with tongue) lingual recognition of the form was evaluated. Deaf children were better performers with passive tongue identification than active identification of geometric shapes. The investigators speculated that deaf children who are orally trained may give greater attention to oral speech and they may depend on fewer cues.

Shelton et al (1973) and Ruscelio and Lass (1977) tested children with misarticulations for the effect of therapy, using oral form recognition test. There was found to be improved performance on the task after speech therapy.

Ringel discarded the oral form recognition test as being inter-sensory in nature and advocated oral form discrimination test as a better tool for testing oral stereo-gnosis. He found that a positive relationship existed between "between-class" (different geometric shapes and sizes) discrimination skills and articulation 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. Ringel et al (1976) suggested the use of "between-class" pairs of forms for better diagnosis.

Sommors, Cox and West (1972) studied articulatory effectiveness, stimulability and children's performance on perceptual and memory tasks. Performances on speech sound stimulability task were not found to be related to performance on any auditory measures and only slightly to the oral sensory task.

Moreau and Lass (1974) used carter-Buck Prognostic Test and oral form discrimination tasks on 49 children with misarticulations. Oral form discrimination test was capable of distinguishing between children who would improve their articulation through maturation and others.

To check the ability of oral stereognosis in predicting speech performance, schlieser and Cary (1973) chose children with functional misarticulation and administered oral form discrimination test. Children's rated speech performances were compared with the scores on oral form discrimination task. Results showed no significant correlation between the scores on oral form discrimination and speech performance. The investigators also found that oral form identification and discrimination tests measured similar oral stereognostic abilities.

Bishop et al (1972) compared the oral form discrimination abilities of manually trained deaf subjects with normals and with orally trained deaf subjects. The two groups of deaf children differed on oral form discrimination test but not on manual discrimination with the hands. This suggested that poorer performance on oral form discrimination test by manually trained deaf was not due to general cognitive deficiency.

Larsen and Hudson (1973) found the same results as Bishop et al (1972) on testing oral and non-oral deaf subjects.

One of the important variables in oral stereognostic tests is age. McDonald ana Aungst (1967) noted that the performance on oral form discrimination task improved as a 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 age and sex variables in oral form discrimination, Mani (1978) tested sixty normal Indian children of both sexes in the age range of 5 to 13 years. It was concluded that oral form discrimination ability increased as a function of age upto 13 years and there was a plateau seen at this age. No sex differences were found in the "odd age" group tested.

A similar study was conducted by shalini (1979) on fortyeight normal Indian children of "even-age" group in the range of 6-12 years. Her study confirmed Mani's findings.

Speech sounds have been observed to be acquired at different age levels. The acquisition of articulation of speech sounds is found to increase with age and reaches maturity at eight years of age (wellman et al 1931; Poole 1934; Templin 1957). Some children have been noted to retain misarticulations beyond the articulation acquisition period, such children were found to differ significantly from children with normal articulation on tests of gross motor ability (Dickson 1962). Oral form discrimination ability was found related to articulation ability as tested on different articulation tests and articulatory rate or oral diadokokinesis (Cross 1936, Bilto 1946, Prins 1962, Jenkins and Lohr 1964, McNutt 1977).

A sex difference has been reported on sensory skills like audition (Pitch 1976, Corso 1967) and vision (Grudden 1941, Thompson 1969). A sex difference in favour of females was reported in Manual dexterity (Tyler 1963). But males have been found superior on Lincoln Osaretsky Motor Development Test (Thompson 1965). In speech sound acquisition, a highly evolved and highly skilled motor ability, a sex difference has been noted with girls acquiring speech sounds about one year earlier than boys (Templin 1952, Winitz 1969; Templin 1957). Oral form discrimination has been found to be related to speech proficiency. Thus the sex difference may be more readily revealed in oral form discrimination ability and articulatory ability.

Language and multilingualism are the least systematically studied variables. Linguistic experience does influence various aspects of human behaviour according to whorf (1956). Speech perception and production are found to be related to or influenced by the language of the individual (Ladefoged 1967). Effect of mother tongue and multilingualism has not been ruled out as a significant variable in oral form discrimination tasks. Hence oral form discrimination development has to be established in different languages and in multilingual environment (Mani 1978, Shalini 1979).

The review of literature shows that there is a great need for tatting oral sensory and motor abilities of different clinical groups with speech problems. The effect of various variables as mentioned previously prompt a great deal of studies. Controversial findings have bean reported regarding the relationship between oral fora discrimination and oral motor ability. Only two studies in India have been conducted so far, on oral form discrimination ability. Wo studies have been conducted on cases with stuttering and misarticulations, using oral form discrimination teat (Ringel 1968) and alternate articulatory motion rate to evaluate oral sensory and motor ability. Hence the present study, using these two reportedly beneficial teats, intended to investigate:

(1) the sex differences among normals;

(2) the differences between normal subjects and subjects with speech problems of stuttering and misarticulations.

CHAPTER III

METHODOLOGY

The purpose of the study was to investigate the differences between normal speakers and speakers with speech problems on oral form discrimination (OFD) task and alternate articulatory motion rates (AMR).

subjects: A total of sixtyfour subjects were used for the study. The table 1 shows the distribution of subjects in group I (normal speakers) and group II a and b (cases with stuttering and misarticulations). The subjects' ages ranged from thirteen to twentyfive years.

Table 1: Table showing the distribution of subjects

	Group I	Group II (a)	Group II (b)
	Normals	stuttering	Misarticulation
N	30	24	10
Mean age	19.8 yrs.	18.4 yrs.	17.8 yrs
Males	14	22	8
Females	16	2	2

Group I: Group I consisted of thirty normal speakers with different languages as mother tongues. All the subjects were screened for hearing, speech and intelligence. The criteria for selection were:

1. The subjects should have normal hearing (screened at 20 dB HL ISO 1969).

2. should present no observable or reported oral structural or functional anamolies or neurological problems.

3. Should have an intelligence quotient of over 90 (as screened on any one of the tests for intelligence at AIISH).

Group II: Group II consisted of thirtyfour subjects with speech problem seen at AIISH or at camps conducted by AIISH. Some of them had received speech therapy for varying durations but still had the speech problem.

Group II a: This group consisted of twentyfour stutterers with varying severity of stuttering from mild to severe. All of them had Kannada as mother tongue and had the onset of stuttering during childhood. The criteria of selection were:

1. Should have normal hearing (as screened at 20 dB HL ISO 1969).

2. Should have an average intelligence with 10 more than 90 as screened by a Clinical Psychologist or any of the tests of intelligence used at AIISH).

3. Should have no reported or observable oral Structural anamolies or neurological problems.

4. Should exhibit stuttering in conversational speech and/or reading as diagnosed by a qualified speech pathologist.

Group II b: Group II consisted of ten subjects with misarticulations ranging from mild to severe misarticulation at least on one phoneme. Criteria of selection were:

1. Should have noanal hearing (as screened at 20 dB HL ISO 1969).

2. Should have average intelligence (10 More than 90 as evaluated by a Clinical Psychologist on any of the tests of intelligence at AIISH).

3. Should possess no reported or observable oral structural anamtolies.

4. Should have a record of misarticulations on any one or more of the phonemes tested with Kannada articulation test (Babu et al 1972).

The study consisted of two experiments: (1) OFD Test (2) AMR. 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 eight geometric forms developed at AIISH on the basis of the test given by Ringel (1968) with 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 bi-concave. They were of two different sizes - small and big. The forms and their dimensions are given in Appendix I. The oral discrimination forms were not mounted on handles so as to permit free oral manipulation. A email forceps was used to place the forms in the mouth and to remove them the following process was in formulate the test list containi the mode and order of presentation of the forms. Each of forms were numbered. Then, the forms were grouped into four geometric categories; Triangle, rectangle, oval and bi-concave. The two forms in each geometric category were) paired with each form in the other geometric category. Thus twentyfour pairs were obtained wherein each stimulus pair was used only once in the test (For example: the use of the pair 7-6 precluded the use of the pair 6-7. Each form was paired with itself (for example: 8-8, 6-6, etc.) thus adding eight more forms to form a total of thirtytwo pairs. Four pairs selected at random, from the total number of pairs were included to check reliability. In total, each subject evaluated a total of 36 stimulus form pairs (Tabular form 2) .

The same list was used for testing all the groups, in the same order. A stop watch was used to maintain time limits.

Instructions to the subject: The subject was seated comfortably on a chair towards the right side of the investigator and was instructed as follows;

"Do you see these forms here? They are called oral discrimination forms. I am going to blindfold you and put one of them in your mouth. I will leave it there for 5 seconds during which time you can move it around within

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

Sl.No.: Name : Age:

Mother tongue: sex: Problem: Normal
stuttering
Misarticulation

Sl.No.	Stimuli pairs	Response	Sl.No.	Stimuli pairs	Response
1	11		19	24	
2	18		20	35	
3	27		21	46	
4	38		22	66	
5	55		23	16	
6	77		24	25	
7	13		25	36	
8	22		26	47	
9	28		27	67	
10	44		28	17	
11	57		29	26	
12	88		30	37	
13	14		31	48	
14	23		32	68	
15	33		33	11	
16	45		34	18	
17	58		35	27	
18	15		36	38	

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 secs. This second form may be the same or different in terms of size and/or ahape. 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 familiarize-tion were given if necessary.

Procedure: The subject was blindfolded and the forms were presented successively. A form of the stimulus pair waa placed in the subject's mouth and the subject was per-mitted to manipulate it orally in his/her mouth for 5 secs., after which, it was removed using forceps. The second form of the stimulus pair was placed in the mouth and again the subject was permitted to manipulate it orally for 5 secs. 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 3 seconds between each stimulus presentation was maintained.

The responses of the subjects were marked in a data sheet, the format of which ia shown along with list (Tabular form 2). Time limits were strictly maintained using a stop watch. After each administration, the forms were sterilized using an antiseptic lotion (Dettol).

scoring: Each error was given a score of one and each correct response a score of zero. Total number of errors were scored for each subject. The total score did not include the scores obtained on items chosen for reliability check.

Experiment II: AMR Test

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

Materials: A Philips tape recorder (model N-2218) was used for recording the response of the subject. A voiced trisyllabic combination of /bʌdʌga/ was used to record the AMR. The trisyllable /bʌdʌga/ was used because (1) its production involved both the 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).

Instructions to the subject: 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. You please take a deep breath and start repeating /bʌdʌga/ 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' and 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.

Procedure: The subjects ware instructed to take a deep breath before beginning and to continue repeating the triayllabic sequence as fast and as long as possible. The AMR 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 firat five seconds of the first, second and third breath groups. The anaiysis over time was done to permit increasing fatigue of prolonged voluntary periodic contractions of muacles (seyffarth 1962, McNutt 1977).

The investigator and another served at 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 tor 5-seconds were determined and compared for different groups.

CHAPTER IV

RESULTS AND DISCUSSION

The results of the two experimental tasks were analysed to find out;

1. the differences between normal male and female subjects of group I.

2. the differences between normals and the group with speech problems : Group I and Group II.

3. the differences between normals and stutterers: Group I and Group IIa.

4. the differences between normals and subjects with misarticulations: Group I and Group IIb.

5. the differences between stutterers and subjects with misarticulations: Groups IIa and IIb

Experimental task I: The means and standard deviations (SDs) of the errors scored on oral form discrimination task were computed for each group. A series of 't' tests (Guilford 1965; Garrett and woodworth 1966) were computed to determine the significances of differences between means.

<u>Comparison of performance of normal male and female subjects of group I on OFD task</u>

Table 3: The comparison of normal males and female subjects in terms of errors on OFD

Sex:	Males	Females
N	14	16
M	2.9	1.7
SD	1.5	1.5

The means and SDs for males and female subjects are shown in Table 3. On examination of the table, it was seen that the mean error scores on the senaory task were more for males than for female subjects. The variability of the male and female subjects was found to be the same. The differences between the two means were not found significant on computation of 't' value.

Thus, this finding accepts the hypothesis (1) that there exists no difference between male and female subjects on the OFD task used in this study. This finding supports two other studies conducted on Indian, younger population which have also shown that there exists no sex difference on OFD ability (Mani 1978, Shalini 1979). This finding is also in favour of the findings on oral form discrimination ability (William and La Pointe 1971, canetta 1977); visual form discrimination ability (Gainer 1956). However, this finding in the present does not fall in line with sex differences found in vision for colours (Thompson 1962), hearing acuity (Corso 1967, Reyman and Rolman 1946), texture and shape discrimination (Gliner 1953) and language development (Templin 1952, 1957).

Comparison of normals (Group I) and subjects with speech problems (Group II)

Table 4: The comparison of Groups I and II in terms of number of errors on OFD

Groups	Normals	Speech defectives
N	30	34
M	2.2	5.9
SD	1.58	3.28

Table 4 shows the comparison of Groups I and II. On examination of the table revealed that the group II tended to perform poorly on OFD task. The group with speech problems showed a greater number of errors than the normal speaking group. The differences between these two groups were found to be statistically significant at 0.01 level. The group II was also found to be aore variable than group I. Thus the hypothesis (2) stating that there is no difference between normals and subjects with speech problems was rejected. These results are in agreeaent with the findings that stutterers and speakers with misarticulations are less adept and inferior to normals on oral sensitivity measures. especially oral form perception (Class 1956, Moser 1967). The study also supports various other investigations which studied the oral sensory abilities in clinical population (Hochbergs and Kabcenell 1967, Chase 1967, Bloomer 1967, Levine 1965, Guilford and Hawk 1968, Rosenbek et al 1970, 1973, Andrews 1973, Teixeira et al 1974, Lum and Russel 1978, Guitar 1975, Manohar et al 1975, Devraj 1978). The results do not agree with a few of the studies on speech problems (Mason 1967, Rutherford and McCall 1967, Pressel and Hechberg 1974). The results agree with the reported finding that subjects with speech probleas have different oral sensory ability as evaluated on this test.

Comparison of group I and Group II a

Table 5 shows the differences in means and SDs between normals and stutterers on the OFD task. The mean errors for stutterers were more than for normals and the difference was found statistically significant at 0.01 level. Thus

Table 5: Comparison of Group I and II a in terms of number of errors on OFD

Groups	Normal	stuttering
N	30	24
M	2.2	5.04
SD	1.58	3.50

the hypothesis (3) stating that there is difference between normals and stutterers in terms of oral sensory ability was rejected.

These results of the present study agree with many of the previous studies on stutterers which suggest the possible role of oral sensory mechaniams in the maintenance of stuttering (Van Riper 1971, 1973; Hutchinson and Ringel 1975; Class 1956; Cohen and Hanson 1975; Guitar 1975; Manohar et al 1975; Devraj 1978). The reaults do not agree with Jenson and his associates'(1975) findings that stutterers do not differ from normals in terms of oral perceptual integrity.

Comparison of Group I and Group II b

Table 6 shows the comparison of means and SDs between normals and speakers with misarticulations. The subjects

Table 6: Comparison of Groups I and IIb in terms of number of errors on OFD

Groups	I Normal	II b Misarticulation
N	30	10
M	2.3	5.2
SD	1.56	2.67

with misarticulations were found to commit significantly more errors on this sensory task of OFD. The variability was also found to be greater for the group with misarticulations. The hypothesis (4) which states that there is no difference between normals and speakers with Misarticulations was rejected.

These results of the present study agree with those of many of the previous studies (Ringel and Scott 1968; Fucci and Robertson 1971; Ringel et al 1970; Sommors et al 1972; Kelly 1977; McNutt 1977) conducted on adults and children with misarticulations. Thus the hypothesis by Fucci and Robertson (1971) that the term "functional" may not really be appropriate for such type of clinical population seems to be supported.

The term "functional" is used whenever no observable abnormality in the organs of speech production is detected with speech problems. It may become necessary to modify the definition of terms like "functional" misarticulation as the present group of speakers with misarticulations were found to show a reduced efficiency in oral form diacrimination ability when compared with normals.

Comparison of Groups IIa and IIb

Table 7: Comparison of Groups IIa and IIb in terms of number of errors on OFD

Croupa	stuttering	Miaartlculatlon
K	24	10
H	5.04	5.2
SD	3.50	2.67

Table 7 shows the means and SDs for the two groups with speech problems of stuttering and misarticulations. The subjects with misarticulation were found to have a slightly greater mean than stutterers. However, the differences between the two groups were not statistically significant in terms of average number of errors. Although the group with stutterers was found to be slightly more variable the difference was not found to be significant. Thus the hypothesis (5) stating that there is no difference between stutterers and speakers with miserticulations was accepted.

These results fall in line with Class's (1956) findings that stutterers and subjects with misarticulations behave in a similar fashion on an oral sensory task. These results feflect the fact that there was no difference found between stutterers and speakers with misarticulations on OFD as used in this study. However, one may be able to find a difference between the two groups using a acre sensitive test of oral sensory discrimination, in this regard, Ringel (1970) suggests that the sensitivity and complexity of the test can be increased by varying the shapes to a greater extent.

Experimental task 2: The means, SDs and 't' values were computed for AMRs (in terms of syllables/5 seconds) of different groups.

Comparison of normal male and female subjects

Table 8: Comparison of normal male and female subjects on AMR (syllables/5 seconds)

Groups	Normal males	Normal females
N	14	16
M	41.00	48.00
SD	9.45	6.32

Table 8 shows a comparison of means and SDs for males and females in the normal group. The AMR of females were higher than those of male subjects and the difference was found to be statistically significant (at 0.05 level). Greater variability was found among male subjects than female subjects. Thus, hypothesis (6) stating that there is no difference between male and female normals was rejected.

The sex difference shown in the present study on motor task falls in line with Tyler's (1965) findings. The females found to be superior to males in articulatory ability (Templin 19S2, 1957; Winitz 1963). Thus the reported finding that female subjects are better in terms of articulatory ability has been supported by the present study.

Comparison of groups I and II

Table 9: Comparison of groups I and II on AMR (syllables/ 5 seconds)

Croups	Normal	Speech defect
N	30	34
M	45	38
SD	7.86	4.05

Table 9 shows the differences between normal and subjects with speech problems in terms of AMRs. The speech handicapped group as a whole demonstrated a lesser AMR than the normal speaking group. As there was a diffe-rence between males and females of group I, the males of group I and group II were compared with each other in terms of means and SDs. The differences between means of the two groups was still found highly significant (0.01 level). The speech handicapped group was found less variable than the normal group. The hypothesis (7) stating that there is no difference between normals and subjects with speech problems was rejected.

The finding that the speech handicapped groups studied in the present population demonstrated reduced oral motor ability falls in line with many of the previous studies (Bilto 1941, Carlson 1946, Kopp 1946, Cooper and Allen 1977, Ringel et al 1970, Prins 1942, Jenkins and Lohr 1964, Yoss and Darley 1974, McNutt 1977). Oral motor ability has been found to be related with speech proficiency. The results of the present study can also be considered as supporting this view. The results do not favour some of the previous studies on motor abilities of subjects with speech problems. (Anderson 1936, Cross 1936, Westphal 1933, Fairbanks et al 1930, 1951; strother and Kriegman 1946; Palmer and Osborn 1940; spriesterbach 1940, Finkelstien and Weisberger 1954).

Comparison of groups I and IIa

Table 10: Comparison of groups I and IIa on AMR (syllables/5 secs)

Groups	Normal	stuttering
N	30	24
M	45	38
SD	7.86	7.86

Table 10 shows a comparison of AMRs for normals and stutterers. An examination of the table revealed that the stutterers had a considerably less AMRs than the normals and the difference was found significant (0.01 level). A further analysis of AMRs of males of group I and males of group IIa also revealed a significant difference between normals and stutterers. Normals and stutterers did not differ in variability. Hence the hypothesis (8) stating that there is no difference between normals and stutterers was rejected. The results are contrary to some of the earlier findings (Anderson 1923, Cross 1936, westphal 1933, strothar and Kriegman 1943; Spriesterbach 1940, Frinkelstien and weisberger 1954) but they support the contention that there exists a reduced capacity of motor output in stutterers (Cross 1936, Kopp 1946, Bilto 1941, Carlson 1946, McKinzie 1966, Cooper and Allen 1977).

Comparison of groups I and IIb

Table 11: Comparison of groups I and IIb on AMR (Syllables/5seconds)

Groups	Normal	Misarticulation
N	30	10
M	45	39
SD	7.86	6.39

The means and SDs of normals and subjects with misarticulations are shown in table 11. An examination of the table revealed that subjects with miSarticulations demonstrated leaser AMR than normal speakers. A comparison of males alone (since the group I had showed a difference between males and females) in the two groups: group I and group IIb, also showed a difference which was found to be statistically significant (at 0.01 level). The two groups did not differ significantly in terms of variability. Hence the hypothesis (9) stating that there is no difference between normals and subjects with misarticulations was rejected. These findings of the study agree with Prins (1962), Jenkins and Lohr (1964), McDonald and Aungst (1967) and Bloomer (1967) that speakers with misarticulations have different oral motor abilities than normal speakers. It was indicated that the oral motor ability is closely associated with speech proficiency.

Comparison of groups IIa and IIb

Table 12: Comparison of groups IIa and IIb on AMR (syllables/5 seconds)

Groups	Stuttering	Misarticulation
N	24	10
M	38	39
SD	7.86	6.39

A comparison of two speech handicapped groups is shown in table 12. A close scrutiny of the means and SDs of stutterers and subjects with misarticulations revealed no significant differences between the two groups. The two groups were found to behave essentially in a similar fashion in terms of AMR. The results were the same even when only males of the two groups were compared with each other. Thus the hypothesis (10) stating that there is no difference between the stutterers and subjects with misarticulations was accepted. These findings agree with other studies which suggested the close relationship of oral motor ability and speech proficiency (Solomon 1945, Bloomer 1967, Rootes and Me Neilage 1967, McDonald and Aungst 1967, Cooper and Allen 1977). There was found to be a positive relationship between oral motor efficiency and speech proficiency.

Thus the findings of the present study revealed reduced oral sensory and motor abilities as evaluated on the OFD and AWE tasks. There was found to be a fairly high degree of negative correlation (r = -0.61) between the two sets of scores obtained for the group with normals i.e., the subjects with lesser number of errors on the oral form discrimination task were found to have higher AMRs and vice versa. However, although the group with speech problems exhibited reduced oral sensory and motor abilities,there was no marked correlation (r = 0.40) seen between the two sets of scores obtained. These results agree with some of the earlier studies which demonstrate no significantly specific correlation between oral sensory-motor abilities and speech production (Fucci and Robertson 1971; Creech and Wertz 1974; Kelly 1977). It was concluded that the two tests used in the present study serve diagnostic and prognostic purposes when used separately than when interpreted in combination.

CHAPTER V

SUMMARY AND CONCLUSIONS

A review of literature indicated controversial findings regarding the possible relationship between oral sensory-motor efficiency and speech proficiency. Hence the present study aimed at evaluating oral sensory and motor abilities on 64 subjects (30 normals, 24 stutterers and 10 subjects with misarticulations) within the age range of 13-25 years.

The two chosen tasks were: Oral fora discrimination test (Ringel 1966) and Lingual alternate articulatory action rate (Barley, Aronson and Brown 1975; Winitz 1969, McNutt 1977).

The oral fora discrimination test consisted of 32 stimulus pairs of 8 plastic forms belonging to 4 geometric categories. The subjects were required to indicate whether the two forms of the pair were "same" or "different" when the pairs of stimuli were presented successively in the mouth. The number of errors committed were scored.

The alternate articulatory motion rate (AMR) test required the rapid alternate repetition of the tri-syllabic combination /bʌdʌga/ 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 analysed statistically.

The findings of the study were:

1. There was no sex difference on the sensory task of OFD, among normals.

2. The motor task of AMR revealed sex differences. The normal females were superior performers on AMR than male subjects.

3. The normals and subjects with speech problems differed remarkably in terms of OFD. The subjects with speech problems were less efficient than normals in the sensory ability.

4. The normals end subjects with speech problems differed significantly in terms of AMR. The subjects with speech problems demonstrated a reduced AMR and hence deficient oro-motor ability.

5. The stutterers and speakers with misarticulations did not differ in terms of oral sensory ability as evaluated on OFD test.

6. The stutterers and speakers with misarticulations did not differ from each other in terms of oral motor ability at evaluated by AMR.

7. There was a negative correlation between the two sets of scores obtained among normals, i.e., lesser the number of errors on OFD, the greater the AMR and vice versa.

a. No significant correlation was found between error scores on OFD task and AMRs among the subjects with speech problems. However, both of them were related to speech proficiency.

Recommendations for further research

1. The same study can be conducted on a larger population.

2. The effect of different variables like linguistic factors, intelligence, socio-econamic status, learning abilities and others can be studied.

3. 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.

4. The other clinical populations can be studied using

the two tests employed in the present study.

3. The use of these two tests as prognostic indicators for the clinical populations to decide whether they need speech therapy or not, can be evaluated.

6. The normative data for these two tests can be established.

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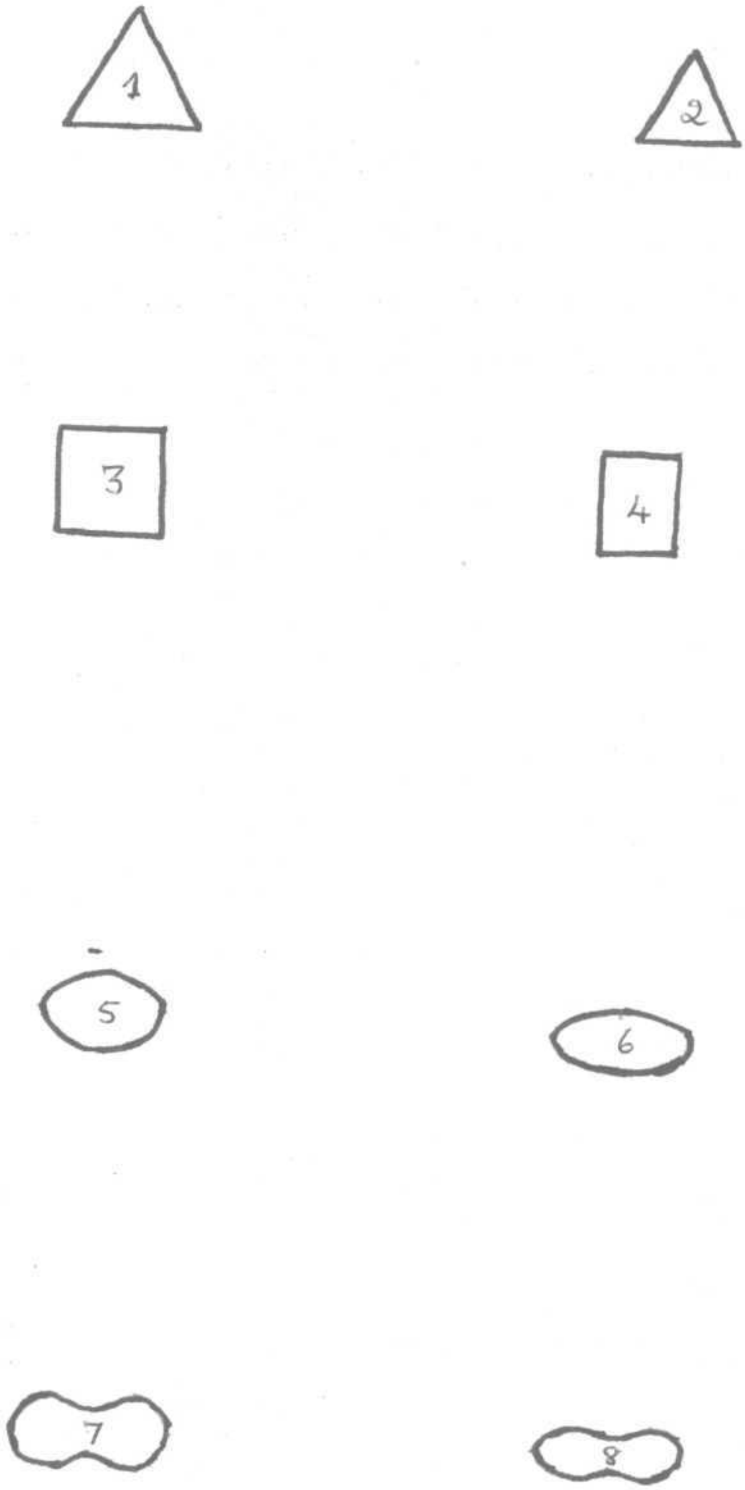
APPENDIX I



TRIANGLE

RECTANGLE

OVAL

BICONCAVE

The 8 geometric forms drawn from the pool of NIDR-20 forms