STRUCTURAL VARIATION AND DIADOCHOKINETIC SEQUENCING IN THE CEREBRAL PALSIED AND NORMALS

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Dedicated to

- Daddy, Mummy,

Ramya & Radhika.

- My brother Chotu

&

- My friend Balaraju

CERTIFICATE:

This is to certify that this Dissertation entitled :

STRUCTURAL VARIATION AND DIADOCHOKINETIC SEQUENCING IN THE CEREBRAL PALSIED AND NORMALS ,

***is the bonafide work in part fulfillment for the Final Year M. Sc. (Speech and Hearing), of the Student with Reg. No.* M. 9117.**

MYSORE
MAY, 1993.

Dr. (Miss) S. Nikam
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CERTIFICATE:

This is to certify that this Dissertation entitled :

"STRUCTURAL VARIATION AND DIADOCHOKINETIC SEQUENCING IN THE CEREBRAL PALSIED AND NORMALS",

has been prepared under my supervision and guidance.

Manjula. R

MYSORE
MAY, 1993.

Mrs. R.Manjula,
Guide.

DECLARATION

I hereby declare that this Dissertation entitled,

"STRUCTURAL VARIATION AND DIADOCHOKINETIC SEQUENCING IN THE CEREBRAL PALSIED AND NORMALS,

is the result of my own study under the guidance of Mrs. R. Manjuta, Clinical Lecturer, Dept. of Speech Pathology, Alt India Institute of Speech and Hearing, Mysore, has not been submitted earlier at any University for any other Diploma or Degree.

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INTRODUCTION

Speech is a highly integrated physiological act characterized by a series of complex motions executed in kinetic chains which is monitored by audition (Fletcher, 1972).

Complex movement patterns during articulation require precision in strength, speed, range and timing of muscular activity to ensure the accuracy of movement. Weakness and slowness of movements are common symptoms of motor dysfunction and comprise about half of the complaints of patients with motor disabilities of neurologic origin (Darley., Aranson., and Brown, 1975; De Jong, 1967).

The traditional methods of speech evaluation of the cerebral palsied population by neurologist and speech pathologist in the early days inclined towards usage of materials such as tongue twisters. Since then, the speech evaluation strategies have become more scientific, organized and informative. The various techniques involved may be grouped as:

1. those techniques involving the usage of physical and physiological measures.
2. techniques based on perceptual measures (Dale, 1950; Bloomer, 1963; ; Buck and Cooper, 1956).

The former measures evaluate the efficacy of various systems of speech production that is respiration , phonation, articulation and resonance with the he!p of instruments.

The perceptual measures of dysarthric speech do not involve elaborate instruments. They have been found to be more feasible and convenient. One of the major constraints imposed upon speech is that the muscle motility governs the rate with which any set of utterances can be accomplished for the required time. The measurement of maximum speech output contains a greater amount of information about the physical and motorical system of speech.

Diadochokinetic measurement is one such measurement. This is important as it helps one to examine and infer upon certain physiologic functions in speech.

Diadochokinetic rate has been defined as the ability to perform rapid alternating and repetitive bodily movements such as opening and closing of the jaw or lips, raising or lowering eyebrows and tapping fingers (Wood, 1971). Oral diadochokinetic rate refers to rapid repetitive and alternating movements of the lip, tongue, jaw and velopharynx.

Diadochokinetic rates have been studied in the normal and disordered population. There is some evidence that diadochokinetic rate improves with age in the normal population (Fletcher, 1972; Blomquist, 1950).

Among the disordered population diadochokinetic test have been administered on the hearing impaired (Priya, 1991); misarticulation (Bloomer, 1963; Maxwell, 1953; McNutt and Dworkin, 1977); and dysarthric (Buck and Cooper, 1956; Canter, 1965b; Heltman and Peacher, 1943; Kruel, 1972; Roshni, 1992).

Hixon and Hardy (1964) demonstrated that the degree of speech defectiveness could be predicted with a fair degree of accuracy in the cerebral palsied children by examining the diadochokinetic performance. This is due to the directly proportional relationship that exists between the oral diadochokinetic rate and the ability to articulate rapidly. The diadochokinetic syllable repetition requires rapid motion super imposed by a balanced equilibrium of oral structures. Hence, the diadochokinetic tasks would be suitable to examine and assess the adequacy of oral motor structures for speech in the cerebral palsied population too.

In the past, reports of diadochokinetic studies of isolated oral structures have been provided (Buck and Cooper, 1956; Canter, 1965b).

But no reports of studies relating the diadochokinetic performance of the different oral structures (lip, jaw, tongue and velopharynx) in isolation and/or in combination in the cerebral palsied are available. Hence the present study aimed at examining the relationship between the diadochokinetic tasks of the different oral structures (lips, jaw, tongue and velopharynx) in isolation and combination in a group of cerebral palsied and normal children.

OBJECTIVES OF THE STUDY:

The major objectives of the study were:

1. To compare the overall performance of normals and the cerebral palsied population on the diadochokinetic tasks.
2. To compare the performance of the normals and cerebral palsied children on the diadochokinetic tasks of the articulatory structures a)lips, b)jaw, c)tongue, d)velopharynx and e) combination of the structures.
3. To compare the performance of cerebral palsied and normal children on isolated diadochokinetic tasks with the combined diadochokinetic tasks.
4. To compare the performance of normals and cerebral palsied children on the paired cognate diadochokinetic tasks in isolation and combination.
5. To see if a developmental trend exists in the normals and the cerebral palsied population for the chosen diadochokinetic tasks.

BRIEF PLAN OF THE STUDY:

1. Development of the diadochokinetic tasks.
2. Conducting a pilot study with a group of normal subjects whose ages ranged from 17 to 22 years.
3. Administration of the tasks on the test groups (normals and the cerebral palsied population).
4. Scoring and analyzing the responses obtained.
5. Discussion.

REVIEW OF LITERATURE

Speech is a dynamic process which requires the precise coordination of the oral musculature. During ongoing speech production, fine muscle movements of the lips, tongue, palate and jaw constantly alter the dimensions of the oral cavity. The speech production demands manipulative movements of the jaw, lips and tongue that are much faster than those demanded by the basic functions of chewing, sucking and swallowing.

Articulation is the production of sounds with identifiable acoustic characteristics. The articulators (tongue, lips, teeth, velum, and others) are specialized structures that alter the sizes, shapes and couplings of the oral, nasal and pharyngeal resonators. A comprehensive definition of articulators at this point would be "A series of overlapping ballistic movements which places varying degrees of obstruction in the path of the outgoing air stream and simultaneously modifies the size shape and coupling of the resonating cavities" (Nicolosi, Harryman and Krescheck, 1978).

Speech clinicians are frequently required to make judgments about the structures and function of the lips, teeth, tongue and palate. An assessment of the client's oral motor skill is typically a part of an articulatory evaluation. Investigators have attempted to identify possible relationships between articulatory status and structural deviations of the oral mechanism.

Among the techniques used to measure the articulatory agility, measurement of diadochokinesis is reported to be one of the best tool to measure the motor abilities of speech production. Tests of diadochokinetic rate or maximum repetition rate have been used most frequently to evaluate oral motor skills. These measures are considered indices of impairment of speech neuromuscular systems affecting speed, range and precision of the speech articulators (Schliesser, 1982). A person who can negotiate rapid shifts of inhibition of muscle contraction is, generally speaking, possessed of a high speed of diadochokinesis and correlatively of the ability to make rapid articulatory movements.

MEASUREMENT OF DIADOCHOKINETIC RATE:

Diadochokinetic rate is established either with a Count by Time' procedure in which the examiner counts the number of syllables spoken in a given interval of time (Prins, 1962; Hixon and Hardy, 1964) or a Time by Count' measurement in which the examiner notes the time required to produce a designated number of syllables. The advantage of the 'time by count' measurement is that, few operations are required, since the examiner will only listen to the syllable count and turn off the timing device when the requisite number of syllables are produced (Fletcher, 1972).

The third approach is to measure the diadochokinetic rate with the help of an instrument. In this approach, for exampie, Spectrograph of a given speech sample is obtained, that is, wide band bar spectrograph of initial segments of /p^, t^, k^/ utterances are taken for 2.5 seconds. Then the number of syllables on the spectrograph are counted to calculate the diadochokinetic rate per minute (Shukla, 1988).

Both, speech activities such as the rates of repetition of the syllable /p^/, /t^/ and /k^/ or their voiced cognates and non-speech activities have been used to determine the diadochokinetic rates.

SPEECH Vs NON-SPEECH ACTIVITY

Netsell (1986) stated that the vegetative and speech movements develop in parallel. Although speech and non-speech activity may share certain embryonic version, they also have separate body and nervous system origins in the embryo. Hixon and Hardy (1964), postulated that there are certain basic neurophysiological difference between the two process, due to the fact that repetition rates for speech syllables were much greater than their non-speech activities in the spastics. Meyers (1959) also said that speech involves more neurological processes at the level where speech is ultimately produced and at this final stage recruitment takes place. Thus, the patterning of production of speech may be less difficult than for performance of controlled non-speech activities of the same structures. Hixon and Hardy (1964) hypothesized that the most appropriate teBt of speech mechanisms was to observe vocal tract movements during the production of speech. The neuronai machinery and patterns of activation responsible for sucking, chewing, swallowing, blowing, imitating orofacial movements, rapid alternating movements (with or without speech production) and isometric muscle contractions are hypothesized to be different from those used for speaking (Netsell, 1986).

The non-speech behaviors are often useful in determining the lesions, locus and general pathophysiologic consequence but the activation of the speech neural mechanisms with meaningful speech may be the only valid test of function for the speech motor system.

Tests of oral diadochokinesis can provide important information in the evaluation of the motor and sensory systems of the mouth and face. A number of investigators have contributed to the general information concerning rates of diadochokinetic performance for lips, tongue and jaw in the normal subjects according to the age of the subject.

There is some evidence that diadochokinetic rates improve with age. Fletcher (1972) examined diadochokinetic rates in children aged 6 to 13 years using a count by time procedure. He reported that children increased the number of syllables produced in a given unit of time at each successive ago from 7 to 13 years.

Biomquist (1950) studied the mean rate of diadochokinetic movements in certain sounds and combinations of sounds involving movements of the lips, tongue and velum of 9, 10 and 11 year old children. Significant difference was found for the sound /pə/ in 9 & 11 year old females and 9 & 11 year old males.

Dale (1950) conducted a study to know whether diadochokinetic rate changes from one consonant to the other and also to know whether there was any sex difference existing in diadochokinetic rate. Results indicated that males were on an average faster than females by 3.2 syllables. The syllables which included the consonants /d/, /t/, /b/ & /p/ were more rapidly produced than the others. The reason attributed to this was that these sounds were the earliest, to be mastered by the children. The consonants /f/ & /v/ were not in the order, both developmentally and diadochokinetically. The /s/ & /z/ were among the last consonants to be mastered and were also the slowest in diadochokinesis.

Rajkumar and Raju Pratap (1990) speculated that the diadochokinetic rates of /pa/ and /pam/ can be good measures of velopharyngeal closure efficiency and can be used clinically. They took 30 normal mate and female subjects and established the norms for the diadochokinetic rate of /pam/ and /pa/. They concluded that when the movements of velopharyngeal closure are affected, more time may be taken for the intelligible articulation of syllables /pam/.

Diadochokinetic rate has also been measured in clinical population such as stuttering, misarticulation and dysarthria.

DIADOCHOKINETIC RATE IN MISARTICULATION CASES

Bloomer (1963) noted that there was difference in performance between some speakers noted to have malocclusion, suspected abnormal swallow and defective speech. He postulated that the observed dysdiadochokinetic patterns were due to a delay in neural maturation or possible subclinical damage to the cortico rubrocerebellar pathways or to the hemispheres of the cerebellum. The postulate of neural damage as a basis for abnormal lingual diadochokinesis received further support from his clinical observations of patients who had demonstrated brain damage and whose swallowing and diadochokinetic patterns were altered to resemble those of children with suspected abnormal swallowing and abnormal diadochokinesis.

Maxwell (1953) studied the relationship between both general and specific motor skills and articulation. He used

13 males with defective articulation and an equai number of males in the control group with good speech. His battery included tests of:

1. Speed of diadochokinetic movements of tongue, lips and jaw using the number of repetitions in two sounds of /pa/, /ta/, /ka/, /la/, and combinations of /pa/, /ta/ and /ka/.
2. Speed of diadochokinetic movements of the hand, measured by tapping and a ball bounce test.

He found reliable difference between the two groups only for the repetition of /pa/, /ta/, /ka/, and of /la/.

The diadochokinetic rates of children with specific misarticulations and their normal speaking peers were examined by Mc Nutt and Dworkin (1977). Mc Nutt examined the rate of alternating syllable productions such as /dʌgə / in children with normal articulation, in children with /s/ misarticulation and children with /r/ misarticuiation. Both groups of children with misarticulation were noted to be slower than normal speakers in syllable production rates. They examined lingual diadochokinetic rate for syllables /t /, /d /, /k / and /g / in normal speakers and frontal lisping speakers, aged 7 to 12 years. The mean rate of utterances of the syllables tested was significantly lower in the disordered group.

Dworkin and Culatta (1985) studied neuromuscular and structural characteristics in children with normal and disordered articulation. They selected a group of 6 females 18 males who were diagnosed as having functional articulation disorder. The two control groups included 20 females and 14 males who did not show any history of speech and language disorder. The tests administered were articulation tests, diadochokinetic rate measurements and examination of oral mechanisms. Results revealed no significant difference in the diadochokinetic rate between these two groups.

Prins (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 diadochokinesis. The diadochokinesis involved rapid alternating articulation of /pa/, /ta/, /ka/ and the number of repetition in a duration of 5 seconds. Results revealed poorer scores in the group with misarticulations on all motor tasks and auditory abilities tested.

DIADOCHOKINETIC RATE IN THE DYSARTHRICS:

Researchers who have concerned themselves with the speech problems of dysarthric patients have frequently noted defective articulation in addition to other vocal deviations.

The relationship between articulation and motor control of the articulators in dysarthria was considered by Buck and Cooper (1956). They compared tongue lip diadochokinetic rates and judgments of articulatory proficiency in 48 presurgical Parkinsonian patients.

Though they noted a trend toward a association between a poor diadochokinetic rate and severe speech involvement, no significant relationship was found.

Heltman and Peacher (1943) constructed a test to discover the articulatory defects and diadochokinetic rate of Spastics ranging from 4 to 23 years of age. Diadochokinetic rate was measured by :

1. Repetitive movements of opening and closing the jaw.
2. Opening and closing the lips without voice.
3. Opening and closing the lips with voice.
4. Repetitive movements of the tongue.

They found that the diadochokinetic rates for Spastic were lower than those for non spastic and it was found to increase with age in the Spastics.

Canter (1965b) studied the possible relationships between the diadochokinesis and articulation in Parkinsonism and the relationship of both to the overall speech adequacy.

The results of the study were as follows:

1. The Parkinsonism group showed impaired ability to

perform rapid movements of the tongue lip, back of the tongue, lips, vocal folds and velopharynx.

2. All measures of articuiatory diadochokinesis (movements of tongue lip, back of the tongue, vocal folds and velopharynx) were found to be correlated with clarity of articulation. The strongest of these relationship was between articulation and rate of tongue movements.

3. Of the 4 indices of physiological support of speech (maximum pitch range, maximum intensity range, maximum phonation duration and diadochokinetic rate), it was found that the articuiatory diadochokinesis had the strongest relationship with overall speech adequacy.

Data reported by Byrne (1959) on Cerebral palsied children showed that, in general, voiceless sounds are more frequently misarticulated in the initial position than their voiced cognates. Therefore the production of the voiceless syllables /pa, ta, ka/ may have been more difficult for the cerebral palsied subjects than the voiced syllables /ba, da, ga/.

Hedges (1955) studied the relationship of three repetitive speech movements to speech understandability among 60 individuals with Spastic and athetoid types of Cerebral Palsy (C.P.). Rates of repetition of syllables /pa/, /ta/ & /ka/ were used as measures of an individual's ability to open and close the mouth, raise the tip of the tongue and elevate the back of the tongue respectively. Ratings of speech understandabiiity were made for each subject by a panel of trained judges. Hedges reported a significant relationship between the diadochokinetic rates of:

1. The mandible and lip movement.
2. Tongue tip movement and understandabiiity.
3. Lingua palatal movement and understandabiiity.

Hedges concluded that the ability to perform certain repetitive speech movements of the articulators was a valid measure of the ability to perform certain repetitive non speech movements of the same structures.

Kruel, J. (1972) reported a study that contradicted the above findings. He studied oral diadochokinesis, sustained phonation and reading rate in Parkinsonism. He took 3 sets of subjects for his study - healthy normal adults, healthy elderly adults and patients with Parkinsonism. Results indicated that reduced ability to prolong vowels and reduced reading rates was associated both with advanced age and Parkinsonism. The study also reveal that the syllable diadochokinetic rate failed to differentiate between normal subjects and subjects with Parkinsonism.

Platt et.al,(1978) assessed speech by taking three measures of intelligibility; single word intelligibility,prose intelligibility and a visual analogue scale of speech handicap. They also assessed articuiatory impairment by diadochokinetic speaking rates in the Spastics. They found that athetoid subjects were consistently inferior in ail the speech measures when compared to the Spastic subjects.

Dworkin, Aronson and Mulder (1980) studied the tongue force in normals and in the dysarthrics. They found that the normal males had significantly higher tongue force than dysarthric patients and anterior tongue forces were significantly greater than lateral in normals and dysarthric patients. The syllable repetition rates were significantly slower in the dysarthric patients than in normals.

Schliesser (1982) conducted a study on the alternate motion rates in diadochokinetic tasks in adults with C.P. The results of their study suggested that in the cerebral paslied adults, certain non speech alternate motion could predict the severity of dysarthria at least equally well as the speech alternate motion rates. The three non speech alternate motion rates which demonstrated strong relationship to dysarthria in the study were opening and closing the jaw, retracting the tongue to the alveolar ridge and retracting and rounding of the lips.

Roshni (1992) investigated the differences between the performance of normal and cerebral palsied population on oral form discrimination tasks and alternate articuiatory motion rate. She found a significant difference between the normal subjects and cerebral palsied subjects on the orai form discrimination. The normal were superior to C.P. subjects in terms of orai form abiiity. On the alternate motion task, depressed performance in lingual motor skills was observed in the cerebral palsied group.

SUMMARY OF THE STUDIES ON THE DIADOCHOKINETIC RATE IN THE DYSARTHRIC POPULATION:

As it is made evident in the review, diadochokinetic rates have been used as a part of an articulatory evaluation of the client's oral motor skills.

Measurement of the diadochokinetic rate also forms an important test for the clinical population of dysarthrics. The diadochokinetic rate studies may be summarized as follows:

1. Due to the imprecise articulatory deficit in the dysarthrics, the diadochokinetic rate also becomes slower in the dysarthrics when compared with the normals (Heltman and Poacher, 1943; Roshni, 1992).
2. The dysarthric population show impaired ability to perform rapid movements of the tongue tip, back of the tongue lips and vocal folds (Canter, 1965b).
3. Of the 4 indices of physiological support for speech (maximum pitch range, maximum intensity range, maximum phonation duration and diadochokinetic rate) articulatory diadochokinesis had the strongest

relationship with overall speech adequacy (Canter, 1965b).

4. The diadochokinetic speaking rates of the athetoids were found to be inferior when compared to the Spastics (Platt.et.al., 1978).
5. Normals have a significantly higher tongue force than the dysarthric patients (Dworkin, Aronson and Mulder, 1980).
6. In general, voiceless sounds are more frequently misarticulated than the voiced sounds, by the C.P. children (Byrne, 1959).

The studies on the dysarthric speech so far have however not given us a clear picture of the relative diadochokinetic ability of the articulatory structures such as the lips, tongue, jaw and velopharynx. The diadochokinetic rates of these structures have to be assessed in order to learn about their possible relation to articulation deficit in the dysarthric patients.

NEED FOR THE PRESENT STUDY:

The present study is an attempt to test the articulatory motor function ia normals and the cerebral palsied population by means of measuring the diadochokinetic rate in speech utterances. The diadochokinetic tasks include the testing of different structures in isolation and in combination. The structures tested here are lip, jaw, tongue and velopharynx and a combination of lipjaw, tip velopharynx, lip tongue, jaw velopharynx, jaw tongue and velopharynx tongue. The performance of the cerebral palsied and normal subjects in chosen diadochokinetic tasks will be analysed to know which are the structures that affect the diadochokinetic rate, indirectly reflecting which of the structures contribute maximum to the articulatory deficit.

It would be interesting to see if any developments trend exists with in the group of cerebral palsied patients and if it exists, the quantitative differences that exists between these group and normals. This assessment procedure would possibly enable the clinician to reflect on the severity of articulatory deficit and to take this factor into consideration while planning the therapeutic activities for the cerebral palsied.

METHODOLOGY

AIM: The aim of the present study was:

1. To compare the performance of different age groups of cerebral palsied children

i) on isolated diadochokinetic tasks

ii) on combined diadochokinetic tasks

iii) on isolated Vs combined diadochokinetic tasks.

2. To compare the performance of different age groups of normal children:

i) on isolated diadochokinetic tasks

ii) on combined diadochokinetic tasks

iii) on isolated Vs combined diadochokinetic tasks.

3. To compare the performance of normal and cerebral palsied children of different age groups

i) on isolated diadochokinetic tasks

ii) on combined diadochokinetic tasks.

4. To compare the performance of normals and C.P. children of different age groups on the cognate pairs among the isolated and combined diadochokinetic tasks.

5. To see if a developmental trend exists in the performances of normals and C.P. on the different diadochokinetic tasks.

SUBJECTS:

The subjects of the study were drawn from two populations. Group-I consisted of 30 normal children of age ranges 4 to

14 years. These children were taken from normal schools. Group-II consisted of 27 cerebral palsied children chosen from Spastic Society of India,' Madras and those attending speech therapy at AIISH, Mysore. The chronological age range of Group-11 selected for this study was between 4 to 14 years.

The male : female ratio for Group-1 and II were as follows:

	Group-I Normals	Group-II Cerebral Palsied
Male	17	14
Female	13	13

For the purpose of statistical analysis the age ranges were divided into three groups for both Group-1 and Group-11.

Group-1 (normals):

Group	Age range	No. of subjects
A	4.1 to 8yrs	11
B	8.1 to llyrs	9
	11.1 to 15yrs	10

Group-II (cerebral palsied):

Group	Age range	No. of subjects
D	4.1 to 8yrs	10
E	8.1 to llyrs	9
	11.1 to 15yrs	8

SUBJECT SELECTION CRITERIA:

In Group-1 The subjects fulfilled the following criteria:

1. They had no history of otoiogical abnormalities.
2. They presented no observable or reported oral structural or functional anomalies or neurological problems.
3. They could articulate the following sounds correctly (the sounds selected for the diadochokinetic tasks)
   a) Vowels - /a/, /i/ and /u/.
   b) Consonants - /m/, /d̪/, /ḍ/ and /g/.
4. They had no perceptual problems.
5. All the subjects attended normal schools.

In Group-II - The subjects selected in this group fulfilled the following criteria:

1. They were of average intelligence or borderline to mild mental retardation.
2. They had no history of otoiogical abnormalities.

3. Ail the subjects had normal oral structures as measured on an orai examination scaie.
4. They could articulate the following sounds correctly (the sounds selected for the diadochokinetic tasks):
   a) Vowels - /a/, /i/, and /i/.
   b) Consonants - /m/, /d̪/, /ḍ/ and /g/.
5. They were able to follow oral instructions and imitate the oral activities demonstrated.

DIADOCHOKINETIC TASKS

Speech sounds which required the active participation of the articulators that is the lips, jaw, tongue and velopharynx were selected to assess the diadochokinetic rate of these structures in isolation (Heltman and Peacher, 1943). A combined action of the above structures namely, lip - jaw, jaw - tongue, lip - veiopharynx, lip - tongue, jaw - veiopharynx and veiopharynx - tongue for the diadochokinetic tasks were also selected.

Voiced sounds were selected for the diadochokinetic tasks as these sounds were reported to be easily articulated in the cerebral palsied population (Byrne, 1959).

The different tasks are shown in Table-I.

A pilot experiment was conducted with a group of normai subject whose ages ranged from 17 to 22 years. They were tested on the isolated and combined diadochokinetic tasks to check the test validity.

TEST ADMINISTRATION

a) Test environment: The subjects were seated comfortably and they were tested in an isolated room with minimum distraction.

Isolated Diadochokinetic tasks (Cognate pairs)	Combined Diadochokinetic tasks (Cognate pairs)
Lips - /u-i/;/i-u/	Lip - jaw /u-a/; /a-u/ /i-a/; /a-i/
Jaw - /a-i/; /i-a/	Lip - Velopharynx /u-m/; /i-m/ /m-u/; /m-i/
Tongue - /d̪-ḍ/; /g-ḍ/; /d̪-d̪/ /d̪-g/; /ḍ-g/; /g-ḍ/	Lip - Tongue /i-d̪/; /d̪-i/ /u-d̪/; /d̪-u/ /i-ḍ/; /ḍ-i/ /u-ḍ/; /ḍ-u/ /i-g/; /g-i/ /u-g/; /g-u/
Velopharynx - /m^m/	Jaw - Velopharynx /a-m/; /m-a/
	Jaw - Tongue /a-d̪/; /d̪-a/ /a-ḍ/; /ḍ-a/ /a-g/; /g-a/
	Velopharynx - Tongue /d̪ ^ m/; /m^ d̪/ /ḍ ^ m/; /m ^ ḍ/ /g ^ m/; /m ^ g/

TABLE-I: Showing the isolated and combined diadochokinetic tasks given to the subjects.

b) Procedure: The test format presented in the Table-I was administered in the following way:

1) Instructions: Recorded and verbal instructions were given

to each subject of the two groups for the sounds and sound combinations in the diadochokinetic tasks. The diadochokinetic tasks was first demonstrated at a fairly rapid rate by the examiner. The child was instructed to repeat the diadochokinetic tasks with maximum speed and least distortion of the sounds until he was instructed to stop. The child was given an opportunity to practice the diadochokinetic tasks before the actual testing, in order to extract optimum performance from each subject. Wherever possible the instructions were supplemented with graphic representations of the phonemes tested.

2. Recording of Response: The final response of the diadochokinetic tasks were audio recorded on a Philips AM-125 tape recorder.

3. Transcription and Tabulation: For the transcription of the data, the Count by Time method, that is counting the number of the syllables at a particular time was employed. Here a fixed time interval of five seconds was taken and the number of phonemes uttered in the diadochokinetic tasks after 5 seconds of initial recording was taken in order to obtain a stable quality. The same procedure was used for the isolated and combined diadochokinetic tasks. The final score obtained for 5 seconds was converted to one minute for future statistical treatment.

4. Reliability check: The entire diadochokinetic task was

administered by the same tester to three randomly chosen subjects after a gap of one month to check for test retest reliability. The scores were found to be 85% reliable in all the diadochokinetic tasks.

RESULTS AND DISCUSSION

The data obtained for the isolated and combined Diadochokinetic (DDK) tasks were tabulated and subjected to suitable statistical analysis.

The results of the experimental tasks were analysed to find out:

1. The differences within the normals, within the C.P. population and between the nromals and C.P. population in terms of:

a) Isolated DDK tasks.

b) Combined DDK tasks.

c) Isolated Vs combined DDK tasks.

d) The cognate pairs among the isolated and combined DDK tasks.

e) Developmental trends across the age groups.

The tabulated data was subjected to discriminate analysis using computerized statistical software package (Canonical Discriminate Analysis). The means and correlation matrix scores were obtained.

I. a) PERFORMANCE OF NORMALS ON THE ISOLATED DDK TASKS:

Table-2 depicts the mean values for the isolated DDK tasks in normals.

GROUPS	AGE RANGE	1	2	3	4	5	6	7	8	9	10	11
A	4.1-8 yrs	99.3	103.6	97.3	99.3	99.7	94.3	99.7	97.1	97.3	108	121.13
B	8.1-11 yrs	108	108	102.7	106.7	116	94.7	125.3	110.7	118.7	124	145.3
C	11.1-15 yrs	114	115.2	121.2	113.2	108	128.4	129.6	123.6	118.8	126	130.8

TABLE-2: Showing the mean values of the isolated diadochokinetic tasks in normals.
[Lips: 1 = UI; 2 = IU; Jaw: 3 = AI; 4 = IA;
Tongue: 5 = D̺Ḍ; 6 = ḌD̪; 7 = GD̪; 8 = D̪G; 9 = ḌG; 10 = GḌ;
Velopharynx: 11 = MM].

The cognate pairs in the DDK tasks wore further analysed for the group of subjects (ABC) in normals and C.P. This was done to look at the performance differences if any, when calculated in percentages for the transition within the cognate DDK pairs. For example in isolated lip DDK task, for the cognate pair U-I and I-U, the DDK mean scores for the ABC groups were compared and the transition which obtained a higher mean score than its cognate was noted down. The better performances were converted into percentage scores. In this example (Table-2 (i)) the I-U transition in DDK task was performed better than the U-I task 100% of the time.

Table-2(i), (ii) and (iii) shows the comparison of DDK scores in percentage for groups A,B and C for the cognate DDK tasks.

1. LIPS:

Rounding to Spreading (UI)	Spreading to Rounding (IU)
O%	100%

Table-2(i). Showing the comparison of lip isolated DDK cognate tasks for aii the three age groups.

Opening to Spreading (AI)	Spreading to Opening (IA)
66.6%	33.3%

Table-2(ii). Showing the comparison of jaw isolated DDK cognate tasks for all the three age groups

3. TONGUE:

Dentai to Retrof lex (d̪ḍ)	Retroflex to Dental (ḍd̪)	Glottal to Dentai (gd̪)	Dental to Glottal (d̪g)	Retroflex to Glottal (ḍg)	Glottal to Retroflex (gḍ)
66.6%	33.3%	100%	0%	0%	100%

<u>Table-2(iii).</u> Showing the comparison of tongue isolated DDK cognate tasks for all the three age groups.

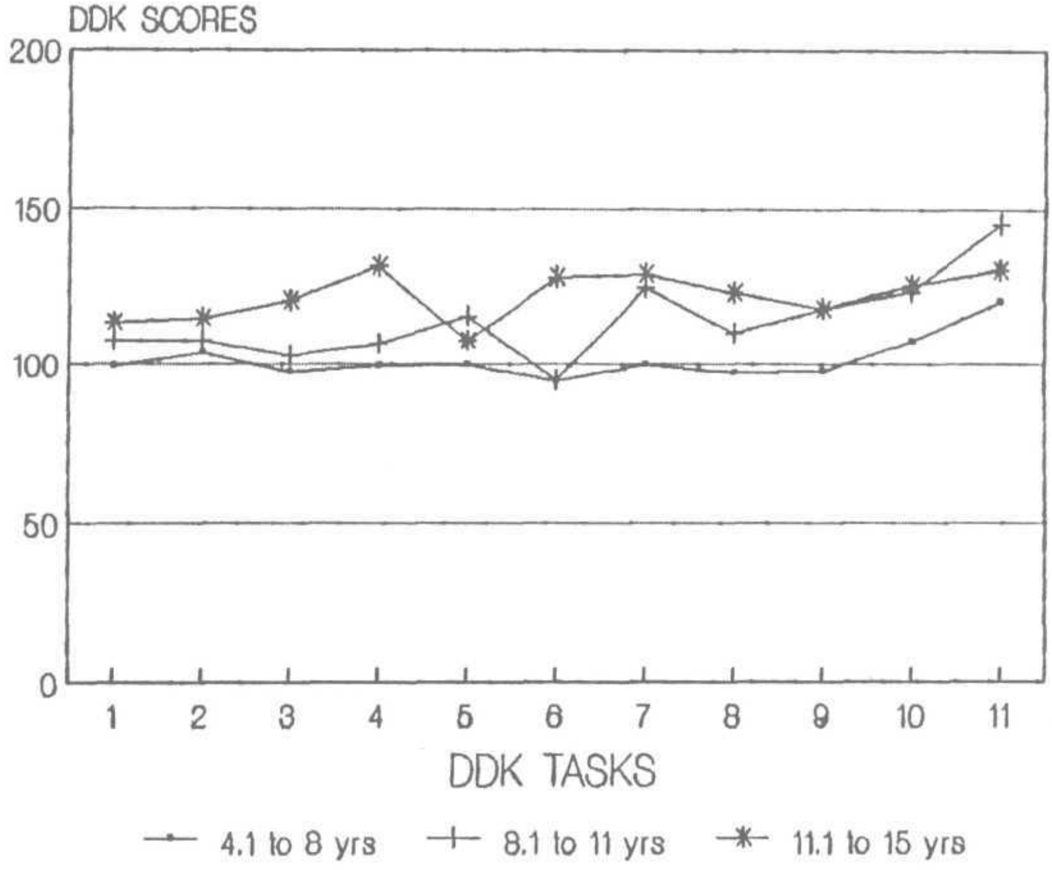
4. VELOPHARYNX: In general, the scores of velopharynx are found to be higher as compared to the other isolated DDK tasks.

From the above results and Graph-i, wo can infer that there is a dvelopmental trend seen in the normal population for the isolated DDK tasks. This is in accordance with studies conducted by Fletcher (1972) who reported an increase in the DDK rates at each successive age group from 7 to 13 years and Blomquist (1950) who found a significant difference in the age groups of 9 and 11 year old children in the DDK task performance.

We can also infer that in the isolated DDK tasks involving the lips, spreading to rounding tasks is better than rounding to spreading DDK tasks. In the Jaw DDK tasks, opening to spreading is better than spreading to opening tasks.

Tasks with the involvement of Lips show that the performance of :

GRAPH-1: Showing the developmental trend in isolated DDK tasks in normals.



[Lips: 1 = UI; 2 = IU; Jaw: 3 = AI; 4 = IA;
Tongue: 5 = DD; 6 = DD; 7 = GD; 8 = DG; 9 = DG; 10 = GD
Velopharynx: 11 = MM].

a) dental to retroflex is better than retroflex to dental.

b) glottal to dental is better than dental to glottal.

c) glottal to retroflex is better than retroflex to glottal.

The velopharynx tasks has been performed better than all the other isolated DDK tasks.

I. b) PERFORMANCE OF NORMALS ON THE COMBINED DDK TASKS:

Table-3 shows the combined DDK performance of age groups A, B and C.

Table-3 (i), (ii), (iii), (iv), (v) and (vi) shows the DDK scores in percentage for groups A,B and C for cognate DDK tasks (combined tasks) for normals.

1. LIPJAW:

Rounding to Opening (UA)	Opening to Rounding (AU)	Spreading to Opening (IA)	Opening to Spreading (AI)
100%	0%	0%	100%

Tabie-3 (i). Showing the comparison of lip - jaw DDK task cognates of ail the three age groups.

GROUPS	AGE RANGE	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
A	4.1-8 yrs	106.2	97.1	101.5	105.8	115.7	114.5	128.7	135.3	113.5	152.3	118.4	150	108	144	109.1	138.5	106.9
B	8.1-11 yrs	109	105.3	101.3	105.3	130.7	137.3	153.3	157.3	132	141.6	134.7	166.7	134.7	164	133.3	164	125.3
C	11.1-15 yrs	121.2	121.2	121.2	132	116.4	123.6	133.2	138	117.6	130.8	127.2	136.8	120	132.7	117.6	128.4	114

GROUPS	AGE RANGE	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
A	4.1-8 yrs	138.5	94.9	133.1	122.2	144	110.2	122.2	97.1	124.4	106.9	138.5	125.5	113.5	112.4	112.4	106.9	110.2
B	8.1-11 yrs	164.3	128	153	148	170.3	126.7	170.7	122	156	113.6	160	153.3	142.7	144	137.3	130.7	142.7
C	11.1-15 yrs	135.6	117.6	144	128.4	141.6	116.8	130.8	112.8	130.8	112.8	138	115.2	123.6	118.8	112.8	112.8	117.6

TABLE-3: Showing the mean values of different combined diadochokinetic task performance in normals.
[Lip jaw: 12=UA; 13=AU; 14=IA; 15=AI; Lip velopharynx: 16=UM; 17=IM; 18=MU; 19=MI;
Lip tongue: 20=ID̪; 21=D̪I; 22=UD̪; 23=D̪U; 24=IḌ; 25=ḌI; 26=UḌ; 27=ḌU; 28=IG; 29=GI; 30=UG; 31=GU;
Jaw velopharynx: 32=AM; 33=MA; Jaw tongue: 34=AD̪; 35=D̪A; 36=AG; 37=GA; 38=AḌ; 39=ḌA;
Velopharynx tongue: 40=D̪ʌM; 41=MʌD̪; 42=ḌʌM; 43=MʌḌ; 44=GʌM; 45=MʌG].

2. LIP VELOPHAHYNX:

Rounding to Bilabial (UM)	Bilabial to Rounding (MU)	Spreading to Bilabial (IM)	Bilabial to Spreading (Ml)
0%	100%	0%	100%

Tabie-3(ii). Showing the comparison of lip velopharynx DDK task cognates of all the three age groups.

3. LIP TONGUE:

Spreading to Dental (ID̪)	Dental to Spreading (D̪I)	Rounding to Dental (UD̪)	Dentai to Rounding (D̪U)	Spreading to Retrofiex (IḌ)	Retroflex to Spreading (ḌI)
33.3%	66.6%	0%	100%	0%	100%

Table-3(iii) contd...

Rounding to Retrofiex (UḌ)	Retrofiex to Rounding (ḌU)	Spreading to Glottal (IG)	Glottal to Spreading (GI)	Rounding to Glottal (UG)	Glottal to Rounding (GU)
0%	100%	0%	100%	0%	100%

Table-3(iii). Showing the comparison of lip - tongue DDK task cognates of all the three age groups.

4. JAW VELOPHARYNX:

Opening to Bilabial (AM)	Bilabial to Opening (MA)
0%	100%

Table-3(iv). Showing the comparison of jaw - velopharynx DDK task cognates of all the three age groups.

5. JAW TONGUE:

Opening to Dental (AD)	Dental to Opening (DA)	Opending to Glottal (AG)	Glottal to Opening (GA)	Opening to Retroflex (AD)	Retrofiex to Opening (DA)
0%	100%	0%	100%	0%	100%

Table-3(v). Showing the comparison of jaw - tongue DDK task cognates of all the three age groups.

6. VELOPHARYNX TONGUE:

Dental to Biiabial (ḌʌM)	Biiabial to Dental (MʌḌ)	Retroflex to Biiabial (ḌʌM)	Bilabial to Retrofiex (MʌḌ)	Glottal to Bilabail (GʌM)	Bilabial to Glottal (MʌG)
66.6%	33.3%	100%	0%	0%	100%

Table-3(vi). Showing the comparison of velopharynx - tongue DDK task cognates of ail the three age groups.

From Tabie-3 we can infer that in the combined DDK tasks, the age groups of 4.1 to 8 years have performed poorly as compared to the other groups. The age group of 8.1 to 11 years have performed better than the others. This could be because the school children selected between 8.1 to 11 years were of a higher socio- economic status than children belonging to 11.1 to 15 years who were of a lower socio economic status.

From Table-3(i), (ii), (iii), (iv), (v) and (vi) we see that in the lip jaw task, rounding to opening task is better than opening to rounding tasks and opening to spreading is better than spreading to opening. In the lip veiopharynx task, biiabial to rounding is better than rounding to bilabiai and bilabial to spreading is better than spreading to bilabial. In the lip tongue DDK tasks, we find that:

i) dental to spreading is better than spreading to dental,

ii) dental to rounding is better than rounding to dental,

iii) retroflex to spreading is better than spreading to retroflex.

iv) retrofles to rounding is better than rounding to retroflex .

v) glottal to spreading is better than spreading to glottal,

vi) glottal to rounding is better than rounding to glottal.

In the Jaw-velopharynx task we find that bilabial to opening is better than opening to bilabial.

From the jaw-tongue tasks, we infer that dental to opening task is better than opening to dental task, glottal to opening is better than opening to glottal and retrofelx to opening is better than opening to retroflex task.

In the velopharynx-tongue tasks, we see that dental to bilabial is better than bilabial to dental, retroflex to bilabial is better than bilabial to retroflex, bilabial to glottal is better than glottal to bilabial.

From the above findings, we can infer that the transition from consonant to vowel is always easier than vowel to consonant transitions. This is in accordance with studies conducted by Blomquist (1950) who chose the consonant to vowel combination tasks for testing DDR rates.

I.c) COMPARISON OF ISOLATED Vs COMBINED DDK TASKS IN NORMALS:

Tabies 4, 5, 6, 7, 8, 9, 10, 11 and 12 shows the mean values of the isolated Vs combined DDK tasks and correlation values of the three age groups.

Age groups	Lips	Lip jaw
A	101.45	102.65
B	108	105.3
C	114.6	123.6
	r = .80	

Table-4. Showing the comparison of Lips Vs Lip-jaw DDK tasks in ail the three age groups.

Age groups	Lips	Lip velopahrynx
A	101.45	123.55
B	108	144.5
C	114.6	127.8
	r = .72	

Table-5. Showing the comparison of Lips Vs Lip-velopharynx DDK tasks in all the three age groups.

Age groups	Lips	Lip tongue
A	101.45	130.26
B	108	145
C	114.6	126.3
	r = .72	

Table-6. Showing the comparison of Lipa Vs Lip-tongue DDK tasks in all the three

Age groups	Jaw	Lip jaw
A	98.3	102 .65
B	104.6	105 .3
C	117.2	123 6
	r = .76	

Table-7. Showing the comparison of jaw Vs Lip-jaw DDK tasks in all the three age groups.

Age groups	Jaw	Jaw veiopharynx
A	98.3	133.2
B	104.6	159.1
C	117.2	135
	r = .48	

Table-8. Showing the comparison of Jaw Vs Jaw-velopharynx DDK tasks in all the three age groups.

Age groups	Jaw	Jaw tongue
A	98.3	116 .5
B	104.6	141..6
C	117.2	123 .6
	r = .50	

Table-9. Showing the comparison of Jaw Va Jaw-tongue DDK tasks in all the three age groups.

Age groups	Tongue	Lip tongue
A	99.35	130..2
B	114.9	145 .1
C	122.4	126 .35
	r = .50	

Table-10. Showing the comparison of Tongue Vs Lip-tongue DDK tasks in all the three age groups.

Age groups	Tongue	Jaw tongue
A	99.35	116 .5
B	114.9	141 .6
C	122.4	123..6
	r = .74	

Table-ll. Showing the comparison of Tongue Vs Jaw-tongue DDK tasks in all the three age groups.

Age groups	Tongue	Tongue volopahrynx
A	99.35	94.75
B	114.9	141.78
C	122.4	118.8
	r = .72	

Table-12. Showing the comparison of Tongue Vs Tongue-velopharynx DDK tasks in all the three age groups.

From the above tables, the findings may be summarized as follows:

Better correlation	Poor correlation
1. Lip Vs Lip jaw	Jaw Vs Jaw tongue
2. Lip Vs Lip velopharynx	Jaw Vs Jaw velopharynx
3. Lip Vs Lip tongue	Tongue Vs Lip tongue
4. Jaw Vs Lip jaw	
5. Tongue Vs Jaw Tongue	
6. Tongue Vs Velopharynx tongue.	

(Better correlation means that the taks are similar to each other and poor correlation means that the tasks are different).

From the results it is seen that in normals, the jaw-tongue and jaw-velopharynx combined DDK tasks performance is better than the Jaw DDK tasks. This could be becuase the transitions in the Jaw DDK tasks (AI & IA) may be more complicated than Jaw-tongue or Jaw-veiopharynx transitions.

The tongue DDK task performance is poorer than lip tongue performance. This could be because the transitions in the tongue DDK tasks (DD, DD, GD, DG, DG, GD) may be more complicated than the lip-tongue transitions.

II.a) PERFORMANCE OF C.P. ON THE ISOLATED DDK TASKS:

Table 13 depicts the mean values for the isolated DDK tasks.

Table-13(i), (ii) and (iii) shows the comparision of DDK tasks scores in percentage for the groups D, E and F for cognate DDK tasks.

1. LIPS:

Rounding to Spreading (UI)	Spreading to Rounding (IU)
66.6%	33.3%

Table-13(i). Showing the comparison of Lip isolated DDK cognate tasks for all the three age groups.

2. JAW:

Opening to Spreading (AI)	Spreading to Opening (IA)
66.6%	33.3%

Table-13(ii). Showing the comparison of Jaw isolated DDK cognate tasks for all the three age groups.

GROUPS	ACE RANGE	1	2	3	4	5	6	7	8	9	10	11
D	4.1-8 yrs	67.2	65.4	64.8	70.8	69	67.2	66	63	65.4	71.4	57.6
E	8.1-11 yrs	77.3	79.3	93.1	74.7	78.7	77.3	78	73.3	73.3	83.3	70.7
F	11.1-15 yrs	85.5	84	82.5	79.5	78	69	73.5	73.3	67.5	72	67.5

TABLE-13: Showing the mean values of different isolated diadochokinetic task performance in the C.P. population.
[Lips: 1=UI; 2=IU; Jaw: 3=AI; 4=IA; Tongue: 5=DD; 6=DD; 7=GD; 8=DG; 9=DG; 10=GD; Velopharynx: 11=MM].

3. TONGUE:

Dentai to Retrof lex (ḍd)	Retroflex to Dental (dḍ)	Glottal to Dentai (gḍ)	Dental to Giottai (ḍg)	Retroflex to Giottal (dg)	Giottali to Retroflex (gḍ)
100%	0%	100%	0%	0%	100X

Table-13(iii). Showing the comparison of tongue isolated DDK cognate tasks for all the three age groups.

4. VELOPHARYNX: In general, the scores of velopharynx tasks have been compartively lesser than the other isolated task performances.

From the results of table 13(i),(ii)and(iii), we can infer that in the lip tasks rounding to spreading is better than spreading to rounding. In the jaw task opening to spreading is better than spreading to opening. In the tongue tasks, dentai to retroflex is better than retroflex to dental, glottal to dentai is better than dental to glottal and glottal to retrflex is better than retrofiex to glottal tasks.

The velopharynx scores are comparatively lower in the C.P. population in all the three groups, indicating that this could be due to a muscular weakness leading to a velopharyngeal insufficiency. This is in accordance with studies done by Canter (1965b) who found that the dysarthric groups show impaired ability to perform rapid movements of tongue tip and velopharynx articulatora. This task could be used to test the velopharynx structure in the C.P. population as it was concluded in the study by Rajkumar and Rajupratap (1990) that /pam/ could be used as a test for insufficient velopharyngeal closure.

We also find that age groups 8.1 to 11 years have performed better than the other groups. This could be due to a sampling error, where the age group of 8.1 to 11 years were less severly affected and had a higher language level as compared to the other groups.

II. b) PERFORMANCE OF C.P. POPULATION ON THE COMBINED DDK TASKS:

Table-14 Showing the mean values of the combined DDK task performance in C.P population.

Table-14(i), (ii), (iii), (iv), (v) and (vi) Showing the comparison of DDK scores in percentage for groups D, E and F for cognate DDK tasks.

1. LIPJAW:

Rounding to Opening (UA)	Opening to Rounding (AU)	Spreading to Opening (IA)	Opening to Spreading (AI)
33.3%	66.6%	66.6%	33.3%

Table-14(i). Showing the comparison of Lip Vs Lip-jaw cognate DDK tasks of all the three age groups.

GROUPS	AGE RANGE	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
D	4.1-8 yrs	74.4	73.7	79.2	76.2	72.6	72	78	75	76.8	81.6	73.8	84	70.8	80.4	75	81.6	67.2
E	8.1-11 yrs	70.7	80.2	82	80	81.3	84	88	100	85.3	93.3	82.7	97.3	84	90.7	87.3	96	92
F	11.1-15 yrs	78	79.5	78	87	89.3	90	87	93	78	76.5	85.5	85.5	81	85.5	82.5	88.5	84

GROUPS	AGE RANGE	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
D	4.1-8 yrs	76.2	67.8	75	75.6	88.2	75.6	79.2	68.4	79.2	72	84	67.2	63.6	69.6	67.2	68.4	67.2
E	8.1-11 yrs	97.3	86.7	104	89.3	110.7	86.7	93.3	86.7	94.7	89.3	104	85.3	84	81.3	84	77.3	84
F	11.1-15 yrs	94.5	82.5	91.5	78	97.5	87	91.5	90	99	87	101.5	81	78	73.5	76.5	79.5	73.5

TABLE-15: Showing the mean values of different combined daidochokinetic task performance in the C.P. population.
[Lip jaw: 12=UA; 13=AU; 14=IA; 15=AI; Lip velopharynx: 16=UM; 17=IM; 18=MU; 19=MI;
Lip tongue: 20=ID; 21=DI; 22=UD; 23=DU; 24=ID; 25=DI; 26=UD; 27=DU; 28=IG; 29=GI; 30=UG; 31=GU;
Jaw velopharynx: 32=AM; 33=MA; Jaw tongue: 34=AD; 35=DA; 36=AG; 37=GA; 38=AD; 39=DA;
Velopharynx tongue: 40=D^M; 41=M^D; 42=D^M; 43=M^D; 44=G^M; 45=M^G].

2. LIP VEL0PHARYNX:

Hounding to Biiabiai (UM)	Biiabiai to Rounding (MU)	Spreading to Bilabial (IM)	Biiabiai to Spreading (MI)
33.3%	33.3%	66.6%	66.6%

Table-14(ii). Showing the comparison of Lip-velopharynx cognate DDk tasks of all the three age groups.

3. LIP TONGUE:

Spreading to Dental (ID̪)	Dental to Spreading (D̪I)	Rounding to Dental (UD̪)	Dental to Rounding (D̪U)	Spreading to Retroilex (IḌ)	Retroflex to Spreading (ḌI)	Rounding to Retrofiex (UḌ)	Retroflex to Rounding (ḌU)	Spreading to Glottal (IG)	Glottal to Spreading (GI)	Rounding to Glottal (UG)	Glottal to Rounding (GU)
33.3%	66.6%	0%	100%	0%	100%	0%	100%	0%	100%	0%	100%

Table-14(iii). Showing the comparison of Lip-tongue cognate DDK tasks of all the three age groups.

4. JAW VEL0PHARYNX:

Opening to Bilabial (AM)	Bilabial to Opening (MA)
0%	100%

Table-14(iv). Showing the comparison of jaw-velopharynx cognate DDK tasks of all the three age groups.

5. JAW TONGUE:

Opening to Dentai (AD)	Dentai to Opening (DA)	Opending to Giottal (AG)	Giottal to Opening (GA)	Opening to Retrofiex (AD)	Retrofiex to Opening (DA)
0%	100%	0%	100%	0%	100%

Table-14(v). Showing the comparison of Jaw-tongue cognate DDK tasks of all the three age groups.

6. VELOPHARYNX TONGUE:

Dental to Bilabial (ḌʌM)	Bilabial to Dental (MʌḌ)	Retroflex to Bilabial (ḌʌM)	Bilabial to Retroflex (MʌḌ)	Glottat to Bilabail (GʌM)	Bilabial to Giottai (MʌG)
100%	0%	33.3%	66.6%	100%	0%

Table-14(vi). Showing the comparison of veiopharynx-tongue cognate DDK tasks of ail the three age groups.

From tables-14(i),(ii),(iii),(iv),(v) and (vi) no can infer the following:

In the iip jaw task opening to rounding is better than rounding to opening and spreading to opening is better than opening to spreading. In the iip velopharynx task bilabial to rounding is better than rounding to bilabial and bilabial to spreading is better than spreading to biiabia!. In iip tongue tasks dentai to spreading is better than spreading to dentai, dentai to rounding is better than rounding to dentai, retroflex to spreading is better than spreading to retroflex, retrofiex to rounding is better than rounding to rotrofiex, glottal to spreading is better than spreading to glottal and glottal to rounding is better than rounding to glottal. In the jaw-velopharynx task bilabial to opening is better than opening to bilabial. In jaw-tongue tasks dental to opening is better than opening to dental, glottal to opening is better than opening to glottal and retrflex to opening is better than opening to retroflex. In the velopharynx tongue tasks we find that dental to bilabial is better than bilabial to dental, bilabial to retroiiex is better than retroflex to bilabial and glottal to bilabial is better than bilabial to glottal tasks.

In the combined tasks the 8.1 to 11 year age groups have performed better than the other two groups. This could again be due to higher language level because of intensive speech and language therapy and lesser severty of symptoms in this age groups.

II.c) COMPARISON OF ISOLATED Vs COMBINED DDK TASK PERFORMANCE IN C.P. POPULATION:

Tables 15, 16, 17, 18, 19, 20, 21, 22 and 23 shows the mean values of the isolated Vs combined DDK tasks and correlation values of the three age groups.

Age groups	Lips	Lip jaw
D	66.3	75.8
E	78.3	78.2
F	84.7	80.6
	r = .82	

Table-15. Showing the comparison of Lips Vs Lip-jaw DDK tasks in all the three age groups.

Age groups	Lips	Lip velopahrynx
D	66.3	74.,4
E	78.3	88.3
F	84.7	89..3
	r = .75	

Table-16. Showing the comparison of Lips Vs Lip-velopharynx DDK tasks in all the three ago groups.

Age groups	Lips	Lip tongue
D	66.3	75.8
E	78.3	91.3
F	84.7	84.6
	r = .74	

Table-17. Showing the comparison of Lips Vs Lip-tongue DDK tasks in all the three age groups

Age groups	Jaw	Lip jaw
D	67.5	75.8
E	83.9	78.2
F	80.25	80.6
	r = .83	

Table-18. Showing the comparison of Jaw Vs Lip-jaw DDK tasks in all the three age groups

Age groups	Jaw	Jaw velopharynx
D	67.5	80.9
E	83.9	100
F	80.25	87.75
	r = .63	

Table-19. Showing the comparison of Jaw Vs Jaw-velopharynx DDK tasks in all the three age groups.

Age groups	Jaw	Jaw tongue
D	67 .5	76 4
E	83 .9	92 45
F	80 .25	62 65
	r = .71	

Table-20. Showing the comparison of Jaw Vs Jaw-tongue DDK tasks in all the three age groups

Age groups	Tongue	Lip tongue
D	67	75. 85
E	77.3	91 .3
F	72.25	84 .6
	r = .72	

Table-21. Showing the comparison of Tongue Vs Lip-tongue DDK tasks in all the three age groups

Age groups	Tongue	Jaw tongue
D	67	76.4
E	77.3	92.4
F	72.25	92.6
	r = .64	

Tab!e-22. Showing the comparison of Tongue Vs Jsw-tongue DDK tasks in all the three age groups

Age groups	Tongue	Velopahrynx-tongue
D	67	67.2
E	77.3	82.6
F	72.25	77
	r = .78	

Table-23. Showing the comparison of Tongue Vs Velopharynx-tongue DDK tasks in all the three age

From the above tabies, the findings may be summarized as follows:

Better correlation	Poor correlation
1. Lip Vs Lip jaw	Jaw Vs Jaw velopharynx
2. Lip Vs Lip velopharynx	Tongue Vs Jaw tongue
3. Lip Vs Lip tongue	
4. Jaw Vs Lip jaw	
5. Jaw Vs Jaw tongue	
6. Tongue Vs Lip tongue	
7. Tongue Vs Velopharynx tongue.	

(Better correlation means that the tasks are similar to each other and poor correlation means that the tasks are different).

The jaw-velopharynx tasks are performed better when compared to the jaw DDK task and the jaw-tongue tasks are better than the tongue DDK tasks. Here we see that in the C.P. population, the transitions of jaw-veiopharynx and jaw tongue are easier than the isolated jaw or tongue task.

The findings may have imoprtant bearing in dysarthria therapy, implicating that DDK tasks of isolated structures like jaw or tongue may be more difficult to a dysarthric partient as compared to DDk tasks involving the alternate movements of coordinate articulatory structures such as jaw velopharynx and jaw-tongue. This observation is also reflected in the normal group of subjects. However, this fact needs to be verified by future research in this direction.

III. COMPARISON OF DDK TASK PERFORMANCE BY NORMALS AND C.P.:

From the mean tables and the graphs we observed that normais have performed better in all the isolated and combined DDK tasks when compared to the C.P. population. This was earlier highlighted in studies conducted by Heltman and Peacher (1943); Canter, (1965b); Hedges, (1955) and Roshni, (1992) who found that the cerebral palsied subjects always performed poorer than the normals in all the DDk tasks. Other studies by Dworkin, Aronson and Mulder (1980) found that C.P. population had a less tongue force as compared to normals. This could be one of the reasons for a inferior performance by the C.P. population.

Table-24 gives Lhe similarties of DDK task performances by normal and C.P. population.

Isolated & Combined DDK tasks	Normals and C.P.
1. Jaw	Opening to spreading is better in both groups
2. Tongue	Dental to retroflex, glottal to dental and glottal Lo retroflex is better in both groups.
3. Lip velopharynx	Bilabial to rounding and bilabial to spreading is better in both groups.

4. Lip tongue	Dental to spreading, dental to rounding, retroflex to spreading, retroflex to rounding, glottal to spreading and glottal to rounding is better in both the groups.
5. Jaw velopharynx	Bilabial to rounding is better in both groups.
6. Jaw tongue	Dental to opening, glottal to opening and retrflex to opening is better in both the groups.
7. Velopharynx tongue	Dental to bilabial is better in both the groups.

Hence we see that there are some similarities in the performance of normals and C.P. population on the DDK tasks, even though the normals have performed superiorly on all the DDK tasks. We can also infer that these DDK tasks, can be used to test the oral motor structures of both normals and C.P. population simultaneously.

SUMMARY AND CONCLUSIONS

The present study was aimed at finding out the relationships between the different oral structures a the diadochokinetic tasks in the normals and the cerebral palsied population. The study also aimed at comparing the performance of different age groups in normals and C.P. subjects on the isolated, combined and isolated Vs combined diadochokinetic tasks, cognate pair comparison on the different DDK tasks and to see if a devlopmental trend exists in the normal and C.P. population.

The subjects taken for this study were 57 (thirty normals and twenty seven cerebral palsied) in the Age range of 4 to 14 years.

The chosen diadochokientic speech task required the active participation of the articulators, that is the tips, jaw, tongue and velopharynx. Also a combination of the above structures namely lip - jaw, jaw - tongue, lip - velopharynx, lip - tongue, jaw - velopharynx and velopharynx - tongue were selected to measure the combined action of the oral structures.

The subjects were required to repeat rapidly the isolated and combined diadochokintic tasks for a duration of five seconds with least distortion in the speech sounds. The number of phonemes for five seconds was counted using the Count by Time' method. The final scores of five seconds was

Performance of Normals and Cerebral Palsy on Isolated DDK Task

Structure	Lips		Jaw		Tongue						Velopharynx
Task	UI	IU	AI	IA	DD	DD	GD	DG	DG	GD	M - M
Description	R to S	S to R	O to S	S to O	D to Ret	Ret to D	G to D	D to G	Ret to G	G to Ret	
Performance	− / +	+ / −	+ / +	− / −	+ / +	− / −	+ / +	− / −	− / −	+ / +	+ / −

Description Code

R = Rounding

S = Spreading

O = Opening

D = Dental

Ret = Retroflex

G = Glottal

B = Bilabial

1st Quadrant = Normals

2nd Quadrant = Cerebral Palsy

Performance of Normals and Cerebral Palsy on Combined DDK Tasks

Structure	Lip – Jaw				Lip velopharynx				Lip – Tongue								
Task	UA	AU	IA	AI	UM	MU	IM	MI	ID	DI	UD	DU	ID	DI	UD	DU	IG
Descricption	R to O	O to R	S to O	O to S	R to B	B to R	S to B	B to S	S to D	D to S	R to D	D to R	S to Ret	Ret to S	R to Ret	Ret to R	S to G
Performance	+ / −	− / +	− / +	+ / −	− / −	+ / +	− / −	+ / +	− / −	+ / +	− / −	+ / +	− / −	+ / +	− / −	+ / +	− / −

			JawV elopharynx		Jaw – Tongue						Velopharynx – Tongue					
GI	UG	GU	AM	MA	AD	DA	AG	GA	AD	DA	D∧M	M∧D	D∧M	M∧D	G∧M	M∧G
G to S	R to G	G to R	O to B	B to O	O to D	D to O	O to G	G to O	O to Ret	Ret to O	D to B	B to D	Ret to B	B to Ret	G to B	B to G
+ / +	− / −	+ / +	− / −	+ / +	− / −	+ / +	− / −	+ / +	− / −	+ / +	+ / +	− / −	+ / −	− / +	− / +	+ / −

Table - 25 : Showing the performance of normals and Cerebral Palsy on different DDK Task converted to per minute scores and were subjected to statistical analysis. The following summarizes the findings of the study.

1. The normals have shown a better performance in terms of diadochokinetic scores in all the diadochokinetic tasks compared to C.P. population.

2. Table-25 shows the performance of normals and C.P. on different diadochokinetic tasks.Most of the tak performedces were similar in both groups,through quantitatively, noramll have performed better.

3. Isolated Vs combined performance Yn normals shows that jaw - tongue and jaw - velopharynx diadochokientic task performance were better than jaw diadochokinetic task performance. The lip - tongue performance was better than lip diadochokinetic performance.

4. Isolated Vs combined performance in C.P. population shows that jaw - velopharynx diadochokinetic task was better than jaw diadochokinetic task and jaw - tongue was better than jaw diadochokinetic task.

IMPLICATIONS OF THE STUDY:

1. The diadochokinetic tasks tested in this study show many similarities between the performance of C.P. and normals although quantitatively normals have performed better in all the tasks. Thus , these tasks could be used as an assessment tool for both normal and C.P. population.

2. It is seen that some of the diadochokinetic tasks involving the isolated structures like jaw or tongue are more difficult to normal as well as C.P. children when

compared to the combined structures like jaw - veiopharynx and jaw - tongue, suggesting that the combined diadochokinetic tasks may be introduced before the isoiated tasks in the therapeutic interventions for C.P.

3. Like the normals, the transitions involving consonant to vowei in diadochokinetic tasks are easier than vowei to consonant transitions for the C.P. and hence, consonant-vowel combinations couid be taken up before the vowei-consonant production in therapy.

LIMITATIONS OF THE STUDY:

1. A developmental trend in the performance on different diadochokinetic tasks in normals was not observed except for the isolated DDK tasks, probably because the higher age group children (11.1 to 15 years) were selected from a lower socio economic status in the school due to non-availability of subjects.

2. A developmental trend in the C.P. population on the different diadochokinetic tasks were not observed probably because the 8.1 to 11 years children selected for this study were undergoing intensive speech and language therapy and hence had a higher language level than the 11.1 to 15 years age group.

3. Comparison of male to female performance in both C.P. and normals could not be done due to small sample size.

4. Only one judge was used to tabulate the diadochokinetic

task production due to time restrains.

SUGGESTIONS FOR FURTHER RESEARCH:

1. To study the performance of a larger group of normal and C.P. population on the different diadochokinetic tasks.
2. To study the performance of diadochokinetic tasks on the sub-groups of C.P. like athetoid, ataxic, mixed etc..
3. To compare the results of the study with diadochokinetic tasks consisting of other consonants and vowel combinations which were not included in the present study.
4. To measure the diadochokinetic tasks with other methods like 'Time by Count' method and instruments like Spectrograph and to compare their results with this study.

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