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Oral Diadokokinetic Rate - An Insight into Speech Motor Control

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Abstract Speech motor disruptions are common with aging. The rate of oral diadochokinesis (DDK) is considered for determining the severity of speech motor control impairments. The aim of this study was to investigate changes in motor control in geriatrics in comparison with younger adults with Diadokokinesis as a speech parameter. Significant difference was observed between the geriatrics compared to the younger groups indicating poor performance of geriatrics on diadochokinetic rate in comparison to normal adults. The present investigation has provided evidence for analysing the error patterns in the syllable repetitions using DDK rate which is a simple yet quantitative measure.
Keywords *DDK, Geriatrics, MSP, Speech Motor Control*

1. Introduction

Speech motor control refers to systems and strategies that regulate the production of speech, including the planning and preparation of movements and the execution of movement plans to result in muscle contractions and structural displacements (1). Compared to many other human motor tasks classically studied in motor control research, speech production has a number of peculiarities that make it particularly complex. Speech is the fastest discrete motor performance that humans can perform. There are ways of measuring rate in discrete motor tasks such as speaking, typing and tapping. One way to measure events per unit time is in the classic task of diadokokinesis. The speed and consistency of speech motor or oral-motor skills develop gradually throughout maturation (2).

A relationship between diadokokinetic movements and speech is proposed to exist. West and Ansberry (1968) state that “The person who can negotiate rapid shifts of inhibition of muscle contraction is, generally speaking, possessed of high speed of diadokokinesis and, correlatively, of the ability to make rapid articulatory movements”. Hence information pertaining on the diadokokinetic rate is useful in determining the status of physiological mechanism for speech production.

General health may interact with age to influence speed and accuracy of movement (3). Speech motor control disruptions generally reported are with older adults performing movements more slowly (4) and with greater variability than younger adults (5, 4, 6). Generalized age-related changes in

processing speed, attentional resources, or working memory capacity and reliance on visual feedback for accurate movement execution have also been noted (7, 8, 9).

A widely used clinical assessment of the oral-motor mechanism is an investigation of diadochokinesis (10,11) whereby, the rapid rate of movement (12) or maximum rate of syllable production in non-linguistic utterances (2) is considered as an index of motor skill (12, 2). The rate of oral diadochokinesis (DDK), defined as the rate of maximally rapid syllable repetition, is a standard component of motor speech assessment (13, 14, 15). The task used to derive oral DDK rate is a speech-like task involving rapid monosyllabic repetitions. The type of rapid repetition of syllable sequences is referred to as alternating motion rate (AMR). The sequential motion rate (SMR) is defined as rapid repetition of a single syllable, such as /pə/ (13, 14). Syllable repetitions performed as fast as possible (oral diadokokinesis) represents a valid probe of maximum speaking rate, being an important measure of articulatory performance.

1.1. Need of the Study

Inaccurate and inconsistent oral DDK performances are frequently observed in individuals with motor speech disorders (14). It is also reported that the groups with the highest and lowest DDK rates were groups with the lowest and the highest severity levels respectively. The diadochokinesis test has been recommended and used to evaluate neurological disorders. It is a speech task that consists of the ability to repeat a segment of speech at high speed. Speech motor control variations across lifespan have been observed and studied over time. Objective measures of speech and non-speech orofacial motor control across the life span are sparse (14). Hence the present study was taken in this direction.

2. Materials and Methods

The study followed a case control design. The Institutional Ethics Committee approval was obtained prior to the conduction of the study.

2.1. Participants

The present study was conducted in a multidisciplinary hospital in the southern part of India. The participants were divided into 2 groups. Group 1 consisted of 20 geriatric individuals (10 males and 10 females) in the age range of 60 to 85 years and the Group 2 consisted of 20 adults (10 males and 10 females) in the age range of 18 to 25 years. The participants were native Kannada speakers and none of them had neurologic, speech or language impairments.

2.2. Procedure

The procedure was carried out in a sound treated room. The monosyllables /pa/, /ta/ and /ka/ and the syllable sequence /pa-ta-ka/ constituted the stimuli for measuring DDK rates in line with suggestions made by Robbins and Klee (1987). The participants were instructed to produce these syllables repetitively and as clearly as possible for 5 sec into the microphone which was placed at a distance of 10 cm from the speaker. The data was collected using Motor Speech Profile (MSP), Model 4151, a module of the CSL (Kay Elemetrics Corp.), which performs an automated analysis of DDK. The parameter selected was the Average Diadochokinesia Rate, which is the number of consonant-vowel vocalizations per second. This rate is inversely related to the average period. Statistical analysis was done using SPSS (Statistical Package for Social Sciences), 16.0 version. A 5% significance level was adopted for the present study.

3. Results

In the present study, the average rate for the all the monosyllables /p/, /t/, /k/ and polysyllables /pataka/ was observed. Significant main effect of the group was observed at $p<0.05$ indicating a significant difference between the younger and older groups. It was also observed that as the syllable proceeded from anterior to posterior, the average rate reduced, but was found to be better for overall /pataka/ for both the groups. There was no gender difference among both the groups.

Table 1: *Group gender interaction for the parameters /p/, /t/, /k/ and /ptk/*

Parameter		Group	Gender	Group Vs Gender
/p/	df	1	1	1
	F	15.867	3.561	0.429
	Sig	0.000	0.067	0.517
/t/	df	1	1	1
	F	35.805	2.952	0.968
	Sig	0.000	0.094	0.332
/k/	df	1	1	1
	F	15.514	4.138	1.698
	Sig	0.000	0.049	0.201
/ptk/	df	1	1	1
	F	40.155	2.039	5.374
	Sig	0.000	0.162	0.026

4. Discussion

DDK syllable repetition requires rapid motion superimposed on the balanced equilibrium of oral structures so assessment of DDK production provides a means of scrutinizing certain physiologic aspects of speech.

A number of instrumental techniques can be used to investigate speech motor skills, including imaging techniques (16). Investigations of rate of speech production use diverse methodologies. Some have measured speech rate in spontaneous connected speech which includes pauses (17) while others have calculated articulation rate by first subtracting the duration of pauses from the total utterances duration. Rate measures have been made in syllables or segments and have been based on spontaneous connected speech data and/or imitated speech where length of target utterance is controlled. Findings are likely to be affected by the choice of methodology, since speed of connected speech production is influenced by a number of variables, including linguistic and cognitive factors as well as utterance length and speaking context (18). Maximum rate of syllable production in non-linguistic DDK tasks is widely used in both research and clinical contexts as a means of gaining insight into an individual's speech motor ability free from many of these complicating factors. Not only is rate the easiest oro-motor skill to measure, but it has also been described as the simplest way to recognize motor speech difficulties (11).

The DDK rate was evaluated in this study in young adults and geriatrics. DDK is defined as the "maximum speed of movement with which a given reciprocating acts can be produced" (23). DDK rate is considered as maximum performance test and it reflects coordination, range, or rate of articulators (19). DDK analysis includes the measurement of rate and accuracy of placement. DDK rate is

sensitive to oro-motor deficits (20). It is also a simple, easy and an objective measure.

The main aim of this investigation was to compare speech motor control ability in younger adults and geriatrics. The results of the present study revealed that there was a significant difference between the two groups indicating that geriatrics performed poorly on diadokokinetic rate in comparison to normal adults. This is in consonance with the earlier research that speech motor control disruptions are often observed in older adults in terms of slower movements (5, 4) and with greater variability than younger adults (5, 21, 4, 6). The findings of the present study support the view that DDK rate measurement indicated better speech accuracy even during increased speeds in young adults, implying that their speech motor resource was greater as compared to the geriatrics.

In the present study there was also a progressive reduction of the number of syllables uttered per second as the utterances went more posterior in the oral cavity. This could be attributed to the effort required for the production of the syllabus and the increased number of muscles involved in the production of the syllables as the articulatory position moves from anterior to posterior. So the effort required to produce labial phonemes may be less, followed by tongue tip phonemes, whereas the syllable production at the back of the tongue requires more effort. Prathanee (22) has commented that for the bilabial production only the orbicular muscles are involved, while for the other phonemes with tongue tip and back of the tongue several other muscles are involved.

5. Conclusion

Oral diadochokinesis may be indicative of structural and physiological changes. The results of the present study revealed that a simple task like DDK was sensitive to reflect the speech motor control disruptions observed with aging. Hence DDK which is objective and simple method that can be used in the evaluation of speech motor control.

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