Comparing Diadochokinetic Performances of Stuttering and Non-Stuttering Children between 7-12 Ages

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Abstract

It is important to evaluate oral motor skills, make appropriate diagnosis and develop appropriate intervention plans for individuals who stutter. One of the measures used to evaluate oral motor skills is diadochokinesia (DDK). Diadochokinesia or diadochokinesis is the ability to make antagonistic movements in quick succession, alternatingly bringing a limb into opposite positions, as of flexion and extension or of pronation and supination. Diadochokinetic analysis examines the speed, accuracy and continuity measures of speech production in monosyllabic /pɅ/, /tɅ/, /kɅ/ and multisyllabic /pɅtɅkɅ/ sequences.

This study aimed to compare the diadokinetic performance of children aged 7-12 with and without stuttering. Participants were composed of girls and boys with and without stuttering from each age group. The data of the diadochokinetic measurements of stuttering children were compared to the data of the typically developing children.

It was found that there was a significant difference in favor of children who do not stutter during production of /pɅ/ and /kɅ/ syllables. Results of the research between the genders found there was a significant difference in favor of girls. In addition, there was significance in favor of 10-12 age group for /pɅ/ syllable.

INTRODUCTION

Speech is the last thing that occurs as a result of connections between linguistic, cognitive and sensorimotor processes [1]. Neuromuscular control requires complex motor skills and coordinated operation of many systems (respiration, phonation and articulation) [2]. In addition, highly synchronous and coherent neural network activity is required for uninterrupted speech motor function [3]. On the contrary, the whole of the most complex motor behaviors developed to facilitate communication.

It is important for speech and language therapists to assess oral motor skills of individuals who stutter and make appropriate diagnoses and develop appropriate intervention plans. One of the measures used to assess these skills is verbal diadochokinesia (DDK also defined as syllable alternating motion rate (AMR)). It shows the ability to make rapid speech movements using different structures in the mouth (tongue, lip, soft palate, etc.).

Medically speaking, DDK is "the act/process of repeating at maximum speed a simple cyclical, reciprocating movement such as raising and lowering of the mandible or protrusion and retracting the tongue" [4].

DDK measures has long been used for the part of the clinical assessment for oral motor function in speech-language pathology since the DDK assists to detect speech variations associated with different underlying conditions [5-13]. DDK analysis examines the speed, accuracy and continuity measures of speech production in single-syllable /pɅ/, /tɅ/, /kɅ/ or multisyllable /pɅtɅkɅ/ sequences. For this reason, it gives information on the speed of movement and placement of the articulators. The information obtained reflects the integration between neuromotor maturation and speech structures (lip, tongue) [15,16].

Stuttering is a disorder in the rhythm and fluency of speaking. The indication of stuttering appears in the form of pause, lengthening, and blocks in voice, syllable, and words. The person with stuttering knows what to talk about and can plan it, but has difficulty maintaining normal speech flow at the time of speech. In the literature on children with stuttering, although there are few studies on motor control of speech [17-19], stuttering speech movement is noted that they exhibit difficulties related to the planning and programming [20]. When DDK data of stuttering children were examined, it was stated that most of these children showed oral-motor problems in motor tasks involves talking...
[21]. Rickenberg (1956) [22] found that stuttering individuals were significantly slower than the control group in the repetition of /pɅ/, /bɅ/, /mɅ/, /tɅ/, /dɅ/, /nɅ/, /kɅ/, /gɅ/ syllables.

Considering the above, the purpose of this study is to find out if there is a difference between DDK tasks of stuttering and non-stuttering children 7-12 years of age.

METHOD AND PARTICIPANTS

Method

Descriptive method was used in this research. Participants were selected by convenience sampling (known as availability sampling as well) method. The setting is a university based affiliated Research Center. The participants were conveniently selected among the patients who were receiving therapy at the Center at given dates with the diagnosis of stuttering during initial interview. The Center serves all types of speech, voice, language, motor speech and dysphagia disorders at all ages. The convenience sampling has advantages such as simplicity of sampling, ability to promote base for hypothesis generation for further studies, data can be collected in a short period of time and cost effective. However, researchers need to be aware of sampling errors [23]. Since the aim of the study group included only one type of speech disorder (i.e., stuttering) the sampling error was not considered as a major handicap. Selection and evaluation process followed the pertinent ethical process approved by the Ethics Committee of the Anadolu University (EK/4381), and signing of the consent form by the families of the participants. Funding was provided by Anadolu University Scientific Research Project Center (BAP no: 16085601) to by the MDVP motor speech profile (Kay PENTAX Motor Speech Profile 5141).

Participants

In this study, syllable repetition rates of children aged 7-12 years were examined. The research’s study group consisted of children with stuttering between the ages of 7-12. Participants were selected among children who had received the diagnosis of stuttering at DILKOM that is the Research Center of Speech and Language Disorders in Anadolu University. At DILKOM, initial evaluation of the participants no matter what the initial application deems (fluency, delayed language, drooling, etc.), the diagnostic procedure follows the certain steps including a hearing screen, oral peripheral examination [24], Turkish Articulation Test [25], and TODIL (Turkish Language Test for School Age Children) [26]. Thus, the participants have completed all the above tests prior to directed to stuttering unit of DILKOM.

Inclusion criteria to the study also included that all participants’ primary and only language is being Turkish, that they do not have any other speech, cognitive and language problems, have no hearing difficulty, and receiving any medications on a continuous basis.

There were two groups one with stuttering and the other is not. Non-stuttering group were selected from the appropriate age siblings of the children with the diagnosis of stuttering. Since the data was collected by convenience method there was no control of male to female group as well as the equal distribution of the age sampling.

The study included 14 girls and 22 boys, a total of 36 participants. Table 1 shows the subjects descriptive information, and figure 1 the age distribution of the all subjects according to sex.

PROCEDURE

1. The procedures underlined below were completed for all subjects in the study: Data was collected upon completion of initial screen of DILKOM for those who are eligible to receive stuttering management.

2. Data was collected in one-to-one basis in a quiet speech therapy room which was specially designed for recording with no echo formation (Speech Therapy Recording Laboratory) by the clinician and a Shure SM 48 microphone was used during recording.

3. Collection of DDK rate trials included:
   a. /pɅ/, /tɅ/, /kɅ/, /pɅtɅ/, /pɅtɅkɅ/ sequence
   b. Subjects were asked to say /pɅ/, /tɅ/, /kɅ/, /pɅtɅ/, /pɅtɅkɅ/ syllables as quickly as possible. Subjects have been given the order “I want you to breathe like you always breathe and do it as quickly as you can.” for each sequence /pɅ/, /tɅ/, /kɅ/, /pɅtɅ/, /pɅtɅkɅ/.

Table 1: Subjects descriptive information.

<table>
<thead>
<tr>
<th>Participants</th>
<th>n(36)</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girl</td>
<td>14</td>
<td>38,9</td>
</tr>
<tr>
<td>Boy</td>
<td>22</td>
<td>61,1</td>
</tr>
<tr>
<td>Age Range</td>
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</tr>
<tr>
<td>7-9 yrs old</td>
<td>16</td>
<td>44,4</td>
</tr>
<tr>
<td>10-12 yrs old</td>
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<td>55,6</td>
</tr>
<tr>
<td>Speech fluency Status</td>
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<td></td>
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<tr>
<td>Stutterer</td>
<td>17</td>
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</tr>
<tr>
<td>Non-stutterer</td>
<td>19</td>
<td>52,8</td>
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<tr>
<td>Fluency status and sex</td>
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<td></td>
</tr>
<tr>
<td>Female stutterer</td>
<td>2</td>
<td>5,6</td>
</tr>
<tr>
<td>Female non stutterer</td>
<td>12</td>
<td>19</td>
</tr>
<tr>
<td>Male stutterer</td>
<td>15</td>
<td>27</td>
</tr>
<tr>
<td>Male non stutterer</td>
<td>7</td>
<td>12</td>
</tr>
<tr>
<td>Fluency status and age</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7-9 yrs old stutterer</td>
<td>7</td>
<td>27,8</td>
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<tr>
<td>7-9 yrs old non stutterer</td>
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<td>27,8</td>
</tr>
<tr>
<td>10-12 yrs old stutterer</td>
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<td>27,8</td>
</tr>
<tr>
<td>10-12 yrs old non stutterer</td>
<td>10</td>
<td>27,8</td>
</tr>
</tbody>
</table>

Figure 1 Age distribution of the all subjects according to sex.
For each sequence was repeated three times and voice recording was taken. On account of the correct understanding and implementation of the process researcher became a role model for participants.

d. At the moment of registration, the subject is seated in a chair and adjusted so that the subjects’ microphone-to-mouth distance is 5 cm.

e. The samples were transferred to Kay PENTAX Motor Speech Profile 5141 (MSP) program in the form of wav file.

4. In the MSP program, the Average DDK Rate / Average DDK Rate (DDKavr) parameter in the Diodeokinetic Rate Protocol was selected and numerical data was obtained. The first eight seconds in the samples were used for analysis [27].

5. The obtained data were analyzed with the Statistical Package for Social Sciences (Statistical Program for Social Sciences) SPSS Statistics 21 packet program.

Data Analysis

Data were analyzed using descriptive statistics. Percent, frequency, mean, standard deviation were calculated. In order to determine the distribution of the data, the histogram graphs of skewness, kurtosis values and data were examined and the Shapiro-Wilk test was performed. Data were not distributed normally, and the nonparametric tests (Mann-Whitney U Test, Kruskal-Wallis Test) were used. SPSS 21 package program was used for the analysis of the data. The results of the collected sample are presented in Tables 2-4.

RESULTS

Results indicated that:

1. Syllable combination of /pɅtɅkɅ/ is produced more slowly than /pɅ/ syllable combination according to the mean values obtained when age and stutter status are taken into consideration. As the number of syllables increases, more articulator movement is needed and the importance of motor planning arises.

2. When the means of /pɅ/, /tɅ/ and /kɅ/ syllables in Tables 3-5 are examined, it is seen that:
   a. Children with stuttering in the 7-9 age group are in the fastest production of single syllable repeats (t = 3.83).
   b. Children with stuttering in 7-9 age group moved the fastest tongue tip syllable production (as in production of /tɅ/; mean=), and followed this with back of tongue syllable production (as in production of /kɅ/; t=3.74).
   c. Children with stuttering in 7-9 age group the syllable included the lip movements with aspiration (as in /pɅ/) were the slowest-moving articulators (t=3.26).

Looking into the averages of /pɅ/, /tɅ/ and /kɅ/ syllables of non-stuttering children in the 7-9 age group in Tables 3-5:

   d. The fastest production is in /pɅ/ syllable production (t= 4.34).
   e. The following are the back of tongue syllable production(/kɅ/; t=4.22) and tongue tip syllable production (/tɅ/; t=4.10).
   f. The means of /pɅ/, /tɅ/ and /kɅ/ syllables are depicted in Tables 3-5;The children with stuttering in the 10-12 age group demonstrated the fastest rate in /kɅ/ syllable repeats (t=3.9).

   g. In the same group, the slowest production was /pɅ/ syllable production (t=2.09).
   h. The same age of non-stuttering group, the fastest production was /kɅ/ syllable production (t=4.40) and the slowest production was /pɅ/ syllable (t=3.69).

Diadookinetic measurement is suggested to be a sensitive measurement method in motor speech disorders, especially in disorders with neurological background [27]. It is a measurement that describes the coordination skills that occur during the performance of fast and successive oral movements. Because it does not have linguistic features, it can be used in many different countries. The evaluation of the motor performance of the muscle system used during speech in the clinical evaluation takes place through the calculation of the number of syllables produced in a single syllable /pɅ/ , /tɅ/ , /kɅ/ and multi syllable /pɅtɅ/ ,/pɅtɅkɅ/ sequences.

Even though the sample is very limited in this study, the data obtained are consistent with the knowledge that younger age children are behind the older children in their use of articulator...
due to neuromotor maturation, children with stuttering experience synchronization problems in transitions between articulators, and also, they have problems in motor programming.

In order to be able to use the diadochokinetic rate as a predictor of stuttering, it is necessary to measure the diadochokinetic rate of the stuttering and non-stuttering individuals and to determine the differences with a large number of subjects. Studies to investigate the diadochokinetic rate in stuttering individuals are addressed to different age groups and fewer in our country.

In our study, a significant difference ($p < .05$) was seen between the 7-9 and 10-12 age groups in /pa/ syllable. In other syllables, it is observed that the difference between age groups is in favor of 10-12 age group. Also, in our study, all age groups of children who stutter did diadochokinetic tasks slower than the mean rates established by Fletcher (1972) for normal speaking children.

The need for further research to examine all the features of DDK evaluation other than just the rate to provide a clinical measurement as diagnosis. The number of participants should be increased including all age groups with possible sex distribution. Recently, knowing that there are immigrants in the country, a possible multi-lingual children section also needs to be included to see if there is a difference in stuttering population. DDK rate can be taken several ways, if possible, a section can be given to see if data collection plays a role (for example, certain number in a given time period or how long it takes to produce 10 repetitions). Finally, knowing that there is a number of coexisting conditions (phonological processing disorder, articulation disorder, developmental apraxia) attached to stuttering [27-30]. A sampling of those into the research would be beneficial in decision making for management.

CONCLUSION

Findings showed that there were significant differences in the /pa/ and /ka/ syllables for the status of stuttering, and there was a significant difference for /pa/ syllable and a significant difference for the gender differences at /ka/ syllable. In general, when looking at the average, children who stutter have a slower diadochokinetic rate than the non-stuttering for all syllables and syllable sequences, and the average of girls is higher than the diadochokinetic rate than the non-stuttering for all syllables and when looking at the average, children who stutter have a slower difference for the gender differences at /ka/ syllable. In general, was a significant difference for /pɑtɑ/ syllable and a significant the /pɑ/ and /kɑ/ syllables for the status of stuttering, and there

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