Eletromiografia e diadococinesia - estudo com crianças fluentes e com gagueira****

Electromyography and diadochokinesia - a study with fluent and stuttering children

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Abstract

Background: electromyography and diadochokinesia. Aim: to analyze the oral movement rate in children with persistent developmental stuttering and in normally fluent children during the repetition of articulatory segments (diadochokinesia - DDK). Method: participants of the study were 50 children, with no distinction of gender and race, enrolled in public schools (primary and junior) of São Paulo city and Great São Paulo, whose families agreed, through informed consent, with the research procedures. The research group (GI) consisted of 19 children diagnosed as stutterers. The control group (GII) consisted of 31 fluent children. Results: the results of the study indicate that there were great similarities in performance in the DDK tasks for both groups. Standard deviation values were high for both groups. Conclusion: statistically significant differences were observed for the ability of sequential movement, i.e. when looking at ANOVA results the group of fluent children presented a better ability to move their articulators rapidly when producing sequential segments (pa/ta/ka).

Key Words: Stuttering; Electromyography; Diadochokinesia; Children; Speech Disorders.

Resumo

Tema: eletromiografia e diadococinesia. Objetivo: analisar a velocidade dos movimentos orais de crianças com gagueira desenvolvimental persistente e crianças fluentes durante a repetição de segmentos articulatórios (diadococinesia - DDK). Método: participaram do estudo 50 crianças sem distinção de raça e sexo, matriculados na rede pública de ensino de pré-escola e ciclo básico, residentes no município de São Paulo e Grande São Paulo, cujas famílias concordaram, através de assinatura do termo de consentimento, na realização dos procedimentos propostos para realização da pesquisa. O grupo de pesquisa (GI) foi composto por 19 crianças com diagnóstico de gagueira. O grupo controle (GII) foi composto por 31 crianças fluentes. Resultados: os resultados do estudo indicam que houve uma grande similaridade no desempenho das tarefas de DDK para ambos os grupos, com graus de desvio padrão elevados também para ambos os grupos. Conclusão: houve diferença estatisticamente significante para a capacidade de movimentação seqüencial, ou seja, no tratamento por ANOVA, o grupo de crianças fluentes apresenta maior habilidade para mover rapidamente a posição dos articuladores em segmentos seqüenciais(pa/ta/ka).

Palavras-Chave: Gagueira; Eletromiografia; Diadococinesia; Crianças; Desordens de Fala.

Introduction

Speech is a complex motor activity distinctive of human race. Speech motor control refers to the systems and strategies that respond for the smooth and coordinated processes of breathing, phonation and articulation. The production of syllables, particularly, involves the necessary rapid and precise control for the transition between the opening, closing and positioning in different configurations of the vocal tract. 1-7

Like any other complex motor activity, speech is subject to instabilities - i.e. speech disruptions - that can occur in the different levels of speech processing, having as possible causes congenital or acquired factors. Persistent developmental stuttering (PDS) is a speech disorder characterized by involuntary repetitions of sounds and syllables, sound prolongations and articulatory blocks. These speech disruptions are typical of stuttering and tend to occur at the beginning of emissions of connected speech, during spontaneous or self-expressive speech production. 8-13

Although the subjacent nucleus of PDS still remains unclear, there is a strong body of evidence suggesting that PDS is a hereditary disorder which manifestation is a dysfunction in central motor speech control. 14-20

In Freed's21 model, the neuromuscular processing can be investigated through evidence given by the behavior of muscles that contribute to normal speech production. If any of these traces are in some way compromised, the motor system will be negatively affected. The nature and the level to which these processes are compromised bring important information for the diagnosis due to the following reasons:

. muscle strength and tonus indicate the ability for contraction.
. movement rate indicates the ability to vary the position of the involved structures and their sequencing possibilities.
. movement amplitude indicates how the articulators are modified during the course of movement.
. movement precision and stability indicate the coordination between strength, rate, amplitude, direction and timing.

In a very solid study, Munhall22 considers that speech is the final product of a complex network of linguistic and cognitive processes. Thoughts and intentions are processed and transformed in movements and sounds, following a pertinent temporal and sequential order for each natural language. The speech motor system is not a passive channel for the transmition of a resultant linguistic signal (processed in former planning stages). On the contrary, this system transforms the linguistic signal in different ways. Starting at a central level, the processing of a non-linear mechanism begins. This process involves tissues and muscles; it determines the inertial strength of articulatory movements and involves the complex system responsible for muscle strength generation. The final product is speech. In order to accommodate this level of non-linearity, the central nervous system has the ability to adjust the internal models of the vocal tract and the acoustic sequence of articulation.

According to Munhall22, articulation involves information processing in such a way that the motor system responsible for the vocal tract during phonetic sequencing is monitored. The course of a great number of articulators should be programmed at a rapid sequence. Variables such as time, strength and control must be considered. The speaker modifies style and speech precision in real time, adjusting speech to the environment and social contexts according to conversational demand. Based on a phonetic-prosodic context, humor, intention, attention, as well the conceptual and emotional meaning of the message (supra-segmental information) are transmitted in parallel to verbal information (segmental information).

Finally, according to Andreatta et al23, speech is a sensorimotor process that involves active strength regulation between the motor system and the vocal tract. The ability of sequential motor command (necessary for the adequate positioning of the articulators during volitional phoneme production) depends also on the motor commands of precision and smoothness in articulatory transition during volitional speech production.

The purpose of the present research was to analyze oral movement rate in children with PDS and in normally fluent children through tasks of articulatory segments repetition (diadochokinesia - DDK). This study allowed the investigation of differences and similarities on the ability of children with PDS and normally fluent children to modify the structures involved in the sequencing of articulatory movements through tasks with no language content (DDK).

Method

This study received prior approval of the Ethics Committee of the Institution (CAPPesq HCFMUSP 266/05) and informed consent was obtained from all of the participants parents/guardians.

Participants

Participants of the study were 50 children, with no distinction of gender and race, enrolled in public schools (primary and junior), residents in the city of São Paulo and Great São Paulo. All parents agreed, by signing a consent form, to the procedures proposed for the research.

Participants of the study were divided in two groups:

The research group (GI) consisted of 19 children diagnosed with stuttering, with no other associated communicative, neurological or cognitive déficit. The stuttering diagnosis was based on the criteria adopted at the Speech-language Investigation Laboratory of Fluency, Facial Functions and Dysphagia (LIF-FFD), as follows:

. fluency profile scores outside reference values for age and gender24);
. 11 points or more on the Stuttering Severity Instrument - 3 (SSI- 3) 25 (severity equivalent to at least "mild").

The control group (GII) consisted of 31 children of both genders and with similar ages to the research group, with no complaints of stuttering and without any communicative deficits and neurological impairment according to information provided by parents. Inclusion criteria for participants of GII were:

. fluency profile scores within reference values for age and gender;
.10 points or less on the SSI-3 (severity equivalent to "very mild");
. no family history for recovered or persistent stuttering.

Material

Recordings of muscle response were captured using a four-channel surface electromyography with analogical/digital conversion and a specific program for data gathering and processing (Windows - EMG System do Brasil) installed in a high resolution computer. Electrodes were disposable Medtrace Mini Ag/AgCl (10mm diameter).

Procedures

Diadochokinesia data gathering - The repetition rate of articulatory segments was analyzed through tasks involving the abiltiy to alternate (AMR - alternating motion rates) and sequence (SMR - sequential motion rates) movements. AMR determines the speed and regularity of reciprocal jaw, lips and tongue movements. It also evaluates the articulatory accuracy and the respiratory and phonation support. SMR measures the ability to rapidly move the articulators from one position to the next in a pre-determined sequence21,26.

For the AMR, participants were asked to repeat, without interruption, the sequence "pa-pa-pa" as fast as possible and without losing articulatory precision as soon as they heard the chronometer beep. Three sequences of fifteen seconds were collected.

For the SMR, participants were asked to repeat, without interruption, the sequence "pa-ta-ka" as fast as possible without losing articulatory precision as soon as they heard the chronometer beep. Three sequences of fifteen seconds were collected.

Muscle activity was captured by disposable electrodes fixed on the middle portion of the inferior perioral region (inferior orbicularis oris), 2mm below the free margin of the lip16. A pair of electrodes was fixed to the skin using adhesive tape (transpore 3M) with a distance of approximately 10mm between each electrode. The purpose was to capture the action potentials of muscle bundles of the perioral region. Based on the electromyographic signal, data of muscle activation amplitude were analyzed using an effective signal value - root mean square (RMS) - in microvolts (?V), referring to the standard of rest and action of the main muscle bundles involved in speech production.27,28

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1. All of the children who were part of the research group received speech-language treatment at LIF-FFD after the research procedures were concluded.

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Results

Each sample was individually processed because it was necessary to indent each signal to select the activation area of major importance for activity. The signal from that cut was analyzed in order to obtain the RMS value. The obtained values represent the mean (RMS) electromyographic activity observed during the speech tasks. In order to compare the results between participants, EMG amplitude values for each participant were normalized to the highest recorded values (% of max value for each electrode arrangement). Statistical tests were performed using the normalized values.

Table 1 displays the descriptive comparative analysis between the groups. Both groups presented high standard deviation values. Table 2 displays the One-way ANOVA result. It is possible to observe statistically significant differences between the groups for the sequential motor activity

Table 3 displays the One-way ANOVA result for the comparison between AMR and SMR for both groups. Statistically significant differences were not observed between the groups.

TABLE 1. descriptive comparative analysis.

Group	Motor activity	n	Mean	Minimum	Maximum	Standard Deviation
GI	Sequential	19	50.81	5.31	161.46	39.10
	Alternating	19	68.47	5.20	159.37	40.74
GII	Sequential	31	73.19	5.20	140.16	33.52
	Alternating	31	78.62	13.65	144.98	27.65

TABLE 2. ANOVA.

One-way ANOVAs					
	Sum of Squares	Degrees of Freedom	Mean of Squares	F	p
Sequential Motion Rate	5903	1	5903	4.628	0.037*
Alternating Motion Rate	1212	1	1212	1.101	0.299

TABLE 3. ANOVA.

One-way ANOVAs					
Group	Sum of Squares	Degrees of Freedom	Mean of Squares	F	p
GI	2965	1	2965	1.86	0.181
GII	456.2	1	456.2	0.483	0.49

Discussion

The results of the study indicate that there were great similarities of performance between the groups for the DDK tasks; both groups presented high standard deviation values. These results are similar to those reported in international studies. However, it is important to highlight that although these studies are about DDK, the methodological approaches are very distinct 29,30,31.

The results of the study indicate a significant statistical difference for SMR, i.e the One-way ANOVA indicated that the group of fluent children presented a better ability to rapidly move their articulators. When comparing the AMR and SMR, the SMR task has a higher motor demand. This result is similar to those found for speech apraxia, involving findings in the left hemisphere and having as neuromotor basis deficits in planning or in motor programming 26.

Conclusion

The study presented is innovative in its proposal of having an objective assessment instrument. Most of the studies about DDK are of a perceptual or acoustic nature. In our study, DDK was analyzed based on the movement rate of a single structure - inferior lip. Although it is logic and almost inevitable that the increase of motor events per time unit indicates the performance in the motor task, it is necessary to highlight that we may have simply captured the amplitude variation of the movement and not the variation in movement rate. This aspect should be considered when generalizing the results.

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