Original Article

Artigo Original

Comparison between the speech performance of fluent speakers and individuals who stutter

Comparação da performance de fala em indivíduos gagos e fluentes

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Keywords

Language
Speech Disorders
Stuttering

ABSTRACT

Purpose: The aim of this study was to compare the speech performance of fluent speakers and individuals who stutter during spontaneous speech, automatic speech, and singing. **Methods**: The study sample was composed of 34 adults, 17 individuals who stutter and 17 fluent controls, matched for gender and age. The speech performance of participants was compared by means of three tasks: monologue, automatic speech, and singing. The following aspects were assessed: total number of common disruptions and total number of stuttering-like disruptions. **Results**: Statistically significant difference was observed only for the monologue task in both intra-and inter-group comparisons. **Conclusion**: The outcomes of this study indicate that tasks of higher motor and melodic complexities, such as the monologue task, negatively affect the speech fluency of both fluent speakers and individuals who stutter.

Descritores

Linguagem
Distúrbios da Fala
Gagueira

RESUMO

Objetivo: O objetivo do estudo foi comparar a *performance* de fala do indivíduo com gagueira e do indivíduo fluente em tarefa de fala espontânea, tarefa de fala automática e a tarefa de canto. **Método**: Participaram deste estudo 34 adultos, 17 com gagueira e 17 fluentes, pareados por gênero e idade. O estudo comparou o desempenho dos participantes em três tarefas de fala: monólogo, fala automática e canto. Foi analisado o número total de rupturas comuns e gagas. **Resultados**: A tarefa de monólogo foi a única que apresentou diferenças estatisticamente significativas, tanto nas comparações intragrupos quanto nas comparações intergrupos. **Conclusão**: O estudo mostrou que tarefas de maior complexidade motora e melódica, como a tarefa de monólogo, prejudica a fluência da fala, tanto em indivíduos com gagueira quanto em indivíduos fluentes.

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Received: July 13, 2016

Accepted: October 29, 2016

Study carried out at Laboratório de Investigação Fonoaudiológica em Fluência, Funções da Face e Disfagia, Departamento de Fisioterapia, Fonoaudiologia e Terapia Ocupacional, Faculdade de Medicina, Universidade de São Paulo – USP - São Paulo (SP), Brazil.

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Financial support: Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP), process number 2014/09404-0.

Conflict of interests: nothing to declare.

INTRODUCTION

Developmental stuttering is characterized by the occurrence of involuntary interruptions in speech motion behaviors, such as block, repetitions of sounds and syllables, prolongations, long pauses, and broken words. These alterations slow the speech rate and cause a degree of disruption above the rate pertinent to the age of the speaker[1]. A recent study concluded, based on epidemiological analyses, that the incidence of stuttering may be greater than 5%, whereas its prevalence may be less than 1%[2]. However, it is not yet known which mechanisms trigger speech disruptions in people who stutter[3-5].

The Internal Model for Sensorimotor Control proposed by Max[6] suggests that, for accurate control of all the information involved during speech production (motor, auditory, and somatosensory), the central nervous system maintains internal representations of the motor sequences used. These representations, or internal models, are the basis for speech motor control.

The internal representations are utilized in speech motor control by two processes - the forward process and the inverse process. The forward process predicts likely sensory consequences of a motor command being generated for speech, whereas the inverse process uses these predictions of sensory consequences of central commands and plans what is needed to achieve them. If the likely sensorimotor command differs from the intended command, the internal models are updated for future attempts.

According to this model, stuttering develops in childhood owing to a problem in the acquisition and/or refinement of these internal representations, that is, internal models. Therefore, the incompatibility between the motor commands generated and the inaccurate internal models leads to repetitive attempts to reconfigure the motor planning, generating interruptions in speech performance. The difficulty in learning, consolidating and in the update between the motor command and the consequence of movement would be one the possible causes for involuntary speech disruptions, with no capacity of automatic recovery, characterized by this disorder[6].

Speech fluency improvement can occur from the implementation of changes in the motor patterns of speech production. These changes are achieved through motor learning, whose benefit is associated with the amount of practice. This effect becomes evident during the so-called "adaptation", i.e., improvement in fluency as a result of repetition of the same sequence of speech. The same sequence of articulatory and phonatory movements enables the prediction of more refined sensory consequences of that movement or sequence of movements and, therefore, a more efficient selection of the necessary motor commands[7].

The melodic function is another mechanism that allows speech fluency improvement based on decreased speech motor control dependence on the internal model. Prosody is a resource of human expression that aims to provide more efficient and appropriate communication from the transmission of paralinguistic information such as tone, intonation, stress, and length[8,9]. When a predetermined melody or speech rhythm is used, clues of length, frequency, and intensity are available and used by the speech motor control system, facilitating fluency.

Little research has been conducted on the difference in motor control between speech tasks so far. It is known that there is a difference in the manifestations of stuttering observed during speech tasks, but there are no definitive studies on the theme. Furthermore, knowledge about the correlation between different speech tasks and their effects on the speech performance of individuals who stutter and fluent speakers is still limited.

The objective of the present study was to compare the speech performance of fluent speakers and individuals who stutter during the tasks of spontaneous speech, automatic speech, and singing. The hypothesis of this study was that tasks of higher motor and melodic complexities negatively affect the speech fluency of both fluent speakers and individuals who stutter.

METHODS

Participants

The study project was approved by the Research Ethics Committee of the "Faculdade de Medicina da Universidade de São Paulo" – FMUSP under protocol no. 265/14. All participants signed an Informed Consent Form (ICF) prior to study commencement.

The study sample was composed of 17 adult individuals (14 males; 3 females) with developmental stuttering, aged 19 to 47 years (mean=31.02; SD=8.90), and 17 adult fluent speakers matched for age and gender to the participants with developmental stuttering.

All selected participants were native speakers of Brazilian Portuguese, high-school graduates, without any other oral communication disorders[10], hearing loss of any degree, and neurological and/or degenerative diseases.

Inclusion criteria for the Study Group (SG) (adults with developmental stuttering) were as follows: Fluency Profile Assessment Protocol - FPAP scores[11] outside the age reference values[11] and score ≥25 points in the Stuttering Severity Instrument – Third Edition (SSI-3)[12], characterizing stuttering of minimal moderate degree. Exclusion criteria for the Control Group (CG) (adult fluent speakers) comprised Fluency Profile Assessment Protocol - FPAP scores[11] within the age reference values[12] and score <10 points in the SSI-3[12].

For confirmation of the inclusion criteria, the participants were submitted to basic audiological evaluation, anamnesis, and speech fluency assessment (Fluency Profile Assessment Protocol - FPAP[11] and SSI-3 tests[12]).

Procedure

The same methodology was used for the collection and analysis of speech samples in both groups. Speech sample collection was conducted with individuals seated in front of a digital camcorder (Sony DRC-SR62) attached to a tripod (Targus TG5060TR).

Spontaneous speech task

In the monologue task, speech samples were obtained from a stimulus figure according to the methodology proposed in the Fluency Profile Assessment Protocol - FPAP[11]. Participants were asked to speak freely about the presented figure and could expand their considerations according to their interest.

Automatic speech task

As for the automatic speech, participants were requested to say out loud the days of the week, months, and count from one to 10.

Singing task

In the collection of the singing samples, participants were asked to sing the song “Happy Birthday”.

Analysis of speech samples

Transcription and analysis of the speech samples were conducted by an experienced speech-language therapist with expertise in the field based on the visualization made available in a portable computer (Sony Vaio VPC-AS) using headphones (Maxwell HP200F). The transcription was performed according to the standardized methodology described in the Fluency Profile Assessment Protocol - FPAP[11].

All samples were transcribed literally and the episodes of speech disruption were marked. Subsequently, these episodes were classified according to their typology: common disruptions (hesitations, interjections, revisions, unfinished words, repetitions of words) and stuttering-like disruptions (repetitions of syllables and sounds, stretching of sounds, locking, pauses, and intrusions of non-relevant sounds or segments).

Statistical analysis

The study data were collected and submitted to statistical analysis using the SPSS 21 software. Nonparametric tests were used because the distribution of data was not normal for all variables. In addition to descriptive analysis, nonparametric inferential analysis was performed using Friedman’s ANOVA and the Dunn test to compare the tasks in each studied variable (intragroup analysis) and the Mann-Whitney test for comparison between groups (intergroup analysis). A level of significance of 5% was adopted for all statistical analyses.

RESULTS

Intragroup comparison - Study Group

Table 1 shows that both the number of common disruptions and the number of stuttering-like disruptions differed significantly between the speech tasks in the Study Group (SG).

A more comprehensive comparison, presented in Table 2, shows that the monologue task differed significantly from the tasks of automatic speech and singing; however, no statistically significant difference was observed between the tasks of automatic speech and singing.

Intragroup comparison - Control Group

Table 3 shows that the number of disruptions differed significantly between the speech tasks in the Control Group (CG).

A comparison based on the Dunn test, presented in Table 4, shows that the number of common disruptions in the monologue task differed significantly from the tasks of automatic speech and singing; however, no statistically significant difference was observed between the tasks of automatic speech and singing. Table 3 shows that there were no stuttering-like disruptions in none of the speech tasks in the CG.

Intergroup comparison

The number of common and stuttering-like disfluencies was higher for all speech tasks assessed in the SG, as shown in Table 5. Monologue was the speech task that presented the greatest difference between the groups. The tasks of automatic speech and singing presented similar results in both groups.

Table 1. Comparison of the total number of common and stuttering-like speech disruptions between the different tasks applied to the Study Group

Typology of speech disruptions	Task	Mean	Standard deviation	Maximum	Minimum	$X^{(2)}$	gl	p
Common disruptions	Monologue	19.52	9.15	39	8	67.808	5	<0.001*
	Automatic speech	0.70	1.53	5	0			
	Singing	0.29	0.58	2	0			
Stuttering-like disruptions	Monologue	33.52	16.15	66	16	65.606	5	<0.001*
	Automatic speech	3.52	4.55	17	0			
	Singing	1.05	1.67	5	0			

*Statistical significance (p<0.05) - Friedman’s ANOVA

Table 2. Paired comparison between the tasks applied to the Study Group for the variables total number of common and stuttering-like speech disruptions

Typology of speech disruptions		Monologue	Automatic speech
Common disruptions	Automatic speech	<0.001*	-
	Singing	<0.001*	1.000
Stuttering-like disruptions	Automatic speech	0.001*	-
	Singing	<0.001*	1.000

*Statistical significance (p<0.05) – Dunn test

Table 3. Comparison of the total number of common and stuttering-like speech disruptions between the different tasks applied to the Control Group

Typology of speech disruptions	Task	Mean	Standard deviation	Maximum	Minimum	$X^{(2)}$	gl	p
Common disruptions	Monologue	6.82	4.17	19	2	77.106	5	<0.001*
	Automatic speech	0.00	0.00	0	0			
	Singing	0.00	0.00	0	0			
Stuttering-like disruptions	Monologue	0.00	0.00	0	0	0.00	0	0.00
	Automatic speech	0.00	0.00	0	0			
	Singing	0.00	0.00	0	0			

*Statistical significance (p<0.05) - Friedman's ANOVA

Table 4. Paired comparison of the tasks applied to the Control Group for the variables total number of common and stuttering-like speech disruptions

Typology of speech disruptions	Task	Monolgue	Automatic speech
Common disruptions	Automatic speech	<0.001*	-
	Singing	<0.001*	1.000
Stuttering-like disruptions	Automatic speech	1.000	-
	Singing	1.000	1.000

*Statistical significance (p<0.05) – Dunn test

Table 5. Comparison between the Study (SG) and Control (CG) Groups for the variables total number of common and stuttering-like speech disruptions

		Common disfluency				Stuttering-like disfluency			
		Mean (SD)	U	Z	p	Mean (SD)	U	Z	p
Monologue	SG	19.52 (9.15)	20.5	-4.279	<0.001*	33.52 (16.15)	0.0	-5.321	<0.001*
	CG	6.82 (4.17)				0.00 (0.00)			
Automatic speech	SG	0.70 (1.53)	102.0	-2.376	<0.001*	3.52 (4.55)	25.5	-4.602	<0.001*
	CG	0.00 (0.00)				0.00 (0.00)			
Singing	SG	0.29 (0.58)	102.0	-2.378	0.001*	1.05 (1.67)	76.5	-3.152	0.001*
	CG	0.00 (0.00)				0.00 (0.00)			

*Statistical significance (p<0.05) - Mann-Whitney test

DISCUSSION

This study compared the speech performance of fluent speakers and individuals who stutter in three speech tasks: monologue, automatic speech, and singing. The hypothesis that tasks of higher motor and melodic complexities would negatively affect the speech fluency of both fluent speakers and individuals who stutter was confirmed.

Difference was observed between the tasks of singing and automatic speech compared with the monologue task; however, no difference was found between the first two tasks in both groups. In speech tasks without self-expressive components, i.e., automatic speech and singing, the content is pre-defined and the speech rhythm is melodically marked, leading to greater speech fluency[13,14].

In the specific literature, there is consensus that the frequency of stuttering is variable but predictable in different speech tasks[13,14]. Adaptation is among the aspects of predictability. According to the Internal Model for Sensorimotor Control[5], repetition of the same speech sequence would update and refine the existing internal model, thus facilitating fluency. Neurophysiological studies on developmental stuttering indicate that the occurrence of a simultaneous fluent model, or of a reduction in the linguistic and motor demand for speech, favor the efficient timing of speech programs. This allows the brain to organize the motor and language functions in individuals who stutter, providing comfortable speaking fluency[15].

The adaptation effect may therefore reflect motor learning associated with the repeated practice of speech motor sequences[15]. A study has tested this hypothesis with a paradigm that used two approaches to identify the role of motor learning in the effect of adaptation on stuttering. The study distinguished the practice effects from the situational effects. To this end, the utilized texts contained repeated sentences and new sentences. To differentiate the learning effects from the temporary performance effects, the stuttering frequency was determined for the initial reading after two and 24 hours. Individuals who were able to adapt presented decreased frequency of stuttering-like disruptions in both repeated and new sentences. Nevertheless, the decrease in the rate of stuttering-like disruptions was greater for repeated sentences. The rate of stuttering-like disruptions was again similar for both types of sentences after 2 hours. After 24 hours, no improvement was observed regarding the new sentences, whereas retention of the repeated sentences was detected. The results revealed the presence of the motor learning effect for previously non-experienced sequences of movements[7].

Singing is another aspect of predictability. The deficit in speech performance would be the result of the mismatch between the predicted sensory consequences and the generated sensory consequences, leading the system to perform repeated attempts to finalize the planned movement or to restart the process. The literature suggests that rhythm provides an external clue of the timing of each syllable[6].

Another factor that contributes for singing to favor speech fluency is the fact that during singing there is a decrease in the articulatory velocity, with increased phonation interval[16]. Decreasing the phonation interval has been one of the great indicators for improving speech fluency in individuals who stutter[17].

Regarding the intergroup comparison, the only statistically significant difference found was related to the monologue task. This outcome was expected considering that this is the task that distinguishes fluent speakers from individuals who stutter. This difference occurs because individuals who stutter present deficits in processing and/or in sensorimotor and learning integration, which leads to difficulties in the temporal control of movement[6,18,19]. The tasks of automatic speech and singing approximated the two groups and presented similar results (there was no statistically significant difference between the groups), which is also in compliance with the literature[2,6].

CONCLUSION

The outcomes of this study indicate that tasks of higher motor and melodic complexities, such as the monologue task, negatively affect the speech fluency of both fluent speakers and individuals who stutter. Further studies on the speech variability of fluent speakers and individuals who stutter should be conducted in order to find clues relevant to a better understanding of stuttering and its possible causes.

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Author contributions

JBC was responsible for the interpretation of data and writing and final revision of the manuscript; APR collaborated with the collection, classification and analysis of data; FSJ was in charge of the analysis of data and collaborated with the final revision of the manuscript; CRFA was the study adviser and was responsible for the study design and writing of the manuscript.