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ORIGINAL ARTICLE

Reaction of the cardiovascular system during anticipation of speech and while speaking in stutterers and non-stutterers

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Abstract: The essence of stuttering lies in its changeability, disfluency of speech appears and disappears in some communication situations, sometimes forever. Most often the cause of stuttering is said to be located in the central nervous system, but this does not mean that another hypothesis claiming that it is located in the autonomic nervous system is wrong. A theory of stuttering which does not explain this phenomenon is not particularly helpful. The difference of stutterers' cardiovascular system activity is the only one noticed so far by the authors, but the structure of c.v.s. function changes is not clear. The goal of our study was to asses c.v.s. activity during speaking in detail. 13 stuttering and 17 non-stuttering volunteers underwent 3 different 5-minute verbal tests, preceded by a 10-minute resting period with continuous heart rate and blood pressure monitoring. No substantial variations in the cycle of changes in the activity of the cardiovascular system was noticed during the anticipation of speech and while speaking in stutterers and non-stutterers. A slightly steeper shape of the parametric curve in stutterers may suggest that they are less immune to communication stress, and that only their autonomic nervous systems are more labil. The cardiovascular system activity first decreases, increases directly before speech, and slows down during speaking; the reactions did not depend significantly on fluent or disfluent speaking. Our study sample did not prove the autonomic stuttering theory, but suggests that other experimental trials should be conducted to differentiate the reasons of c.v.s. lability.

Key words: stutterers and non-stutterers, anticipation of speech , heart rate, blood pressure

INTRODUCTION

The essence of stuttering lies in its changeability [1, 2]. Disfluency of speech appears and disappears, sometimes forever. It occurs in some communication situations but not in others. A theory of stuttering which does not explain this phenomenon is not particularly helpful. The changeability of speech disfluency suggests that this disfunction is not permanent. Most often it is said to be located in the central nervous system, but this does not mean that another hypothesis claiming that it is located in the autonomic nervous system is wrong. The connection between stuttering and the functioning of heart and blood flow may be more significant than that between stuttering and the direct functioning of brain.

Peters and Hulstijn [3] did not notice any significant differences in physiological reactions among stutterers and non-stutterers, except for the differences in the activity of the cardiovascular system. During anticipation of speech the heart rate of stutterers was 4.7bpm lower than that of non-stutterers. Similar results were registered by Weber and Smith [4]. During the anticipation of speech the heart rate was 2.5% lower in stutterers than in non-stutterers, whereas while speaking the heart rate increased by 5.7% in the first group. and by 10.4% in the other group. Caruso et al. [5] showed that the heart beats significantly slower in stutterers than in non-stutterers, and that the difference between them increases together with the rise in intensity of stress. The heart rate was 7.6bpm lower in low–stress situations, 12.9bpm lower in medium–stress situations, and 20.5bpm lower in high–stress situations. Alm [6] (2004), while summarizing the results of research, did not point to any connection between stuttering and the activity of the sympathetic nervous system. The author only found a paradoxical slowdown in the heart rate of stutterers during anticipation of speech, which suggest that there is a connection between stuttering and the activity of the parasympathetic part of the nervous system.

In up-to-date studies, physiological reaction differences between stutterers and non-stutterers have not been specified in detail. The type of stress reaction especially associated with speaking causes c.v.s. reaction, but it's specific course remains unknown.

AIMS

The suggested connection between stuttering and the activity of the cardiovascular system is interesting, but not thoroughly understood. For this reason our primary research deals with the following questions:

- What is the character of changes in the functioning of the cardiovascular system in stutterers and non-stutterers during anticipation of speech and while speaking?
- Do changes in the functioning of the cardiovascular system depend on the type of utterances, their order, and on the duration of the test?

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RESEARCH GROUPS AND METHOD

13 stuttering volunteers (5 women and 8 men) who had previously participated in therapy because of their disorder, took part in the research. Average age of the examined people was 29 ± 7, and there was no statistically significant age difference between sexes (p=0,746036). The control group consisted of 17 volunteers chosen according to age (27 ± 8 years old) and sex (3 women, 14 men) as a counterpart to the research group.

The examined people underwent 3 verbal tests:
1) continual reading of a standard text;
2) describing a freely chosen nude woman nude;
3) a steered conversation.

The order of the tests was selected randomly. Each 5-minute test was preceded by a 10-minute period of resting while waiting for an utterance. In aggregate, the tests lasted 45 minutes while the respondents were in a horizontal position. The activity of the circulatory system was assessed by means of heart rate measurement using 3-channel holter ECG monitoring, and blood pressure measurement using 24-hour blood pressure monitoring by the oscilometric method. Heart rate reading, taken on average at one minute intervals, was taken from the electrocardiograph. Blood pressure was measured every minute during speaking and every 2-3 minutes during silence. The respondents were informed beforehand about the aim and progress of the verbal tests. They could observe the clock, and were conscious of the impending moment of speaking.

Statistical importance of the observed changes in the parameters of the cardiovascular system in time, and of the comparison of the groups was measured by means of analysis of variance test (ANOVA); detailed comparisons were measured using the *post hoc* comparison LSD test (the lowest significant difference).

Table 1 Stutterers' test – trend of cardiocascular system paremeters.

Minutes of test		Diastolic blood pressure (mmHg)		Systolic blood pressure (mmHg)		Heart rate (bpm)	
		X	SD	X	SD	X	SD
Anticipation of speech	1	130	15	78	10	80	13
	2	130	15	78	10	78	13
	3	128	15	76	9	78	13
	4	127	15	76	9	77	13
	5	126	15	75	10	76	13
	6	126	15	75	10	76	13
	7	126	15	74	10	76	13
	8	127	15	76	11	76	13
	9	129	15	77	11	78	13
	10	131	15	80	12	83	13
Speaking	11	134	14	82	12	83	14
	12	135	14	82	11	84	13
	13	134	15	82	10	83	13
	14	135	17	81	10	83	13
	15	133	18	79	11	81	11
Total		130	15	78	11	80	13

Table 2 Non-stutterers' test – trend of cardiocascular system paremeters.

Minutes of test		Diastolic blood pressure (mmHg)		Systolic blood pressure (mmHg)		Heart rate (bpm)	
		X	SD	X	SD	X	SD
Anticipation of speech	1	140	15	81	10	74	15
	2	140	15	80	10	74	15
	3	138	15	79	10	74	15
	4	138	16	79	10	72	14
	5	136	15	79	10	72	14
	6	137	15	79	11	71	13
	7	135	15	78	11	71	14
	8	134	15	78	11	71	14
	9	136	15	80	11	73	14
	10	139	15	84	11	79	15
Speaking	11	141	15	86	11	77	14
	12	141	15	84	11	76	14
	13	140	16	84	11	75	13
	14	141	15	83	12	75	12
	15	140	14	82	11	75	14
Total		138	15	81	11	74	14

RESULTS

Systolic pressure readings taken during the test gave the following average values: 130±15mmHg in stutterers and 138±15mmHg in non-stutterers. In both groups of respondents there occurred substantial variations in systolic and diastolic pressure levels, as well as in heart rate (Table 1, 2).

In the period of silent anticipation for speech, the registered parameters fell until the 7th or 8th minute. There was then a slight rise, with a considerable jump in the values between the 9th and 10th minutes when the respondents started speaking, reaching their maximum level in the 1st to the 2nd minute of speaking (11th - 12th minute of the whole test). After this apogee, the values fell again, gradually returning to their primary levels.

In stutterers, the increase in pulse and pressure values during speaking in proportion to the values during the anticipation of speech was statistically significant (p=0.017876 and p=000491 for systolic and diastolic pressure, and p=0.016709 for heart rate). The statistically significant difference was still observed during the 4th minute of speaking (e.g. p=0.020135 for systolic pressure, 8th vs. 14th minute of the test). In the control group, in spite of the similar profile of the changes, the amplitude was slightly smaller and the change was significant only with regard to diastolic pressure (p=0.0001020).

The average difference between the lowest value during silence and the highest value while speaking in stutterers was: 9mmHg for systolic pressure, 8mmHg for diastolic pressure and 8bpm for heart rate. In the control group, this amplitude was 7mmHg, 7mmHg and 7bpm, respectively.

Both in stutterers and non-stutterers there occurred a statistically important decrease in blood pressure and heart rate values during the whole 45-minute test; in the control group p=0.011501 for systolic pressure, p=0.004379 for diastolic pressure, p=0.000002 for heart rate, and p=0,785840, p=0,16723 and p=0,000002, respectively, during the test). The decrease could be easily noticed especially in the case of heart rate, where the average value during the last 15 minutes, in proportion to the first 15 minutes, fell by 6bpm in the research group and 7bpm in the control group.

The order of the tests did not have any influence on the parameters of the cardiovascular system (Table 3). In stutterers, the average values for systolic pressure were: 131±15mmHg for test 1, 130±16mmHg for test 2, and 129±16mmHg for test 3. Average diastolic pressure values were as follows: 80±11mmHg

Table 3 Average cardiovascular system parameters and speech test sequence.

Stutterers	Diastolic blood pressure (mmHg)		Systoli blood pressure (mmHg)		Heart rate (bpm)	
	X	SD	X	SD	X	SD
First test	131	15	80	11	83	15
Second test	130	16	77	10	79	12
Third test	129	16	77	10	77	12
All tests	130	15	78	11	80	13
Non-stutterers	Diastolic blood pressure (mmHg)		Systolic blood pressure (mmHg)		Heart rate (bpm)	
	X	SD	X	SD	X	SD
First test	141	16	83	11	78	14
Second test	137	14	80	11	73	14
Third test	138	15	80	11	71	13
All tests	138	15	81	11	74	14

for test 1, 77±mmHg for test 2, and 77±10 for test 3. Average heart rate values were as follows: 83±5bpm for test 1, 79±12bpm for test 2, and 77±10bpm for test 3. The results recorded for the control group were similar. Average systolic pressure values were: 141±16mmHg for test 1, 137±14mmHg for test 2, and 138±15 for test 3. Diastolic pressure reached the following average values: 83±11mmHg for test 1, 80±11mmHg for test 2, and 80±11mmHg for test 3. Heart rate average values were as follows: 78±14bpm for test 1, 73±14bpm for test 2, and 71±13bpm for test 3.

Similarly, the character of the verbal tests did not have particular influence on the parameters of heart functioning (Table 4). In stutterers, the average values of systolic pressure were as follows: 130±15mmHg while reading, 130±14mmHg while describing, and 131±16mmHg during the conversation; diastolic pressure: 77±10mmHg while reading, 79±11 while describing, and 78±11 during the conversation; heart rate parameters were: 80±13bpm, 80±13bpm and 79±13bpm. In the control group, the average values of systolic pressure were: 138±16mmHg while reading, 139±14mmHg while describing, and 139±16 during the conversation. Diastolic pressure values for the tests were 80±11mmHg, 81±11mmHg and 82±12mmHg, and heart rate values were 73±13bpm, 74±13bpm and 75±16bpm.

Table 4 Average cardiovascular system parameters and type of speech test.

Stutterers	Diastolic blood pressure (mmHg)		Systolic blood pressure (mmHg)		Heart rate (bpm)	
	X	SD	X	SD	X	SD
Reading	130	15	77	10	80	13
Speaking	131	16	78	11	79	13
Describing	130	14	79	11	80	13
All tests	130	15	78	11	80	13
Non stutterers	Diastolic blood pressure (mmHg)		Systolic blood pressure (mmHg)		Heart rate (bpm)	
	SD	X	SD	X	SD	SD
Reading	138	16	80	11	73	13
Speaking	139	16	82	12	75	16
Describing	139	14	81	11	74	13
All tests	138	15	81	11	74	14

DISCUSSION

The heart is perceived as the place where emotions directly connected with readiness to act are located [7]. Active dealing with stress leads to an increase in the activity of the cardiovascular system, caused by an increase in the activity of the autonomic system. Tonic changes in this system are slow and prolonged, whereas phasic changes are quick and temporary. Tonic changes are characterized by a slow increase in heart rate and an equally slow return to primary values, but the amplitude is often substantial. Phasic changes are characterized by temporary decrease in heart contractions which is not present in tonic changes. Tonic changes usually result from the functioning of the sympathetic nervous system, whereas phasic changes result from the functioning of the parasympathetic nervous system.

Indicators of the activity of the cardiovascular system – systolic pressure, diastolic pressure and heart rate – registered in our research are within the widely-understood norms. These indicators are slightly higher in non-stutterers than in stutterers, but this may result from the mode of choice of the tests and of the control group.

The character of the verbal test (reading, describing and conversation), as well as the order of the tests, did not have a particular influence on the values of the parameters of the cardiovascular system. What is interesting is that there occurred a substantial decrease in the values of blood pressure and heart rate during the whole 45-minute period of the test. Thus, it seems that prolonged speaking combined with breaks for silence and relaxation stabilizes the functioning of the cardiovascular system. Admittedly, looking for interchangeable emotional counterparts to physiological changes is still problematic [7], but it may be presumed that the stabilization mentioned results from the gradual releasing of negative emotions: logophobia in stutterers and stage fright in non-stutterers. Interestingly, the conclusion is that it is the duration of speech and not the type of utterance that may be vitally important for therapeutic purposes.

The results of our research are not fully in accordance with the results of previous researches [3, 4], which suggests the occurrence of the paradoxical effect – a slowdown in heart rate during anticipation of speech. Such a slowdown was observed during the first 7 minutes of silence, but the heart rate started to accelerate and blood pressure began to rise a minute or two before speaking. These parameters reached their apogee in the 1st – 2nd minute of speaking, and then gradually decreased. What can be observed here, therefore, is a certain cyclicity of changes. The phase of anticipation of speech can be divided into 2 stages. In the first stage, blood pressure and heart rate decrease slowly, caused predominantly by a decrease in the symphatetic system activity with the constant tonus of the parasympathetic system. The decrease in the values of these parameters is sustained by the horizontal position of the respondents during the test, which allows relaxation. The second stage begins when the state of ease is disturbed by "communication stress", which is triggered off by observation of the clock showing the time left to the speaking moment, or by thinking about this moment. Concentrating on these stimuli causes a rise in heart rate and blood pressure at the physiological level, and an increase in emotional tension at the psychological level [4]. In the light of our results, this reaction is gradual and at first is not only in accordance with the decrease in the parasymphatetic system tonus (phasic

change), but also with the activation of the sympathetic nervous system, with a somewhat delayed effect – tonic change). The reaction reaches its apogee at the beginning of speaking. After this critical stage, there occurs the process of restoring the disturbed balance. This results from the decrease in the symphatetic system tonus and from the stable activity of the parasymphatetic system, which reduces heart rate during speaking. It can therefore be stated that speaking is relaxing, regardless of whether it is fluent or disfluent.

CONCLUSIONS

Our research did not show any substantial variations in the cycle of changes in the activity of the cardiovascular system during anticipation of speech and while speaking in stutterers and non-stutterers. A slightly steeper shape of the parametric curve in stutterers may suggest that they are less immune to communication stress, and that their autonomic nervous systems are more labil. Our conclusions are:

- Cardiovascular system activity first decreases, but increases directly before speech and slows down during speaking.
- The reactions did not depend significantly on fluent or disfluent speaking.

REFERENCES

1. Tarkowski Z: Jąkanie (Stuttering). *Wydawnictwo Naukowe PWN,* Warsaw 2002.
2. Tarkowski Z: Psychofizjologia jąkania. Dlaczego jąkający się nie mówią płynnie (Psychophysiology of stuttering. Why stutterers do not speak fluently). *Wydawnictwo Fundacji „Orator"*, Lublin 2007.
3. Peters HF, Hulstijn W: Stuttering and anxiety: The difference between stutterers and non-stutterers in verbal apprehension and physiologic arousal during the anticipation of speech and non-speech tasks. *J Fluency Disord* 1984, **9**, 67-84.
4. Weber CM, Smith A: Automatic correlates of stuttering and speech assessed in a range of experimental tasks. *J Speech Hear Res* 1990, **33**, 690-706.
5. CarusoA J, Chodźko-Zajko WJ, Bidinger DA, Sommers RK: Adults who stutter : Responses to cognitive stress. *J Speech Hear Res* 1994, **37**, 746-754.
6. Alm PA: Stuttering, emotions, and heart rate during anticipatory anxiety: a critical review. *J Fluency Disord* 2004, **29**,123-133.
7. Sosnowski T, Zimmer K: Metody psychofizjologiczne w badaniach psychologicznych (Pschychophysiological methods in psycho-physiological research). *Wydawnictwo Naukowe PWN,* Warsaw 1993.