

CHANGES IN THE STATE OF MEDICAL STUDENTS DURING PARTICIPATION IN A PERCEPTUAL EXPERIMENT

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Abstract

The goal of this work was to study the changes in the psychological, psychophysiological, and physiological state of the subjects - medical students of junior and senior courses before and after participating in a perceptual experiment. We have developed a comprehensive methodological approach that allows us to evaluate the interaction of medical students with children with atypical development (AD). The approach includes an assessment of the psychophysiological and psychological state of the study participants, conducting a perceptual study, recording and analyzing the mimic expression and speech of the subjects. During the perceptual experiment, students are presented with test sequences containing speech signals of children with typical development (TD) and AD (Down syndrome; autism spectrum disorders) and a video test containing behavioral patterns of AD children. During the perceptual experiment, a parallel video recording of the behavior of the auditors is carried out, which makes it possible to verify their answers using the specialized software FaceReader, which determines the true emotional state of a person by his facial expression. After the perceptual experiment, the auditors answer questions regarding their relationship to the listened speech signals. The psychoemotional status of students is determined before and after the experiment using a battery of psychological tests. The change in the state of the subjects was determined by instrumental spectrographic analysis of their speech recorded before and after participating in the experiment. The speech material was analyzed using the Cool Edit Pro audio editor. The study participants were 40 students of the St. Petersburg State Pediatric Medical University - adult native speakers of the Russian language. The subjects were divided into 2 groups. The first group consisted of students of the first and second courses; the second group - students of the fifth and sixth courses. In the course of the work, original data were obtained on the acoustic characteristics of speech, reflecting the state of medical students before and after participating in a perceptual experiment aimed at recognizing the type of child development. According to the results of psychological testing, it was found that the students of the second group experienced less emotional tension before the start of the study, compared with the subjects of the first group. Relationships between the psychological parameters of the subjects and the success of the tasks of the perceptual experiment were determined.

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Keywords: *Speech, atypical development, typical development, perceptual experiment.*

1. Introduction

The method of perceptual experiment is widely used in the study of various aspects of the speech of children with typical and atypical development (e.g., Lyakso, et al., 2020; Grigorev, Frolova, Lyakso, 2018). Based on the material in different languages, the ability to recognize the state of the speaker by the characteristics of his voice is shown (e.g., Paulmann, Uskul, 2014; Chronaki et al., 2018). It is known that the definition of emotions in speech is influenced by the duration and values of the pitch of the speech signal. Based on the material of the English, it has been established that emotional speech can be characterized by a change in the rate of speech, compared with speech in a calm state (Abelin, Allwood, 2000).

Nowadays in Russia, there are insufficient systematized data on the degree of preparedness of medical students and graduates to interact with children with atypical development (AD). The goal of this work was to study the changes in the psychological, psychophysiological, and physiological state of the medical students of junior and senior courses before and after participating in a perceptual experiment.

2. Materials and methods

The study participants were 40 students of the St. Petersburg State Pediatric Medical University - adult native Russian speakers. The students were divided into 2 groups. The first group consisted of students of the first and second courses ($n=20$, average age - 19.4 ± 1.3 years, 7 men and 13 women, without experience of interacting with children - 2, with household experience - 15, with professional experience - 3); the second group - students of the fifth and sixth years of medical and pediatric faculties ($n=20$, average age - 23.9 ± 3.5 , 2 men and 18 women, with household experience - 8, with professional experience - 12). Household experience means the presence of their own children, the presence of younger brothers or sisters in the family, children in the families of friends or relatives with whom the subjects interact regularly, professional experience means the experience of working as a nurse in children's medical institutions, long-term volunteering.

To assess the current physiological and psychophysiological state before the perceptual experiment, the informants tested: determination of heart rate (HR) and blood oxygen saturation using a pulse oximeter (ChoiceMMed MD300 C22); psychological testing - the Spielberger test for identifying personal and situational anxiety; WAM test (well-being, activity, mood, Doskin et al, 1973); Sheehan Patient-Rated Anxiety Scale (SPRAS); Zung Self-Rating Depression Scale (SDS); Luscher's 8-color test (reflection of the subject's focus on a certain activity, mood, functional state and the most stable personality traits). The SPRAS, SDS, and the Spielberger Personality Anxiety Test were performed to assess the condition of the subjects prior to the start of the study in order to identify links between depression and anxiety scores and the success of performing tasks in the perceptual experiment. These tests have been repeatedly used to identify the level of anxiety and depression in medical students (for example, Molchanova et al., 2020; Tolmachev et al., 2020). Situational anxiety, according to Spielberger, the WAM test and the Luscher's 8 - color test was carried out to control the current psychological state of the subject.

Before the perceptual experiment, the subjects in the form of a dialogue with the experimenter were asked to answer a series of questions that would allow them to establish their attitude towards children with typical and atypical development (7 questions).

After determining the current psychophysiological state of the student, a perceptual experiment was carried out. Speech samples were selected from the AD_CHILD.RU database (Lyakso et al., 2019). Test sequences were created using the Cool Edit Pro 2.1 sound editor. Three test sequences, containing the speech of children 6-8 years of age, 18 children with atypical development (AD) (10 children with autism spectrum disorders (ASD) and 8 children with Down syndrome (DS)) and 6 typically developing (TD) children were created. Each group of children included the equal number of boys and girls the interval between speech samples in the test sequences is 5 s, each sound fragment is repeated once. Test sequences contain 30 speech samples, thus, the total number of speech fragments is 90 (45 fragments for TD and AD children each). The choice of children with ASD and DS is due to the specific features of their speech, which manifest themselves at different levels of organization of speech communication and behavior (Olivati et al., 2017, Bonneh et al., 2011, Kent, Vorperian, 2013; Wolk, Brennan, 2016). When listening to audio tests, the subjects filled out specially designed questionnaires. On the questionnaire, opposite each number indicating the number of the sound fragment, the auditors had to indicate in the appropriate columns the type of development of the child (typical/atypical), his age, gender, whether the meaning of what was said was clear, whether there was any peculiarity (specificity) of speech.

To assess the ability of the subjects to recognize the type of development of the child, a video test was created containing fragments of the behavior of AD children's. The video test included video recordings of the behavior of 9 children with ASD (5 boys and 4 girls) and 3 children with DS (2 boys and 1 girl). Fragments are arranged in random order there are no pauses between video fragments. When creating a video test, the audio track was removed from all video fragments in order to exclude the influence of children's speech and/or voice-over on the results of a perceptual experiment.

After watching the video test, the subjects answered questions about their feelings (4 questions). Then, the physiological and psychophysiological parameters of the students (registration of HR and determination of blood oxygen saturation using a pulse oximeter, the Spielberger method for detecting situational anxiety; the WAM test, the 8-color Luscher test) were reevaluated.

During the dialogue, the subjects' speech was recorded using a Marantz PMD660 recorder with a Sennheiser e-835S external microphone. The speech material was analyzed using the Cool Edit Pro audio editor. The utterance duration, the duration of pauses in utterances after the removal of the experimenter's speech, the average values of the pitch for the phrase, the minimum and maximum values of the pitch, the range of pitch, the rate of speech were determined (determined as the number of syllables uttered per second (Grigorev et al., 2018)).

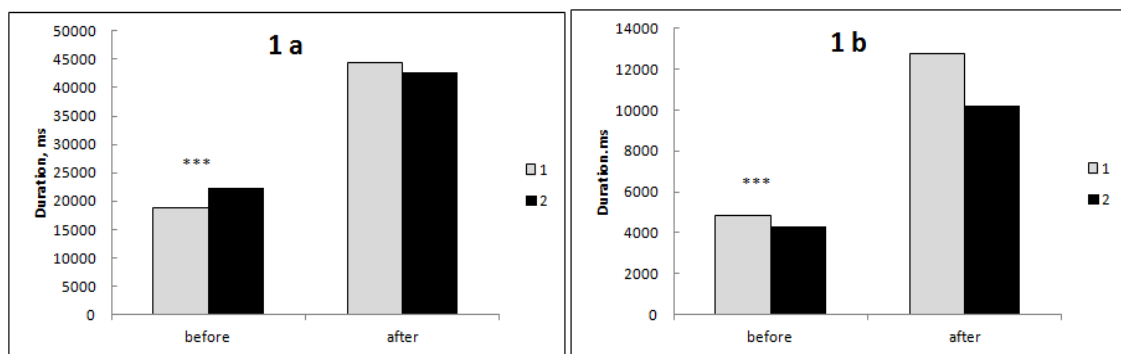
Statistical analysis was carried out using the STATISTICA 10.0 program. The study was approved by the Ethics Committee of Saint Petersburg State University.

3. Results

Based on the instrumental analysis of speech, it was found that the utterances duration of students of both groups is significantly lower ($p < 0.001$, nonparametric Mann-Whitney U test) before the perceptual experiment than after participation in the experiment. Prior to the beginning of the perceptual experiment, the duration of utterances (median values) for students of the 1st group was 18.8 s, for the students of the 2nd group - 22.2 s; after participating in the perceptual experiment, the students of the 1st group - 44.4 s, the students of the 2nd group - 42.8 s (Figure 1a). Significant differences between the groups not found.

The pauses duration in the speech of students of both groups is significantly lower before participation in the perceptual experiment than after it (Figure 1b). The duration of pauses (median values) for the students of the first group before participating in the perceptual experiment is 4.8 s, for the students of the second group - 4.3 s; after participation in the experiment - 12.7 s for students in the first group and 10.2 s for students in the second group. The ratio of the number of pauses in the utterance before and after the perceptual experiment does not change: before participation in the perceptual experiment it was $24.2 \pm 9.5\%$ of the students in the 1st group and $25.7 \pm 9.6\%$ of the 2nd group; after participation in the experiment - $25.3 \pm 6.8\%$ in the 1st group and $27.2 \pm 8.8\%$ in the 2nd group).

Figure 1a. The total duration of the utterances of the subjects during the dialogue with the experimenter; 1b - the total duration of pauses in the speech of the subjects during the dialogue with the experimenter. On the horizontal axis - recording time, on the vertical - duration, ms. Gray columns are data for students of the first group, black columns – for students of the second group. *** - $p < 0.001$, Mann-Whitney U test.



There were no significant differences in the rate of speech between the students of the first and second groups, as well as between the time of recording speech material: before the perceptual experiment, the rate of speech (median values) for the students of the first group was 4.1 syllables per second, for the students of the second group - 3.7; after the perceptual experiment, the students of the first group had 3.9 syllables per second, the students of the second group - 3.6. There were no significant differences between the students of both groups, as well as between the recordings before and after the perceptual experiment, in the average pitch values, the minimum and maximum values of the pitch, the range of the pitch.

Based on the results of psychological testing, it was found that, according to the Luscher's 8 color test, prior to the start of the perceptual experiment, the indicators of emotional tension of the students of the second group are lower than those of the students of the first group - regression analysis ($F(1,38)=4.811$ $p < 0.034$ $R^2=0.112$ $\beta=-0.335$). These results are confirmed by discriminant analysis ($F(4,35)=2.446$ $p < 0.065$ Wilks' - $\Lambda=0.875$). According to the results of other psychological tests, there were no significant differences between the groups.

It was found that the students of both groups are significantly better at recognizing the state of TD children. There were no statistically significant differences between the 2 groups in terms of the success by recognizing the child's psychoneurological state. There were no differences in the level of recognition of the psychoneurological state in children with ASD and DS. When performing the task of recognizing the gender of children, the students of both groups significantly better ($p < 0.001$) recognize the male than the female in AD children. The students of the 2nd group were significantly better at recognizing the gender of TD girls than boys ($p < 0.001$); the female gender in TD children, compared with the students of the 1st group ($p < 0.05$).

The both groups of students significantly better ($p < 0.001$) determine the age of TD children compared to AD children. They are indicated the age of TD children's close to the real, and the age of AD children's is lower than the real.

The both groups of students more often noted that they understood what was said by the child if the speech belonged to TD children, compared with AD children ($p < 0.001$, Mann-Whitney U test). When analyzing the recognition of a child's psychoneurological state by a video test, it was found that all the subjects correctly noted the presence of AD children on the video recording, however, 50% of the subjects in both groups answered that TD children were also present in the tests.

Based on the multiple regression analysis $F(16,20)=6.56$, $R^2=0.84$ the experience of the subjects ($\beta=-0.645$ $p=0.000$), the scores of the WAM test "mood" after the study ($\beta=-0.397$ $p=0.002$) is associated with the recognition of the psychoneurological state of AD children; $F(8,28)=4.678$, $R^2=0.572$ the difference between the "mood" WAM score before and after the study ($\beta=0.584$ $p=0.000$) is associated with the recognition of the psychoneurological state of TD children.

For the first group of students, on the basis of Spearman's correlation analysis of 73 indicators, it was found that: Luscher test indicators at the end of the study are associated with recognition of the state of TD children's ($r = -0.48$); the values of the WAM scores ("well-being" at the beginning of the study) - with the recognition of the age of the AD children's (0.45). Correlation analysis of 31 indicators revealed the correlation between students anxiety when communicating with AD children, and indicators of SDS (0.76), SPRAS (0.60), WAM ("mood" after the study) (-0.61) and personal anxiety (0.74) tests (students who are anxious when interacting with AD children are more anxious).

For the second group of students, based on Spearman's correlation analysis of 73 indicators, it was found that the values of the Luscher test at the beginning of the study are associated with the recognition of the gender of AD children's ($r = 0.45$); SDS scores – with SPRAS scores (0.70), personal anxiety scores (0.65), the age recognition of TD children's (-0.59); SPRAS scores – with the values of personal anxiety (0.65) and situational anxiety at the end of the study (0.59), the recognition of the state of TD children (-0.54), the recognition of the age of TD children (-0.49); WAM scores ("well-being" at the beginning of the study) - with the values of personal anxiety (-0.64), the recognition of the state of TD children (0.57); WAM scores ("activity" at the beginning of the study) - with the values of personal anxiety (-0.49), the recognition of the state of AD children (-0.47), the recognition of the age of TD children (0.56); WAM scores ("well-being" at the end of the study) - with the values of personal anxiety (-0.53), the recognition of the state of TD children (0.63); WAM scores ("activity" at the end of the study) - with the values of personal anxiety (-0.50), the age recognition of TD children (0.52); WAM scores ("mood" at the end of the study) with recognition of the state of TD children (0.51).

Correlation analysis of 40 indicators revealed links between whether students experience anxiety when communicating with AD children and the experience of the subjects (-0.63), SDS (-0.82), SPRAS (-0.66) test scores (more experienced students do not experience anxiety when communicating with AD children).

Based on regression analysis for students of the 1st group: indicators of the Luscher test at the end of the study are associated with the recognition of the state of TD children $F(1,18)=9.901$ $p < 0.005$ ($R^2=0.355$ $\beta=-0.596$). Based on regression analysis for students of the 2nd group: SDS scores are associated with the recognition of the age of TD children $F(1,18)=7.88$ $p < 0.012$ ($R^2=0.304$ $\beta=-0.552$). SPRAS scores are associated with the recognition of the age of TD children $F(1,18)=6.264$ $p < 0.022$ ($R^2=0.258$ $\beta=-0.508$). WAM scores ("activity" at the beginning of the study) are associated with the recognition of the state of AD children $F(1,18)=4.52$ $p < 0.048$ ($R^2=0.201$ $\beta=-0.448$), the recognition of the age of TD children $F(1,18)=7.072$ $p < 0.016$ ($R^2=0.282$ $\beta=0.531$). WAM scores ("well-being" at the end of the study) are associated with the recognition of the state of TD children $F(1,18)=5.987$ $p < 0.025$ ($R^2=0.25$ $\beta=0.5$). WAM scores ("activity" at the end of the study) are associated with the recognition of the age of TD children $F(1,18)=6.918$ $p < 0.017$ ($R^2=0.278$ $\beta=0.527$).

4. Conclusion

The original data on the acoustic characteristics of speech, reflecting the state of medical students before and after participating in a perceptual experiment aimed at recognizing the type of child development were obtained. It is shown that before participating in a perceptual experiment, the subjects have a significantly shorter duration of utterances than after participating in it; after the experiment, the subjects answer the experimenter's questions in more detail, while the total duration of the pauses also increases. The general ratio of the number of pauses in the utterance before and after the perceptual experiment does not change, nor do the parameters reflecting the emotional state of the auditors - the rate of speech and the pitch value.

It was found that students of both groups are significantly better at recognizing the psychoneurological state of TD children compared to children with ASD and DS. It was revealed, that students of both groups are significantly better at recognizing the male gender in AD children compared to the female gender; the students of the second group better recognize the female gender in TD children

than the male one. Students of both groups better recognize the age of TD children, compared with the age of AD children, while the subjects indicate the age of TD children close to the real one, and the age of AD children is lower than the real one. The results that the state of TD of children is recognized better than the state of AD children correlate with the data for 11-12 years old children (Frolova et al, 2019), about age recognition - with the results for 8-9 years old children (Lyakso et al., 2020).

According to the results of psychological testing, it was found that the students of the second group experienced less emotional tension before the start of the study, compared with the subjects of the first group. Correlations between the psychological parameters of the subjects and the success of performing the tasks of the perceptual experiment were revealed.

It can be assumed that medical students of the last years are generally ready for successful interaction with children with typical and atypical development and for the successful provision of medical care for them, since their psychological indicators of anxiety did not change by the end of the study.

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