

nna Krzyżak

itory processing and semantic fluency and syntactic competence of musicians and musicians in experimentalneurolinguistic research

visors: prof. dr hab. Mirosław Michalik, dr hab. Michał Pawełek

INTRODUCTION: Music and language are the competencies developed by man through relationships and conditions are of interest to researchers for many years. The use of neuroimaging tools allows observation of brain processes while performing linguistic or musical tasks. Language and music as acoustic and phonological phenomena have sequential structure and syntax and semantics specific to each of them, use different neural resources, and interact. Their interactions are still an area of scientific interest. This represents problems waiting to be solved. Mental linguistics and cognitive musicology, concepts integrating various linguistic and musicological directions, assume that the acquisition of language or music skills occurs not only as a result of cognitive processes, but also in a sociocultural context. The influence of musical education on cognitive processes and regulating emotions is proven in many experiments. Researchers still try to assess how musical education determines linguistic competence in structural and functional terms.

OBJECTIVES: The aim of the study was to assess the impact of music education on the model of auditory speech processing and linguistic competence, especially semantics and syntax. The choice of strategies for solving language tasks in musicians and musicians as well as verbal memory and sensitivity to emotional prosody were also assessed. As well as determining whether gender matters in auditory processing, lateralization and language competence.

MATERIAL AND METHODS: The study included 80 healthy adults aged 25–60. The research group consisted of musicians – active instrumentalists learning music since childhood. The study of central auditory processing was performed on 39 musicians, women (n = 20), and men (n = 19). The control group (n = 40) consisted of non-musicians who had not learned to play an instrument in their lifetime and had not taken singing lessons, women (n = 20), and men (n = 20). The study of language competence was conducted in 41 musicians: women (n = 21), and men (n = 20), and 41 non-musicians: women (n = 20), and men (n = 21). Experimental, non-invasive methods of data acquisition were used: tools for central auditory processing, as well as tests to assess syntactic competence, semantic fluency, learning process, verbal memory, and emotional prosody.

RESULTS: In the study of central auditory processing, significant differences between the research group and the control group were observed in the following tests: Simple Reaction

Time Test ($p = 0.012$) in favor of non-musicians, Consonant-Vowel-Consonant in the conditions of attention directed to the right ear ($p < 0.001$), and left ($p < 0.001$), Frequency Pattern Test ($p < 0.001$), and Difference Limen for Frequency ($p < 0.001$) in favor of musicians. The results of the Consonant-Vowel-Consonant Test indicate that women more often than men recognize a sound stimulus in the left ear, while men are more likely to be binaural. This relation is statistically significant ($p = 0.026$). Female musicians perform much better in the following tests: SRT ($p = 0.014$), CVC in conditions of attention directed to the right ear ($p = 0.004$), and left ear ($p = 0.002$), as well as in the FPT ($p < 0.001$), and DLF ($p < 0.001$) tests. Male musicians show an advantage over male non-musicians in the following tests: CVC in attention conditions directed to the right ear ($p = 0.002$), and left ear ($p = 0.002$), FPT ($p < 0.001$), and DLF ($p < 0.001$). The relation between gender and the type of dominant ear in the group of musicians is significant: IW Chi2 = 8.05; $p = 0.02$. In women musicians, the dominant ear is the right ear, in men as well, but as many as 26.3% are binaural. There was no relation between the type of dominant ear and gender in the group of non-musicians. In the study of language competences, significant differences between musicians and non-musicians were observed in the study of Auditory-Verbal Learning Test by Luria (AVLT) – (third measurement: $p = 0.015$, fifth: $p = 0.033$, after the distractor: $p = 0.033$, memory capacity: $p = 0.028$ and durability of memory traces: $p = 0.048$). Musicians more often use strategies in the learning process in the auditory modality (83% : 47%). They also achieve better results in the syntactic competence test ($p = 0.034$), and in the Stroop test (time I: $p = 0.031$, time II: $p = 0.020$, errors: $p = 0.009$). In the study of Verbal Fluency (VF), in categories with a rarer frequency of occurrence (letter – A and categorical – sharp objects), musicians do significantly less repetitions ($p = 0.003$ and $p = 0.016$). The same applies to the difference between female musicians and female non-musicians in terms of the number of repetitions (letter – A: $p = 0.005$, categorical – plants: $p = 0.008$, and sharp objects – $p = 0.018$), and male musicians and non-musicians (letter A: $p = 0.013$). Depending on the gender of the respondents: in the group of women and men in the study of AVLT women obtained better results in the second ($p = 0.024$), third ($p = 0.001$), and fourth ($p = 0.033$) measurement, after the distractor ($p = 0.003$), and in the memory trace ($p = 0.002$). They also use strategies more often than men (80% : 51%), and they make mistakes less often in the Stroop Test ($p = 0.037$). In the group of musicians, women achieve higher results only in the third measurement of AVLT ($p = 0.024$), while in the group of non-musicians, in the third ($p = 0.036$), in the fifth ($p = 0.024$) measurement, after the distractor ($p = 0.002$), and in the study of memory trace ($p = 0.001$).

Male musicians show higher competence than male non-musicians in the fifth measurement ($p = 0.007$), after the distractor ($p = 0.016$), and in the study of memory trace ($p = 0.017$). Non-musician men rarely use memorization strategies compared to non-musicians women (17% : 72%), with small gender differences in this aspect in the group of musicians (79% : 88%). Differences in favor of female musicians were also observed between women musicians and non-musicians in the Syntax Competence Test ($p = 0.038$), and the Stroop Test (time II: $p = 0.035$). In the group of men, musicians achieved better results in the Emotional Prosody Test ($p = 0.009$), and the Stroop Test (time I: $p = 0.012$, errors: $p = 0.049$).

CONCLUSIONS: Music education affects auditory processing, including speech. Musicians present a different model of verbal processing than non-musicians. It may be related to the strategies used in perception and analysis of music. Musical education does not correlate with the results of the dichotic listening test and does not affect the hemispheric dominance for speech, but musicians direct verbal auditory attention in different way and more effectively than non-musicians. The model of auditory processing presented by musicians does not affect semantic but it is significant in syntactics competence, which is probably related to the use of common neural resources in the processing of speech and music syntax. Musicians learn faster in the speech modality, and remember more and longer. They use memory strategies more often and show better cognitive flexibility. Gender is important in the study of auditory lateralization, but not in other parameters of central auditory processing. Women are more sensitive to utterance intentions, use strategies more often in language tasks, maintain attention longer, and have a more efficient working memory. Musical education is important for the distribution of data by gender.