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## **Music as a Motivational Tool for Better Motor Outcomes in Children**

The study aimed to investigate the potential influence of music tempo while performing the plate-tapping test. Four hypotheses were formulated. They were focused on examining whether the speed of music impacts movement speed. Additionally, we sought to explore variations in results between individuals engaged in dance/music activities who may possess enhanced rhythmic precision, compared to those not involved in such activities. We hypothesized that individuals without dance/musical backgrounds would have limited exposure to music, and, therefore, struggle to perceive musical rhythm effectively.

**Methods:** In our study, we employed an experimental methodology. The testing took place in a controlled environment at the Milojka Štrukelj Elementary School gymnasium in Nova Gorica. Two different pieces of music were played while conducting the plate-tapping test.

**Participants:** The study included 51 female students attending the 7th grade in the 2021/2022 academic year, aged 11–12. Participants were exclusively female, aligning with existing literature (Starc et al., 2010) that indicates statistical differences in plate-tapping tests between male and female students in this age group. Given that more female students engage in esthetic sports where the rhythm of music is essential and since we compared these two groups, only female participants were included in the study. Before testing, we ensured that participants had no injuries or movement restrictions in their hands.

**Procedure:** Participants performed the plate-tapping test twice. One test was accompanied by slow-tempo music at 100 beats per minute (bpm), sourced from the YouTube channel (Workout Music Source, 2022). The other test was accompanied by fast-tempo music at 190 bpm, sourced from the YouTube channel (Knee Friendly, 2022). Participants were informed about the test and given instructions but were not informed that they would be tested with different music tempos. This prevented participants from consciously influencing the test results.

The choice of music tempos was not arbitrary. They were identified in relevant literature on the influence of music on movement. According to our literature review, music at 100 bpm is considered "Andante", the slowest tempo within the moderate speed range in music. On the other hand, music at 190 bpm is considered "Presto", the fastest tempo among fast tempos in music (Troiano, 2022).

**Equipment:** For measurements, we used the prescribed equipment for the plate-tapping test. We employed the electronic tapping device, a tool for measuring touches left/right within a 20-second interval (Figure 1). The kit includes a base plate, an electronic counter with a connecting cable, and 4 LR6 1.5 V AAA batteries.

The base plate is a board with two circular plates attached, each with a diameter of 20 cm, and the lower edges are 61 cm apart. We also used a table and chair adjusted to the age and height of the students (Starc et al., 2010).

Adaptation for left-handed/right-handed individuals is automatic. A left-handed individual places his or her right hand in the middle and his or her left hand on the right plate while a right-handed individual places his or her left hand in the middle and his or her right hand on the left plate. The tapping device automatically recognizes which side to start counting by displaying "LE" or "RE" (left/right) on the screen after 3 seconds of holding both plates in the initial position. Following this, the screen displays "00:20" while both plates are held, indicating that the device is ready to count touches. The left pair of numbers count touches, and the right pair count down the time available to complete the exercise. After 20 seconds, the right counter resets to "00", signifying the end of counting touches. The result remains displayed on the left side of the monitor until the next user is ready for testing. When hands are placed in the starting position, the result resets after 3 seconds, allowing the next user to begin testing (Electronic tapping instructions, 2024).

**Task:** The participant sits at a table with a board and two plates. The less dominant hand is placed in the middle between the plates while the other hand is placed on the plate on the opposite side. On the command "go", the participant starts touching both plates alternately as quickly as possible with the dominant hand. Each touch of both plates counts as one point (Starč et al., 2010).

**Evaluation:** The result is the number of points (touches) in 20 seconds.

Additionally, we administered a questionnaire to gather information on participants' involvement in music school and engagement in esthetic sports involving music-related exercises. We predicted that participants performing under a faster tempo would exhibit superior results and that dancers/musicians would outperform non-dancers/non-musicians due to their familiarity with musical tempo.

After completing the test, participants filled out a questionnaire, answering questions about whether they attended music school, engaged in sports, and participated in esthetic sports involving movements to the rhythm of music (dance, rhythmic gymnastics, roller skating, twirling, etc.). In the subsequent discussion, these categories will be collectively referred to as "dance".

Data analysis was performed using IBM SPSS Statistic 26.0. We conducted paired-sample t-tests to examine the differences in plate touches between slow and fast tempos, as well as paired-sample t-tests to assess the differences in plate touches between participants involved in music school or esthetic sports and those not involved in such activities.

**Discussion:** The statistical analysis revealed differences between tests conducted with slow- and fast-paced music. The average difference between the two measurements is 3.12 touches, representing 8.5% relative to the overall average of all plate-tapping test results. These differences were further confirmed by a paired t-test, indicating a statistically significant difference between the groups. There are significant statistical differences between the plate-tapping test performed with slow music and the one performed with fast music. The hypothesis has been confirmed, suggesting that a faster tempo is the reason for achieving better results in simple movements.

However, a limitation of the study is acknowledged because differences in plate-tapping interactions may also stem from a desire to improve results from the initial measurement. To conduct more objective measurements, result monitors should be concealed to prevent participants from checking their results in real time. Nonetheless, during the test execution, it may be challenging to monitor results closely because participants are focused on performing the test and this aspect likely had minimal impact.

Another question posed is whether additional hours of exposure to music and rhythm affect the results. Differences were found between dancers/musicians and non-dancers/non-musicians in the slow music test but the difference was only 0.5 touches. The t-test did not show statistical differences between the groups. Thus, for slow music, it cannot be asserted that the influence of music on dancers/musicians is different from that on non-dancers/non-musicians because there are no statistical differences in the plate-tapping test results. In the fast music test, the average difference is also 0.5 touches, and the t-test is not statistically significant. Therefore, it cannot be claimed that dancers/musicians perform the test faster compared to non-dancers/non-musicians in the case of fast music. However, dancers/musicians achieve better results in both cases. Since the number of athletes in the non-dancer/non-musician group is unknown, conclusions cannot be drawn about whether these results are also due to the general athletic performance of participants in the dancer/musician group.

Results indicate an average difference of approximately one touch between dancers/musicians and non-dancers/non-musicians in both slow and fast music scenarios. There are no statistical differences in plate-tapping test results between dancers/musicians and non-dancers/non-musicians for both slow and fast music, and thus, no differences can be proven among the participants.

It has been observed that regardless of whether participants attend music school or engage in dance or other sports related to music, fast music stimulates faster movement. Prior knowledge of music or dance does not significantly influence the speed of the plate-tapping test. It can be assumed that participants

have enough knowledge to perceive the rhythm and speed of music even without additional hours in music or dance, which stimulates them during the test. This knowledge may be acquired in school through music and sports classes, and other subjects where rhythm is present. Koban Dobnik et al. (2012, p. 6) argue that music pedagogy theory and practice emphasize the importance of music education and the active acquisition of musical experiences wherein students shape their musical behavior. Additionally, movement and dance activities hold a significant place in music curricula at all levels of education.

Similar to Edworthy and Waring (2006), it has been found that the tempo of music influences the speed of movement, specifically in the plate-tapping test (for simple movements). Pistotnik (2011) suggests that speed is predominantly influenced by genetic traits, indicating limited potential for training to impact its development. Nevertheless, it appears that the speed of music also influences the frequency of movements to some extent. Chanda and Levitin (2013) state that "stimulating" music increases sympathetic arousal, subsequently raising heart rate, causing vasodilation in skeletal muscle arteries, respiratory rate, skin conductivity, catecholamine secretion, etc.

The question arises whether the results would be different if testing were conducted without music. Brownley et al. (1995) tested running with fast music, slow music, and without music. The results indicated differences in consistent breathing during running between efforts without music and with music. However, this was observed only in untrained runners.

The results suggest that athletes can benefit from using fast-paced music during speed training to enhance their performance. Consistent with Kraševac's study (2018), it is noted that music tempo affects the central factors (muscle activation) and peripheral factors (contractile mechanism) crucial for muscle strength development. Therefore, it can be argued that music serves as an external motivator for achieving better results in specific motor tasks. It would make sense to incorporate fast-paced music in sports classes to boost speed.

According to Habe and Delin (2010, p. 35), elementary school teachers only occasionally or rarely use music as a motivational tool. Most often, they employ it to improve the atmosphere, promote relaxation, enhance esthetic appreciation, and uplift students' moods. It would be meaningful to consider using music also to stimulate and motivate students for better performance in other subjects, thereby enhancing students' productivity.