Comparison of Psychomotor Function between Music Students and Students Participating in Music Training

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Objective: *To compare psychomotor function between a music student group who had music education and a non-music student group who participated in music training.*
Material and Method: *Consecutive sampling was used for completing questionnaires, testing reaction times (visual, auditory, and tactile system), measuring electromyography of upper trapezius muscles both sides and taking photos of the Craniovertebral (CV) angle in the sitting position. Data collection was made twice for each student group: the music students at one-hour intervals for resting and conducting nonmusic activities, the non-music students at two-day intervals, 20 minutes/session, and performed music training (by a manual of keyboard notation).*
Results: *The non-music students (n = 65) improved reaction times, but responded slower than the music students except for the tactile system. The music students (n = 28) showed faster reaction times and higher activities of the trapezius muscle than the non-music students at post-test. In addition, the CV angle of the non-music students was significantly improved.*
Conclusion: *The level of musical ability may influence the psychomotor function. Significant improvement was observed in visual, auditory and tactile reaction time, and CV angle in the non-music students. However, upper trapezius muscle activities between both student groups were unchanged.*

Keywords: *Music training, Reaction time, Electromyography, Craniovertebral angle*

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Thais spend 3.6 hours a day on leisure activities mainly watching television[1], while Americans spend 5.58 hours a day on sport and music activities[2]. Music preference was found to promote psychomotor function or cognitive use of music[3]; however, such a system might be different between undergraduates with and without music training[4]. To understand psychomotor function after music training in Thai students, such a function for students with no music background might be improved after participating in music training compared with music students. The present study aimed to 1) investigate psychomotor function of the music students, 2) compare the psychomotor function of the non-music students between pre- and post-tests, and 3) compare the psychomotor function between the music students and the non-music students immediately after participating in music training.

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Material and Method

This was a comparative study design. The participants were divided into two groups: music and non-music students. The music students were undergraduate students at Mahidol University and Bansomdejchaopraya Rajabhat University who had been studying music education (piano, violin, guitar, vocalist, string and brass instruments). The non-music students were undergraduate students at Mahidol University who had no music education. Volunteers aged 18-25 years in both sexes enrolled in the study and the participants signed consent forms. The present study was approved by the Institutional Review Board, Mahidol University (COA. NO. MU-IRB2011/034.2202). The sample sizes were calculated using statistical calculation (df = 0.67, Power = 0.81 and Sample size = 20)[5].

Measurements

Both groups of participants were asked to answer questionnaires about demographic information including age, sex, handedness, type of musical

instruments they were playing, frequency of musical leisure and starting age for music education or musical leisure etc. After that, all participants were asked to take the psychomotor tests for pre- and post-test as follows: 1) unwarned reaction time (average of ten times for visual, auditory, and tactile stimulation via a red light, 1,000 Hz speaker and a micro switch pen touched at the spinous process of C7)[6], 2) surface electromyography (EMG) (two electrodes attached to each side of the upper trapezius muscle), and 3) the Craniovertebral (CV) angle (the intersection of a line joining the right tragus and spinous process of C7 in the sitting position and a horizontal line)[7].

Music training

The non-music students received two separate sessions of music training at two-day intervals and 20-minute sessions. This dose was selected according to a previous study[8] to ensure improvement in psychomotor function. In the first session, the non-music students were asked to play 'Happy Birthday Song' and 'Jingle Bell Song' three times each song. In the second session, they were asked to play these two songs once, and 'Fog & Smoke (Thai) Song' for twice. This group was not allowed to practice those songs at home during that week. The music students did not receive music training, but performed non-music activities for one-hour interval on the same day[9].

The SPSS for Windows, version 17.0, was used for data analyses using Paired t-test, Independent t-test, and Cross-tab Chi-square test with 95% confidence intervals[5].

Results

A total of 93 university students (n = 93) participated in the present study. The mean (SD) age of the music students (n = 28) and the non-music students (n = 65) were 20.86 (1.48) and 20.75 (0.75) years, respectively. No significant difference in age was found (Z = -0.085, p = 0.932). When comparing the characteristics of both groups, significant differences were found in sex (χ^2 = 47.102, p<0.001) and frequency of musical leisure (χ^2 = 60.244, p<0.001). Males and frequency of musical leisure for the music students were 92.9% and 75%, while those for the non-music students were 16.9% and 9.2%, respectively. However, the music and non-music students had no significant difference in handedness–most were right handed: 82.10% vs. 93.80%; χ^2 = 3.067, p = 0.080 and starting age for music education or musical leisure was 13.58$\pm$4.66 years vs. 14.50$\pm$4.51; t = -0.365, p = 0.718, respectively.

Unwarned reaction time

In both pre- and post-tests, the music students reacted to visual and auditory stimulation significantly faster than the non-music students. Within the music students, the post-test showed faster visual and auditory reaction time than the pre-test. Within the non-music students, similar results were found.

No significant differences were found in tactile reaction time between pre- and post-tests for the music students. The non-music students showed significantly slower tactile reaction time than the music students in the pre-test; however, no significant difference was found in the post-test. The non-music students showed faster tactile reaction time between the pre- and post-tests.

Surface EMG

In the pre-test of the right side, the music students showed significantly greater motor amplitude than the non-music students. This result was similar to the post-test of the right side. In the pre-test of the left side, the music students had significantly higher motor amplitude than the non-music students. This result was similar to the post-test of the left side. However, no significant differences were found between the pre- and post-tests within the music students, as well as, within the non-music students for the right and left sides.

CV angle

In the pre-test, no significant difference was found between both music and non-music students. Also, the results of the post-test were the same as those of the pre-test. However, the post-test showed significantly greater CV angle than the pre-test only for the non-music students. The mean and standard deviation values of all reaction times, EMG both sides and CV angle are shown in Table 1.

Discussion

The present study aimed to compare psychomotor function between the music students who were studying music education and the non-music students who participated in two sessions of music training. The major findings of the present study revealed the improvements in auditory and visual reaction times, as well as, neck on upper thoracic posture after short-term music training.

Table 1. Mean (SD) values of reaction time, muscle activity and Craniovertebral angle for the music students and non-music students

Parameters	Music students (n = 28)	Non-music students (n = 65)		*p*-value within non-music students	*p*-value between groups
		Pre-test	Post-test		
Reaction time (seconds)					
Visual	212.08 (29.40)	287.88 (52.57)	259.98 (98.16)	<0.037[a]	0.013[b]
Auditory	202.21 (23.82)	306.77 (66.87)	250.34 (52.52)	<0.001[a]	<0.001[b]
Tactile	164.32 (33.97)	222.72 (67.92)	177.17 (38.15)	<0.001[a]	<0.128
EMG					
Right	81.17 (57.34)	52.45 (32.67)	46.58 (27.72)	0.209	0.005[b]
Left	85.14 (64.17)	53.39 (34.10)	46.68 (32.02)	0.149	0.005[b]
Craniovertebral angle (degrees)	39.51 (7.47)	38.09 (7.88)	39.51 (7.47)	0.021[a]	0.366

[a] Significant difference at *p*-value <0.05 from the paired t-test
[b] Significant difference at *p*-value <0.05 from the independent t-test

The present study also demonstrated how motor learning could be assessed by reaction time[11,12] explained by three frameworks of motor learning. First, Hick's Law describes the linear relationship between reaction time and the logarithm of the number of stimulus-response alternatives meaning the reduction of uncertain information for human behaviors could help us interpret that information into a constant amount of motor learning[13]. Second, the framework of Bayesian explains using reaction time for comparing cognitive information and natural learning between the expert and non-expert skills[14]. Third, the reaction-time task paradigms explain how reaction time measures cognitive plasticity of learning - transformation of asynchronous information to synchronous information[15].

Both music and non-music students participating in the present study started playing music after seven years. This age group is the so-called late-trained young adults according to previous studies[9,10] that explained the effect of late-trained playing music on selective attention in auditory and speech perception. From the results of the present study, the music students improved the reaction time in visual and auditory system. This improvement might be undertaken through a circuit of working memory[9]. The music students always manipulate and operate index fingers quickly while pressing the light and sound buttons, especially for the greatest improvement of auditory system[9,10]. However, the tactile reaction time was not improved in the music students. This phenomenon may relate to individual motor learning including motivation, sensory and motor adaptation in visual and auditory systems[10]. On the other hand, the non-music students seemed to be motivated by challenging and non-familiar practice. Reaction time indicates the planning of performing tasks[8,11,12]. The results of the present study imply that the visual and auditory reaction time can be improved by two sessions of 20-minute music training. They also imply that this duration of music training might be optimal for improving the tactile reaction time for the non-music students because reaction times of the post-test between the music and non-music students were not significantly different.

Regarding muscle activities, the music students showed greater motor amplitude than non-music students indicating that higher motor units were required for the former group. This statement implies a risk of muscle injury among the music students[16]. In addition, the CV angle in the non-music students demonstrated a greater angle after music training. This phenomenon indicates that the non-music students could feel relaxed leading to less forward head posture[7].

There were some limitations in the present study as described below. First, regarding sample recruitment -a significant difference was found in sex between the music and non-music students. According to a previous study[17], sex has an influence on reaction time and dexterity[18]. Having more females among the non-music students may have inflated the reaction time while having more males among the music students may slow dexterity on the reaction time's switch.

Second, regarding heterogeneous recruitment and gained incorrect data - mixed-musical students (such as violin, guitar, or non-piano studies) might not be familiar with the keyboard test employed in the present study. Third, different time intervals of data collection between both groups was used (two separate days vs. one hour). Recommendation for further studies include determination of the effect of music training on successful aging in elders[18].

Conclusion

This preliminary study highlights significant improvement in visual, auditory and tactile reaction times and CV angle among the non-music students after short-term music training. On the other hand, the music students did not improve tactile reaction time. This finding suggests that the non-music students learned to play music through all stimuli. In addition, upper trapezius muscle activities were not improved in both groups.

What is already known on this topic?

Music preference has shown to promote psychomotor function.

What this study adds?

Significant improvement was demonstrated in visual, auditory and tactile reaction times and neck on upper thoracic posture among non-music students after short-term music training.

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Potential conflicts of interest

None.

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เปรียบเทียบการทำงานทางจิตประสาทการเคลื่อนไหวระหว่างนักศึกษาดนตรีและนักศึกษาที่เข้าร่วมฝึกดนตรี

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วัตถุประสงค์: *เพื่อเปรียบเทียบการทำงานทางจิตประสาทการเคลื่อนไหวระหว่างกลุ่มนักศึกษาที่เรียนดนตรีและกลุ่มนักศึกษาที่เข้าร่วมการฝึกดนตรี*

วัสดุและวิธีการ: *คัดเลือกกลุ่มตัวอย่างแบบสะดวกเพื่อตอบแบบสอบถาม และทดสอบเวลาการตอบสนองระบบการมองเห็น ได้ยิน และสัมผัส สัญญาณไฟฟ้าของกล้ามเนื้อ Upper trapezius ทั้งสองข้างและถ่ายภาพนิ่งด้านข้างเพื่อวัดมุมการทรงท่าของคอ (Craniovertebral angle) ในท่านั่ง เก็บข้อมูล 2 ครั้งในแต่ละกลุ่ม กลุ่มที่เข้าร่วมการฝึกดนตรีเก็บข้อมูลห่างกัน 2 วัน ๆ ละ 20 นาทีโดยเข้าร่วมฝึกดนตรีด้วยคู่มือการเล่นโน้ตคีย์บอร์ด ส่วนกลุ่มที่เรียนดนตรีเก็บข้อมูล 2 ครั้งห่างกัน 1 ชั่วโมงโดยนั่งพักผ่อนและทำกิจกรรมที่ไม่เกี่ยวข้องกับดนตรี*

ผลการศึกษา: *ในการทดสอบครั้งที่สอง กลุ่มที่เข้าร่วมการฝึกดนตรี (n = 65) มีเวลาการตอบสนองเร็วขึ้น แต่ช้ากว่ากลุ่มที่เรียนดนตรี ยกเว้นระบบสัมผัส กลุ่มที่เรียนดนตรี (n = 28) มีเวลาการตอบสนองทุกระบบเร็วกว่าและมีสัญญาณไฟฟ้าของกล้ามเนื้อมากกว่ากลุ่มที่เข้าร่วมการฝึกดนตรี นอกจากนั้นกลุ่มที่เข้าร่วมการฝึกดนตรีมีมุมการทรงท่าของคอเพิ่มขึ้น*

สรุป: *ระดับของความสามารถทางดนตรีอาจส่งผลต่อการปรับตัวของการทำงานทางจิตประสาทการเคลื่อนไหว กลุ่มที่เข้าร่วมการฝึกดนตรีมีการตอบสนองระบบการมองเห็น ได้ยิน และสัมผัสและมุมการทรงท่าของคอดีขึ้น แต่สัญญาณไฟฟ้าของกล้ามเนื้อระหว่างนักศึกษาสองกลุ่มไม่เปลี่ยนแปลง*