Role of Executive Function among Young Adults in Music and Non-Music Programs

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Abstract
Each aspect of human development; physical, psychological and social development across life span is a critical issue to many researchers to examine. During the emerging adulthood transitional period, a person is not adolescence but is also not yet fully adult. Hence, the word "young adults" is used to refer to this group under the study. Resulting from neural immatureness in prefrontal control areas, risky behaviors and problems can be found as threatening factors during this transitional period. As they are more independent and exposed to new things, attraction, stress, and risky environments, Executive Function (EF) has made itself important in self-controlling to cope with such distractions, solve problems and manage life's complexity. Thus, the importance of executive function must be addressed during this transition period. Several studies revealed the advantages of music training on various aspects including executive function improvement. Less is however known about the executive function and effect of music training on executive function during this young adulthood period development. This research aims to study the effect of music training on executive function among young adults studying in different studies programs particularly in Music and Non-Music Programs at university level. The Wisconsin Card Sorting Test (WCST) is used for the assessment of the executive function among the selected group. The results show that young adults in Music Program performed better on 2 of the WCST sub-scores (total correct and conceptual level response) when compared to young adults in Non-Music Program.

Keywords: Executive Function, Music and Non-Music Programs, Wisconsin Card Sorting Test (WCST), Young Adults

1. Introduction

Each aspect of human development; physical, psychological and social development across life span is a critical issue to many researchers to examine. The transition period from adolescence to adulthood is defined as emerging adulthood, aged between 18 to 25 years old. During this stage of life, a person is not adolescence but is also not yet fully adult. University students can be categorized into this transition period. It is an experimentation and exploration period (Arnett, 2007; Santrock, 2011). Hence, the word "young adults" is used to refer to this group under the study.

The changes during this period are still associated with not only the biological but also behaviors. Resulting from neural immatureness in prefrontal control areas, risky behaviors and problems (Konrad, Firk & Uhlhaas, 2013) such as: psychiatric disorders, drug and alcohol use, smoking, conflicts within family relationships, incidence of unintentional injuries, violation, unplanned pregnancy and sexually transmitted diseases, can be found as threatening factors during this transitional development (Casey, Jones, & Hare, 2008; Steinberg, 2005; Spear, 2013). As they are more independent and exposed to new things, feeling, attraction, love, stress, different changes and risky environments (Santrock, 2011; Spear, 2013; Zarrett & Eccles, 2006), executive function (EF) has made itself important in self-controlling to cope with such distractions, solve problems and manage life's complexity (Blakemore & Choudhury, 2006). Thus, the importance of executive function must be addressed during this transition period.

EF is important to our life towards mental, physical, school, cognitive and social development (Diamond, 2013). It is the higher cognitive function set of inhibition, attention, working memory, and planning needed for goal-oriented behaviors (Anderson, 2001) and associated with the goal-oriented control function of prefrontal cortex (PFC) (Best, Miller, & Jones, 2009). PFC is the last brain area to reach maturation and has an influence on cognitive and affective processes and control of executive function. The major critical brain region of executive function development is in PFC including several networks across brain regions (Lenroot & Giedd, 2006). After examining several research studies on the executive function, it can be explained that the development of executive function emerges to develop in early childhood through adolescence and reaches the maturation during early adulthood (Best, Miller & Jones, 2009; Huizinga, Dolan & van der Molen, 2006; Runsáková & Rektor, 2012).

Several studies revealed the advantages of music training on various aspects. For example, music training has influences towards children's academic achievement (Young, Cordes & Winner 2013), abstract reasoning ability (Bilhartz, Bruhn & Olson, 1999; Forgeard et al., 2008), and listening skills (François et al., 2013). There are also influences on adults' language skill, emotions and cognition. Moreover, the studies on effect of music training on cognitive executive function report a better working memory and attention performance, in musicians group rather than non-musicians group (Miendlarzewska & Trost, 2014; Hannon & Trainor, 2011).

Interestingly, the existing research studies support the idea of music enhancement towards executive function throughout human lifespan. However, several researches have investigated on the preschool years since this is a period of the emergence of

executive function development (Espinet, Anderson & Zelazo, 2013). Less is however known about the executive function during this emerging adulthood period development.

Even though, music training can enhances this high-order function, the study of the influence of music training on executive function among university students is limited. Therefore, this study aims to fill this gab by studying the effect of music training on executive function among young adults studying in different studies programs particularly in music and non-music programs at university level.

This study also attempts to understand the effects and advantages of music training on executive function among university students. The findings would be useful for those interested in understanding these differentiations. The results of this study would be beneficial for researchers in the similar field to develop new ideas in educational program developments such as; creating better study programs for next generations, including music training as an extra-curricular activity and for those who look for a free elective course, leisure activity or an executive function intervention.

2. Method

2.1 Participants

The participants were undergraduate students from Music and Non-Music Program. These were the inclusion and exclusion criteria of this study.

Inclusion criteria

- Gender: Male & Female
- Within 18 to 25 years old (18 years 0 month and 24 years 11 months)
- Thai nationality
- Full time students
- Currently studying in the programs mentioned
- Both physically and mentally healthy
- Normal or corrected vision and hearing
- Consent to participate in the study
- Equal number of male and female participants

Exclusion criteria

- Exchange and visiting students
- Brain dysfunction
- Special children
- Mental disorder
- Those who do not meet the requirements

2.2 Instruments

2.2.1 The questionnaire

The questionnaire was developed to get background information, confounding variables such as age, gender, extra lessons, and hobbies as well as to categorize the subjects according to inclusion and exclusion criteria. The subjects were asked to fill in the questionnaires before taking the test.

2.2.2 The Wisconsin Card Sorting Test

The Wisconsin Card Sorting Test (WCST) computer version is used for executive function assessment. It consists of 4 stimulus cards and 128 response cards. They are different in forms (crosses, circles, triangles or stars), colors (red, blue, yellow or green), and number of figures (one, two, three or four). Before the test, the instruction will be given to every subject. The subjects are asked to match each consecutive card shown on the screen to the stimulus card whichever one they think matches. After each match, the subjects get feedback whether it is "Right or Wrong" from the screen and the sound. They are not given any details or indication of the (correct) sorting principle. The sorting principle will be changed (to other category) without prior information.

2.2.3 Research design / Measure/ Data collection procedure

The undergraduate students in each of the two selected study programs were recruited and divided into two groups; Music Program group and Non Music Programs group and only those that fulfill the requirements were chosen to participate in this study. The consent forms were given to the selected subjects. The questionnaires were distributed and WCST (see 2.2.2) was conducted.

3. Results and Discussions

The total number of subjects in this study included 40 young adults consisting of 20 students each from Music and Non-Music Programs. 50% (n=20) of the participants in both the programs were male and another 50% (n=20) were females. The age group of young adults in Music Program group ranged from 18 years and 4 months to 23 years and 5 months (Mean=20.20 SD=1.17). As for Non-Music Program group, they ranged between 19 years to 24 years and 8 months (Mean= 22.20, SD=1.88).

As for the past experience with musical instruments for the Music Program group, all of them have played music instruments for more than 4 years (Min=5, Max=17). 10% of them started playing music at the age of less than 5 years. 40%, 20%, 25% started playing music between the age of 5 and 7; 8 and 10; and 11 and 13 years old respectively. There were only 5% of the participants that started playing music at the age of 14 years and after.

It was seen that 10% of them can play only Thai musical instruments, 85% of them can play only Classical musical instruments and 5% can play both types of musical instruments. 85% of the subjects were professionally good at playing any Classical musical instruments where as 15% was good at playing Thai musical instruments. For the frequency of playing music, 50% of the total subjects in Music Program group played music every day. However there were 25%, 15% and 10% of the subjects that played music once or twice a week; 3-5 times/week; and once/twice a month or longer respectively. The number of hours of playing music each time ranged from 10 minutes to 8 hours (Mean=2.50, SD=1.94).

The Executive Function has been assessed in this research by the Wisconsin Card Sorting Test (WCST). The scores on the WCST between these two groups were analyzed using the independent sample t-test. This paper analyzed the scores that are presented in raw scores form only.

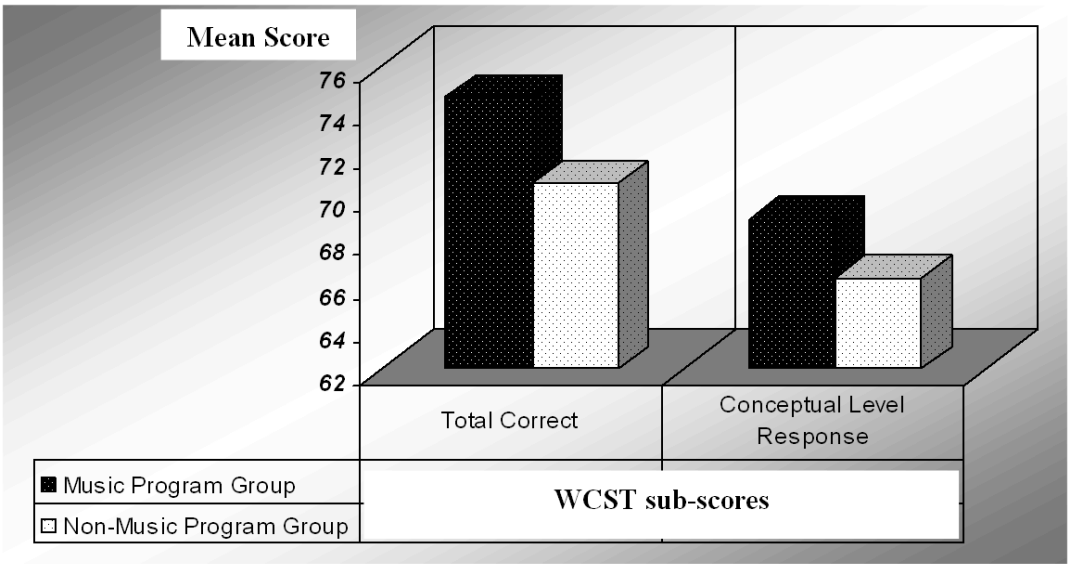
Table 1: Standard means and standard deviation for WCST sub-scores

WCST sub-scores	Group		*p*-value
	Music Program Group (n=20)	Non-Music Program Group (n=20)	
Total Correct	74.55 (10.51)	68.90 (7.77)	0.030*
Conceptual Level Response	70.60 (9.13)	66.20 (6.88)	0.046*

Note: *p<0.05, one-tailed

As shown in Table 1, young adults in Music Program Group had significantly higher scores on 2 of the WCT sub-scores when compared to young adults in Non-Music Program Group; Total Correct and Conceptual Level Response at an alpha level of 0.05 (p.<0.05). However, there were no statistically significant differences found between young adults in Music Program Group and Non-Music Program Group on other WCST sub-score. The mean score of young adults in Music Program Group and Non-Music Program Group for the sub-score on Total Correct were 74.55 and 68.90 respectively. For Conceptual Level Response, the mean score of young adults in Music Program Group and Non-Music Program Group were 70.60 and 66.20 respectively.

Figure 1: Comparison between two groups on the WCST sub-scores



According to the WCST sub-scores results, it can be revealed that higher mean scores on 2 of the WCST sub-scores (Total Correct and Conceptual Level Response) of those young adults in Music Program Group were projected to perform better on the

above mentioned sub-scores when compared to young adults in Non-Music Program Group as shown in **Figure 1**. It can be indicated that young adults in Music Program had a better performance in "Executive Function" including performances related to shifting, inhibition, working memory, planning/organization and problem solving.

This present finding is consistent with the previous studies on the influence of music experience on executive function and also found some slight differences which will be discussed in the following section.

Previous researchers have found that music training has an impact on cognitive executive function in adolescent musician group than those without music training. Even though the different executive function assessment instruments (Simon task, Stroop task, WCST, Iowa Gambling Task) were used in the previous studies, the findings presented that musician group had a better performance than the other groups (Bialystok & Depape, 2009; Usa, 2012; Anuch, 2012).

This study found significantly higher mean score on Conceptual Level Response in Music Program group as evident in a previous study in Thailand (Usa, 2012). Nevertheless, the significantly higher mean scores differences on the sub-scores on Perserverative Response and Perseverative Error were not found between Music Program Group and Non-Music Program Group but were evident in the earlier research done in Thailand (Usa, 2012).

4. Conclusion

This research analyzed the effect of music training on executive function among young adults studying in different programs mainly in Music and Non-Music Programs at the university level. The undergraduate students in each of the two selected study programs were selected though questionnaires distributed and a total of 40 students that met the criteria were recruited. The Wisconsin Card Sorting Test (WCST) was conducted for the assessment of the executive function. The results show that young adults in Music Program performed significantly better on 2 of the WCST sub-scores; Total Correct and Conceptual Level Response, when compared to young adults in Non-Music Programs. Higher scores on these 2 WCST sub-scores are relevant in projecting that the person has better personal abilities to adapt with changing situations, thus reflecting good executive function. This study suggests that a better understanding of executive function throughout one's lifespan is beneficial to the study of human development.

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