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Research report

Music and academic performance

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HIGHLIGHTS

- Students who select music courses have better grades than the others in all subjects.
- Cognitive mechanisms related to overcoming cognitive dissonances are discussed.
- Enjoyment of music might cause academic improvement.

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ABSTRACT

In a previous study we demonstrated that listening to a pleasant music while performing an academic test helped students to overcome stress, to devote more time to more stressful and more complicated task and the grades were higher. Yet, there remained ambiguities as for the causes of the higher test performance of these students: do they perform better because they hear music during their examinations, or would they perform better anyway because they are more gifted/motivated? This motivated the current study as a preliminary step toward that general question: Do students who like/perform music have better grades than the others? Our results confirmed this hypothesis: students studying music have better grades in all subjects.

1. Introduction – 'Mozart effect', music, and academic performance

The 'Mozart effect' is a short-term improvement on "spatial-temporal reasoning" [1–5]. In our previous publication we demonstrated that listening to a pleasant music while performing an academic test helped students to overcome stress due to cognitive dissonance, to devote more time to more stressful and more complicated task and the grades were higher [6]. It is known that the experience of pleasure tends to optimize behavior [7,8]. Our results have suggested that the 'Mozart effect' is caused by overcoming cognitive dissonance during academic tests. This short-time effect could be a small part of the musical cognitive function. A fundamental cognitive function of music could be its facilitation of accumulating knowledge. Overcoming stress due to cognitive dissonance is necessary for accumulating knowledge and therefore is fundamental for the entire human evolution [9]. These previous results therefore might be significant for understanding the cognitive function of music, its origin, and evolution – the issues remaining mysterious for 2500 years [10–20]. Here we continue this line of inquiry by addressing a question if long term study of music systematically improves academic performance.

There are quite a few studies that show significant differences in individuals that are musically trained compared to individuals that do not have that musical training. Groussard et al. [21] found that musical expertise resulted in additional activations in the areas of the hippocampus, medial frontal gyrus and superior temporal areas in both hemispheres which suggest that there is a constant interaction between episodic and semantic memory. George and Coch [22] found that long-term music training in non-professional musicians is associated with improvements in working memory. Musically trained individuals outperformed not musically trained on standardized subtest of visual, phonological, and executive memory.

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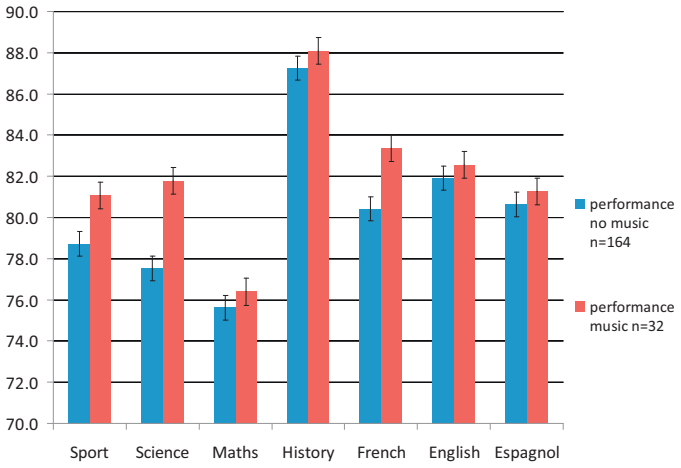

Fig. 1. The mean grades for different courses for the students (14–15 yrs) from the third school-year of secondary school, during the year 2011–12.

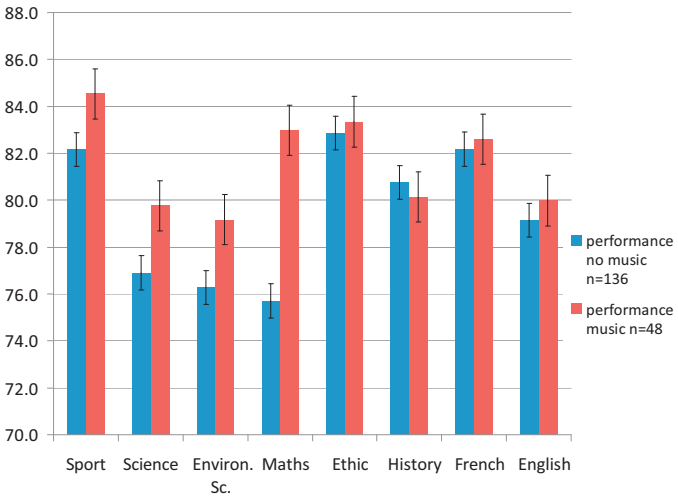

Fig. 2. The mean grades for different courses for the students (15–16 yrs) from the fourth school-year of secondary school, during the year 2011–12.

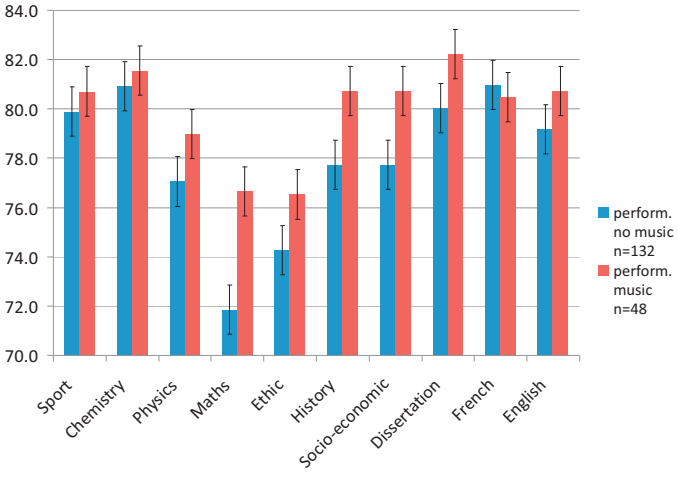

Fig. 3. The mean grades for different courses for the students (16–17 yrs) from the fifth school-year of secondary school, during the year 2011–12.

However, these studies compared "musicians" with "non-musicians". Whether music itself has an effect on memory and cognitive functions in general is still under debate. This question also was addressed by a number of previous studies [23–25]. However the results again have been inconclusive, these references suggest that more research needs to be done to see if long-term music participation improves academic achievements. This question is addressed here.

2. Methods

The population studied consisted of students from a secondary school of the province of Québec Canada. The students belonged to the *International Baccalaureat* program for which they were selected on their first year of secondary school based on their high grades in previous years. They formed a homogenous group in terms of their grades. During the first 2 yrs of their secondary school curriculum (levels 1 and 2), music was compulsory with two courses taking nine days per period. Over the third, fourth, and fifth years (years 3, 4, and 5), music courses were optional and students had to choose one option between plastic art (painting and sculpture), dramatic art, and music. During the first two years the student academic performance was similar in this highly selective and performing population. Over the following three years all students were still of similar academic standard, but any student who disliked music was free to choose another optional course, and all the students who liked music could continue to take it at the school. A new experienced teacher, very skilled and much liked by students, had been teaching over the last three years of the music course. Several of his students were eventually able to enter the *Conservatoire de music* after these three years.

The mean grades for the academic year 2011–2012 were recorded for three different school years, corresponding to the third year (n = 196 students), the fourth (n=184 students) and the fifth (which is the senior class of the secondary school; n = 180 students). Students were of both sexes, aged 14–15, 15–16, and 16–17 years old (for the corresponding school year). It is important to keep in mind that all the students were among the top grade level of their school, whether they selected music courses or not.

The three different school years were analyzed as three separate groups. From all the test results available we selected only courses with quantifiable performance including: sport, science, mathematic, French, English, history, chemistry, physics, Spanish, ethics, present-day world.

3. Results

Figs. 1–3 illustrate striking results. Each year, the mean grades of the students that had chosen a music course in their curriculum were higher than those of the students that had not chosen music as an optional course. This tendency is true regardless of the topic of the course.[1]

Table 1
Statistical significance of the results in Fig. 1: T-test probabilities of the null hypotheses, H0, are low for Science and French (H0: music has no positive influence on academic performance as measured by the mean grade for each course for the students (14–15 yrs) from the third school-year of secondary school, during the year 2011–12).

subject	Sport	Science	Math	History	French	English	Spanish
$p<$	0.11	0.00	0.43	0.32	0.06	0.31	0.34

Statistical significance of these results is very high. The probability of null hypothesis (H0: music does not positively affect academic performance), according to T-test over all data is very low, $p < 0.001$. For individual subjects over years statistical significance varies, with many cases reaching high statistical significance, as shown in the following Tables 1–3 (corresponding to Figs. 1–3).

These results confirm that music has a link to cognition. They do not indicate causality: whether the students have better grades because they practice music from time to time or whether they chose music because they are better at school. However these data

[1] There are two exceptions to this statement. Of the 25 courses rated over 3 years (Figs. 1–3) there are only 2 cases when non-musical student scores are higher than musical student scores (History year 2, French year 3); in both cases the differences are of low statistical significance.

Table 2
Statistical significance of the results in Fig. 2: *T*-test probabilities of the null hypotheses, H0, are low for Sport, Science, Environmental science, Mathematics (H0: music has no positive influence on academic performance as measured by the mean grade for each course for the students (15–16 yrs) from the fourth school-year of secondary school, during the year 2011–12).

Subject	Sport	Science	EnviSci	Math	Ethics	History	French	English
$p<$	0.00	0.01	0.02	0.00	0.35	0.33	0.33	0.25

Table 3
Statistical significance of the results in Fig. 3: *T*-test probabilities of the null hypotheses, H0, are low for Mathematics, History, Socio-economics (H0: music has no positive influence on academic performance as measured by the mean grade for each course for the students (16–17 yrs) form the fifth school-year of secondary school, during the year 2011–12).

Subject	Sport	Scienc	EnvSci	Math	Ethics	History	Socio-econ.	Diss.	French	English
$p<$	0.26	0.12	0.15	0.03	0.12	0.03	0.03	0.35	0.11	0.13

correspond to the previous results: music helps students to hold contradictory knowledge despite stress from cognitive dissonance caused by this contradictory knowledge [6]. We wanted to understand why students quit music courses and conducted a survey of students who had quit the music course. 15 students responded to this survey (some indicated more than 1 reason): dislike music (2 answers), curiosity to try something else (7 answers), like music but do not like playing with an instrument (6 answers), already practicing music outside of school on a regular basis (3 answers).

4. Discussion

This study confirmed a long line of research linking music and cognition. Students taking musical courses achieve better performance on all other subjects. When combined with our previous results [6], this gives a strong support to the hypothesis that music helps overcoming stress due to cognitive dissonance, helps accumulating knowledge, and music is fundamental for human evolution [9].

These results contribute to understanding another long-standing issue. 2500 years ago Aristotle asked why music, being just sounds, has a strong power over human psyche [10]. Kant attempted to answer this question but could not; he concluded that music has no fundamental function in working of the mind and just tickles sensitive spots in our brain [11,16–19]. Darwin considered the origin, evolution, and power of music "the greatest mystery" [12]. A fundamental cognitive function of music remains a mystery for contemporary evolutionary psychologists and musicologists [13–15,20,26,27]. A recent theoretical hypothesis suggests that music helps resolving contradictions among knowledge and therefore is fundamental for survival [9,16–19]. Accumulating experimental evidence supports this hypothesis [6,28,29], music might be fundamental for the entire human evolution [9].

Understanding functions of music in cognition would require addressing a question of specificity and uniqueness of music for resolving cognitive dissonance. It has been reported that physical fitness correlates with academic performance [30]; however correlations have been less pronounced. Thompson et al. [4] demonstrated that the 'Mozart effect' can be explained by enjoyment, arousal, and mood. Exposing students to an adagio by Albinoni, which scored negative on these measures, resulted in lower test achievements. This publication is interesting in that it has ignored the fact that the adagio by Albinoni is among the most popular music pieces in western music. How can this be explained? Our hypothesis suggests that sad music, such as Albinoni adagio, helps resolving cognitive dissonances between human strivings for happiness and unavoidable losses and distresses of human life.

A recent publication [31] added an additional dimension to analyzing influences between music and cognition. The authors of that publication emphasized that existing data have not addressed the issue of causality: does "music training causes improvements in cognition... (or) high-functioning children are more likely than other children to take music lessons, and that they also differ in personality"? The issue of causality has not been resolved in this publication. Possibly, combining a theoretical prediction of musical emotions being the mechanism resolving cognitive dissonance [16,32–35], experimental confirmations of this hypothesis [6,28,29], and evidence for correlation between engagement with music and other cognitive achievements (including this paper) give solid evidence for causality of interaction between music and cognition.

The authors of [31] demonstrated that "personality variables are at least as good as cognitive variables at predicting music training." The future correlational studies of links between music training and non-musical ability, they suggest, should account for individual differences in personality. We emphasize that this should be a part of a wider study developing approaches to measuring musical emotions as well as emotions of cognitive dissonances and establishing relations between them. It is possible that a large number of musical emotions have evolved for overcoming similarly large number (a virtual continuum) of emotions of cognitive dissonances [6,16,29,32,36,37]. These future studies could contribute to our understanding of enjoyment of sad music. Experimental verifications of discussed hypotheses will have to be addressed by future research.

5. Conclusion

The current paper contributes to establishing relations between music education and academic performance. We have demonstrated that students selecting musical courses perform better than those declining such courses, despite equally high initial achievements. This further contributes to accumulating theoretical and experimental evidence that music helps overcoming stress caused by cognitive dissonance, and helps accumulating knowledge [6,16,29], which is fundamental to human evolution [9]. In addition to addressing this fundamental scientific question about the origin and evolution of music, it also contributes to the ongoing debate about needs and usefulness of musical education.

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