

Musical learning and cognitive performance

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According to literature, there are broad associations between music and cognitive abilities, which apparently result from the frequency of music lessons. The aim of the present work was to test these associations between a group of music students and a control group of students with no music education, thereby contributing toward understanding the link between music learning, intelligence, and academic achievement. The Battery of Reasoning Tests (BPR/7-9), collated for the Portuguese population, as well as the academic classifications of two groups of students, provided the basis for this study's quantitative analysis. The sample population comprised students who frequented Year 7 of the basic music course in specialist music education and of the basic course in mainstream education (no music lessons). Compared with the students in the control group, those in the groups which included formal music education showed increases in their general capacity of reasoning (g factor) and in tasks of spatial and numerical reasoning. Equally, there were increases in academic achievement. The results suggest that the duration of exposure to music lessons is associated with an increased intelligence and increased academic achievement.

Keywords: specialist music education; mainstream education; general capacity of reasoning; academic achievement; cognitive skills

It has been suggested that music may be more than just an art form, and that it may indeed be able to produce benefits in other domains, such as cognitive abilities or general intelligence. According to Schellenberg (2005, 2006a), different lines of research have shown that both passive listening to music and formal musical training reveal such a connection. However, the differ-

ences between these two activities make it unlikely that both could have similar effects upon the non-musical aspects of human behavior (Schellenberg 2006a). This study focuses upon the hypothesis that music lessons could provide benefits in non-musical areas of cognition.

Of the musical activities that appear to improve cognitive performance, the most significant appear to be the playing of a musical instrument (particularly keyboard instruments), vocal training, musical learning in general, and rhythmic training. The underlying transfer effect (Barnett and Ceci 2002) may prove to be unique in children that have received music lessons for prolonged periods; as such, lessons involve activities such as:

Focused attention..., regular...practice..., reading music, memorizing extended passages and entire pieces, learning about rules of pattern formation that define western musical structures..., incremental improvement of fine motor skills..., and learning to express emotions through music... (Schellenberg 2006b, p. 466).

The combination of these activities with genetic predisposition and environmental factors may play an important role, not only in music but also in other areas of cognition (Barbro 2006), particularly during childhood when cerebral development is still very flexible (Huttenlocher 2002).

Some researchers believe that music lessons are associated to specific sub-areas of intellectual skills. These include spatial skills (Bilhartz *et al.* 2000, Rauscher *et al.* 2006), reading (Lamb and Gregory 1993, Butzlaff 2000), subcomponents of literacy such as vocabulary (Orsmond and Miller 1999) and verbal memory (Ho *et al.* 2003), mathematics (Vaughn 2000, Maureen 2008), and mathematical subcomponents such as arithmetic (Rauscher *et al.* 2006) and geometry (La Mont 2008). According to Schellenberg (2004) “the most parsimonious explanation of these diffuse associations is that they stem from a common component, such as general intelligence” (Schellenberg 2004, p. 511). Schellenberg (2004, 2006a) also claims that music improves general intelligence. Increased intelligence and enhanced performance in subtests for academic competence were found in music students. There is also evidence that the duration of musical training is positively associated to intelligence, and that this association is general (i.e. not limited to a specific subgroup of intellectual skills) (Schellenberg 2006b).

The research described in this paper examines associations between music lessons and general capacity of reasoning (the so-called “g factor”), and between the duration of the musical training and the increase in the general capacity of reasoning. The performance of music students in each reasoning

task (abstract, numerical, verbal, mechanical, and spatial) was compared with that of students who had not had music lessons. The general academic performance of the students was also taken into account.

METHOD

Participants

The sample population ($n=134$) consisted of students from the seventh grade of the basic music course (specialized musical education program), and others undergoing conventional education. The average age was 13 years. The students were divided into three groups, two experimental and one control: (1) students receiving specialized musical education, who had had between 5-7 years of musical training ($n=63$, "SME 5-7"), (2) students from specialized musical education with 3-4 years of musical training ($n=21$, "SME 3-4"). The control group ($n=50$) consisted of students undergoing conventional schooling ("CS"), which did not include music lessons. All students were from a similar socioeconomic and cultural background.

Materials

The data used in this study was obtained using a Battery of Reasoning Tests, BPR/7-9 (Almeida and Lemos 2006), designed to assess general capacity of reasoning (g factor). These tests, which had been specially adapted to the Portuguese population, included five instruments to evaluate performance in different tasks of reasoning: abstract, numerical, verbal, mechanical, spatial.

Procedure

The participants were recruited from ten schools around Portugal by means of an invitation addressed to their parents or guardians. The pupils were tested individually using the BPR/7-9 at the beginning of the school year. Statistical tests were then performed to gauge differences between groups.

RESULTS

Comparing the average g factor scores, it was found that the SME group with 5-7 years of musical education had the highest average, followed by the SME group with 3-4 years of musical education (see Figure 1). Sheffé's post hoc tests showed that only the differences between the groups "CS" and "SME 5-7" were significant (mean difference=-2.12, $SE=0.493$, $p=0.000$). In short, the students that had musical education displayed a higher general capacity

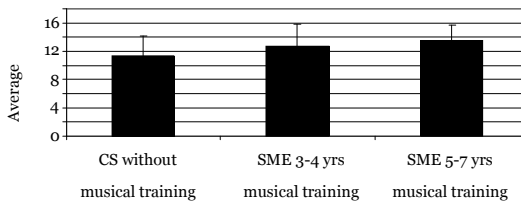


Figure 1. Mean general capacity of reasoning for the CS, SME 3-4, and SME 5-7 groups.

of reasoning than the students from the control group, a difference which became more pronounced with the duration of musical training.

Using MANOVA, the performances of the three groups was compared with relation to each task. Scheffé tests were used to assess the differences between the various tests in the three groups. Although the students from the SME 5-7 and SME 3-4 groups scored better than those from the CS group in abstract and verbal reasoning and those from the SME 5-7 group scored better than the CS group for mechanical reasoning, the differences were not significant. However, in the spatial reasoning tasks, the difference between the averages obtained by the CS group and the SME 5-7 and SME 3-4 groups was significant (respectively, mean difference=-2.97, SE=0.710, $p=0.000$, and mean difference=-2.44, SE=0.974, $p=0.046$). In the numerical reasoning task, there was a significant difference between the CS group and the SME 5-7 group (mean difference=-3.15, SE=0.666, $p=0.000$).

DISCUSSION

The results of this study corroborate the hypothesis that there is a significant relationship between musical education and cognitive growth. This association between the general capacity of reasoning and the number of years' involvement with musical education is confirmed by literature dealing with the relationship between musical education and cognitive ability (Schellenberg 2005). As in some of the studies cited above, this research showed that associations were limited to specific tasks. However, when we considered educational performance as a whole, it was found that music lessons affected general intellectual abilities. Students that had a musical education generally obtained higher grades in academic achievement than their counterparts who had not, and this difference seemed to increase with the number of years of

music lessons. We might infer that music lessons play an important role in the results achieved, rather than extracurricular activities as this was tested elsewhere (Santos-Luiz *et al.* 2009).

The music students in our sample had been tested for musical aptitude, among other things, before embarking on their musical studies. Researchers examining whether musical aptitude is associated to other cognitive capacities have noted that performance in this type of task tends to be positively correlated with general intelligence (Lynn *et al.* 1989). Therefore, it is possible that increased musical aptitude through musical training is accompanied by improved general cognition (Schellenberg 2006a).

The association of music with intelligence and academic performance may result from a simple characteristic or from a cluster of abilities that are fostered by musical education or musical stimulation. Musical structures are abstractions that involve a range of transformations, and mental representations of music must be sufficiently abstract to allow recognition of similarities between varying patterns. Formal musical training may promote the ability to recognize regular patterns and think in a flexible way (Schellenberg 2006b). These abilities are central to the g factor. This study therefore appears to corroborate the assumption that there are associations between music lessons and intellectual ability, although further research is required before this can be asserted with confidence.

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