The power of music: its impact on the intellectual, social and personal development of children and young people

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Executive Summary

Recent advances in the study of the brain have enhanced our understanding of the way that active engagement with music may influence other activities. The cerebral cortex self-organises as we engage with different musical activities, skills in these areas may then transfer to other activities if the processes involved are similar. Some skills transfer automatically without our conscious awareness, others require reflection on how they might be utilised in a new situation.

Perceptual, language and literacy skills

Speech and music have a number of shared processing systems. Musical experiences which enhance processing can therefore impact on the perception of language which in turn impacts on learning to read. Active engagement with music sharpens the brain's early encoding of linguistic sound. Eight year old children with just 8 weeks of musical training showed improvement in perceptual cognition compared with controls.

Speech makes extensive use of structural auditory patterns based on timbre differences between phonemes. Musical training develops skills which enhance perception of these patterns. This is critical in developing phonological awareness which in turn contributes to learning to read successfully.

Speech processing requires similar processing to melodic contour. Eight year old children with musical training outperformed controls on tests of music and language.

Learning to discriminate differences between tonal and rhythmic patterns and to associate these with visual symbols seems to transfer to improved phonemic awareness.

Learning to play an instrument enhances the ability to remember words through enlargement of the left cranial temporal regions. Musically trained participants remembered 17% more verbal information that those without musical training.

Children experiencing difficulties with reading comprehension have benefitted from training in rhythmical performance.

Numeracy

Research exploring the relationships between mathematics and active musical engagement has had mixed results, in part, because not all mathematics' tasks share underlying processes with those involved in music. Transfer is dependent on the extent of the match, for instance, children receiving instruction on rhythm instruments scored higher on part-whole maths problems than those receiving piano and singing instruction.

Intellectual development

Learning an instrument has an impact on intellectual development, particularly spatial reasoning. A review of 15 studies found a 'strong and reliable' relationship, the author likening the differences to one inch in height or about 84 points on standardised school tests. A study contrasting the impact of music lessons (standard keyboard, Kodaly voice) with drama or no lessons found that the music groups had reliably larger increases in IQ. Children in the control groups had average increases of 4.3 points while the music groups had increases of 7 points. On all but 2 of the 12 subtests the music group had larger increases than control groups.

General attainment and creativity

There is a consistent relationship between active engagement in music and general attainment but much research has been unable to partial out confounding factors. A recent study, adopting more sensitive statistical modelling overcame these difficulties. Two nationally representative data sources in the USA with data from over 45,000 children found that associations between music and achievement persisted even when prior attainment was taken into account.

Music participation enhances measured creativity, particularly when the musical activity itself is creative, for instance, improvisation.

Personal and social development

General attainment may be influenced by the impact that music has on personal and social development. Playing an instrument can lead to a sense of achievement; an increase in self-esteem; increased confidence; persistence in overcoming frustrations when learning is difficult; self-discipline; and provide a means of self-expression. These may increase motivation for learning in general thus supporting enhanced attainment.

Participating in musical groups promotes friendships with like-minded people; self-confidence; social skills; social networking; a sense of belonging; team work; self-discipline; a sense of accomplishment; co-operation; responsibility; commitment; mutual support; bonding to meet group goals; increased concentration and provides an outlet for relaxation.

Research in the USA on the benefits of band participation found that 95% of parents believed that participation in band provided educational benefits not found in other classrooms.

Working in small musical groups requires the development of trust and respect and skills of negotiation and compromise.

In adolescence music makes a major contribution to the development of self-identity and is seen as a source of support when young people are feeling troubled or lonely.

Music has been linked to the capacity to increase emotional sensitivity. The recognition of emotions in music is related to emotional intelligence.

Increasing the amount of classroom music within the curriculum can increase social cohesion within class, greater self-reliance, better social adjustment and more positive attitudes, particularly in low ability, disaffected pupils.

The positive effects of engagement with music on personal and social development will only occur if, overall, it is an enjoyable and rewarding experience. The quality of the teaching, the extent to which individuals perceive that they are successful, and whether in the long term it is a positive experience will all contribute to the nature of any personal or social benefits.

Physical development, health and wellbeing

Rhythmic accompaniment to physical education enhances the development of physical skills.

Learning to play an instrument enhances fine motor co-ordination.

There may be particular health benefits for singing in relation to the immune system, breathing, adopting good posture, improved mood, and stress reduction. The research has been carried out with adults but these benefits could equally apply to children.

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Introduction

Recent advances in the study of the brain have enabled us to enhance our understanding of the way that active engagement with music influences other development. Although our knowledge of the way the brain works is still in its infancy some of the fundamental processes involved in learning have been established. The human brain contains approximately 100 billion neurons a considerable proportion of which are active simultaneously. Information processing is undertaken largely through interactions between them, each having approximately a thousand connections with other neurons. When we learn there are changes in the growth of axons and dendrites and the number of synapses connecting neurons, a process known as synaptogenisis. When an event is important enough or is repeated sufficiently often synapses and neurons fire repeatedly indicating that this event is worth remembering (Fields, 2005). In this way changes in the efficacy of existing connections are made. As learning continues and particular activities are engaged with over time myelinisation takes place. This involves an increase in the coating of the axon of each neuron which improves insulation and makes the established connections more efficient. Pruning also occurs, a process which reduces the number of synaptic connections, enabling fine-tuning of functioning. Through combinations of these processes, which occur over different time scales, the cerebral cortex self-organises in response to external stimuli and the individual's learning activities (Pantev et al., 2003).

Extensive active engagement with music induces cortical re-organisation producing functional changes in how the brain processes information. If this occurs early in development the alterations may become hard-wired and produce permanent changes in the way information is processed (e.g. Schlaug et al., 1995). Permanent and substantial reorganisation of brain functioning takes considerable time. Long years of active engagement with particular musical activities in Western classical musicians are associated with an increase in neuronal representation specific for the processing of the tones of the musical scale, the largest cortical representations being found in musicians playing instruments for the longest periods of time (Pantev et al., 2003). Changes are also specific to the particular

musical learning undertaken (Munte et al., 2003). Processing of pitch in string players is characterised by longer surveillance and more frontally distributed event-related brain potentials attention. Drummers generate more complex memory traces of the temporal organisation of musical sequences and conductors demonstrate greater surveillance of auditory space (Munte et al., 2003). Compared with non-musicians, string players have greater somatosensory representations of finger activity, the amount of increase depending on the age of starting to play (Pantev et al., 2003). Clearly, the brain develops in very specific ways in response to particular learning activities and the extent of change depends on the length of time engaged with learning. The extent of musical engagement and its nature will be important factors in the extent to which transfer can occur to non-musical activities.

The ways that we learn are also reflected in specific brain activity. When students (aged 13-15) were taught to judge symmetrically structured musical phrases as balanced or unbalanced using traditional instructions about the differences (including verbal explanations, visual aids, notation, verbal rules, playing of musical examples), or participating in musical experiences (singing, playing, improvising or performing examples from the musical literature), activity in different brain areas was observed (Altenmuller et al., 1997). The tools and practices utilised to support the acquisition of particular musical skills have a direct influence on brain development and preferred approaches to undertaking musical tasks, also influencing approaches to tasks outside music. Musicians with similar observable skills may have developed different approaches to developing them which may or may not facilitate transfer to other tasks.

Each individual has a specific 'learning biography' which is reflected in the way the brain processes information (Altenmuller, 2003:349). As individuals engage with different musical activities over long periods of time permanent changes occur in the brain. These changes reflect what has been learned and how it has been learned. They will also influence the extent to which developed skills are able to transfer to other activities.

Transfer of learning

The transfer of learning from one domain to another depends on the similarities between the processes involved. Transfer between tasks is a function of the degree to which the tasks

share cognitive processes. Transfer can be near or far and is stronger and more likely to occur if it is near. Salomon and Perkins (1989) refer to low and high road transfer. Low road transfer depends on automated skills and is relatively spontaneous and automatic, for instance, processing of music and language, using the same skills to read different pieces of music or text. High road transfer requires reflection and conscious processing, for instance, adopting similar skills in solving very different kinds of problems. Some musical skills are more likely to transfer than others. For instance, the musical skills more likely to transfer are those concerned with perceptual processing of sound (temporal, pitch, and rule governed grouping information), fine motor skills, emotional sensitivity, conceptions of relationships between written materials and sound (reading music and text), and memorisation of extended information (music and text) (Schellenberg, 2003; Norton et al., 2005).

The aim of this paper is to consider what we know about the ways that transfer can occur in relation to the skills developed through active engagement with music and how they may impact on the intellectual, social and personal development of children and young people. The paper synthesises indicative research findings and considers the implications for education.

Perceptual and language skills

Music has long been argued to provide effective experiences for children to develop listening skills in mainstream schools and those for children with learning difficulties (Hirt-Mannheimer, 1995; Wolf, 1992; Humpal and Wolf, 2003). Research is now able to offer explanations as to why this might occur. When we listen to music or speech we process an enormous amount of information rapidly without our conscious awareness (Blakemore and Frith, 2000). The ease with which we do this depends on our prior musical and linguistic experiences. This knowledge is implicit, learned through exposure to particular environments, and is applied automatically whenever we listen to music or speech. Speech and music share some processing systems. Musical experiences which enhance processing can therefore impact on the perception of language which in turn impacts on reading.

Musical training sharpens the brain's early encoding of sound leading to enhanced performance (Tallal and Gaab, 2006; Patel and Iverson, 2007) improving the ability to distinguish between rapidly changing sounds (Gaab et al. 2005), and enhancing auditory

discrimination (Schlaug et al.,2005). This has an impact on the cortical processing of linguistic pitch patterns (Schon et al., 2004; Magne et al, 2006).

The influence of musical training emerges quickly. Eight year old children with just 8 weeks of musical training differed from controls in their cortical event related potentials (ERPs) (Moreno and Besson, 2006). Flohr et al. (2000) provided music training for 25 minutes for 7 weeks for children aged 4-6 and compared measured brain activity with controls. Those children who had received musical training produced EEG frequencies associated with increased cognitive processing.

Playing a musical instrument triggers changes in the brainstem not only the cortex (Musacchia et al., 2007). Musicians have been found to have earlier brainstem responses to the onset of a syllable than non-musicians and those playing since the age of 5 have quicker responses and increased activity of neurons in the brain to both music and speech sounds. Musicians also have high-functioning peripheral auditory systems. The quality of sensory encoding is related to the amount of musical training (Wong et al., 2007).

Early studies found correlations between the performance of first grade children on tests of phonemic and musical pitch awareness. The ability to perceive slight differences in phonemes seemed to depend on the ability to extract information about the frequencies of the speech sounds (Lamb and Gregory, 1993). Recent studies have confirmed that having musical skills predicts the ability to perceive and produce subtle phonetic contrasts in a second language (Slevc and Miyake, 2006) and the reading abilities of children in their first language (Anvari et al., 2002). It also enhances the ability to interpret affective speech rhythms (Thompson et al. 2004). Speech makes extensive use of structural auditory patterns not based on pitch but timbre based differences between phonemes. Musical training seems to develop these skills.

Studies with pre-school children have found relationships between musical skills, the manipulation of speech sounds (Peynircioglu et al., 2002), and phonological awareness and reading development (Anvari et al., 2002). Gromko (2005) studied kindergarten children who received 4 months of music instruction for 30 minutes once per week. The instruction included active music-making and kinaesthetic movements to emphasise steady beat, rhythm and pitch as well as the association of sounds with symbols. The children who received the

music instruction showed significantly greater gains in phonemic awareness when compared to the control group. Learning to discriminate differences between tonal and rhythmic patterns and to associate their perceptions with visual symbols seems to have transferred to improved phonemic awareness.

Humans are able to recognise a melody transposed in frequency easily. This skill may be related to its importance in spoken intonation. A listener needs to be able to hear the similarity of intonation patterns when spoken in different pitch registers. Speech processing requires similar processing to melodic contour and is one of the first aspects of music to be discriminated by infants (Trehub et al., 1984). The two seem to be processed by the same brain mechanisms (see Patel, 2009). Magne et al. (2006) compared 8 year old children who had musical training with those who did not and found that the musicians outperformed non-musicians on music and language tests. The study showed that in the neural basis of development of prosodic and melodic processing pitch processing seemed to be earlier in music than in language. The authors concluded that there were positive effects of music lessons for linguistic abilities in children.

Overall, the evidence suggests that engagement with music plays a major role in developing perceptual processing systems which facilitate the encoding and identification of speech sounds and patterns, the earlier the exposure to active music participation and the greater the length of participation the greater the impact. Transfer of these skills is automatic and contributes not only to language development but also to literacy.

Literacy

The role of music in facilitating language skills contributes to the development of reading skills. An early study where music instruction was specifically designed to develop auditory, visual and motor skills in 7-8 year old students over a period of 6 months, found that the mean reading comprehension scores of the intervention group increased while those of the control group did not (Douglas and Willatts, 1994). Similarly, Gardiner et al. (1996) provided children with seven months of Kodaly training alongside visual arts instruction. Their reading scores were compared with controls and were found to have shown greater improvement.

Phonological awareness is linked to early reading skills in 4-5 year old children (Anvari et al., 2002) and moderate relationships have been found between tonal memory and reading age (Barwick et al., 1989), although finding the main and subsidiary beats in a musical selection has not been found to be a significant predictor of reading in 3rd and 4th grade students (Chamberlain, 2003). Several studies have found no difference in reading between children receiving musical training and controls (e.g. Lu, 1986; Montgomery, 1997; Bowles, 2003; Kemmerer, 2003), although Butzlaff (2000) in a meta-analysis of 24 studies found a reliable relationship. While overall, the research shows a positive impact of musical engagement on reading, differences may be explained by the nature of the children's prior and current musical experiences and their already developed reading skills. If language skills are well developed already, musical activity may need to focus on reading musical notation for transfer benefits to occur in relation to reading. There may also be other factors which need to be taken into account. For instance, Piro and Ortiz (2009) focused on the way that learning the piano might impact on the development of vocabulary and verbal sequencing in second grade children. 46 children who had studied piano for 3 consecutive years participated as part of an intervention programme, while 57 children acted as controls. At the end of the study, the music learning group had significantly better vocabulary and verbal sequencing scores. However, they had already been playing the piano for two years but with no differences in reading between their skills and those of the control group. The authors suggested a number of reasons for this: because it takes a long time for effects to be felt; because the age of tuition is important; or because the summer holidays prior to testing may have lowered initial their scores. There may also have been changes in the nature of the tuition and the development of fluency in reading music which impacted on transfer. Overall, there do seem to be benefits for engaging in musical activities in relation to reading beyond those associated with language development but our understanding of these processes is currently limited.

Some studies have focused on children who are experiencing difficulties with reading. Nicholson (1972) studied students aged between 6- 8 categorised as slow learners. After music training the experimental group exhibited significantly higher reading scores scoring in the 88th percentile versus the 72 percentile. After an additional year of musical training the reading scores of the experimental group were still superior to the control group's scores. Movsesian (1967) found similar results with students in grades 1, 2, and 3.

Rhythmic performance seems to be an important factor in reading development. Atterbury (1985) found that reading-disabled children aged 7-9 could discriminate rhythm patterns as well as controls but were poorer in rhythm performance and tonal memory than normal-achieving readers. Long (2007) found that very brief training (10 minutes each week for 6 weeks) in stamping, clapping and chanting in time to a piece of music while following simple musical notation had a considerable impact on reading comprehension in children experiencing difficulties in reading. There are also indications from a range of sources that rhythmic training may help children experiencing dyslexia (Thomson, 1993; Overy, 2000, 2003). Overy (2003) found that children with dyslexia have difficulty with rhythmic skills (not pitch) and that tuition focusing on rhythm had a positive effect on both phonological and spelling skills in addition to musical abilities.

One way in which music instruction may help reading in addition to those relating to more general perception, timing and language skills is that it increases verbal memory. Chan et al. (1998) showed that learning to play a musical instrument enhanced the ability to remember words. Adult musicians had enlarged left cranial temporal regions of the brain, the area involved in processing heard information. Those participants in the study with musical training could remember 17% more verbal information that those without musical training. Ho et al. (2003) supported these findings in a study of 90 6-15 year old boys. Those with music training had significantly better verbal learning and retention abilities, further, the longer the duration of music training the better the verbal memory. A follow up study concluded that the effect was causal. There were neuro-anatomical changes in the brains of children who were engaged in making music.

Much less attention has been paid to the influence of active engagement with music on writing than reading. An exception was a study where children from economically disadvantaged homes participated in instruction which focused on the concepts of print, singing activities and writing, The children in the experimental group showed enhanced print concepts and pre-writing skills (Standley and Hughes, 1997). Register (2001) replicated this work with a larger sample of 50 children. Results again showed significant gains for the music-enhanced instruction in writing skills and print awareness.

Numeracy

Historically, it has long been assumed that there is a strong connection between music and mathematics (Vaughn, 2000). Musicians playing from notation are constantly required to adopt quasi-mathematical processes to sub-divide beats and turn rhythmic notation into sound. However, this type of activity is not related to all aspects of mathematics. Transfer is only likely to occur when the skills required are 'near'. This is supported by a recent study which showed that children receiving instruction on rhythm instruments scored higher on part-whole maths problems than those receiving piano and singing instruction (Rauscher et al., submitted).

Research exploring the relationships between mathematics and active musical engagement has had mixed results. For instance, Geoghegan and Mitchelmore (1996) investigated the impact of a music program on the mathematics achievement of preschool children. The group of children involved in musical activities scored higher on a mathematics achievement test than the control group, although home musical background may have been a confounding factor. Gardiner et al. (1996) researching the impact of an arts programme also found that participating children performed better in mathematics than those who did not, those participating the longest having the highest scores overall. A study using a national US data base also found positive effects for engagement with music. Catterall et al. (1999) using the NELS:88 data compared low socio-economic status students who exhibited high math proficiency in the 12th grade and found that 33% were involved in instrumental music compared with 15% who were not involved. Focusing on children learning to play an instrument, Haley (2001) found that those who had studied an instrument prior to 4th grade had higher scores in mathematics than those in other groups. However, Rafferty (2003) found no effect of the Music Spatial-Temporal Maths Program on the mathematics achievement of second graders. The contradictory outcomes of the research might be explained by the types of musical activities engaged in and the length of time spent.

Addressing these issues, Cheek and Smith (1999) examined whether the type of music training was related to mathematics achievement in 8th grade. Those who had two or more years of private lessons had higher scores, while those learning keyboard instruments had higher scores than those learning other instruments. Length of engagement were considered by Whitehead (2001) who found that middle and high school students who were placed in high, moderate and no treatment groups for music instruction differed in mathematics gains,

the high involvement children showing the greatest gains. Overall, the evidence suggests that active engagement with music can improve mathematical performance, but the nature of this relationship, the kinds of musical training needed to realise the effect, the length of time required and the specific types of mathematical problems which are affected need further investigation.

Intellectual development

One of the first studies to consider the role of music in children's intellectual development was undertaken by Hurwitz et al. (1975). First-grade children were assigned to one of two groups. An experimental group received Kodaly music lessons for five days each week for seven months, a control group did not. At the end of the study, the experimental group scored significantly higher than the control group on three of five sequencing tasks and four of five spatial tasks. No statistically significant differences were found for verbal measures, although the children in the experimental group had higher reading achievement scores than those in the control group which were maintained after two academic years.

During the 1990s there was a resurgence of interest in these issues which had as a particular focus the impact of active engagement with music on spatial reasoning, an element of intelligence tests. In a typical study, Rauscher et al. (1997) assigned children from three pre-school groups to music, computer or no-instruction groups. The instruction groups received tuition in keyboard and group singing, group singing alone or computer lessons. Singing was for 30 minutes daily. The children in the keyboard group scored significantly higher in the spatial recognition test. Since then, several studies have confirmed that active engagement with music has an impact on visual-spatial intelligence (Gromko and Poorman, 1998; Bilhartz et al, 2000; Graziano et al., 1999; Orsmond and Miller, 1999; Rauscher and Zupan, 2000; Rauscher, 2002; Costa-Giomi, 1999). A review of 15 studies Hetland (2000) found a 'strong and reliable' relationship and concluded that music instruction leads to dramatic improvements in performance on spatial-temporal measures. She commented on the consistency of the effects and likened them to differences of one inch in height or about 84 points on the SAT (p 221). The consistency of these findings suggests a near transfer, automated effect perhaps related to the skills acquired in learning to read music.

Other research has focused on more general manifestations of intelligence. Bilhartz et al. (2000) studied the relationship between participation in a structured music curriculum and cognitive development in 4-6 year olds. Half of the children participated in a 30 week 75 minute weekly parent-involved music curriculum. Following this, children were tested with 6 sub-tests of the Stanford-Binet intelligence test and the Young Child Music Skills Assessment test. There were significant gains for the music group on the music test and the Stanford-Binet Bead Memory subtest. Adopting a cross sectional approach, Schlaug et al. (2005) compared 9-11 year old instrumentalists with an average of 4 years training with controls. They showed that the instrumental group performed significantly better than the control group on musical audiation, left hand index finger tapping rate, and the vocabulary subtest of the WISC-III. Strong non-significant trends were seen in the phonemic awareness test, Raven's Progressive Matrices, and the Key Math test. Schellenberg (2004) randomly assigned a large sample of children to four different groups, two of which received music lessons (standard keyboard, Kodaly voice) for a year, the control groups receiving instruction in a non-musical artistic activity (drama) or no lessons. All four groups exhibited increases in IQ as would be expected over the time period but the music groups had reliably larger increases in full scale IQ with an effect size of .35. Children in the control groups had average increases of 4.3 points while the music groups had increases of 7 points. On all but 2 of the 12 subtests the music group had larger increases than control groups. Catterall and Rauscher (2008) argue that the gains seen in more general IQ are likely to be the result of specific gains in visual-spatial intelligence but there may also be effects related to enhanced development of language and literacy skills.

A key issue arising from this research is what kinds of musical activity bring about change in particular kinds of intellectual development and why. The research reported above has been based on children's participation in a variety of musical activities, some offering a broad musical education, others focused more closely on instrumental tuition. To begin to address these questions, Rauscher et al. (2007) explored the impact of different types of musical activity in at risk preschool children. Five groups received piano, singing, rhythm, computer or no instruction for two years. The three music groups scored higher following instruction than the control groups on mental imagery tasks but the scores of the rhythm group were significantly higher than all other groups on tasks requiring temporal cognition and mathematical ability. The findings from this study suggest that it is rhythmic training which is important for the development of temporal cognition and mathematics (see Rauscher, 2009

for further discussion), while developing enhanced perceptual skills in relation to pitch and melody supports language development, although rhythm emerges as important in relation to literacy. Overall, taking these findings together it would appear that active engagement with making music can have an impact on intellectual development. What requires further research is the specific types of musical participation which develop skills which transfer automatically to other areas and what are the common features of these skills.

General attainment

Most of the research examining the relationship between general achievement and active engagement with music has been based on correlations. Evidence from the USA has shown that students who participate in music education do better than their peers on many measures of academic achievement. Using data relating to over 13,000 students from the National Centre for Educational Statistics, Morrison (1994) reported that high school students who participated in music reported higher grades in English, math, history, and science than those who did not participate. Johnson and Memmott (2006) studied 4,739 elementary and middle school students in 4 regions of the USA and revealed a strong relationship between elementary (3rd and 4th grade) students' academic achievement as measured by test scores and their participation in high-quality music programmes. Similar effects were found by Trent (1996) and Cararelli (2003), although Schneider and Klotz (2000) comparing enrolment in music performance classes or athletic extracurricular activities and academic achievement found that all groups were equivalent in the 5th and 6th grade but during the 7th, 8th and 9th grades the musicians achieved significantly higher academic achievement scores than the athletes but not than the non-participant controls. Several literature reviews support the overall trend of these findings (see Arnett-Gary, 1998; Shobo, 2001; Yoon, 2000) and Hodges and O'Connell (2007) further point out that being excused from non-music classes to attend instrumental lessons does not adversely affect academic performance.

One of the difficulties with this research, however, is that participating in musical activities may be related to other factors which promote academic attainment, for instance, having supportive parents and a home environment conducive to studying. A recent study, adopting more complex and sensitive statistical modelling (Southgate and Roscigno, 2009) using national data sets was able to overcome the difficulties experienced by early correlational

studies. Three measures of music participation were used: in school, outside school and parental involvement in the form of concert attendance. Two nationally representative data sources ECLS-K (20,000 US kindergarten students) and NELS:88 (25,000 adolescents) were used. Music involvement was found to vary systematically by class and gender status, and such involvement had implications for both mathematics and reading achievement and for young children and adolescents. However, associations between music and achievement persisted even when prior achievement was taken into account. There was evidence of social class variation in within-school music involvement in adolescents but not in early childhood, while the effects of class on parental music involvement were strong and consistent in both samples. Southgate and Roscigno suggested that this was likely to be related to resource issues. As a mediator of educational outcomes music involvement was significant for both mathematics and reading achievement. It generally increased achievement levels although gains were not distributed equally among all students, a white student advantage existed. This may relate to the type of musical activity engaged in and the opportunities afforded the students for performance which may contribute to enhanced self-esteem and increased motivation.

Of the experimental studies that have been carried out on the effects of participation in music on general attainment, two indicated a positive effect (Barr et al., 2002; Hoffman, 1995), while Hines (2000), studying students with learning difficulties from kindergarten through to 9th grade found neither reading or mathematics achievement were affected by type of music instruction, motoric or non-motoric. Legette (1993) also found no effect of music instruction.

Overall academic attainment depends on the development of literacy and numeracy skills which have been discussed earlier. Motivation is also crucial in how well children perform at school. Motivation is closely linked to self-perceptions of ability, self-efficacy and aspirations (Hallam, 2005). If active engagement with music increases positive perceptions of self, this may transfer to other areas of study and increase motivation to persist. This may account for some of the conflicting evidence relating to general attainment and will be discussed later.

Creativity

Researchers have paid less attention to the impact of music on creativity than other types of learning. Simpson (1969) studying 173 high school music and 45 non-music students found that the music students scored higher on several elements of the Guildford's tests of creativity. Wolff (1979) studied the effects of 30 minutes of daily music instruction for an entire year on first graders. Those participating exhibited significant increases in creativity and in perceptual motor skills compared with controls. Kalmar (1982) studied the effects of singing and musical group play twice weekly for three years on pre-school children of 3-4 years of age and found that these children scored higher than controls on creativity, had higher levels of abstraction, and showed greater creativity in improvised puppet play. They also demonstrated better motor development. High school and university music students scored higher on tests of creativity than none music majors, this being particularly marked in those with more than 10 years of music education (Hamann et al., 1990). A further study compared music students with those whose experiences included theatrical and visual arts. The music students exhibited greater creativity than controls but no effects were found for the visual arts. The greater the number of units of music classes the greater the creativity (Hamann et al., 1991). Other major national reports on the arts have emphasised their importance in developing a range of transferable skills including those related to creativity and critical thinking (NACCCE, 1999).

The development of creative skills is likely to be particularly dependent on the type of musical engagement. This is supported by recent work. Koutsoupidou and Hargreaves (2009) studied 6 year olds comparing those who had opportunities for musical improvisation with those where music lessons provided no opportunities for creativity. Performance on Webster's measures of Creative Thinking in Music assessed change in extensiveness, flexibility, originality, and syntax. The improvisation activities significantly supported the development of creative thinking as opposed to the didactic teaching. To enhance creativity music lessons may need to be based on creative activities. This is an area where further research is required.

Social and personal development

Research on the impact of participation in music on social and personal development tends to be based on self-report, either questionnaires or interviews. It has received less attention than

the impact on intellectual development and attainment, despite the fact that the effects on achievement may in part be mediated by an increase in social and cultural capital. For instance, Broh (2002) showed that students who participated in musical activities talked more with parents and teachers, and their parents were more likely to talk with friends' parents. She concluded that these social benefits were likely to lead to higher self-esteem in the children in turn leading to increased motivation and self-efficacy. A study by the Norwegian Research Council for Science and Humanities supported this finding a connection between having musical competence and high motivation which led to a greater likelihood of success in school (Lillemyr, 1983). There were high correlations between positive self-perception, cognitive competence score, self-esteem, and interest and involvement in school music. Whitwell (1977) drew similar conclusions and argued that creative participation in music improves self-image, self-awareness, and creates positive self-attitudes. Similar findings have been found with urban black middle school students (Marshall, 1978) and children of low economic status (Costa-Giomi, 1999). It would appear that success in music can enhance overall feelings of confidence and self-esteem increasing motivation for study more generally.

Research in Switzerland showed that increasing the amount of classroom music within the curriculum did not have a detrimental effect on language and reading skills despite a reduction in time in these lessons (Spychiger, et al., 1993; Zulauf, 1993) and there was an increase in social cohesion within class, greater self-reliance, better social adjustment and more positive attitudes in the children. These effects were particularly marked in low ability, disaffected pupils (Spychiger, et al., 1993). Harland (2000) showed that the most frequent overall influences on pupils derived from engagement with the arts in school were related to personal and social development. In music there were perceived effects relating to awareness of others, social skills, well-being and transfer effects. Variations in response between schools related to the degree of musical knowledge and experience that the pupils brought to the school curriculum. Some students perceived the benefits of music classes in being listening to music and the development of musical skills while others referred to the sheer fun and therapeutic nature of music, how it gave them confidence to perform in front of others, how it facilitated group work and how it enabled them to learn to express themselves. Those who played instruments mentioned an increase in self-esteem and sense of identity. Tolfree and Hallam (in preparation) also reported a sense of achievement, increased confidence and the provision of an alternative means of communicating feelings for children aged 9-17 in

relation to playing an instrument. They also spoke of enjoying playing with friends and the frustrations that they felt when practising alone when they were unable to get things right.

Two studies researched the perceived benefits of school band participation in the USA. The benefits included accomplishment, appreciation, discipline, fun, active participation and maturing relationships (Brown 1980). 95% of parents of non-band participants believed that band provided educational benefits not found in other classrooms and 78% agreed that band was more educational than extra-curricular. Band directors talked in general terms about the benefits of discipline, teamwork, co-ordination, development of skills, pride, lifetime skills, accomplishment, cooperation, self-confidence, sense of belonging, responsibility, self-expression, creativity, performance, companionship, building character and personality, improving self-esteem, social development and enjoyment. In a follow up study (Brown, 1985), 91% of non-band parents, 79% of non-band students, 90% of drop-out band parents and 82% of drop out band students agreed that participating in a band builds self-esteem, self confidence and a sense of accomplishment. Similarly, in the UK, peripatetic instrumental teachers working in schools reported considerable benefits of learning to play an instrument including the development of social skills; gaining a love and enjoyment of music; developing team-work; developing a sense of achievement, confidence and self-discipline; and developing physical co-ordination (Hallam and Prince, 2000).

Being involved in the extra-curricular rehearsal and performance of a school show has been shown to facilitate the development of friendships with like-minded individuals and make a contribution to social life through a widespread awareness of the show by non-participants (Pitts, 2007). Such participation increased pupils' confidence, social networks and sense of belonging, despite the time commitment which inevitably impinged on other activities. Research in the USA has also shown that involvement in group music activities in the high school helps individuals learn to support each other, maintain commitment and bond together for group goals (Sward, 1989). Reflecting on previous and current group music making activities, university music students reported benefits in terms of pride in being an active contributor to a group outcome, developing a strong sense of belonging, gaining popularity and making friends with 'like-minded' people, enhancement of social skills, and the development of a strong sense of self-esteem and satisfaction. Students also reported enhanced personal skills facilitating the students' personal identity and encouraging the development of self-achievement, self-confidence and intrinsic motivation. A further study

with non-music students who had previously participated in musical groups established similar benefits but there was a greater preoccupation with the impact of group music making on the self and personal development. Students reported that active involvement in music helped them develop life skills such as discipline and concentration and provided an outlet for relaxation during demanding study periods (Kokotsaki and Hallam, 2007; in preparation). In a study of 84 members of a college choral society, 87% indicated that they had benefitted socially, 75% emotionally, and 49% spiritually. Meeting new people, feeling more positive, and being uplifted spiritually were all referred to (Clift and Hancox, 2001).

Within small musical groups the social relationships and the development of trust and respect are crucial for their functioning (Davidson and Good, 2002; Young and Colman, 1979). For long-term success rehearsals have to be underpinned by strong social frameworks as interactions are typically characterised by conflict and compromise related mainly to musical content and its co-ordination, although some interactions are of a more personal nature (e.g. approval). (Young and Colman, 1979; Murningham and Conlon, 1991) The smaller the group the more important personal friendship seems to be.

In adolescence, music makes a major contribution to the development of self-identity. Teenagers listen to a great deal of music (Hodges and Haack, 1996). In the UK, typically almost three hours a day (North et al., 2000). They do this to pass time, alleviate boredom, relieve tension, and distract themselves from worries (North et al., 2000; Zillman and Gan, 1997; Tolfree and Hallam, in preparation). Music is seen as a source of support when young people are feeling troubled or lonely, acting as a mood regulator, helping to maintain a sense of belonging and community (Zillman and Gan, 1997). Its affect on moods at this time can be profound (Goldstein, 1980). It is also used in relation to impression management needs. By engaging in social comparisons adolescents are able to portray their own peer groups more positively than other groups in their network and are thus able to sustain positive self-evaluations. Music facilitates this process (Tarrant et al., 2000).

In addition to developing personal and social skills, music may also have the capacity to increase emotional sensitivity. Resnisow et al. (2004) found that there was a relationship between the ability to recognise emotions in performances of classical piano music and measures of emotional intelligence which required individuals to identify, understand, reason with and manage emotions using hypothetical scenarios. The two were significantly

correlated which suggests that identification of emotion in music performance draws on some of the same skills that make up everyday emotional intelligence.

While it is clear from the research outlined above that music can have very positive effects on personal and social development, it must be remembered that the research has largely focused on those currently participating in active music making not taking account of those who have not found it an enjoyable and rewarding experience. The quality of the teaching, the extent to which individuals experience success, whether engaging with a particular type of music can be integrated with existing self-perceptions, and whether overall it is a positive experience will all contribute to whether there is a positive impact on social and personal development.

Physical development, health and wellbeing

Recent concerns about health and well-being in populations have led to an increase in research exploring the impact of the arts and music. Some work has focused in particular on physical development in children, some on more general issues concerned with well-being. Research has established that using rhythmic accompaniment to support physical education programmes improves performance. Anshel and Marisi (1978) observed positive results in performance accuracy and endurance when music was rhythmically synchronised with motor performance and Painter (1966) found similar results. Beisman (1967) found that throwing, catching, jumping and leaping improved when children participated in a programme involving rhythm, while Brown et al. (1981) also found that an integrated music and PE programme improved pre-schoolers motor performance more than movement exploration. Derri et al. (2001) investigated the effect of a 10 week music and movement programme on the quality of locomotor performance in children of 4-6 years and found that the experimental group improved on galloping, leaping, horizontal jump and skipping. A further study showed that the programme compared favourably with free play activities (Deli et al., 2006). There is also evidence that learning to play an instrument improves fine motor skills (Schlaug et al., 2005).

There has recently been a surge of interest in the specific benefits of singing to health and well-being. Almost all of this research has been carried out with adults an exception being the work of Ashley (2002) who studied choir boys aged 10-14 singing in a major city centre

parish church. The boys showed deep appreciation of and engagement with music and exhibited many aspects of personal wellbeing including the social competence to combat a macho male culture. In a study of young people who were members of a university choir, Clift and Hancox (2001) found that 58% reported having benefited in some physical way, 84% responding positively in relation to health benefits mainly referring to lung function, breathing, improved mood, and stress reduction. Further analysis identified 6 dimensions associated with the benefits of singing – well-being and relaxation, benefits for breathing and posture, social benefits, spiritual benefits, emotional benefits, and benefits for heart and immune system (Clift and Hancox, 2001). In a review of the literature, Clift et al. (2008) considered five studies which had used the immune system marker salivary immunoglobulin as a measure of the immune system's effectiveness. Four reported increase in this antibody associated with singing (Kreutz et al, 2004; Kuhn, 2002; Beck et al., 2000; 2006).

Reviews of the research with adult singers have concluded that there are a range of health and well-being benefits of participating in a choir. There is every reason to suppose that these benefits would also apply to children. The benefits include: physical relaxation and release of physical tension; emotional release and reduction of feelings of stress; a sense of happiness, positive mood, joy, elation, and feeling high; a sense of greater personal, emotional and physical well-being; an increased sense of arousal and energy; stimulation of cognitive capacities – attention, concentration, memory and learning; an increased sense of self-confidence and self-esteem; a sense of therapeutic benefit in relation to long-standing psychological and social problems; a sense of exercising systems of the body through the physical exertion involved, especially the lungs; a sense of disciplining the skeletal-muscular system through the adoption of good posture; being engaged in a valued , meaningful worthwhile activity that gives a sense of purpose and motivation (Clift et al, 2008; Stacey et al., 2002).

Studies of adults have shown other physical benefits of engaging with music. Playing the piano exercises the heart as much as a brisk walk (Parr, 1985) and there are lower mortality rates in those who attend cultural events, read books or periodicals, make music, or sing in a choir (Bygren, Konlaan & Johnansson, 1996; Konlaan, Bygren and Johansson, 2000; Johansson, Konlaan and Bygren, 2001; Hyyppa and Maki, 2001). Music making has also been shown to contribute to perceived good health, quality of life, and mental well-being (Coffman and Adamek, 1999; Vanderark et al, 1983; Wise et al., 1992; Kahn, 1998).

Endnote

This overview provides a strong case for the benefits of active engagement with music throughout the lifespan. In early childhood there seem to be benefits for the development of perceptual skills which effect learning language subsequently impacting on literacy which is also enhanced by opportunities to develop rhythmic co-ordination. Fine motor co-ordination is improved through learning to play an instrument. Music also seems to improve spatial reasoning, one aspect of general intelligence which is related to some of the skills required in mathematics. While general attainment is clearly affected by literacy and numeracy skills, motivation which depends on self-esteem, self-efficacy and aspirations is also important in the amount of effort given to studying. Engagement with music can enhance self-perceptions but only if it provides positive learning experiences which are rewarding. This means that musical experiences need to be enjoyable providing challenges which are also attainable. Teaching needs to generate an environment which is supportive and sufficiently flexible to facilitate the development of creativity and self-expression. Group music making is also beneficial to the development of social skills and can contribute to health and well-being throughout the lifespan and can therefore contribute to community cohesion providing benefits to society as a whole.

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Playing musical instruments can improve a child's mind

Learning to play a musical instrument can help children to learn languages by increasing the brain's sensitivity to sounds including speech.

By Nick Collins
Published: 7:30AM GMT 22 Feb 2010

Tests revealed that exposure to music can be beneficial to the brain in its developmental stages

Music lessons could have a direct impact on a child's ability to learn languages by affecting the mind's sensitivity to all sounds, scientists have claimed.

Tests revealed that exposure to music can be beneficial to the brain in its developmental stages, and would have advantages for all children, including those who are dyslexic and autistic.

Researchers at Northwestern University in Chicago, America, established a link between musical ability and the capacity of the nervous system to take in sound patterns.

Professor Nina Kraus, who led the team, said playing an instrument had an impact on automatic processing in the brainstem, the lower section of the brain which governs breathing, the heartbeat and reaction to sounds.

She said: "Playing music engages the ability to extract relevant patterns, such as the sound of one's own instrument, harmonies and rhythms, from the 'soundscape.

"Playing an instrument may help youngsters better process speech in noisy classrooms and more accurately interpret the nuances of language that are conveyed by subtle changes in the human voice."

A National Autistic Society spokeswoman said many children with autism respond well to music.

She said: "It seems that music can help children to communicate and interact with those around them, relax or to express emotions."

Playing musical instruments may improve reading

Learning to play a musical instrument could help to improve children's reading and their ability to listen in noisy classrooms, according to new research.

By Richard Gray, Science Correspondent
Published: 9:00PM GMT 20 Feb 2010

The part of the brain that interprets sound, known as the auditory cortex, responds faster in people with musical training and is better primed to pick out subtle patterns from the huge volumes of information that flood into the brain from our senses.

Neuroscientists have found that musicians benefit from heightened brain activity that allows them to process information from their eyes and ears more efficiently than non-musicians. They found that the part of the brain that interprets sound, known as the auditory cortex, responds faster in people with musical training and is better primed to pick out subtle patterns from the huge volumes of information that flood into the brain from our senses.

Professor Nina Kraus, a neuroscientist and amateur musician at Northwestern University in Evanston, Illinois, has also found that this part of the brain plays a crucial role in reading.

Speaking at the annual meeting of the American Association for the Advancement of Science in San Diego on Saturday, she called for music to become a more important part of school syllabuses to help children develop better reading and language skills. She said: "There is a strong argument for more musical education, especially in schools.

"Our eyes and ears take in millions of bits of information every second and it is not possible for the brain to process all of that, so the sensory systems in our brains are primed to tune into regularities or patterns in the signals it receives.

"People who are musically trained are better at picking up these patterns because they learn to recognise notes and pitches within melodies and harmonies. The better you are at picking up these patterns in music, the better reader you are. This makes sense as letters and words on a page are really just patterns."

Professor Kraus and her team have used a method known as electroencephalography, which measures electrical activity in the brain, to examine how musicians and non-musicians brains respond to different stimulus. She found that people who are better at picking out harmonies and timing in sounds are also better at reading.

Preliminary findings, which are still to be published, have also shown that musicians are better at reading. She is currently conducting a major study of children in schools in Chicago to test whether musical training can improve their reading skills.

She has also shown that musicians are better at picking out speech in noisy environments such as restaurants and classrooms because their brains are primed to distinguish notes within melodies and harmonies. She said: "Musical experience can enhance everyday listening and language tasks. We are making new strides in understanding what changes happen in the brain with musical experience."

Dr Aniruddh Patel, a neuroscientist at the Neurosciences Institute in San Diego, California, added: "Music and language have a lot more interactions than anyone had previously thought and have real implications for treating people with language problems."