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The impact of music on child functioning

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Abstract

This article provides a review of empirical studies on the effects of music education on cognitive, social-emotional, and motor functioning of children. Twenty-one studies published in peer-reviewed journals in the period 1995 – 2011 that met the inclusion criteria were identified. Eighteen of these studies focused on cognitive functioning. All of them, with three exceptions, reported positive or moderate positive effects. All reviewed studies on social-emotional and motor functioning showed positive effects of music education. The authors conclude that exposure to music and music education can have a positive influence on child functioning. However, given the diversity in research design among the different studies the jury on how robust these effects are and how they can be explained is still out. (Quasi-)experimental studies need to be conducted, compliant with standards for scientific research. Only then, undeserved claims can be refuted and the surplus value of music education can be demonstrated.

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1. Introduction: For a long time, music educators have suggested that music, either in the form of music education, music practice, or exposure to music, can have a significant impact on school achievement, school attendance rates and students' conduct, both in elementary and secondary education (Koopman, 2005; Waller, 2007). Educational scientists have addressed the question of what effects music education can have on child development from a research point of view. Some researchers claim to have found effects on cognitive growth, such as the increase of the ability to concentrate and academic achievement. Also effects in the social and emotional domain have been reported (Bastian, 2002; Elliott, 1995; Gardner, 2004). From a large-scale longitudinal study Bastian (2002) arrived at the conclusion to have identified a significant improvement of social competencies, an increase of motivation to learn, a significant improvement of IQ, and the ability to concentrate as a result of enhanced music education, consisting of playing Orff-instruments, recorder lessons, lessons on other musical instruments, and special music projects.

Understandably, musicians and music educators point at studies like these to underpin the importance of music education. The leading organization in the United States of America, The National Association for Music Education (NAfME, before MENC), goes even further by putting on its website under 'Facts and Figures' the 'The Benefits of the Study of Music' "The study of music helps to achieve: success in society; success in school and learning; success in developing intelligence; success in life." Claims like these are supported with statements of opinion leaders, among them president John F. Kennedy, who said in 1962: "The life of the arts, far from being an interruption, a distraction, in life of the nation, is close to the center of a nation's purpose – and is a test to the quality of a nation's civilization" (MENC, 2009).

1.1 Previous review studies

Waterhouse (2006) wrote a critical review on multiple intelligence, the Mozart effect, and emotional intelligence. As to the Mozart effect, that is to say the effect of music exposure on intelligence, the available evidence did not support the belief that the Mozart effect is a mechanism that can improve spatial skills without practice or emotional arousal. The evidence disconfirming the Mozart effect suggested that there is no effect at all. The evidence confirming the Mozart effect, however, suggested that certain compositions of Mozart may be a pleasant means of inducing emotional arousal and may thus provide a brief improvement in spatial-temporal skills precisely because it induces such arousal. Waterhouse (2006) also argued that it may be that cortical arousal stimulated by music can prime cortical circuits for spatial processing where the circuits for music and spatial processing overlap. In sum she concluded: "The evidence to date does not justify advocating music as means to improve spatial skills 'for free.' The Mozart effect theory should not be taught without consideration of the disconfirming evidence or without consideration of the possibilities of the mechanisms that may underpin the Mozart effect (Waterhouse, 2006, p. 216)."

Eady and Wilson (2004) studied the effects of music education and concluded in their literature review of the influence of music appreciation and music performance on students' learning performance, that several studies and observations show a possibly positive impact of music on both academic achievement and study skills. Eady and Wilson emphasized popular music and music technology. Various studies and observations indicated that music can influence learning in core subjects (such as language and mathematics) as well as contribute to the attainment of core goals of learning.

Hallam (2010) concluded in her review on the power of music education that positive effects of active engagement with music on personal and social development only occur if it is an enjoyable and rewarding experience. According to this author, this would have implications for the quality and methodology of teaching music:

“In early childhood there seem to be benefits for the development of perceptual skills which affect language learning and which subsequently impact on literacy. Opportunities to be able to coordinate rhythmically also seem important for the acquisition of literacy skills. Fine motor coordination is also 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.” (Hallam, 2010, p. 281/282).

In many studies on exposure to music, music therapy and music education, cognitive development is operationalized in terms of school academic achievement (Slijper, 1998; Waller, 2007). Research has been done to the effects of music therapy in residential settings and special education. In a meta-analysis in which 12 studies had been used to investigate the influence of music therapy interventions on academic achievement Slijper (1998) reported about 1606 subjects in total with a mean age of around 11 years old. A total of 794 subjects attended a form of music therapy, while the control group consisted of 812 subjects. The main research question was: “Can music help to increase one’s academic performance, and if so, is there a dose-response relationship?” The analysis of this study shows that music therapy had a small but significant effect on academic achievement. The interventions in the reviewed studies were similar to the ones that are used in regular educational settings (Kodály (Houlahan & Tacka, 2008), arts enriched programs, using background music, et cetera), while the control groups got no treatment at all, or were offered a non-music program. Because of the nature of these interventions it is likely to assume that the positive outcome of this study would be similar in regular educational settings.

Gold, Voracek & Wigram (2004) performed a meta-analysis on the size of effects of music therapy for children and adolescents with a wide range of psychopathology (developmental delay, disorders in psychological development, emotional disturbance, et cetera). They examined how the size of the effect of music therapy had been influenced by the type of pathology, client’s age, music therapy approach, and type of outcome. In this meta-analysis 11 studies were incorporated with a total of 188 subjects. The effect sizes were combined with weighting for sample-size, and their distribution was studied. After exclusion of an extreme positive outlying value, the analysis revealed that music therapy had a medium to large positive effect (ES .61) on clinically relevant outcomes, that was statistically highly significant ($p < .001$) and statistically homogeneous. The authors found no evidence of publication bias. Effects tended to be greater for behavioral and developmental disorders than for emotional disorders; greater for eclectic, psychodynamic, and humanistic approaches than for behavioral models; and greater for behavioral and developmental outcomes than for social skills and self-concept. However, considering the specific pathological conditions in these studies, it is questionable if these highly positive effects of music therapy interventions for children with a psychopathology may be translated to regular educational situations.

Based on the two literature reviews and two meta-analyses discussed above we may

conclude that music education, music therapy and exposure to music can have a positive effect on child functioning. However, the studies analyzed in these review still seem limited in their scope and subjects, and were undetermined as to the content of the musical interventions. Although the reviews above may be taken as suggesting a possible relationship between music and performance, it is still unclear whether this relationship can be maintained for regular education in families and schools in general. Moreover, a number of reviews also report negative results with regard to the influence of music on human functioning (Jones & Zigler, 2002; Waterhouse, 2006).

2. Problem Statement: Music education and exposure to music by listening or active music making would make children smarter and would have a positive influence on children's social-emotional skills, motor development and even improve their chance for success in society. The question is if these claims find support in available scientific studies.

3. Research Questions: However strong the rhetorical power of statements and claims in favor of music (education) may be, the question that remains to be answered is: can statements be substantiated with evidence, acquired through scientific research conducted in accordance with quality criteria for such research? In other words: "What are the empirically demonstrated effects of music education on social, emotional, cognitive and motor functioning of children?"

4. Purpose of the Study: In this article the available scientific evidence for the effects of music exposure and music education programs on functioning of children and youth, grosso modo defined in this article as the age group of 3-18 years old, on cognitive, social-emotional and motor functioning is reviewed. In general terms, cognitive functioning refers to one's ability to learn, remember, reason, solve problems, and make sound judgments (cognitive intelligence) and the acquisition and retention of mental representation of information and the use of this representation as the basis for behavior. Social-emotional functioning refers to the ability that enables an individual to interact and communicate appropriately and competently in a given social context. Motor functioning refers to the changes in motor skills that occur over an entire lifespan, which reflect the development of muscular coordination and control and are also affected by personal characteristics, the environment, and interactions of these two factors (see APA-dictionary, VandenBos, 2007).

The authors of this review are aware of the fact that a broad variety of interventions is included under the term music education. Music education can be defined as encompassing three categories of interventions: 1) exposure to music, 2) music instruction, and 3) music therapy. The formats of these interventions will be described later in this review.

The present review describes the impact of exposure to music and music education in formal educational settings. The main goal of this review is to provide a summary of the available scientific evidence for the effect of music education, music practice, and exposure to music on social-emotional, cognitive and motor functioning of children.

5. Research Methods The main goal of this literature review is to provide an overview of the available scientific evidence for the effect of music education on child functioning for children in the age group of 3 through 18 years old, based on studies published in peer reviewed journals in the

period 1995 – 2011. The selection of studies for this review focused on studies into effects of music education, either as music instruction, music exposure, or music therapy, on cognitive, social-emotional and motor functioning.

5.1 Literature search

The following scientific databases were consulted: ERIC, EBSCO and Academic Search Elite, as well as the internet search machines www.google.com, www.scirus.com en www.picarta.nl. Searches have been conducted only for publications in the English language. The keywords used were the following: “music”, “development”, “functioning”, “social skills”, “emotional skills”, “academic skills”, “academic achievement”, “academic performance”, “effect”, “learning success”, “Mozart effect”, “music task performance”, “perceptual motor development”, “cognitive development”, “affect” and “intellectual development”. These keywords have been used in all possible combinations.

5.2 Inclusion criteria

For inclusion in the review, studies had to meet all of the following criteria:

- 1 | The study concerned an intervention that is designated as either music instruction, exposure to music, or music therapy.
- 2 | The study used an experimental or quasi-experimental research design with a control or comparison group. Correlational studies were excluded.
- 3 | At least one of the described interventions must have a musical character, which means that the intervention concerned a form of music education, music therapy, or music exposure.
- 4 | Aspects of cognitive, social-emotional and/ or motor functioning were examined as dependent variables in the study.
- 5 | The subjects involved fell within the age range 3 – 18 years.
- 6 | The study had been published in the period 1995 – 2011.
- 7 | The language of the study had to be English.
- 8 | The study has been published in a peer reviewed journal or appeared as an ‘unpublished doctoral dissertation’².

5.3 Selected studies

The number of studies that met the inclusion criteria was 21. They form the research units in this review. The studies have been rated, respectively scored on a series of aspects by the authors of this review:

- 1 | Main objective or research question;
- 2 | Sample (*N*, student age, group, gender)

² One exception had been made: Bastian, H.G. (2002). *Musik(erziehung) und ihre Wirkung. Eine Langzeitstudie an Berliner Grundschulen*, Mainz: Schott. This study is included as it tries to answer the same research question as ours and represents a long-term and large-scale study. Given these characteristics of the study, we consider it an exceptional kind of study that we didn't want to exclude from the review for the reason that it fails on just one criterion.

- 3 | Research design (experimental/ quasi-experimental/ within subject design/ randomization/ pre-, post-, follow-up);
- 4 | Measures;
- 5 | Outcomes/ findings reported by the authors.

5.4 Independent variable: intervention formats

The major independent variable is the intervention format. The intervention format used to promote students' cognitive, social-emotional and motor functioning was categorized in the following three ways: exposure to music, music instruction, and music therapy.

Exposure to music. In a total of nine interventions (43%) subjects were exposed to music in order to measure their task performance. In three studies participants were randomly assigned to music conditions and tested after each condition (Ivanov & Geake, 2003; McKelvie & Low, 2002; Schellenberg, Nakata, Hunter & Tomoto, 2007). In five studies subjects were exposed to music and/ or background sound (favorite music (Abikoff, Courtney, Szeibel & Koplewicz, 1996), background music (Furnham & Stephenson, 2007; Hallam & Price, 1998; Hallam, Price & Katsarou, 2002), background sound & music (Furnham & Strbac, 2002)). The one intervention on motor functioning (Palmer & Meyer, 2000) used four sets of eight isochronous (constant-duration) sequences to test a transfer-for-learning task.

Music instruction. Music instruction was the most common strategy (52% (11) of the 21 interventions) used in the included studies included in this review. Music instruction can be divided in classroom-based music instruction (eight of 11 interventions), group music teaching (two of 11 interventions) and individual music lessons (one of 11 interventions). In all cases specialized music teachers conducted the music instruction. The nature of the interventions was diverse: Kodaly (Geoghegan & Michelmore, 1996); Montessori bells (Eastlund Gromko & Smith, 1998); Individual piano lessons (Costa-Giomi, 1999); Orff (Bilhartz, Bruhn and Olson, 2000; Bolduc, 2009); Increased in-school music instruction: additional vocal ensemble participation time, learning to play the recorder, exploring rhythm through percussion, and intro to music and technology (Rossini, 2000); Playing Orff-instruments, recorder lessons, instrumental lessons, special music projects (Bastian 2002); Music and movement (Zachopoulou, Tsapakidou & Derri, 2004); Instruction based on Jerome Bruner's theory of cognitive representation: singing songs, accompanied with simple body percussion or kinesthetic movement (Eastlund Gromko, 2005); Voice or keyboard lessons (Schellenberg 2004); Musical improvisation (Koutsoupidou & Hargreaves, 2009).

Music therapy. One intervention (Ulfarsdottir & Erwin, 2000) involved a short-term music therapy intervention, based on techniques of musical dialogues and improvisations. The children experimented with different rhythms, volume, sources and sound. They created their own instrumental music, as well as melodies and lyrics.

6. Findings: In the following section the general outcomes will be described briefly, following authors' descriptions in the published studies. Twenty-one studies were identified that met the inclusion criteria. Twenty of these studies focused on one area of functioning. Eighteen of the 21

selected studies focused on children's cognitive functioning. One of the 18 studies on cognitive functioning also examined the effects of music education on social-emotional functioning. One of the 21 studies solely addressed social-emotional functioning. Two of the 21 studies described the effects of music education on motor functioning of children.

Most studies, namely 15 of 21, date from the period 2000 – 2007. The vast majority is Anglo-Saxon and conducted in North America (10) and the United Kingdom (7). Of the remaining four studies one came from Germany, two from Australia, and one from Greece.

Eight of the 21 studies concern an intervention with children in the age of 3 - 6 years old. Eleven studies deal with an intervention for children in the age of elementary education 6 - 12 years, one study regards to the age group 12 - 18 years. And one study regards to the age group 4 - 12 years.

The total number of subjects included in this literature review is 1750. Two of the included studies had less than 25 subjects. Five studies had between 25 and 50 subjects. Two studies had between 50 and 75 subjects. Five studies had between 75 and 100 subjects, and seven studies had more than 100 subjects. In the following section we report the outcomes of the identified studies on different dimensions.

6.1 Cognitive functioning

Eighteen of the 21 identified studies were intervention studies that focused on cognitive functioning. These studies can be divided into three categories: 1) studies in which the influence of music is studied in relation to the academic performance of children (Bastian, 2002; Bolduc, 2009; Eastlund Gromko, 2005; Geoghegan & Mitchelmore, 1996; Rossini 2000); 2) studies with regard to enhancement of cognitive task performance (including the so called "Mozart effect") (Bilhartz et al., 2000; Costa-Giomi 1999; Eastlund Gromko & Smith Poorman, 1998; Hallam et al., 2002; Hallam & Price 1998; Ivanov & Geake, 2003; Koutsoupidou & Hargreaves, 2009; McKelvie & Low, 2002; Schellenberg, 2004; Schellenberg et al., 2007), and 3) intervention studies in which music has been investigated as facilitator of cognitive processes (Abikoff et al., 1996; Furnham & Stephenson, 2007; Furnham & Strbac, 2002). In this latter category, the extent to which music or sound distracts children from a given assignment is examined. Difference between the second and third group of studies consists in their focus: the second group concentrates on the direct positive effects of music and sound on cognitive task performance, while the third group focused on the facilitation of cognitive processes by mitigating the influence of existing cognitive impediments.

Of the studies that reported on the influence of music on cognitive development, the majority, i.e. eight of 18 studies (Abikoff et al., 1996; Bastian, 2002; Bilhartz et al., 2000; Bolduc, 2009; Eastlund Gromko, 2005; Furnham & Strbac, 2002; Hallam & Price, 1998; Schellenberg et al., 2007) reported positive outcomes of the intervention; seven studies (Furnham & Stephenson, 2007; Geoghegan & Kitchelmore, 1996; Hallam et al., 2002; Koutsoupidou & Hargreaves, 2009; Ivanov & Geake, 2003; Rossini 2000; Schellenberg, 2004) reported a moderate positive outcome, and in three studies (Costa-Giomi 1999; Eastlund Gromko & Smith Poorman, 1998; McKelvie & Low, 2002) the intervention had no influence on the cognitive functioning of the children.

6.1.1 Academic performance

Of the five studies that investigated the effect of music education on academic performance Geoghegan and Mitchelmore (1996) investigated the impact of music education on mathematics

achievement in preschool children. Their intervention was based on Kodaly techniques, sequenced to concepts of pitch, dynamics, duration timbre and form, as well as skills in movement, listening, singing and organizing sound. The control group had no music intervention at all. The music intervention lasted for 10 months, one hour a week.

The initial scores of children in the experimental group on the Test of Early Mathematics Ability-2 were higher than the children in control group. For further analysis the experimental group was divided into two groups: children with music at home and children without music at home. Musical experiences at home (listening to their own music collection, and listening to a family member singing to the child) and other pre-existing differences (not specified by the authors of the study) may have contributed to group differences. There was no difference in mathematics achievement between the control group and the experimental group without music at home. However, the experimental group with music at home scored higher in mathematics achievement than the experimental group without music at home. This finding, however, might also indicate a stimulating home environment in this group that goes beyond the domain of music.

Rossini (2000) investigated whether increased in-school music instruction would positively affect students' achievement levels as measured by an achievement test in reading, language arts, and mathematics. Increased music instruction in this study meant additional vocal ensemble participation time, musical instruction on learning to play the recorder (both practice and performance), exploring rhythms through percussion instruments and an introduction to music and technology through the use of computers and specific software.

The outcomes of this study indicated there was possibly some benefit of the increased music instruction. However, the results remain inconclusive due to the fact that specific links between subjects were not clearly defined. Rossini also determined that while some increase in achievement levels was established for students in the research group, their scores were not significantly higher than those of the students in the comparison group. Qualitative evidence showed a need for increased cooperative planning among regular classroom teachers and music specialists. Overall, we have to conclude there was no demonstrable effect of the increased music instruction.

From his 6-year research project Bastian (2002) concluded that children who attended music education at the age of 8 through 11 years old showed significantly better results with regard to school subject matters such as spelling and arithmetic, compared to children without extended music education ($N = 170$). The music education program offered to the experimental group included singing, playing Orff instruments, recorder lessons with the whole class or in smaller groups. From grade 3 (about 8 years old) children could follow instrumental lessons, and special music projects were conducted. In the experimental group the music program was conducted by a music specialist. The control group only got one or two hours music education a week as prescribed by law. These music lessons were conducted by the classroom teacher.

Besides the influence of music education on academic achievement, Bastian's participants were subjected to intelligence tests. The results of these tests confirmed the hypothesis that children benefited from music education and developed faster in arithmetic, abstract reasoning and general development. For children with an average IQ, no significant difference in development was found during the first years of the elementary school between the experimental and control group. However after five years at school and four years of extensive music lessons, the children in the

experimental group showed a significantly higher IQ. The IQ of children in this group with an above average IQ from the start, improved more noticeably after 4 years of lessons in solo- and ensemble playing than that of comparable children from the control group without comprehensive music education. Bastian concluded that the development of children who were socially weak and backward in IQ (having a lower IQ than average) also benefited from extended music education. Their IQ increased with the years, what could not be concluded about the children with a low IQ in the control group. (Bastian, 2002, p. 278).

Bastian (2002, p. 343 ff) reported another significant finding with regard to the children's ability to concentrate, namely that children with the biggest concentration problems were in the control group. They had a demonstrably poorer concentration than the lowest scoring children in the experimental group. This in contrast with the beginning when the control group had a significant better percentile score than the experimental group. Bastian concluded from this that music education can help children with concentration problems. Music education can compensate the lack of concentration. The authors of this review, however, question the internal validity of these conclusions. Although the outcomes of this study are remarkable, it can not be excluded that activities other than the music intervention (e.g. Hawthorne-effect due to the long-term positive attention) could have had a positive effect on intelligence and concentration.

Eastlund Gromko (2005) conducted a study to determine whether music instruction was related to significant gains in the development of young children's phonemic awareness, particularly in their phoneme-segmentation fluency. Children in the experimental group received 4 months of music instruction, while the children of the control group received no music instruction. Music instruction in this study consisted of weekly sessions of 30 minutes conducted by advanced music-methods students, under supervision of the kindergarten teacher. The music treatment was based on Jerome Bruner's theory of cognitive representation (1966). At the heart of the music instruction the children learned to sing a new folk song, accompanied with simple body percussion or kinesthetic movement (dancelike movement to help children to organize their perception of musical sound in time and space). Finally, children touched a graphic chart while singing that consisted of, for example, clots to represent steady beat, squares and rectangles to represent word rhythms, or lines to represent melodic contour. Whereas beginning readers of text learn to connect sounds to graphemes or letters, beginning readers of music learn to connect perception of rhythm and pitch to graphic shapes that look the way sound goes.

An analysis of data revealed that the children who received music instruction showed significant greater gains in development of their phoneme-segmentation fluency. The results of this study supported a near-transfer hypothesis that active music making and the association of sound with developmentally appropriate symbols may develop cognitive processes similar to those needed for segmentation of a spoken word into its phonemes.

Bolduc (2009) conducted an intervention study in which the influence of music training programs on phonemic awareness skills of children was studied ($N = 104$). Phonemic awareness skills are a subset of phonological awareness skills in which listeners are able to hear, identify and manipulate phonemes, the smallest units of sound that can differentiate meaning. In this study, two interventions were compared. The experimental group was exposed to an adapted version of the Standley and Hughes music training program for children with special needs, which integrated some principles from the Orff Schulwerk's approach, but was for the most part inspired by studies in the fields of music therapy and music education. The four objectives of this program were: 1) to

give rise to skills related to song and instrumental interpretation; 2) to incite children's creativity; 3) to develop the musical receptivity of the children; and 4) to awaken the children's musical comprehension. In this program, emergent literacy, the reading and writing behaviors that precede and develop into conventional literacy, was achieved by analyzing lyrics, composing rhythmic rhymes, reading children's books associated with musical concepts (i.e. making instruments, meeting great composers) as well as writing words (i.e. songs or names of instruments).

The program of the control group was, at the music level, an equivalent of the experimental program. This program had three main competences: 1) inventing vocal or instrumental pieces that engaged pupils in age-appropriate activities of improvisation, arranging and composition; 2) introducing pupils to interpret musical pieces using a variety of vocal and instrumental repertoire of different eras; and 3) appreciating musical works, personal achievements and peer achievements. This curriculum also allowed pupils to experience various cultures through exposure to multicultural musical samples. Listening and creation activities (compositions, adaptations, et cetera) were meant to awaken the children's critical thought and aesthetic awareness.

Bolduc concluded that both music-training programs contributed similarly to the development of tonal and rhythmic perceptive skills. However, the experimental music-training program proved to be more effective when it came to developing phonological awareness skills ($F = 0.063$, $d.f. = 101$, $p < 0.01$). In conclusion, this article argued that auditory perception, phonological memory and meta-cognitive abilities play an essential role in the development of musical and linguistic skills.

6.1.2 Enhancement of cognitive task performance

There is also a number of studies that looked into the effect of specific forms of music on aspects of intelligence, in particular spatial reasoning. This has become well known as the so called Mozart effect. The Mozart effect refers to the phenomenon that people's spatial reasoning enhances after listening to music of Wolfgang Amadeus Mozart.

The Mozart effect was first documented in 1993 by Rauscher, Shaw & Ky. They conducted an experiment with 36 college students whereby a possible causality between music cognition and spatial reasoning performance was investigated. Students were assigned to 3 music conditions: 1) listening to a Sonata for 2 pianos in D major of W.A. Mozart (KV 448); 2) listening to relax instructions; and 3) silence. Each of the listening conditions lasted for 10 minutes. All students took part in each condition. The students were tested after each condition with a Stanford-Binet-Intelligence scale. Translated to spatial IQ, the results after listening to the piano Sonata were 119, 111 after relaxation and 110 after silence. Rauscher et al. (1993) found a remarkable and significant difference between the music condition and the other 2 conditions.

In line with the study of Rauscher et al. (1993), Bilhartz, Bruhn and Olson (2000) conducted a study into the effect of music and cognitive functioning of young children. However, they focused on the effect of early music training on child cognitive development. They also indicated a significant relation between participation in a structured music curriculum and cognitive development ($N = 71$). The results of this study underpinned the hypothesis that a significant relation exists between music education at a young age and cognitive development of specific non-musical skills. Even children in this study who received a minimum music intervention, scored significantly higher than children in the control group on one measurement with regard to abstract

reasoning ability, namely de Stanford-Binet Bead Memory subtest. The improvements were the biggest for the participants who fully attended the program. This link between the music intervention and memory (Bead Memory score) was of special importance because this subtest showed both spatial-temporal reasoning abilities and sequencing strategies. Both mental processes were speculatively described in terms of neural firing patterns necessary for performing activities, including music (Leng et al., 1990).

McKelvie and Low (2002) investigated the Mozart effect as documented by Rauscher, Shaw and Ky (1993) with 55 school-aged children between 11 and 13 years. Because music that sounds like the piano sonata of Mozart tended to reproduce the Mozart-effect. McKelvie and Low chose to use a completely different kind of music as a stimulus next to the music of W.A. Mozart, namely dance music of the band Aqua. The participating children were directed to 4 groups that were tested in 4 sessions. The groups were exposed to Mozart's music, or the music of Aqua as a music condition. There was no significant main effect of music and no significant difference between the pretest and post-test scores for both groups. Owing to the non-significant findings, a second experiment was carried out. The researchers used a methodology that had previously replicated the Mozart effect. Again, the second experiment did not support the claim that Mozart's music can enhance spatial performance. Groups performed similarly on the control test and the experimental test, irrespective of whether they listened to Mozart or to popular dance music. Although the two different designs produced similar findings, the data suggest that the Mozart effect is so ephemeral that McKelvie and Low (2002) question whether any practical application will come from it.

Also Ivanov and Geake (2003) tried to reproduce the Mozart-effect. Except for the reproduction of the effect, the researchers wanted to know if the Mozart effect could only be produced if children listened to music of W.A. Mozart. The 76 participants cooperating in this study were assigned to 3 conditions. In the first condition the participants listened to the Sonata in D, KV448 of W.A. Mozart. The second condition consisted of listening to a piano version of the Toccata in G major, BWV 916 of J.S. Bach. The third condition implied listening to background noise. This latter was the control group. Both the participating children from the first and the second condition performed significantly better than the children in the control group. The researchers believed that this study is the first study to find a Mozart effect for school children in a natural setting, in contrast to the original study of Rauscher, Shaw and Ky (1993) who examined the effects of listening to W.A. Mozart on the spatial task performance of university students in a laboratory setting. They also concluded that the Mozart effect is not only provoked by music of Mozart, but also by music of other composers.

Schellenberg, Nakata, Hunter & Tomoto (2007) conducted two experiments with regard to the Mozart effect on cognitive abilities. The first of the two studies was conducted with subjects between 18 and 23 years old and thus is beyond the scope of this review. The second experiment was conducted with 39 Japanese children at the age of 5 years old. They were tested on their creative abilities after exposure to music of Mozart, Albinoni or well-known children's music (listening or singing). Schellenberg et al. (2007) concluded from their study that the children exposed to well-known children's songs showed a longer enhancement compared with T_0 than children who had been children drawing after listening to music of Mozart or Albinoni. Their drawings were also considered more creative, energetic and technically driven, by adults, after listening or singing. The results didn't show significant differences between listening to well-known children's songs and the singing of these songs. Both ways were effective in enhancing the

creativity of young children. Schellenberg et al. (2007) concluded that the results indicated that 1) exposure to different types of music can enhance performance on a variety of cognitive tests; 2) these effects were mediated by changes in emotional state, and 3) the effects generalize across cultures and age groups.

The studies above studied the enhancement of cognitive task performance specifically related to the so called Mozart effect. The next four studies also investigated the enhancement of cognitive task performance, however regardless of the Mozart effect (Costa-Giomi 1999; Eastlund Gromko & Smith Poorman, 1998; Koutsoupidou & Hargreaves, 2009; Schellenberg, 2004).

Eastlund Gromko & Smith Poorman (1998) investigated the effect of music training on preschoolers' performance IQ. The experimental group received weekly music training during 6 months time. The children, all preschoolers from a private Montessori school that were in the experimental group received a 20-note set of songbells to keep at home for practice. Each week, children took a practice plan home, so parents could guide their children's practice. Every child received a tape of songs, to be played and sung between the music sessions.

A new song was presented in each session. The sessions were designed to involve the children's motor system in response to musical sound, to draw their attention to pitch and rhythmic aspects of songs, and to increase their memory for musical sound. Therefore, children sang the new song several times; accompanied their singing with body percussion; took turns playing a simplified version of the song on songbells or hand chimes; made a picture of the song using round stickers on a paper; and followed a tactile touch chart that outlined the contour of the song. In addition two familiar songs were danced and sung.

Regression of IQ gain scores on age showed significantly less gain for older children in the control group. A regression analysis showed that the relationship of Performance IQ to age was not significant for the experimental group. Slopes intersected at age 3. For 3-year-olds in this study, an intellectually stimulating environment, per se, results in a gain in ability to perform spatial-temporal tasks.

Costa-Giomi (1999) studied the relationship between music and cognitive abilities by observing the cognitive development of children provided, and not provided individual piano lessons. Each child in the experimental group received, at no cost, three years of piano instruction. The lessons were 30 minutes long during the first two years, and 45 minutes during the third year.

It was found that the treatment affected children's general and spatial cognitive development. The magnitude of such effects (omega squared) was small. Additional analysis showed that although the experimental group obtained higher spatial abilities scores in the Developing Cognitive Abilities Test after one and two years of instruction than did the control group. However, the groups did not differ in general or specific cognitive abilities after three years of instruction. The treatment did not affect the development of quantitative and verbal cognitive abilities.

Schellenberg (2004) conducted a study to test the hypothesis that music makes smarter. A large sample of children was randomly assigned to two types of music lessons (keyboard or voice) or to control groups that received drama lessons or no lessons. The lessons were taught for 36 weeks at the Royal Conservatory of Music in Toronto. Qualified instructors, in groups of six children, gave the lessons.

IQ was measured before and after the series of lessons. Compared with children in the control groups, children in the music groups exhibited greater increases in full-scale IQ. The effect was relatively small, but it generalized across IQ subtests, index scores, and a standardized measure of academic achievement. Unexpectedly, children in the drama group exhibited substantial pre- to post test improvements in adaptive social behavior that were not evident in the music groups.

A study with regard to the enhancement of cognitive task performance is conducted by Koutsoupidou & Hargreaves (2009). Koutsoupidou & Hargreaves investigated the effects of improvisation on the development of children's creative thinking in music. The study was conducted in a primary school classroom with two matched groups of 6-year-old children over a period of six months. The music lessons for the experimental group were enriched with a variety of improvisatory activities, while those in the control group did not include any improvisation. These lessons were didactic and teacher-centered. Children in the experimental group were offered several opportunities to experience improvisation through voices, their bodies, and musical instruments. Analysis of the data obtained with Webster's Measure of Creative Thinking in Music – MCTC revealed that improvisation affects significantly the development of creative thinking, in particular musical flexibility, originality, and syntax in children's music making.

6.1.3 Music as facilitator of cognitive processes

A separate category of intervention studies with regard to music and cognition is a group of four studies in which music is studied as an facilitator of cognitive processes. The studies in the section above on enhancement of cognitive task performance focused on the contingent positive effects of music on cognitive task performance. Studies below enquired the contingent negative effects of exposure to music. Can music be a facilitator of cognitive processes and mitigate obstructions of cognitive task performance? Music allegedly can have a cognitive effect on the performance of certain tasks e.g. academic task performance. The question is whether personality factors, such as introversion or extraversion, do have a moderating influence on this.

Abikoff, Courtney, Szeibel & Koplewicz (1996) studied the effect of listening to the favorite music of children on their academic performance. They studied this on children with attention-deficit/hyperactivity disorder (ADHD, $N = 40$). The tests were taken under experimental conditions: 1) 10 minutes music; 2) 10 minutes background speech; and 3) 10 minutes of silence. The results showed that children with ADHD who listened to music during the first condition had twice as many correct answers as compared to children with ADHD who listened to music as a second or third condition. It can be concluded that music has a significant positive effect on the academic performance for children with ADHD.

Hallam and Price (1998) investigated if the use of background music can improve the behavior and academic achievement of children with emotional and behavioral difficulties. They conducted a study with eight children at a school for children with emotional and behavioral difficulties.

The design of the study was counterbalanced with each student acting as his/ her own control. The first four trials were completed without background music, followed by four trials with background music. After one week the procedure was repeated in reverse order for three trials under each condition. The music for this study was selected based on previous research with children by Gilles (1991) as 'mood calming'. For each session two measures were recorded: the number of correctly completed mathematic problems, and the number of times rules were broken.

The effect of the music intervention was significant. There was a significant improvement in behavior and mathematics performance for all the children. The effects were particularly marked for those whose problems were related to constant stimulus seeking and over-activity. Improvements were also observed in improved cooperation and a reduction in aggression during the lessons immediately following the study.

Furnham and Strbac (2002) studied whether background noise would distract children in their performance as much as music does. In this study Furnham and Strbac also compared the performance of introverts versus extraverts in both conditions. Previous studies had found that introverts' performance on complex cognitive tasks were more negatively affected by distracters, e.g. music and background television, than by extraverts' performance. A reading comprehension task, a prose recall task and a mental arithmetic task was carried out by all 66 subjects. The data of this study showed that the performance of the children decreased in the presence of music and noise as compared to silence, but in the presence of music and noise extravert children performed better than introvert children. A significant interaction was found on the reading comprehension task only, although a trend for this effect was clearly present on the other two tasks. These outcomes supported Eysenck's hypothesis which holds that introverts have a lower level of optimum cortical arousal than extravert children, which influences their performance in the presence of music. Introverts and extraverts have different optimum levels of arousal, with introverts having a lower level and extraverts a higher level, thus it was expected that background music, which increases levels of arousal, could have a more negative affect on introverts as it causes them to be beyond their optimum functioning level. In contrast, extraverts, who have a higher level of optimum cortical arousal, will not exceed their optimum functioning level (Eysenck, 1981).

Hallam, Price & Katsarou (2002) explored the effects of music perceived as calming and relaxing on performance in arithmetic and on a memory task in two studies. In the second study by Hallam et al. (2002), the researchers selected music of which they expected it would be experienced pleasant or unpleasant, arousing, and aggressive by the 30 participants. The students were given the assignment to learn sentences by heart that were presented to them in written form from a booklet. Then, they were asked to add the missing sentences in this booklet. From the results, Hallam et al. draw the following conclusion: "The calming music led to better results on both tasks, compared with a non-music condition. Music perceived as arousing, aggressive and unpleasant disturbed the memory task and caused less altruistic behavior by children. The altruistic behavior by the children was assessed by means of a series of stories whereby the children were asked to choose an answer." The outcomes of this study suggest that the effects of music on the performance of a task is influenced indirectly via arousal and mood, rather than by directly affecting cognition. The type of background music played can be clearly defined by a group of listeners as calming and pleasant or arousing and unpleasant, it can have distinctive effects on task performance and the reporting intended altruistic behavior. Calming relaxing music can have a positive effect on for example problem solving, while music perceived as arousing, unpleasant and aggressive, can have a negative effect on task performance and led to a lower level of reported pro-social behavior (Hallam et al., 2002).

Furnham & Stephenson (2007) studied the nature of the interaction between the affective value of musical distraction, personality type and performance on the cognitive tasks of reading comprehension, free recall, mental arithmetic and verbal reasoning in children aged 11–12 years (*N*

= 118). It was hypothesized that the cognitive performance of extraverts would be significantly poorer when in presence of background music that had a positively affective value. It was predicted that the converse of this would be true for introverts and neurotic personality types.

The result of the study was not statistically significant ($t(62) = -9.19, p = .06$): the affective value of the distracter (positive versus negative) had no significant impact on the performance of the four cognitive tasks by extravert children. According to the authors, however, the outcome was close to significance and could be taken as an indication that the affective value of the distracter had some effect on the cognitive performance of extravert children.

6.2 Social-emotional functioning

Of the selected studies, two of the 21 focused on social-emotional functioning (Bastian, 2002; Ulfarsdottir en Erwin, 1999).

In their study on the influence of music on social cognitive skills, Ulfarsdottir and Erwin (1999) studied the question whether skills in interpersonal cognitive problem solving would improve by a short music therapy intervention in regular pre-schools. The music therapy program emphasized the techniques of musical dialogues and improvisation. The children experimented with different rhythms, volume and sources of sound. They created their own instrumental music, as well as melodies and lyrics. This study was conducted with 77 children in Iceland pre-schools. One class in each of two pre-schools was randomly allocated to one of two conditions. Participants in condition 1, the experimental condition ($N = 27$) received a short-term music therapy intervention. Condition 2 ($N = 33$) constituted a no-treatment control. Condition 3 ($N = 16$) was a comparison condition, consisted of a class of pre-schoolers in an institution with an established musical enrichment program.

No significant differences were observed in the control or intervention group between the pre- and post interventions assessments. However, a follow-up test showed a significant difference after seven months. The children who had attended the music therapy program, showed a significant improvement with regard to alternative solution thinking and consequential thinking, which appeared to generally underpin social adjustment, as compared to children in the control group. For the children in condition 3, the musically enriched pre-school, there was a highly significant difference in their alternative solution thinking and consequential thinking scores compared to children in the control group.

Besides the effect of music education on academic achievement Bastian (2002) also studied the influence of music education on children's social skills. Both the experimental group and the control group were subjected to sociometric research in which children were questioned about their factual and desirable interactions in the classroom. This yielded a bigger number of positive responses in the experimental group. From these outcomes, Bastian (2002, p. 310 - 311) concluded that the hypothesis was confirmed that music education can improve the social climate in a classroom and the school as a whole.

One and a half year after reaching these results, the ability to think over social situations in both the experimental as the control group had diminished. There was however a significant difference between both groups. At that moment in time, children in the control group scored about 70% under the average, while 51% of the children in the experimental group scored above or equal to the average (Bastian, 2002, p. 304 - 308). Bastian suggested that music forms an appropriate

means to handle feelings of aggression, pride and insecurity and supports a desire for independence.

6.3 Motor functioning

From the selected studies, two of the 21 focused on motor development. Palmer and Meyer (2000) studied motor development of young pianists. Zachopoulou, Tsapakidou & Derri (2004) studied a music and movement program.

Palmer and Meyer (2000) studied the motor independency for music performance in a transfer-of-learning task ($N = 16$). With a transfer-of-learning task is meant a task in which movement control is learned in one situation and transferred to another. This often provides insight into the contents of mental plans for actions (Schmidt & Young, 1987). Thereby they wondered if the mental plans for action, abstract or specific, were in terms of movement with which they are produced. Using 4 sets of 8 isochrone (constant-duration) sequences developed by the authors, the participants were assessed. A sequence is the immediate restatement of a motif or longer melodic (or harmonic) passage at a higher or lower pitch in the same voice. In this case a restatement of a melodic motive, played on the piano. Greatest effect of transfer was observed when the same conceptual relations were retained from training to transfer, regardless motor movements. More experienced child pianists showed transfer on both motor and conceptual dimensions; the least experienced demonstrated transfer only to sequences with identical motor and conceptual dimensions. These findings suggest that mental plans for action become independent of the required movements only at advanced skill levels.

Zachopoulou, Tsapakidou & Derri (2004) studied the effects of a developmentally appropriate music and movement program and an also developmentally appropriate physical education program of jumping and dynamic balance. 90 Children participated in this study. The students were randomly divided into two groups. The experimental group participated in a music and movement program, based on rhythmic education principles of the Orff approach, while the control group received physical education. Both groups were tested on their jumping and dynamic balance skills. The results showed that the experimental group had made a significant development on both jumping as dynamic balance. Zachopoulou et al. concluded that a developmentally appropriate music and movement program can have a positive effect on jumping and dynamic balance for preschool children.

7. Conclusions: Our review of the literature warrants the conclusion that overall child functioning is positively affected by music, either music exposure, or in-school music education. This effect is most convincingly demonstrated with regard to cognitive functioning. Of the 18 studies reviewed 15 indicated substantive to moderately positive effects on one or more cognitive parameters. Specifically positive effects have been found on enhancement of cognitive task performance, such as concentration and special task performance, on academic performance, and music as a facilitator of cognitive processes. Three studies (Costa-Giomi 1999; Eastlund Gromko & Smith Poorman, 1998; McKelvie & Low, 2002) showed no positive influence of music exposure or music education on the cognitive functioning of the children. Eastlund Gromko & Smith Poorman's study to the effect of music training on preschoolers' spatial-temporal task performance (1998) didn't show significant effects. Neither did the study done by Costa-Giomi (1999) into the relationship between

music and cognitive abilities by observing the cognitive development of children with or without individual piano lessons. McKelvie and Low (2002) performed two experiments to replicate the Mozart effect. Both experiments did not support the claim that Mozart's music can enhance spatial performance.

As to social-emotional functioning the picture that emerges is also that music exposure (Ulfarsdottir & Erwin, 1999) or music education Bastian (2002) has substantive to moderate effects on interpersonal problem solving, interactions in the classroom, and the ability to reflect upon social situations. However, the number of studies to substantiate such a conclusion on 2 studies in total is so small, that it has to be drawn with great caution. The more so, because these studies differ substantially from one another in design, intervention and outcome parameters.

The same can be said about the effect of music exposure or music education on motor functioning. Only two studies that met the inclusion criteria could be identified. Both studies showed positive effects of music education on motor independency (Palmer and Meyer, 2000), and jumping and dynamic balance (Zachopoulou, Tsapakidou & Derri, 2004).

In almost all studies reviewed, both those that focus on cognitive, social-emotional as well as on motor functioning, the positive effects of music exposure and music education either appeared to be short-lived or no follow-up data on the sustainability of effects were available. There is only one study (Bastian, 2002) that indicates long-term effects. Overall, with an exception for the studies on the Mozart-effect, the studies reviewed differ widely in terms of design, music intervention and measures applied. Besides the samples used are generally small.

Additionally, the wide diversity of music interventions used, is problematic. The review shows that there are almost as many types of music interventions as there are studies. Consequently there is little standardization. Furthermore written manuals for their implementation are virtually absent. This in and by itself makes it virtually impossible to identify effective ingredients or components of music interventions as well as dose-response relationships. As a result, proper replication, with an exception for the Mozart-effect, is absent. In addition, it can also not be excluded that certain effects observed, such as with regard to social-emotional development (e.g. positive effects on interpersonal problem solving), could and therefore should be more parsimoniously attributed to non-specific factors, such as group processes or Hawthorne effects, than to music education as such.

In summary, any conclusions regarding robust effects of music exposure and education on cognitive, social-emotional and motor development are premature. This does not mean that no such effects exist, but the present state of research has not been able yet to identify such effects in a reliable, valid and sustainable manner. One of the reasons for this state of affairs might be that the world of music educators and the world of rigorous scientific research have not combined forces enough and where they have, not profoundly enough. Such despite the fact that, as Levitin (2006) shows so eloquently in his treatise "This is your brain on music", music evolved in human's evolutionary history because it promotes cognitive development. Or to put it differently, the function of music for the child brain is that it prepares the brain for a number of cognitive and social activities (Cosmides & Tooby, 1989). Apparently, until now we have not been able to answer that essential question regarding music education, namely; "What does to Whom or What Where When How and Why?"

7. References:

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