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# Perspectives on the Potential Benefits of Children's Group-based Music Education

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**Abstract**

Recent empirical evidence suggests that attending individual instrumental training in music schools benefits the development of cognitive skills such as language and executive functions. In this article, we examine studies that have found these transfer effects provided by group-based music education in school and preschool contexts. We conclude that group-based music lessons may enhance children's language skills and possibly executive functions, but evidence for the impact of music activities on intelligence—as measured by nonverbal intelligence tests—or long-term prosocial abilities is scarce. Although the beneficial effects of music on language skills and executive functions are small, they seem to be discernible. However, we do not know if they apply to all children or only to, for example, children who enjoy engaging in musical activities. We suggest that group-based music education should be part of the national school and preschool curricula, because of both the enjoyment of learning music-related skills and the impact it may have on children's general learning. In parallel, we encourage new empirical longitudinal projects to be launched, enabling further investigations into the promises of music.

**Keywords**

Executive functions, intelligence, language, music education, prosocial skills

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## Introduction

Music—whether listening to or practicing it—brings positive experiences and well-being to human beings, irrespective of age and culture, according to the World Health Organization (WHO) (Fancourt & Finn, 2019). In addition to offering enjoyment and enhancing music-related skills, an abundant body of recent research has suggested that engaging in musical activities enhances other skills that are not related to music, such as language skills, executive functions, social skills, and intelligence (Bugos & DeMarie, 2017; Cirelli et al., 2014; François et al., 2013; Jaschke et al., 2018; Kirschner & Tomasello, 2010; Linnavalli et al., 2018; Moreno et al., 2009; Schellenberg, 2004; Schellenberg et al., 2015) (for a recent review, see Ilari, 2020).

Pioneering correlational studies have shown that musicianship is reflected in brain function and structure (Bangert & Schlaug, 2006; Bermudez et al., 2009; Gaser & Schlaug, 2003; Koelsch et al., 1999; Pantev et al., 1998; Schlaug et al., 1995; Schneider et al., 2002; Tervaniemi et al., 2001). More recent longitudinal research has also suggested that music training can induce these structural and functional brain changes (Habibi et al., 2017; Herdener et al., 2010; Hyde et al., 2009; Kraus & Strait, 2015; Putkinen et al., 2014; for a review, see Putkinen & Tervaniemi, 2018). The musician's brain seems to differ structurally from the nonmusician's brain in, for example, the auditory

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cortex, corpus callosum, primary motor areas, anterior superior parietal area, and inferior temporal gyrus (Gaser & Schlaug, 2003; Schlaug et al., 1995; Schneider et al., 2002), and areas such as precentral gyrus, auditory cortex, and corpus callosum have shown plasticity related to music training in childhood (Habibi et al., 2017; Hyde et al., 2009). Because each of these areas is also involved in other than music-related neuronal processing (e.g., visuospatial and speech processing, planning and execution of movements), it seems reasonable to conclude that the enlargement of brain structures and improvement of neural connections because of music training may—at least to some extent—affect other skills processed by the same areas and neuronal networks. This perspective presents the basis for transfer effects, which is a form of skill training from one domain generalizing over to another domain. Although the definitions seem to differ slightly according to the resource, *near transfer* refers to the situation where specific skill training improves skills in a closely related area (rehearsing a tune facilitates playing another tune), whereas *far transfer* suggests that training a specific skill improves abilities in a more distant domain (e.g., practicing music improves nonmusical abilities, such as executive functions) (Barnett & Ceci, 2002). Regarding education, the possible transfer effects of music—or other nonacademic activities—are a topical issue. If researchers can find new ways of supporting children's development, it may benefit not only the children and their families, but also society.

In the present article, we examine the studies providing group-based music training for typically developing children and contemplate some empirically confirmed and some speculated behavioral effects of music training on four cognitive domains: language, executive functions, intelligence, and prosocial skills. The inspected studies have implemented music training in school or preschool environments. Additionally, in some cases, we also have inspected such interventions that, because of their feasibility, could be implemented in these school contexts.

## Correlation and Causality in Experimental Music Studies

There is often confusion about the level of generalizability and implications of the obtained data; thus, it is important to make a distinction between correlational and causal studies. Typically, correlational studies are made with a cross-sectional design that cannot reveal the reasons behind the possibly found differences in the measured features. However, longitudinal intervention studies can trace the lines of causality behind the studied features but must also be interpreted with caution. In follow-up studies, the main difficulty lies in controlling for all the essential factors, for example, family background, school/preschool environment, and possible prior musical experience, all of which may influence the studied effects. However, it is often seen that the correlational results are announced as a proof for causality, even by researchers (as pointed out by Schellenberg, 2020) and especially by media; thus, the correct interpretation of individual studies relies on the reader.

Cross-sectional studies have found that children attending private music lessons or other teacher-led music activities show better phoneme processing skills, reading development, vocabulary, and verbal memory (Corrigall & Trainor, 2011; Forgeard et al., 2008; Ho et al., 2003), higher self-reported beliefs of one's own academic abilities (Degé & Schwarzer, 2017; Degé et al., 2014), enhanced executive functions (Degé et al., 2011; Zuk et al., 2014), and higher scores on intelligence tests (Forgeard et al., 2008; Schellenberg, 2011) than their peers who do not participate in such regular musical activities. Nevertheless, it is essential to remember that this does not necessarily mean that the causes for the detected differences lie in music training. As has been pointed out (Albert, 2006; Corrigall et al., 2013; Swaminathan et al., 2017), the individuals engaging in institutional instrument training typically come from families representing higher socioeconomic status (SES) than their peers not attending to such activities. This higher SES, in turn, largely accounts for the higher scores in tests measuring intelligence, executive functions, and language skills (Bradley & Corwyn, 2002; Fernald et al., 2013; Skoe et al., 2013). Thus, to disentangle the effects of background variables, such as SES and music training, longitudinal studies with carefully balanced comparison groups (including active control group), a long enough follow-up period, and carefully conducted analyses are crucial. In these studies, (randomly) divided groups are provided with different activities or lessons (i.e., interventions), for example, music lessons or sports training, that last from, for example, 2 weeks to as long as several years. If the groups differ in their measured properties after but not before the intervention and if all the essential factors are controlled for, this suggests that one intervention boosts the measured abilities more than the other.

Research from the past 20 years using longitudinal settings has reported causal connections between music training and cognitive functions in children. Some of these connections seem to be already fairly well documented, such as the causal association between music training and language skills (Bhide et al., 2013; Degé & Schwarzer, 2011; Flaugnacco et al., 2015; François et al., 2013; Linnavalli et al., 2018; Moreno et al., 2009; Nan et al., 2018; Overy, 2003; Roden et al., 2012; Slater et al., 2014); these studies show improvement in different domains of language, such as reading and literacy, phoneme awareness, segmenting speech sounds, verbal intelligence, verbal memory, and rapid naming after interventions lasting from 4 weeks to 2 years. Somewhat fewer studies suggest that music training impacts executive functions, namely inhibition, planning, cognitive flexibility, and working memory (e.g., Bugos & DeMarie, 2017; Jaschke et al., 2018; Shen et al., 2019), boosts social skills (Cirelli et al., 2014;

Kirschner & Tomasello, 2010; Rabinowitch et al., 2012; Schellenberg et al., 2015), and has an effect on intelligence (Costa-Giomi, 1999; Kaviani et al., 2014; Schellenberg, 2004).

### *Schools and Preschools as Premises for Music Activities*

Schools—and in some countries, also preschools—are optimal premises for offering children music activities. Children's home environments vary substantially, and all caregivers do not sing and play with their children or provide them with training in music institutions. If music lessons are provided in schools, all children can engage in music activities. Depending on the national educational culture, the amount and quality of music teaching in schools and preschools may differ substantially. If the local policies support having music lessons in these institutions, however, it might be possible to invest in training teachers and, via this, provide all children with high-quality music lessons. The same applies to preschools in those countries that offer low-cost day care and early childhood education to all families.

Here, we focus on studies that have received considerable attention over the past 20 years. The selected studies have provided group-based music interventions for typically developing children between 4 and 11 years of age and have mostly provided these interventions with such an intensity that makes it possible to implement the music program in the children's daily curricula in the school and preschool environments. Some schools have offered music lessons several times a week for a few weeks, while some have provided training only once a week, here lasting for months or even years. The group size in the interventions varies a lot, ranging from small (4–6 children) to large (24 children), while some studies even fail to report this.

The chosen interventions have focussed on active music making, such as teacher-led singing, playing simple instruments, and the training of specific skills linked to specific musical aspects, such as discriminating pitches and harmonies and repeating rhythms. The interventions did not include orchestral playing or focus on knowledge-related aspects of music, such as music theory or history.

Instead of weighting the received positive and negative results on transfer effects, we concentrate on studies reporting far-transfer effects and contemplate the studies' quality. All the inspected studies are listed in Table 1.

## Effects of Music Lessons on Children's Language Development, Executive Functions, Intelligence and Prosocial Skills

### *Language*

As discussed, several longitudinal studies have reported the causal effects of music education on typically developing children's phoneme awareness, vocabulary, reading and literacy, rapid naming, and verbal memory (Degé & Schwarzer, 2011; François et al., 2013; Linnavalli et al., 2018; Moreno et al., 2009; Nan et al., 2018; Roden et al., 2012). These interventions have offered children extra music activities lasting from 20 weeks to 2 years and have been implemented in school or preschool curricula. Three of these studies were conducted in preschools and the other three in schools.

Degé and Schwarzer (2011) conducted a study in 5–6-year-old preschool children ($N = 41$), who were randomly assigned to a music group, a sports group, and a group that practiced phonological skills. The intervention sessions lasted for 10 min daily, and the music sessions included, for example, joint singing, joint drumming, rhythmic exercises, meter execution, and dancing. After 20 weeks, both the music group and group in the phonological skills program outperformed their peers in the test for phonological awareness. There were no differences in SES between the groups. The limitation of this study is the small sample size, which diminishes the power of the study.

In China, Nan et al. (2018) provided 4–5-year-old children with music or reading training in small groups of 4–6 children, testing the children's ($N = 74$) word discrimination skills before and after the intervention. The children were pseudo-randomly divided into three groups so that the groups did not differ statistically in age, gender, and SES variables or in their general cognitive measures. The piano group received teaching in musical theory: notes, rhythm, and notation. During the lessons, the children listened, discriminated against, and recognized the notes and played the piano both with and without accompanying CD records. There were no requirements for practicing outside the class. After 6 months of the intervention, the music group outperformed both the reading and passive control groups in consonant discrimination. The pseudo-randomized design and high number of participants are the strengths of this study. Regarding preschool environments, the excessive amount of instrumental or reading training (45 min, three times a week) diminishes the feasibility of such lessons in the curricula, at least for those preschools that follow some national early childhood pedagogy plan.

Linnavalli et al. (2018) found that even existing practices, such as professionally taught music playschool, may support children's linguistic development. Their study ($N = 66$) showed that a weekly 45-min group music lesson held in preschools enhanced 5–6-year-old children's phoneme processing skills and vocabulary knowledge more than similarly provided dance lessons. This improvement became apparent after 2 years of participation in music playschool. The strength of this study was that instead of comparing groups, the conducted analyses took into account the number of months that the individual child had participated in the music or dance lessons, along with their socioeconomic background. The music playschool lessons included joint singing, clapping, playing games along with

**Table 1.** Longitudinal studies showing far-transfer effects of group music interventions.

| Study | Research design | Participants | Prior music training (PMT) / music aptitude (MA) | Duration, intensity and group size of music activities | Data analyses | Enhanced by music activities |
|---|---|---|---|---|---|---|
| Bugos & DeMarie, 2017 | Randomized controlled trial (RCT) comparing music or Lego training.<br>SES asked, not compared between the groups. | $N = 34$<br>4–5 years | No PMT<br>MA measured: similar between groups | 6 weeks<br>2 x 45 min/week<br>No information about the group size in interventions | rANOVA<br>Predictors: group, time<br>Dependent: test scores and reaction time | Inhibition and visual discrimination:<br>Matching Familiar Figures Test (Egeland & Weinberg, 1976) |
| Degé & Schwarzer, 2011 | RCT study comparing three groups: phonological, music, sports training<br>No difference in SES between groups. | $N = 41$<br>5–6 years | PMT not asked<br>MA not measured | 20 weeks<br>10 min daily<br>5–7 children in intervention groups | rANOVA<br>Predictors: group, time<br>Dependent: test scores | Phonological Awareness:<br>Bielefelder Screening (BISC; Jansen et al., 2002)<br>[music = phonological training > sports] |
| Francois et al., 2013 | Pseudo-randomized study comparing two groups: music and painting training<br>No difference in SES between groups. | $N = 24$<br>8 years | No PMT<br>MA not measured | 2 years<br>First year: 2 x 45 min/week<br>Second year: 45 min/week<br>12 children in intervention groups | rANOVA<br>Speech segmentation<br>Predictors: group, time<br>Dependent: correct responses<br><br>EEG<br>Predictors: group, familiarity, electrode location<br>Dependent: response negativity | Segmentation of pseudowords after familiarization phase<br>Larger ERP differences between familiar and unfamiliar pseudo-words |
| Jaschke et al., 2018 | Block-randomized study comparing four groups: music lessons, music lessons + music lessons outside school, visual arts lessons and passive control group.<br>No difference in SES between groups. | $N = 147$<br>6–7 years | No PMT in other groups than Music+<br>MA not measured | 2.5 years<br>1–2 hr/week<br>No information about the group size in interventions | rANCOVA Predictors: group, time, age<br>Dependent: test scores | Planning:<br>Tower of London (planning) (Shallice, 1982)<br>Inhibition:<br>Go/No-Go Task<br>Verbal IQ: The Wechsler Intelligence Scale for Children (WISC III, Wechsler, 1991). |
| Kaviani et al., 2014 | Pseudo-randomized study comparing two groups: music and passive.<br>No difference in SES between groups. | $N = 60$<br>5–6 years | No PMT<br>MA not measured | 12 weeks<br>75-min lesson/week<br>15 children in intervention group | ANOVA<br>1.experiment<br>Predictors: group, time<br>Dependent: general IQ<br>2. experiment<br>Predictor: group<br>Dependent: index difference scores | Verbal reasoning, short-term memory (Stanford-Binet Intelligence Scale IV, Thorndike et al., 1986) |
| Linnavalli et al., 2018 | Non-randomized study comparing children who participate in music playschool, dance lessons or neither.<br>SES controlled in the analyses | $N = 66$<br>5 years | PMT taken into account in the analyses<br>MA not measured | 20 months<br>45 min/week<br>8–12 children in intervention groups | LMM<br>Predictors: months in music playschool and/or dance lessons, mother's education<br>Dependent: test scores | Phoneme processing (Nepsy II, Korkman et al., 2007)<br>Vocabulary (WISC IV, Wechsler, 2010) |

*(continued)*

**Table 1.** (continued)

| Study | Research design | Participants | Prior music training (PMT) / music aptitude (MA) | Duration, intensity and group size of music activities | Data analyses | Enhanced by music activities |
|---|---|---|---|---|---|---|
| Moreno et al., 2011 | Pseudo-randomized study comparing two groups: computerized music training in music/visual arts.<br>No difference in SES between groups. | $N = 48$<br>4–6 years | PMT not reported<br>MA not measured | 4 weeks<br>2 hr/day (5 days/ week)<br>24 children in intervention groups | rANOVA<br>Behavioral Predictors: group, time<br>Dependent: test scores<br>EEG<br>Predictors: group, time, condition, electrode location<br>Dependent: peak- and mean amplitudes | Vocabulary (WPPSI-III: Wechsler, 2002)<br>Correct answers in go/no-go task<br>EEG:<br>larger peak amplitudes in the no-go trials |
| Moreno et al., 2009 | Pseudo-randomized study comparing two groups: music/painting.<br>No difference in SES between groups | $N = 32$<br>10 years | No PMT<br>MA not measured | 24 weeks<br>2 x 75min/week<br>16 children in intervention groups | rANOVA<br>Reading test<br>Predictors: group, time, word type<br>Dependent: test scores<br>EEG<br>Predictors: group, time, sound congruence, electrode location<br>Dependent: ERP responses | Reading:<br>complexity of print to-sound correspondences<br><br>Pitch in speech: whether the last word or note seemed normal or strange |
| Nan et al., 2018 | Pseudo-randomized study comparing three groups: piano/reading/passive control.<br>All children were from similar socioeconomic backgrounds. | $N = 74$<br>4–5 years | No PMT<br>MA not measured | 6 months<br>3 x 45 min/week<br>4–6 children in intervention groups | rANOVA<br>Behavioral discrimination tasks<br>Predictors: group, time<br>Dependent: task scores<br>EEG<br>Predictors: group, time, electrode location<br>Dependent: ERP responses | Word discrimination:<br>words/ vowels: music > control<br>consonants: music> reading/control<br>EEG<br>**l**exical tone changes/ musical pitch changes (P3) music > reading/controls |
| Rabinowitch et al., 2012 | RCT (within schools) study comparing three groups music/game/control. Game and control combined in the analyses.<br>All schools had similar socioeconomic and school aptitude ratings | $N = 52$<br>8–11 years | Similar PMT in groups.<br>MA not measured | Two music groups: 9 months and 3 months<br>1 hr/week<br>4–8 children in intervention groups | rANOVA<br>Predictors: group, time<br>Dependent: test scores | Index Empathy (Bryant, 1982) (trend)<br>Memory Task: whether or not emotional video clip affects children's memory of facial expressions shown before the clip |
| Roden et al., 2012 | Non-randomized study comparing three groups: music/natural science/passive control.<br>No difference in SES between groups. | $N = 73$<br>7–8 years | PMT not known<br>MA not measured | 18 months<br>45 min/week<br>Max. 5 children in intervention groups | rANCOVA<br>Predictors: group, time, age, IQ<br>Dependent: test scores | Verbal memory,<br>German adaptation of Rey's Auditory Verbal Learning Test (Rey, 1941) |

*(continued)*

**Table 1.** (continued)

| Study | Research design | Participants | Prior music training (PMT) / music aptitude (MA) | Duration, intensity and group size of music activities | Data analyses | Enhanced by music activities |
|---|---|---|---|---|---|---|
| Schellenberg, 2004 | RCT study comparing four groups piano/vocal/drama/control. Piano & vocal groups, and drama & control groups combined in the analyses.<br>SES controlled through random assignment to groups | $N = 132$<br>6 years | PMT not asked<br>MA not measured | 1 year<br>1 lesson/week<br>6 children in intervention groups | ANOVA<br>Predictors: group, time<br>Dependent: test scores | Full-scale IQ & four index scores (Freedom From Distractibility, Processing Speed, Verbal Comprehension, Perceptual Organization) WISC-III (Wechsler, 1991) |
| Schellenberg et al., 2015 | Non-randomized study comparing two groups: music (school-provided program)/passive control program provided in school.<br>Recruited schools from neighborhoods with similar SES. | $N = 84$<br>8–9 years | PMT not asked.<br>Parent's estimation of the child's musicality and interest in music. | 10 months<br>40 min/week<br>No information about the group size in interventions | ANOVA<br>Predictors: group, time, initial performance<br>Dependent: test scores | Sympathy:<br>Child-Report Sympathy Scale (Zhou et al., 2003) (only in children with lower scores in pre-test)<br>Prosocial behavior:<br>Social Behavior Questionnaire (Tremblay Loeber et al., 1991) (only in children with lower scores at in pre-test). |
| Shen et al., 2019 | Block-randomized study comparing two groups: music/passive control.<br>Two included kindergartens were from similar socioeconomic area. | $N = 61$<br>mean age 4 | no PMT<br>MA not measured | 12 weeks<br>5 x 45 min/week<br>No information about the group size in interventions | rANOVA<br>Predictors: group, time<br>Dependent: test scores | Inhibition:<br>Day/Night Stroop (Gerstadt et al., 1994)<br>Cognitive flexibility:<br>Dimensional Change Card Sort<br>Working memory:<br>Dot Matrix Test,<br>Backward Digit Span Task |

ANOVA = Analysis of Variance; rANOVA = repeated measures ANOVA; ANCOVA = Analyses of CoVariance; LMM = Linear Mixed Model; SES = socioeconomic status music, playing simple instruments, rhyming, and moving to the music. However, even though each preschool (altogether 26 institutions during the follow-up) offered either one or neither of these activities, preventing the families from choosing between music, dance, or none, the apparent limitation of this study is that the children were not randomized into studied groups.

Roden et al. (2012) found that 18 months of group instrument training provided in German schools for groups of, at most, five children improved 7–8-year-old children's ($N = 73$) verbal memory compared with those participating in natural science lessons or belonging to the passive control group. The SES was similar in all groups. The extra lessons were provided only once a week and lasted 45 min, and the children in the music group got to choose their instrument from guitar, violin, cello, flute, trumpet, clarinet, and drums and were guided by professional instrument teachers. The lessons included singing, rhythm (clapping and percussion), and pitch identification exercises. The children were allowed to practice at home, but according to the authors, only some of them did. Thus, although the children learned to play traditional classical instruments, the concept did not resemble attending instrumental lessons in a music school, where the lessons are typically held with only one student present and extensive practicing is required. However, the children were not randomly divided into groups, and their prior experience of music training was not known.

A study by François et al. (2013) presented a music intervention in school that showed positive effects on school-aged children's linguistic skills and would be feasible within the school context. In this study, 24 8-year-old French children attended 45-min group lessons in music or painting for 2 years, first twice a week and once a week in the second year. In this study, the children were pseudo-randomly assigned to the two groups, ensuring that, on average, the SES, prior music training, and cognitive test performance were similar for both groups. The music group received lessons based on a combined model of the Orff and Kodaly methods, focussing on rhythm, melody, harmony, and timbre, and guided by a professional music teacher. After 1 year, the children in the music group showed better speech segmentation skills; after 2 years, they showed better implicit differentiation between familiar and unfamiliar pseudo-words—as revealed by electroencephalogram—than their peers in the painting group. Apart from the modest sample size, the design of the study is convincing.

Finally, Moreno et al. (2009) compared the music and painting groups, where 10-year-old children ($N = 32$) were pseudo-randomly assigned to the groups. After receiving 75-min music lessons twice a week for 24 weeks, the music group showed better reading skills and pitch processing in speech than their peers in the similarly provided painting group. As in the study by François et al. (2013), the music lessons were based on a combined model of the Orff and Kodaly methods. Despite the study's indisputable strengths regarding the school curricula, the 75-min music lessons twice a week may be a lot more than most countries may offer in their national school curricula.

To sum up, even when considering their limitations, the reviewed studies conducted in preschools (Degé & Schwarzer, 2011; Linnavalli et al., 2018; Nan et al., 2018) and schools (François et al., 2013; Moreno et al., 2009; Roden et al., 2012) support the view that school and preschool music lessons may positively impact children's language abilities. Most of them used randomized or pseudo-randomized assignment to groups (Degé & Schwarzer, 2011; François et al., 2013; Moreno et al., 2009; Nan et al., 2018), had an adequate sample size (Linnavalli et al., 2018; Moreno et al., 2009; Nan et al., 2018; Roden et al., 2012), and all of them controlled for SES. The inspected language skills differed in these studies, but all three studies that found improvement in phoneme awareness/processing were conducted in preschools with 4–6-year-old children, suggesting that music lessons may be especially beneficial for acoustically driven language skills during these years (Degé & Schwarzer, 2011; Linnavalli et al., 2018; Nan et al., 2018). The reviewed studies encourage further investigation and utilization of school- and preschool-based music lessons in advancing the language development of children.

## *Music and Executive Functions*

Executive functions (EFs) refer to a set of skills needed to supervise and regulate higher-level functions—such as planning, decision making, and problem solving—enabling goal-oriented behavior (Diamond, 2013; Friedman & Miyake, 2017). Notably, the literature is not altogether consistent on the exact subskills included in EFs, but one widely accepted model by Miyake et al. (2000) assesses EFs as comprising inhibitory control, cognitive flexibility, and working memory. As with sufficient language skills, EFs are essential for learning and doing well in school. Also, as with language skills, some of these functions have been suggested to benefit from music training (Bugos & DeMarie, 2017; Jaschke et al., 2018; Moreno et al., 2011; Shen et al., 2019). The interventions in the studies by Moreno et al. (2011) and Shen et al. (2019) were highly intensive, with 1–2 hr of daily music lessons and, thus, cannot be thought of as feasible for schools and preschools. Instead, Bugos and DeMarie (2017) conducted a longitudinal study in a preschool with 4–5-year-old children ($N = 36$) who were randomly assigned to music or Lego training groups. Both groups received training for 45 min, twice a week, for 6 weeks. The music lessons were based on the Kodaly and Orff pedagogies, included vocal development and improvisation exercises with acoustic and percussion instruments, and were taught by professional music educators. After the intervention, the music group made fewer errors in the Matching Familiar Figures Test (Egeland & Weinberg, 1976), measuring inhibition, than the Lego group made. In addition to random assignment in groups, the strength of this study was that musical aptitude was measured and was found to be similar in the groups. However, the Matching Familiar Figures Test included only three trials per child, and the study failed to find a difference between the groups in a Stroop task, which is more commonly used as a measure of inhibition skills (Ikeda et al., 2014). Thus, these results cannot be taken—at least on their own—as highly convincing evidence for the benefits of music training on EFs.

However, some more convincing evidence exists. A recent study conducted in the Netherlands (Jaschke et al., 2018) used a block randomization design and a follow-up of 2.5 years. Here, 6–7-year-old children ($N = 147$) attended music or visual arts training for 1–2 lessons per week. Both activities were included in the school curricula, including theory and practice. The music lessons were planned in collaboration with the Ministry of Research and Education in the Netherlands and an expert center for arts-based education (MOCCA) for all primary schools in the Netherlands. Music lessons included theory and history, along with collective music making with instruments, singing, and improvising. Both the theoretical and instrumental lessons were supervised by trained music teachers, and the children in the music group were not allowed to practice their instruments at home. Additionally, the third group of children received music education both in and outside school (i.e., in music schools), and the fourth group did not attend any music or visual arts programs. After the follow-up, but not before it, the children belonging to either one of the music groups outperformed their peers in other groups in tests measuring inhibition and planning, which are skills included in or related to EFs. The study is of a high standard: the SES was similar in all groups, the children were block-randomized into groups, the number of participants was high, the amount of prior musical background was controlled (though not on an individual level), and the improvement of EF showed on more than one test. Hence, it is difficult to find any severe limitations in this study. However, as is typical with intervention studies, a lack of similar results regarding EFs has been encountered in other longitudinal studies (Linnavalli et al., 2018; Moreno et al., 2009; Nan et al., 2018). Notably one could argue that in some cases, this is because of the interventions lasting a considerably shorter time (Moreno et al., 2009; Nan et al., 2018). Because it is reasonable to suspect that several null findings have been left unpublished, at present, the evidence for the emergence of far-transfer effects of music on EF in group music settings is still scarce. However, the results from Jaschke et al. (2018) encourage further investigation of the possibilities of utilizing group music lessons to enhance children's EFs.

## Music and Intelligence

The impact of music training on intelligence has been a much-debated issue. Even though several cross-sectional studies have found a positive correlation between music training and intelligence in children, adolescents, and adults (dos Santos-Luiz et al., 2016; Schellenberg, 2011; Schellenberg & Mankarious, 2012; Silvia et al., 2016; Trimmer & Cuddy, 2008), there is little evidence from longitudinal studies in showing the existence of causal connection between music training and intelligence. In a much-cited study, Schellenberg (2004) found that 6-year-old Canadian children attending weekly instrumental (standard keyboard) lessons or singing lessons relying on the Kodaly method in school improved their scores on intelligence measures during one school year more than their peers in the drama lesson and passive control groups. The children ($N = 132$) were recruited to the study via newspaper advertisements and were randomly assigned to the four groups. The lessons were given in groups of six at the conservatory by professional-level teachers. This randomized setting is the strength of the study. However, both music groups were pooled and compared with a pooled group of drama and control children, and this diminishes the impact of the study because the original active control group was mixed with the passive group.

Another group-based music intervention study by Kaviani et al. (2014) explored the effects of music on intelligence. Here, 5–6-year-old children ($N = 60$) were pseudo-randomly assigned to two groups (music and control) with a similar SES, and the music group received 75-min music lessons once a week. After 12 weeks, the music group outperformed their peers in two subtests of the Stanford-Binet Intelligence Scale (Thorndike et al., 1986): verbal reasoning and short-term memory tests. However, despite the strength of the pseudo-randomized design, the lack of an active control reduces the value of this study because it cannot be concluded that the improvement is because of music training per se or because of the extra activity offered to children.

Some other longitudinal studies have found results suggesting that music training enhances intelligence, but these studies also lack active control groups and include individual instrumental lessons (Costa-Giomi, 1999), or are unclear about the total amount of music and physical exercise received in the groups (Bugos & Jacobs, 2012), so they cannot be given too much emphasis in our context. In addition, considering that the assumed causal connection between music and intelligence has raised a lot of interest, it is remarkable that no more studies supporting it have been published. The lack of supporting evidence does suggest that there is a severe publication bias concerning this issue (although some evidence for null findings has been published, e.g., Linnavalli et al., 2018; Mehr et al., 2013; Moreno et al., 2011; Nan et al., 2018). At present, it may be concluded that there is not enough evidence to support the existence of any causal link between music training and nonverbal intelligence.

### *Music and Social Skills*

According to some studies, music sessions also promote children's prosocial skills and empathy (e.g., Buren et al., 2019, Cirelli et al., 2014; Good & Russo, 2016; Kirschner & Tomasello, 2010; Rabinowitch et al., 2012; Schellenberg et al., 2015; see review Cirelli, 2018). However, excluding Rabinowitch et al. (2012) and Schellenberg et al. (2015), these studies investigated the short-term effects of music on socioemotional behavior, showing that after being engaged in joint singing and clapping or synchronized bouncing with their peers or the experimenter, small children were more helpful and cooperative towards them (Cirelli et al., 2014; Kirschner & Tomasello, 2010).

More essentially, two longitudinal studies have found a long-term impact of school-based music activities on children's prosocial skills. In a study following 8-year-old children for 10 months ($N = 84$), ukulele lessons were implemented in two schools that incorporated an "enhanced group music programme" into their curricula (Schellenberg et al., 2015). The children who received additional 40-min weekly ukulele lessons were compared with children from the other schools receiving only standard music lessons. In addition to including ear training, notation, playing different scales and changing meters, singing and improvising, the lessons encouraged cooperation and interaction between the students. After the intervention period, scores for the sympathy and prosocial questionnaires were improved in the ukulele-playing group compared with the control group. Interestingly, this improvement was apparent only in the children who scored poorly in these skills before the intervention, suggesting that music activities may promote social behaviors, especially in children showing difficulties in their socioemotional development. However, because the control group did not receive any added program, it is not possible to conclude if the reached effects were because of the music activities per se or from having some extra activity that promoted interaction. Furthermore, the study has some other limitations: the children's musical training outside school was not reported, the possible difference of SES between the groups was not controlled for, and the children were not randomized or pseudo-randomized in groups.

Furthermore, Rabinowitch et al. (2012) found that group music lessons that aimed to enhance the interactions between the children enhanced children's empathy scores (Index Empathy, Bryant, 1982) marginally. Also, the children in the music group performed better in an emotional memory task (developed by the authors) that was only conducted after—and not before—the intervention. In this study, the 8–11-year-old children ($N = 52$) were randomly assigned into three groups that either participated in a weekly music lesson, game session, or neither for one school year. The music lessons consisted of specially designed games where interaction between the children was essential, for example, encouraging individuals to participate in the joint musical interaction or improvising together to the constantly changing rhythm. The game group also focussed on the interactions between the children. However, in the end, the game group ($n = 8$) and passive control ($n = 21$) group were pooled together and compared with the music group; thus, the control group consisted of some active but mostly passive control children. Furthermore, the marginally significant results from the empathy test, as well as the lack of a pre–post design for emotional memory tasks, diminish the influence of the study.

Considering the possible publication bias and, for example, a previously inspected study with a robust design (Schellenberg, 2004) reporting the causal effects of drama but not music training on prosocial skills, it is debatable whether music lessons actually do have positive long-term effects on children's prosocial skills. More studies and reporting of null results are clearly needed to conclude whether it is possible to support children's prosocial development with school- and preschool-based music lessons.

## Discussion

Based on the reviewed studies, music lessons implemented in schools or preschools show some promise in supporting children's language skills and perhaps even EFs. Apart from one study (Bugos & DeMarie, 2017), SES was controlled for in all of these studies by either pseudo-randomized assignment of the participants or taking it into account in the analyses. However, it is important to remember that although statistically significant, the transfer effects are typically small and do not allow for interpretations about their existence among individual children.

The evidence for the long-term impact of music on prosocial abilities and intelligence is less convincing; studies have lacked active control groups or have pooled active and passive control groups together. Especially, given the amount of interest in the connections between music and intelligence, it seems plausible that several studies with null results have been left unpublished.

Regarding the far-transfer effects of music, it is promising that the positive effects have emerged in group music settings because these practices are highly implementable in school and preschool curricula. Because these contexts are accessible to all children (regarding preschools, at least in countries where preschool is organized by the communities or state), maintaining or implementing music lessons in the curriculum promotes equality among children, all of whom are not able to participate in private lessons offered by music schools, which typically charge for them. Thus, also children whose families are not able to provide them with private music lessons can enjoy music activities. These findings, even with their limitations, are societally important because formal studies in music (namely, instrument training) to a great extent are focussed on children with higher SES who already obtain other cultural enrichment because of their family contexts (for reviews, see Albert, 2006; Corrigall et al., 2013; Swaminathan et al., 2017).

Evidence from both brain-imagining studies (Herdener et al., 2010; Hyde et al., 2009) and studies measuring event-related potentials (e.g., François et al., 2013; Moreno et al., 2009; Nan et al., 2018; Putkinen et al., 2014) suggests neuronal plasticity in childhood and adolescence because of music training. Because it seems that music training is capable of molding the structure and functioning of the neural networks linked to overall auditory processing, the claims about, for example, far-transfer effects on language seem reasonable enough (Besson et al., 2011). Yet a recent meta-analysis conducted by Sala and Gobet (2020, p. 1429) argued that "music training is ineffective regardless of the type of outcome measure (e.g., verbal, nonverbal, speed-related, etc.), participants' age, and duration of training" and that "small statistically significant overall effects are obtained only in those studies implementing no random allocation of participants and employing nonactive controls." Although many arguments about far-transfer effects have been overly positive, it should be noted that in their meta-analyses, Sala and Gobet (2017, 2020) did not differentiate between different music intervention studies, instead placing the same emphasis on short and intense versus long-term and less frequent interventions. They also dealt equally with papers in which individual instrumental training and group-based programs were conducted, even if from a music education perspective these have quite different means and aims. Maybe most importantly, we argue that the conclusion that music training is ineffective in bringing any domain-general cognitive benefits is somewhat based on the mechanical demands on the controllability of studies. A rigorous demand for randomized controlled trials (RCTs) in longitudinal studies, which are often conducted in community settings, leads to problems in the overall feasibility of these studies and interpreting their results.

It is of note that RCT designs have been known to lead to many drop-outs because of a lack of motivation, especially when long-term programs are the focus (for a related discussion, see Habibi et al., 2018; Tervaniemi & Huotilainen, 2018). This is particularly troublesome because, based on previous longitudinal studies, music interventions should last relatively long to yield neuroplastic or cognitive transfer effects. For instance, Kraus and Strait (2015) and Linnavalli et al. (2018) showed that positive effects on children's auditory brain processes or language skills could be observed only after two years of music exposure, with one year not being sufficient. Furthermore, in a study by Putkinen et al. (2014), individual instrument training of 6 years was not sufficient to enhance all the feature-specific auditory brain processes in school-aged children when compared with the control children. Random allocation of the participants in such a protocol does not optimally support the intrinsic motivation of the learner to be engaged in such a long learning process. If there is no motivation to practice or even attend the lessons, the learning outcome and, thus, possible transfer effects will be compromised. In such a protocol, it would be premature to conclude that transfer effects do not exist. Moreover, as pointed out by Habibi et al. (2017), in a research context, it might be considered unethical to exclude children from music enrichment. Hence, even if there are research contexts in which random allocation of the participants provides an optimal protocol, it is sometimes suboptimal or even not recommended. In studies not using a RCT design, it is important to take into account the imbalance in the compared groups. Typically, this is done by controlling the compared groups' scores for intelligence and the family's SES in the statistical analyses.

Admittedly, we do not know whether all children show far-transfer effects from music activities, irrespective of their motivation or musical aptitude, because these are not always (or regarding motivation, almost never) measured in intervention studies. Far-transfer effects of music could depend on some individual facility, for example, "musicality," and this calls for further studies where these features are controlled for.

Here, it is important to note that the positive findings about the transfer effects have received a remarkable amount of attention in the media, and in some cases, oversimplifications and overinterpretations have taken place. These have been discussed by scientists who emphasize the need for caution from academics in their public appearances and media presence (e.g., see Odendaal et al., 2018). However, sometimes the news articles are written based on press releases or oral presentations, thus reflecting the voice of the journalist, not just that of the researcher.

As discussed previously, in the scientific literature, there is a strong bias to launch and discuss the positive findings and not publish the negative or null findings. Because there is evidence from different studies reporting no transfer effects to, for example, language, they should not be ignored. Several factors in the experimental settings may explain the varying results: intervention settings, individual teachers, school curricula, and cultural differences. Furthermore, cognitive skills can be measured using several tests focussing on different aspects of language (e.g., phoneme processing, vocabulary knowledge, verbal memory), EFs (e.g., working memory, inhibition, cognitive flexibility), and intelligence (e.g., nonverbal reasoning, visuo-spatial skills); sometimes, contradictory evidence may emerge because of the different focus in testing.

## Conclusions and Future Directions

In its recent review, the World Health Organization (Fancourt & Finn, 2019) concluded that the arts in general and music specifically seem to contribute positively to health, well-being, and children's development. Although it is important to account for the contradictory evidence and remember that most of the found effects are small, it seems that group-based music lessons have a positive impact on language development and possibly on EFs in childhood. However, the evidence for the far-transfer effects of music on intelligence and long-term prosocial skills does not appear to be strong.

It is encouraging that most of the found positive effects have emerged because of relatively little exposure to active music making and that group music sessions carried out once or twice a week—when continued for several years—seem to be enough to support the development of language skills, and possibly even EFs. In addition to bringing enjoyment to children, implementing and maintaining music in national school and preschool curricula is also important for the benefits it might offer to other areas of learning.

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TL, ASG and MT researched literature. TL wrote the first draft of the manuscript. All authors reviewed and edited the manuscript and approved the final version of the manuscript.

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