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15 Arts education, academic achievement and cognitive ability

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Although art is often considered to be a means for maximizing human potential, the causes and consequences of artistic experiences are poorly understood. The present chapter reviews the relevant literature concerning the consequences of participating in the arts. It is clear that training in the arts improves performance on arts-specific tasks. For example, children who take music lessons perform better than their untrained peers on musical tasks such as perceiving musical key and harmony (Corrigall and Trainor, 2009). But training in the arts may also be associated with performance in non-arts domains. This chapter examines the possibility of four such associations, namely whether arts education is associated with academic achievement, general cognitive ability, language processing and visuospatial skills. In each case, the literature is evaluated in terms of the consistency of the findings and the evidence for claims of causation.

Training in the arts and academic achievement

Training in the arts is associated positively with academic achievement. For example, in a sample of Canadian high-school students, participation in musical activities in the eleventh grade predicted academic achievement in the twelfth grade (Gouzouasis, Guhn and Kishor, 2007). Other results point to similar associations between academic achievement and involvement in *any* type of arts-related activity. In one study that included more than 25,000 American high-school students, arts participation and school grades were recorded during the eighth, tenth and twelfth grades (Catterall, Chapleau and Iwanaga, 1999). At each point in time, students who were involved in the arts had better grades than other students. A similar positive association emerged in a meta-analysis of five correlational studies (Winner and Cooper, 2000). In a larger meta-analysis of 10 years of data from the American College Board (1988–98), Vaughn and Winner (2000) concluded that compared to students without arts training, students reporting any form of arts involvement (dance, drama, music and visual arts) obtained higher scores on the Scholastic Aptitude Test (SAT). This advantage for the arts group was evident for the verbal

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score, the mathematics score and the composite score. Students with drama lessons showed the strongest association, followed (in descending order) by students studying music, painting and dance. Even enrollment in theoretical classes (e.g., music or art history courses) was predictive of better SAT scores.

Although Vaughn and Winner's (2000) results demonstrated verbal *and* mathematical advantages for students involved in any arts-related activity, it is nevertheless possible that training in different forms of art is differentially associated with performance on specific academic subjects. For example, there is evidence of an association between music training and mathematical skills (Catterall *et al*., 1999; Cheek and Smith, 1999; Gouzouasis *et al*., 2007; Graziano, Peterson and Shaw, 1999; Vaughn, 2000) including scores on tests of geometry (Spelke, 2008). Individuals with training in the visual arts (i.e., painting) also perform well on geometry tasks, perhaps because both geometry and painting require the ability to represent and manipulate visual images (Spelke, 2008; Walker *et al*., 2010). Children with drama lessons, however, perform equivalently to children with training in writing on geometry tasks, and worse than children with training in music, dance or visual arts (Spelke, 2008). In one study of 5- to 7-year-olds, specialized arts lessons (including both Kodály music and visual art) taken in school for 1 or 2 years were predictive of improved grades in mathematics *and* reading (Gardiner *et al*., 1996).

Are there associations between arts training and language-related school subjects other than reading? Integrating drama techniques into language classes is known to improve school-based language outcomes (Podlozny, 2000). For music training, however, associations with language abilities are inconsistent. For example, positive associations with grades in high-school English classes may be limited to adolescents with keyboard training (Gouzouasis *et al*., 2007). The evidence for associations between grades in language classes and training in the visual arts or dance is also inconsistent (Keinänen, Hetland and Winner, 2000; Burger and Winner, 2000).

Does duration matter, such that longer participation in the arts is predictive of higher levels of academic achievement? The answer appears to be *yes*. For example, the difference in academic achievement between participants and non-participants is greater in the twelfth grade compared to the tenth grade, and greater in the tenth grade compared to the eighth grade (Catterall *et al*., 1999). Similarly, longer duration of arts participation is predictive of higher scores on tests of verbal and mathematical abilities (Winner and Cooper, 2000). In the study of SAT scores, high-school students with 4 or more years of training in the arts had better outcomes than their counterparts with less training (Vaughn and Winner, 2000). When researchers treat duration of music training as a continuous variable, it is positively correlated with reading comprehension (Corrigall and Trainor, 2011), performance on a geometry test (Spelke, 2008) and average grades in school (Schellenberg, 2006; Wetter, Koerner and Schwaninger, 2009). In general then, longer periods of training in the arts are accompanied by higher levels of academic achievement.

But are associations with academic achievement evident for non-arts extracurricular activities as well? In one instance, children participating in sports were just as likely as arts participants to win academic awards, and both groups were more likely to win awards than the average child in the US (Winner, Goldstein and Vincent-Lancrin, 2013). Other findings reveal that mathematical abilities do not differ between children who are musically trained and those who are active in sports (Spelke, 2008). In other words, children who participate in *any* extracurricular activity appear to do well in school, not just those who are involved in arts programs.

Finally, does involvement in extracurricular activities *cause* advantages in academic achievement? Although training in the arts or sports may indeed cause academic gains, it is also possible that children who do well in school have more time to participate in the arts or sports, and that they get more encouragement to do so from their parents and teachers. In other words, better scholastic performance could be the cause instead of the consequence of participating in the arts. In line with this view, academic achievement in elementary school predicts participation in high-school music lessons (Frakes, 1985). Similarly, children who do well in fourth grade are more likely than other children to participate in school music programs when they reach sixth and eighth grades (Kinney, 2008). Academic performance is also predictive of relatively long-lasting participation in musical activities (e.g., Kinney, 2010; Klinedinst, 1991).

In principle, associations between training in the arts and academic achievement could be a consequence of a third unmeasured variable, such as socioeconomic status (SES), which is known to predict academic achievement (e.g., Sirin, 2005; White, 1982) *and* participation in arts activities (Corenblum and Marshall, 1998; Kinney, 2010; Klinedinst, 1991). In other words, scholastic advantages of training in the arts may be due to SES. Families that are well off can also afford to provide their children with a variety of experiences, including but not limited to training in the arts. Indeed, children who enroll in music lessons also report a relatively high number of extracurricular activities (Orsmond and Miller, 1999; Schellenberg, 2006). More generally, scholastic advantages that tend to accompany training in the arts could stem from multiple factors in an enriched home environment.

Nevertheless, the association between arts training and academic achievement does not appear to be merely an artifact of SES. For example, among students from low SES backgrounds, those who participate in the arts also exhibit performance advantages at school (Catterall *et al.*, 1999). In fact, the association between academic performance and enrollment in school music programs is evident across different levels of SES (Fitzpatrick, 2006). Moreover, the association between length of private music training and academic achievement persists even after holding constant SES as well as participation in non-musical extracurricular activities (Schellenberg, 2006).

Other pre-existing individual differences could also influence the association between arts training and academic achievement. For example, children who have

high IQs to begin with are likely to do well in school and in the arts. Interestingly, music training predicts grades in school even when IQ is held constant (Schellenberg, 2006), which implicates a role for other individual differences. One possibility is that personality influences both the decision to participate in the arts as well as performance in school. *Conscientiousness* and *openness to experience* from the five-factor personality framework (McCrae and Costa, 1997) are especially promising candidates. Highly conscientious students are prone to working hard and to be achievement-oriented, and conscientiousness has a strong positive association with academic performance (e.g., Chamorro-Premuzic and Furnham, 2003; De Fruyt and Mervielde, 1996; O'Connor and Paunonen, 2007). There is also evidence that children who receive high scores on the openness dimension tend to perform well academically (e.g., Dollinger and Orff, 1991) and on intelligence tests (Chamorro-Premuzic and Furnham, 2005). Moreover, children who score high on openness are likely to seek out and excel in artistic activities. A recent study confirmed that duration of music training in childhood is associated positively with openness and conscientiousness (Corrigall, Schellenberg and Misura, 2013). In fact, after individual differences in personality were held constant, the association between music training and cognitive abilities (i.e., IQ and academic achievement) disappeared.

In order to infer that training in the arts *causes* improvements in academic performance, such an association must be independent of normal maturation. It must also remain evident after controlling for pre-existing individual differences. Evidence of the association should emerge from longitudinal studies, when children do not differ at Time 1 (before training begins) but they do at Time 2 (after, say, 2 years of training). Nevertheless, experimental studies are the only way to infer causation unequivocally, such as when children are assigned randomly to one or more arts-related activities, control activities (e.g., sports) that are similar in the time and effort involved or no additional activities.

To date, the results of longitudinal and experimental studies are not encouraging. In a large-scale meta-analysis of experimental studies that examined the effect of training in the arts on academic achievement, the mean effect size was not significantly different from 0 (Winner and Cooper, 2000). In a large-scale study conducted in the Netherlands, children who received 2 years of arts training did not have an academic advantage over other children at the end of the study (Haanstra, 2000). One 3-year longitudinal study with quasi-random assignment to piano or no lessons found that 2 years of lessons led to improvements in school grades, but the advantage disappeared after the third and final year of the study (Costa-Giomi, 2004). Finally, a recent report that reviewed multiple published and unpublished studies (Winner, Goldstein and Vincent-Lancrin, 2013) found no improvements in academic ability that could be attributed unequivocally to taking lessons in the arts. In sum, although positive associations between arts training and academic achievement are evident in a variety of contexts, there is little reason at present to believe that training in the arts actually improves academic achievement.

Arts and general cognitive ability

We now turn to a discussion of associations between training in the arts and general cognitive abilities, which are typically measured with IQ tests. Most research in this area focuses on music training. In general, musically trained individuals have higher IQs than their untrained counterparts. For example, findings from quasi-experimental studies, which compare musically trained and untrained individuals (i.e., without random assignment), reveal IQ advantages for the trained group in samples of Canadian 7- and 8-year-olds (Schellenberg and Mankarious, 2012), 10- to 12-year-olds (Schellenberg, 2011a) and undergraduates (Schellenberg, 2011b; Trimmer and Cuddy, 2008). Similar but slightly weaker results are evident among 6- to 15-year-old boys living in Hong Kong (one-tailed test; Ho, Cheung and Chan, 2003, Experiment 1). Moreover, German 5- and 6-year-olds with music training have faster mental processing speeds than their untrained counterparts (Gruhn, Galley and Kluth, 2003), and processing speed is known to be a central component of IQ (Deary, 2001).

There is also some evidence that music training *causes* small improvements in IQ. In one controlled experiment (Schellenberg, 2004), a large sample ($N = 144$) of 6-year-old children was assigned randomly to 1 year of keyboard lessons, vocal music lessons (in the Kodály method), drama lessons or no lessons. All children were administered the Wechsler Intelligence Scale for Children – Third Edition (WISC-III) before and after the intervention. At the beginning of the study, the four groups did not differ in IQ. By the end of the study, IQ scores of all four groups had increased, a likely consequence of going to school (Ceci, 2001). More importantly, increases were similar in size over the course of the year for the two music groups and for the two control groups (drama lessons and no lessons), but a direct comparison of the music and control groups revealed larger increases for the children who had taken music lessons. The size of this effect would typically be considered small or moderate ($d = 0.35$). Because children were assigned randomly to the different groups, we can infer that music training *caused* an IQ advantage. Note that the advantage for the musically trained children was evident across the WISC-III subtests, which measure different aspects of cognitive abilities including verbal and spatial abilities, processing speed, memory and attention.

Longer duration of music training is also predictive of greater cognitive benefit, pointing to a dose–response association. For example, among 147 children who were administered the WISC-III, IQ scores were correlated positively with duration of music training (Schellenberg, 2006). Among 150 adults tested with the Wechsler Adult Intelligence Scale – Third Edition (WAIS-III) – IQ scores were correlated with duration of participation in musical activities during childhood (Schellenberg, 2006). In both instances, these correlations remained evident after taking into account SES and family variables. As one might expect, the association between duration of training and intellectual ability was stronger in childhood, while the children were still taking lessons, than in adulthood, after the adults had stopped taking lessons.

Despite Schellenberg's (2004) evidence that music training causes small increases in IQ, the literature is not without conflicting findings. Two longitudinal studies did not find significant differences between musically trained and untrained children after 6 (Ho *et al*., 2003, Study 2) or 9 (Moreno *et al*., 2009) months of training, although the short duration between the two test sessions may have played a role. For example, the musically trained children tested by Moreno *et al*. had increases in IQ that were 5 points larger than control children (who took painting lessons), but the difference between groups was not significant because of very large increases from pre-test to post-test across groups (12 points for the music group, 7 for the painting group), and very large individual differences. In fact, the standard deviation of difference scores was 14 points in the music group, which means that some children's IQ scores changed by approximately 30 points from pre- to post-test.

Nevertheless, even adults with many years of music training do not always show an IQ advantage over controls with no training, particularly when they are tested with measures of fluid (unlearned) intelligence (Bialystok and DePape, 2009; Brandler and Rammsayer, 2003; Helmbold, Rammsayer and Altenmüller, 2005; Schellenberg and Moreno, 2010). When undergraduate music majors are compared with students majoring in other disciplines (e.g., psychology or business), the results can be inconsistent (Helmbold *et al*., 2005) or even favor the non-music students (Brandler and Rammsayer, 2003). In other words, music training is associated with general cognitive abilities when the training is an activity added on top of regular schooling. When music training takes the place of other studies or becomes the central activity (i.e., one's job), associations with general intelligence are much less likely to be evident.

It is also possible that training in the arts could be beneficial for some people but not for others. For example, a number of studies reported that curricula that incorporate drama as a pedagogical component benefit younger but not older children (Conard, 1992; Kardash and Wright, 1986; Pellegrini and Galda, 1982). Associations between visual arts training and visual skills also appear to be stronger among younger compared to older children (Haanstra, 1996). Genetic differences could play an additional role in determining whether or not one reaps intellectual benefits from training in the arts. For example, personality traits may influence whether training in the arts is intellectually beneficial. Individual differences in openness to experience are particularly likely to be a moderating factor, because openness predicts the length of time a child stays in arts training as well as general intellectual ability (Corrigall *et al*., 2013).

The finding that music but not drama training improves IQ (Schellenberg, 2004) raises the question of whether associations between arts training and cognitive abilities are restricted to music lessons, or, alternatively, whether such associations extend to other arts activities such as painting or dancing. In the experiment by Moreno *et al*. (2009) noted above, 8- and 9-year-olds had 9 months of training in music or painting. Increases in IQ from pre- to post-test were evident for both groups (12 and 7 points, respectively), but the magnitude of the difference between

groups was not statistically reliable. On the one hand, these findings could mean that music training and painting lessons caused statistically equivalent increases in IQ in children. On the other hand, because there was no control group without arts training, the possibility that the increase in both arts group was the consequence of repeated testing without a sufficient gap between the two test sessions cannot be dismissed. In general, the same IQ test should not be administered twice without at least 1 year in the interim. Moreover, the sample size was small, with only 16 participants in both groups, which reduced power to detect between-group differences. Had the sample been bigger, a difference of 5 IQ points would likely have been significant.

Moving now to dance lessons, there is some evidence that learning to dance is accompanied by higher non-verbal reasoning skills, including IQ (Keinänen *et al*., 2000). It should be noted, however, that this finding came from a meta-analysis of four unpublished studies that used tests of IQ *or* spatial ability as outcome measures. Thus, it is impossible to know whether the result is predominantly a reflection of associations with IQ scores or spatial ability, or whether the methods in the original studies were optimal. Moreover, it is unknown whether the size of the association between IQ and dance instruction is equivalent to that between IQ and other art forms. Finally, the available data do not allow us to conclude that learning to dance *causes* improvements in IQ.

Why should some arts training be associated with IQ while other types of training are not? One possibility is that the similarity between scholastic activities and arts lessons is likely to determine increases in intellectual ability (Schellenberg, 2005). It is well established that attending schools increases IQ scores (Ceci, 2001). From this perspective, music lessons may be more school-like than drama lessons, and perhaps other arts lessons as well. Intermediate variables may also play a role in the association between music training and IQ. One possibility is that music lessons, and perhaps arts lessons in general, lead to intellectual advantages because they train attention (Hannon and Trainor, 2007; Posner *et al*., 2008; Schellenberg and Peretz, 2008). Attention is amenable to training (Rueda *et al*., 2005) and it is positively correlated with general cognitive ability (Salthouse, 2005). Thus, attention could potentially be a mediating variable between arts lessons and general cognitive abilities.

In line with this view, there is some evidence of a positive association between music training and attention. For example, individuals with music training are particularly proficient at attending to auditory information (Strait *et al*., 2010). They are also better than untrained controls at hearing sounds in noise (Parbery-Clark, Skoe and Kraus, 2009) and this advantage extends to hearing speech in noise (Parbery-Clark, Skoe, Lam and Kraus, 2009; Strait and Kraus, 2011). Musically trained adults also perform better than untrained participants on an auditory Stroop task (Bialystok and DePape, 2009). Although these associations could be a consequence of the fact that musically trained individuals have good listening skills, there is also evidence of enhanced performance on non-auditory tests of executive functions (Degé, Kubicek and Schwarzer, 2011). In fact,

Degé *et al*. found that when individual differences in performance on tests of selective attention and inhibition were held constant, the association between music training and IQ disappeared. Some studies, however, have failed to find differences in attention between musically trained and untrained participants (Petitto, 2008; Schellenberg, 2011a). It is also unknown whether attention is associated with training in the visual arts or drama, although there is suggestive evidence of a positive association with dance lessons (Petitto, 2008).

To summarize, although music training may cause small increases in IQ (Schellenberg, 2004), most of the available data come from quasi-experiments and correlational studies, and these findings are also consistent with the alternative view – that high-IQ children are more likely than other children to take music lessons. These two interpretations are not mutually exclusive. High-functioning children may be more likely than other children to take music lessons, which exaggerate their pre-existing cognitive advantages. IQ does not appear to have similar associations with drama lessons, however, and it is unclear whether there are links with training in the visual arts or dance. Further study of mediating and moderating variables is likely to make important contributions to our understanding of associations between arts training and general cognitive ability.

Arts training and language skills

This and the next section review evidence of associations between training in the arts and more specific cognitive abilities. In the present section, we focus on language skills distinct from those evident in courses taught in school (discussed above). The relevant studies focused primarily on music or drama lessons, with visual art and dance receiving much less attention.

Music training and language skills

The possibility of associations between music training and language skills has been subject to much research activity in recent years. Both music and language use auditory rule-bound structures that incorporate variations in pitch and rhythm for communication. Because of these perceptual and functional similarities, it is reasonable to expect that music training would be positively associated with language skills, or that music training might even cause improvements in some aspects of language abilities.

Participants who are musically trained are better listeners than those who are untrained. These sorts of findings are pertinent because listening is central to language reception and production. For example, musically trained participants are better at tapping back a rhythm they just heard (Hurwitz *et al*., 1975). It is perhaps not surprising, then, that musicians are better than non-musicians at detecting linguistic stress patterns (Kolinsky *et al*., 2009). Musically trained individuals also exhibit enhanced performance on pitch discrimination tasks, tests of

relative pitch and measures of pitch processing speed (Schellenberg and Moreno, 2010), and they are better than controls at recognizing melodies (Orsmond and Miller, 1999). Moreover, musically trained children and adults process pitch more efficiently at the neural level, showing larger responses to pitch changes (e.g., Chandrasekaran, Krishnan and Gandour, 2009; Fujioka *et al*., 2004; Koelsch, Schroeger and Tervaniemi, 1999; Schon, Magne and Besson, 2004; Shahin *et al*., 2003; Virtala *et al*., 2012). The pitch processing advantage for simple tones and music also extends to processing pitch in speech (Besson *et al*., 2007; Dankovičová *et al*., 2007; Magne, Schon and Besson, 2006; Marques *et al*., 2007; Moreno *et al*., 2009; Thompson, Schellenberg and Husain, 2004; Wong *et al*., 2007).

Musically trained participants are known to perform better than untrained controls on a number of tests of verbal abilities. For example, they have better memory for words, outperforming untrained controls on list-learning tasks (Chan, Ho and Cheung, 1998; Franklin *et al*., 2008; Ho, Cheung and Chan, 2003). Trained individuals also exhibit better recall of spoken or sung words (Kilgour, Jakobson and Cuddy, 2000), and they outperform controls on tests of verbal working memory (Franklin *et al*., 2008; Hansen, Wallentin and Vuust, 2012). Music training is also associated positively with vocabulary (Forgeard, Winner *et al*., 2008; Piro and Oritz, 2009), understanding sequential verbal information (Piro and Oritz, 2009) and facility with a second language (Petitto, 2008; Posedel *et al*., 2012). Moreover, musically trained participants show a stronger response at the neural level while parsing syntax in language (Jentschke and Koelsch, 2009). Nevertheless, because all of these findings were reported from studies with correlational or quasi-experimental research designs, they tell us nothing about the direction of causation. Music training could be causing improvements in language ability, individuals with good language skills could be more likely than other individuals to study music, the association could be bidirectional or individuals with high IQs could have good language abilities *and* be particularly likely to study music.

There is some evidence, however, that music training does indeed *cause* improvements in vocabulary. In one study, children between 4 and 6 years of age were assigned randomly to 20 days of computerized lessons in music or visual art (Moreno, Bialystok *et al*., 2011). The music lessons focused on listening tasks that trained children in musical concepts, but the children did not learn how to play an instrument. Before and after the training, the children were tested on two subtests from the Wechsler Pre-School and Primary Scale of Intelligence – Third Edition (WPPSI-III). One subtest, Block Design, measured visuospatial abilities. The other was the Vocabulary subtest that required children to define words. Only the music group improved significantly from pre- to post-test, but only on the Vocabulary subtest. The effect size was large ($d = 1.12$), however, with 90 percent of children in the music group having a higher score at post- compared to pre-test. Thus, even short periods of training in music listening improve some aspects of language ability in children. By contrast, the same duration of training in the visual arts does not appear to have the same effect ($d = 0.20$).

The association between music training and reading has also received much attention. It is well known that reading skill is associated positively with music aptitude tests that measure pitch perception (Anvari *et al*., 2002; Barwick *et al*., 1989; Forgeard, Schlaug *et al*., 2008; Lamb and Gregory, 1993; Loui *et al*., 2011) or rhythm perception (Douglas and Willatts, 1994). Moreover, children with dyslexia, a condition that manifests behaviorally as difficulty in reading and spelling, tend to show deficits in pitch (Atterbury, 1985) and rhythm (Atterbury, 1985; Goswami *et al*., in press; Huss *et al*., 2011; Overy *et al*., 2003) processing. Because music training improves pitch and rhythm processing, it is reasonable to hypothesize that music training may also improve reading skill. In line with this view, 9-year-olds who study music for 9 months exhibit improvements in reading irregularly spelled words, an improvement that is not evident among children assigned to painting lessons for the same duration of time (Moreno *et al*., 2009). Because Western music is notated visually, learning to read music might also provide an opportunity to enhance symbol-sound decoding skill. Moreover, for children taking singing lessons, learning the words of songs gives them additional exposure to language, which could, in turn, improve reading or other language skills.

Before children learn to read, however, they must develop an understanding of the phonological structure of their native language and the ability to associate arbitrary visual symbols with sounds. The existing evidence suggests that training in music improves both of these pre-reading skills. For example, music training is associated positively with phonological awareness, or the ability to perceive and identify individual speech sounds in words (Overy, 2003; Wandell *et al*., 2008). One longitudinal study found that after receiving 4 months of music training (i.e., emphasizing singing and movement), preschool-age children attained larger improvements in phonological awareness compared to controls (Gromko, 2005). A more recent study randomly assigned German kindergarteners to one of three conditions: music lessons (primarily listening), phonological skills training or sports training (Degé and Schwarzer, 2011). After 10 minutes of daily training for 20 weeks, the phonological awareness skills of children in the music group matched those of children in the program designed specifically to improve these skills, and both groups outperformed the sports group, thereby ruling out the role of simple maturation. Another experiment, with 4- to 6-year-olds, found that 4 weeks of music training (again, primarily listening) led to better performance – compared to studying visual art – on a task that required children to match arbitrary symbols with words (Moreno, Friesen and Bialystok, 2011).

Although a meta-analysis of correlational studies found evidence of an association between music training and reading, a similar association was not evident in experimental studies (Butzlaff, 2000). Another meta-analysis (Standley, 2008) found significant effects for both correlational and experimental studies, but the author used a very broad definition of music training, including interventions that incorporated music as a means to teach reading. In any event, it is clear that music training is associated positively with language abilities, including reading, pre-reading skills,

vocabulary, verbal memory and speech perception. Evidence that music training is causing these associations comes primarily from short-term interventions that emphasized listening rather than learning to play a musical instrument.

Drama lessons and language skills

Engaging in dramatic activities provides children with opportunities to use symbolic representations. Because language is also a system of symbolic representation, with words linked arbitrarily to their referents, it is reasonable to speculate that drama might improve language skills. In fact, the study of the influence of drama training on language skills has a long history. For example, after locating thirty-two studies that examined the effect of drama lessons on language ability, Vitz (1983) concluded that drama can be used to improve language skills. This sentiment has been echoed by other researchers, who report that integrating drama into language classrooms improves story comprehension, reading and writing (e.g., De la Cruz, Lian and Morreau, 1998; DuPont, 1992; Pellegrini, 1980; Pellegrini and Galda, 1982; Rose *et al*., 2000; Saltz and Johnson, 1974). Although these studies vary methodologically (Mages, 2008) by defining drama in different ways (e.g., creative drama, sociodrama, dramatic play), in each case the effect of an integrated drama curriculum (as opposed to extracurricular drama lessons) on language skills is assessed. Moreover, most studies are longitudinal or experimental in design, allowing conclusions about improvement – although not necessarily causation – to be drawn.

Do integrated drama lessons actually improve language skills? Two early meta-analytic studies provided positive evidence with respect to reading and speaking abilities (Conard, 1992; Kardash and Wright, 1987). A more recent meta-analysis considered the results of eighty longitudinal and experimental studies and found that using drama to learn a story led to better understanding (Podlozny, 2000). Even stories that were not used during drama instruction were found to be understood better by children taking the drama curriculum. Furthermore, the curriculum led to improvements in reading achievement, reading readiness, speaking, vocabulary and writing. Because the meta-analysis used longitudinal and experimental findings, the positive results provide evidence that drama-integrated curricula improve language skills. At the same time, it is difficult to know whether improvements result from the incorporation of drama per se. They could be the consequence of making the teaching method more engaging. In other words, pedagogical changes that do not include drama could make classroom instruction similarly engaging, with similar positive outcomes.

Visual arts training, dance training and language skills

Because reading as well as the perception and production of visual art rely on visual attention and pattern recognition, training in the visual arts could improve reading. One meta-analysis found that including a visual arts component in reading

instruction improved reading *readiness*, the ability to match shapes and identify images (Burger and Winner, 2000). The same authors reported mixed results, however, with respect to actual reading abilities. In short, although the visual art component may improve basic skills necessary for reading, whether it actually improves reading remains an open question.

The possibility of associations between reading ability and training in dance has received some attention from researchers, but most of the relevant studies remain unpublished. The hypothesis that dance instruction improves reading ability stems from the obvious fact that rhythm is central to dance, as well as from findings pointing to a positive association between reading skills and rhythm processing abilities (Atterbury, 1985; Douglas and Willatts, 1994; Huss *et al*., 2011; Overy *et al*., 2003). Nevertheless, in one meta-analysis, there was no evidence for an association between learning to dance and reading skills (Keinänen *et al*., 2000).

A more recent longitudinal study examined the effects of integrating dance and movement exercises into a program aimed at literacy development (MacMahon, Rose and Parks, 2003). First graders were instructed to listen to the sound of words and to move their bodies into the shapes of the alphabet corresponding to the sounds. After twenty sessions taken over 10 weeks, pre-reading skills improved more among children in the integrated dance program compared to children who did not receive the intervention. Specifically, the dance group showed greater improvement on tasks that required phoneme segmentation and identification of vowels and consonants. These results provide suggestive evidence that incorporating movement into the school curriculum may have beneficial effects on reading, although it is possible that the intervention simply made the instruction more engaging.

Arts training and visuospatial skills

There is much evidence of an association between music training and visuospatial skills. In general, musically trained children outperform their untrained counterparts on tests measuring visuospatial abilities (Bilhartz, Bruhn and Olson, 2000; Costa-Giomi, 1999; Graziano *et al*., 1999; Gromko and Poorman, 1998; Hassler, Birbaumer and Feil, 1985; Hurwitz *et al*., 1975; Rauscher and Hinton, 2011; Rauscher *et al*., 1997; Rauscher and Zupan, 1999). Moreover, a meta-analysis of experimental studies concluded that music training *causes* improvements in visuospatial abilities (Hetland, 2000). It is no surprise, then, that similar associations are found in comparisons of adults who are musically trained or untrained (Brochard, Dufour and Deprés, 2004; Jakobson *et al*., 2008; Patston, Hogg and Tippett, 2007; Patston and Tippett, 2011; Sluming *et al*., 2002; Sluming *et al*., 2007; Stoesz *et al*., 2007).

Training in the visual arts has been studied in terms of its association with three types of visuospatial skills: namely, observation skill, visual processing and

imaging ability, and geometry processing. Simply training people to view and analyze visual art improves their observational skills. In one study, sixty medical students were assigned randomly to one of two groups (Dolev, Friedlaender and Braverman, 2001). One was an intervention group, in which each student viewed a painting for 10 minutes and described the painting in detail. Students in the control group attended an anatomy lecture emphasizing history and physical-examination skills. The art group subsequently outperformed controls at describing pictures of people with medical disorders. In another study, training medical students to analyze art improved their ability to read emotions from faces (Bardes, Gillers and Herman, 2001). Similarly, training 9- and 10-year-old children to look closely at art and describe what they see makes them more observant and analytical about non-art images, such as when they are asked to describe pictures of fossils (Tishman, MacGillivray and Palmer, 1999). In sum, training people to be better observers using art makes them better observers more generally.

Students who are trained in the visual arts also exhibit advantages on tests of mental imagery (Calabrese and Marucci, 2006). On one test of spatial ability, students majoring in fine arts performed better than students in the humanities and social sciences, but worse than students in mathematics and science (Winner *et al*., 1991). The duration of visual arts training is also positively associated with visual imagery skill, with fifth-year undergraduate fine arts students outperforming their first-year counterparts (Pérez-Fabello and Campos, 2007). Nevertheless, associations between visual arts training and visual skill can be inconsistent. In an early meta-analysis of thirty studies (mostly unpublished), there was no evidence of improved visuospatial skills after training in the visual arts (Haanstra, 1996). In another study, however, fine arts majors consistently outperformed other undergraduate majors on multiple visual processing tasks, including a Gestalt completion task, embedded figures and mental rotation tasks, and a task that required participants to identify objects in pictures that were out of focus (Kozbelt, 2001).

Correlational evidence points to an association between training in the visual arts and abilities in geometry. For example, visual arts majors tend to be better at geometric reasoning compared to non-arts majors (Walker *et al*., 2010). Similarly, children learning to paint outperform children taking drama lessons or no lessons at all in geometric reasoning, and equivalently to those with music or dance training (Spelke, 2008).

Considered as a whole, the available evidence for links between visual arts and visuospatial abilities is sparse and largely inconsistent. At present, it is unclear whether training in visual arts causes improvements in visuospatial skills, especially considering that the evidence for a simple association is inconsistent. As for training in dance, results from one meta-analysis suggest that it may typically be accompanied by visuospatial processing advantages, although this finding is equivocal because some of the data came from studies that measured IQ (Keinänen *et al*., 2000).

Conclusions

In general, convincing evidence for educational and cognitive outcomes of arts training is lacking. In most cases, it is impossible to determine whether advantages in educational and cognitive tasks are the cause or consequence of training in the arts. Most of the exceptions involve music training, which appears to cause improvements in visuopatial and language abilities, and perhaps even small increases in IQ. When drama lessons are integrated into language curricula, there are also positive outcomes for many language skills. In the future, it would be informative to determine the role of pre-existing individual differences, and how these differences interact with arts training in associations that are evident when educational and cognitive variables are measured. Moreover, examination of mediating factors would help to identify the mechanisms underlying associations among arts training, academic achievement and cognitive abilities. Although music training has received the most attention from researchers, a more complete understanding of the relative merits of training in other art forms could help to illuminate why the arts play a central role in human experience, and how the arts maximize human potential.

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