Chapter 10

Brain outcomes of arts education

In this chapter we discuss how a growing body of neuroscientific research explores the links between arts education and brain outcomes. We give a few examples of the types of research carried out but argue that brain stimulation or changes are not a good outcome per se, which is why we have decided to present the findings of this important research body in the other chapters, according to outcomes that we consider as more meaningful.

It is well established that the brains of trained musicians differ both structurally (anatomically) and functionally (in terms of areas activated by music) from the brains of non-musicians (e.g. Jäncke, 2006; Schlaug, 2001). These differences are most likely not inborn but rather caused by the work of learning an instrument because these differences are found most sharply in children who begin instrumental training at an early age (Amunts et al., 1997; Elbert et al., 1995; Jäncke, 2008; Jäncke et al., 1997; Lotze et al., 2003; Schlaug et al., 1995a,b).

Functional differences between the brains of visual artists and non-artists when making or imagining making art have been reported by Belkofer (2008) and by Bhattacharya and Petsche (2005). And functional differences between the brains of dancers and non-dancers when responding to dance (Calvo-Merino, Glaser, Grezes, Passingham and Haggard, 2005), thinking about creating a dance (Fink et al., 2009), and actually doing simple dance steps (Brown et al, 2006) have been reported (see also Grafton and Cross, 2008).

In this book we have reported brain outcomes of arts education where relevant and when these have been associated with behavioural (cognitive) outcomes. Thus we described studies showing that music training alters the brain stem response to

sound. We do not provide a separate analysis on brain outcomes as we believe that brain outcomes are most clearly understood when they are discussed in terms of the cognitive/behavioural outcomes with which they are associated.

Advocates for arts education have sometimes pointed to these kinds of findings as proof of the importance of arts education. For example, in his 2001 book entitled *Arts with the Brain in Mind*, one of the arguments that the author Eric Jensen makes for the centrality of the arts in education is that the arts are "brain based," which appears to mean that we can identify areas in the brain that respond selectively to specific art forms. But of course everything we do activates certain areas of the brain. The claim that, for example, music activates just about all areas of the brain (Levitin, 2006, 2008) or even increases the volume in some areas of the brain cannot be a justification for teaching music in schools since everything that we do and learn changes the brain. For example, the brains of London taxi drivers have been found to be enlarged in an area important for spatial representation (Maguire et al., 2000), and three months of training in juggling has been shown to lead to growth in areas associated with processing complex visual motion (Draganski et al., 2004).

These findings contradict the traditional view that brain plasticity in adulthood occurs only functionally but not anatomically. We now know that adult brains change structurally in response to learning. A study of the effects of instrumental music training in childhood showed that after 15 months of lessons, children (who entered the study between the ages of 5 and 7) showed structural (and not just functional) brain changes that correlated with changes in both music perception and hand motor skills (Hyde et al., 2009).

Since all learning changes the brain, the important question to ask about arts education and the brain is not whether art education changes the brain. Of course it does. The question to ask, if we are interested in the question of transfer, is whether arts education alters the brain in a way that makes learning of another non-arts kind of skill more possible. Stimulation of the brain is not *per se* an argument for an activity: we must show that the particular kind of brain activation in question is associated with an outcome that we value (Croft, 2009). Hence our decision to present studies of brain outcomes along with the studies of skills that they subserve.

In Box 10.1, we present a summary of music studies with brain outcomes (some of which were mentioned in earlier chapters because they also has cognitive outcomes).

Studies of the effects of other forms of arts training on the brain remain to be conducted. The music-brain studies described suggest that instrumental training affects areas of the brain involved in speech perception, auditory working memory, executive functioning, and attention. Most of these studies are correlational, however; experimental studies need to be conducted to determine whether these children and adults had atypical brains to begin with, or whether, as is more likely, their brains were shaped by music training.

Box 10.1. **Music and brain outcomes: A few examples**

There is a growing body of neuroscientific literature on music training and brain outcomes. Here we offer a few examples of these studies to give the reader an idea of this literature.

Instrumental music training is correlated with enhanced brain activity in the left supramarginal gyrus, a region involved in phonological working memory (Ellis, Bruijn, Norton, Winner and Schlaug, 2013). This suggests that music training strengthens auditory working memory. However, we cannot conclude a causal relationship since the study was correlational rather than experimental.

Children with music training have a stronger brain response than those without training to pitch patterns in their native language (Besson, 2007). A stronger brain response means there is likely to be a stronger behavioural response to pitch patterns; a stronger behavioural response means means greater sensitivity to pitch patterns.

Musically trained children show a stronger event related potentials (ERP) brain response to both music and language violations than do those without training (Jentschke, Koelsch and Friederici, 2005).

Instrumentally trained children have a stronger electrical brain response to irregularities of syntax in both language and music than do non-musically trained children (Jentschke and Koelsch, 2009).

When exposed to speech, the brain stem response in adult musicians corresponds more directly to the pitch cues than we see in the brain stem response of non-musicians (Parbery-Clark, Skoe, and Kraus, 2009). This implies that the musicians should have a greater sensitivity to pitch in speech.

Violin training affected a brain outcome known to be associated with attention (Fujioka et al., 2006, as described in Box 3.7).

A kind of neural response seen in children who have had at least one year of music lessons is associated with stronger executive functions of attention and memory (Shahin et al., 2008).

After 20 days of interactive computerised music training given to 4-6 year old children (compared to 20 days of interactive computerised visual arts training, each randomly assigned), children in the music but not the visual arts group improved significantly on an executive function task assessing level of control and attention, and there was a positive correlation between performance on the changes in functional brain plasticity related to executive function (Moreno, Bialystok, Barac, Schellenberg, Cepeda and Ghau (2011).

References

Belkofer, C.M. and L.M. Konopka (2008), "Conducting art therapy research using quantitative EEG measures", *Art Therapy: Journal of the American Art Therapy Association*, Vol. 25/2, pp. 56-63.

Besson, M., D. Schon, S. Moreno, A. Santos and C. Magne, (2007), "Influence of musical expertise and musical training on pitch processing in music and language", *Restorative Neurology and Neuroscience*, Vol. 25/3-4, pp. 399-410.

Bhattacharya, J. and H. Petsche (2005), "Drawing on mind's canvas: Differences in cortical integration patterns between artists and non-artists", *Human Brain Mapping*, Vol. 26/1, pp. 1-14.

Brown, S.M., J. Michael and L.M. Parsons (2006), "The neural basis of human dance", *Cerebral Cortex*, Vol. 16/8, pp. 1157-1167.

Calvo-Merino, B., J. Grezes, D.E. Glaser, R.E. Passingham and P. Haggard (2005), "Action observation and acquired motor skills: An fMRI study with expert dancers", *Cerebral Cortex*, Vol. 15/8, pp. 1243-1249.

Croft, J. (2009), "Artistic justifications: The role of the arts in education", unpublished paper, Harvard Graduate School of Education.

Draganski, B., C. Gaser, V. Busch, G. Schuierer, U. Bogdahn and A. May (2004), "Changes in grey matter induced by training", *Nature*, Vol. 427/6972, pp. 311-312.

Elbert, T., C. Pantev, C. Wienbruch, B. Rockstroh and E. Taub (1995), "Increased use of the left hand in string players", *Science*, Vol. 270/5234, pp. 305-307.

Ellis, R.J., B. Bruijn, A.C. Norton, E. Winner and G. Schlaug (2013), "Training-mediated leftward asymmetries during music processing: A cross-sectional and longitudinal fMRI analysis", *Neuroimage*, Vol. 75C, pp 97-107.

Fink, A., B. Graif and A.C. Neubauer (2009), "Brain correlates underlying creative thinking: EEG alpha activity in professional vs. novice dancers", *NeuroImage*, Vol. 46/3, pp. 854-862.

Fujioka T., B. Ross, R. Kakigi, C. Pantev and L.J. Trainor (2006), "One year of musical training affects development of auditory cortical-evoked fields in young children", *Brain*, Vol. 129/10, pp. 2593-2608.

Grafton, S. and E. Cross (2008), "Dance and the brain" in M. Gazzaniga (ed.), *Learning, Arts, and the Brain: The Dana Consortium Report on Arts and Cognition*, The Dana Foundation, New York/Washington, DC, pp. 61-70.

Hyde, K.L., J. Lerch, A. Norton, M. Forgeard, E. Winner, A.C. Evans and G. Schlaug (2009), "Music training shapes structural brain development", *Journal of Neuroscience*, Vol. 29/10, pp. 3019-3025 (reprinted in *New York Academy of Sciences*, Vol. 1169, pp. 182-186).

Jäncke, L. (2008), *Macht Musik schlau? Neue Erkenntnisse aus den Neurowissenschaften und der kognitiven Psychologie*, Verlag Hans Huber, Bern.

Jäncke, L., G. Schlaug and H. Steinmetz (1997), "Hand skill asymmetry in professional musicians", *Brain and Cognition*, Vol. 34/3, pp. 424-432.

Jensen, E. (2001), *Arts with the Brain in Mind*, Association for Supervision and Curriculum Development.

Jentschke, S. and S. Koelsch (2009), "Musical training modulates the development of syntax processing in children", *NeuroImage*, Vol. 47/2, pp. 735-744.

Jentschke S., S. Koelsch and A.D. Friederici (2005), "Investigating the relationship of music and language in children: Influences of musical training and language impairment", *Annals of the New York Academy of Sciences*, Vol. 1060, pp. 231–242.

Levitin, D.J. (2006), *This is Your Brain on Music: The Science of a Human Obsession*, Penguin New York, NY.

Levitin, D.J. (2008), "The illusion of music", *The New Scientist*, Vol. 197/2644, pp. 35-38.

Lotze, M., G. Scheler, H.R.M. Tan, C. Braun and N. Birbaumer (2003), "The musician's brain: Functional imaging of amateurs and professionals during performance and imagery", *NeuroImage*, Vol. 20/3, pp. 1817-1829.

Maguire. E.A., D.G. Gadian, I.S. Johnsrude, C.D. Good, J. Ashburner, R.S.J. Frackowiak and C.D. Frith (2000), "Navigation-related structural change in the hippocampi of taxi drivers", *PNAS*, Vol. 97/8, pp. 4398-4403.

Moreno, S., E. Bialystok, R. Barac, E.G. Schellenberg, N.J. Cepeda and T. Chau (2011), "Short-term music training enhances verbal intelligence and executive function", *Psychological Science*, Vol. 22/11, pp. 1425-1433.

Moreno S., C. Marques, A. Santos, M. Santos, S.L. Castro and M. Besson (2009), "Musical training influences linguistic abilities in 8-year-old children: More evidence for brain plasticity", *Cerebral Cortex*, Vol. 19/3, pp. 712-723.

Parbery-Clark, A., E. Skoe and N. Kraus (2009), "Musical experience limits the degradative effects of background noise on the neural processing of sound", *The Journal of Neuroscience*, Vol. 29/45, pp. 14100-14107.

Schlaug, G. (2001), "The brain of musicians. A model for functional and structural adaptation", *Annals of the New York Academy of Sciences*, Vol. 930, pp. 281-299.

Schlaug, G., L. Jäncke, Y. Huang, J.F. Staiger and H. Steinmetz, (1995a), "Increased corpus callosum size in musicians", *Neuropsychologia*, Vol. 33/8, pp. 1047-1055.