Making Sense Neuroscience

Public interest in possible connections between how the brain works and education has increased steadily in recent years (Goswami, 2004). Yet, relating neuroscience research to classroom practice can be challenging. Almost daily, mainstream media outlets such as the *New York Times, The Atlantic,* or *USA Today* report a newly identified link between specific academic performances and areas of the brain that "light up." Virtually overnight, members of the public, as well as educators and school administrators, cite the "brain-based" research in arguments for proposed changes in the classroom, the curriculum, and entire school districts.

Kodály-trained music educators are probably no more immune to the seductive influence of neuroscience research than other educators. In our pursuit of research findings to strengthen our arguments concerning the value of music education, we too may find ourselves referencing claims supported by neuroscience research.

The challenge for educators is to make sense of nuanced neuroscience research. To do this, they may need to look at the original research for themselves as well as be skeptical of media reports. In this article, I will examine some of the possible pitfalls of applying neuroscience research in the classroom and suggest some criteria for teachers to evaluate research themselves.

The Appeal of Neuroscience

The mere mention of neuroscience can have an amazing effect on the value people place on a particular piece of research. In a well-known set of experiments, members of the public, as well as students and educators, were found to be more accepting of a claim based on faulty science or to give additional credence to a claim founded on solid science if the claim was accompanied by a neuroscience reference (Weisberg, Keil, Goodstein, Rawson, & Gray, 2007). Similar results were obtained by simply including an image of a brain in the report. McCabe and Castel (2008) found that including brain images with neuroscience research produced higher reader evaluations than research with bar graphs. However, the effect is not universal: a number of educators find little or no value in neuroscience (Pickering & Howard-Jones, 2007). Still others are of the opinion that any attempt to draw a connection between firing neurons and classroom behavior is unreasonable (Bruer, 1997).

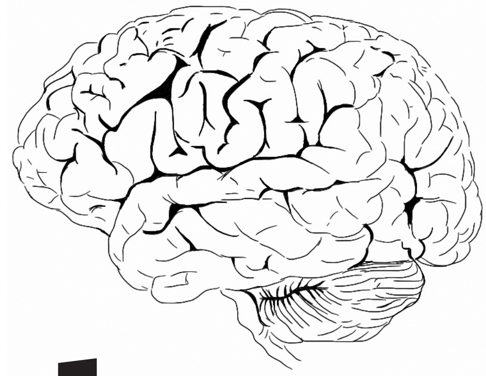
An additional problem is that mainstream media are often the first place the public learns about new scientific information. However, various pressures—including economic, time, and editorial—may force journalists to quickly create stories that appeal to as large an audience as possible. This means that reporting accurate, balanced, and critical information necessary for public understanding may be difficult at best. Additionally, mainstream media often fail to mention limitations and uncertainty associated with the reported research (Jensen, Krakow, John, & Liu, 2013; Racine, Waldman, Rosenberg, & Illes, 2010). This practice stems from the belief that the public is challenged by uncertainty and therefore wishes to steer clear of it (Jensen et al., 2013). The resulting reports often present research as either "good" or "bad" without consideration of the study's relative strengths and limitations.

In spite of these objections, neuroscience research continues to gain momentum in the world of education. Increasingly, school administrators and policy makers look to neuroscience research to support their positions on a wide array of educational issues.

Mainstream Media versus Original Research

To overcome the shortcomings of mainstream media reports, educators may need to actively investigate the research on their own. We can appreciate this need by considering a case of neuroscientific research from the 1990s. In 1995, mass media outlets began to report on a little-known study from a group of University of California–Irvine researchers. Rauscher, Shaw, and Ky ("Music and Spatial Task Performance: A Causal Relationship," 1993) investigated whether music activity might share neuronal pathways with higher cognitive functions. The authors concluded that their work replicated and extended previous studies on a causal relationship between music listening

# of Research



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and a specific spatial rotation task. Additionally, Rauscher and colleagues noted the limitations of the study:

> Although we have shown that music training can improve the spatial reasoning of three-year-olds, further research is needed before we can state with confidence that the effect will be shown with older children, predict how long it will last, or specify a mechanism for it (p. 20).

At first, the research gathered little interest, with a total of seven citations in 1993 (Bangerter & Heath, 2004). However, unlike other comparable published studies, Rauscher and colleagues showed increased citation in subsequent years, with significant spikes in years when the research was associated with outside events. Figure 1 shows media interest (Bangerter & Heath, 2004, p. 613).

The spikes in interest came from a variety of sources, including legislative action and, most notably, the publication of studies in 1999 challenging the findings (Chabris, 1999). During this time, a number of studies looked to either replicate or refute what was then beginning to be labeled the "Mozart effect," a term first used in the conclusion of the original research article (McKelvie & Low, 2002; Peterson, 2011). While academic discussion certainly played a part in the sustained place of Rauscher and colleagues' work in the public forum, there was another factor that contributed in an entirely unexpected way: flocking.

According to Singh, Hallmayer, and Illes (2007), flocking is "mass, migratory-type social behaviours" (p. 153) accompanying either acceptance or rejection of scientific findings. The initial public reaction then directs further public behaviors and beliefs. In the case of the Mozart effect, the public flocked to an intervention that mass media had suggested could provide a cognitive benefit in early childhood. A similar example of flocking would be the public's reaction to reports of "mad-cow" disease, beginning in 1986 (Singh et al., 2007). In the case of the Mozart effect, mainstream media contributed to flocking in two important ways. First, mainstream media reports typically ignored the scientific aspect of the study and chose to sensationalize the potential value of the Mozart effect. Second, mainstream media increasingly associated the Mozart effect with infants, though the original subjects were college students (Bangerter & Heath, 2004). This adaptation of the Mozart effect may have been the result of the public's increasing interest in critical periods of infant development (Bruer, 1999).

Eventually, the Mozart effect became the rationale for the state of Georgia to supply classical tapes and CDs to parents of newborns (Sack, 1998). In Florida, statute 411.0106 mandated 30 minutes of classical music in state-funded day-care facilities. The term "Mozart effect" was eventually copyrighted by Don Campbell (1947–2012), an author whose best seller, *The Mozart Effect*, championed the positive effects of music on mind and body and applied the term to an entire industry devoted to the production of Mozart effect products (www.mozarteffect.com).

Perhaps the most significant contributor to the resilience of the Mozart effect has been the mainstream media's extension of Rauscher and colleague's findings to populations beyond those originally studied. In this case, the original findings were transformed to meet the public's belief in "infant determinism" (Kagan, 1998): that is, the belief in an irreversible critical period in childhood brain development (Bangerter & Heath, 2004).

This is not to say that the research of Rauscher and colleagues (1993) was without flaws. It is fair to say that, as a rule, research is neither entirely good or bad. Though the Mozart effect has, in the eyes of many, been debunked ("Mozart Effect," *Huffington Post*, 2011), Rauscher has continued to defend not only the original findings, but also subsequent research based on those findings (2000).

While Rauscher's research was in the field of psychology, the proposed theory was in part based on neuroscientific data. Because of this connection between the Mozart effect and neuroscience, many continue to regard neuroscience research into music with skepticism.

The Growth of Neuromyths

The Mozart effect can be called a *neuromyth* (Peterson, 2011). Neuromyths are mistaken beliefs about brain and mind functions that may arise from distortions or misrepresentations of scientific fact (Geake, 2008; Goswami, 2004). They may also originate as unintended extensions of a scientific theory, as is the case with the Mozart effect. Regardless of the merits of Rauscher's theory and research, the resulting cultural extension into the Mozart effect has become a meme (a cultural behavior transmitted by nongenetic means) and is impervious to corrections or modifications (Pasquinelli, 2012).

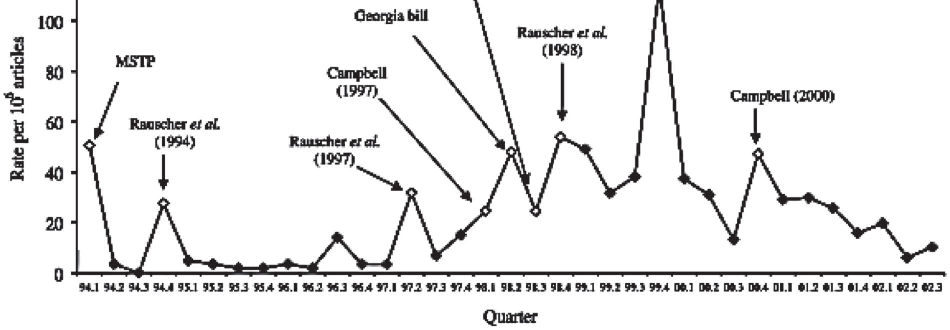
Neuromyths stubbornly persist in contemporary culture. Some of the most accepted include (1) that humans use only 10% of their brains, (2) that the first three years are a critical period for brain development, (3) that there are "left-brained" and "right-brained" people, and (4) that there are specific learning styles (visual, auditory, kinesthetic; Geake, 2008). A closer look at the first and last of these will help define neuromyth.

The idea that humans use only 10% of their brains is among the most persistent neuromyths. The original statement has been attributed to a number of people, including Albert Einstein (Geake, 2008). While the original observation was almost assuredly made from a psychological perspective, it somehow moved to a neuroscience perspective (Pasquinelli, 2012). The 10% figure may in some way refer to an individual's untapped cognitive potential, but it cannot be taken literally to mean that 90% of the physical brain is inactive. There are many arguments against the 10% myth. From a neuroscience perspective, the most compelling evidence comes from brain imaging showing that even in sleep all parts of the brain are active. (For an excellent presentation on other evidence against the 10% myth, see Beyerstein, 1999).

Another prevalent neuromyth is brain lateralization, or left-brain–right-brain thinking (Organisation for Economic Co-operation and Development, 2002). The theory that specific cognitive functions exist in one side of the brain or the other may have its roots in case studies of patients who had their brains surgically split (Goswami, 2004). The problem came when media reports extended the observed lateralization of functions in these patients to the brains of normal subjects. Proponents of left-brain–right-brain thinking cite studies that situate language processing in localized areas of the brain's left side. Unfortunately, these studies have generally included only right-handed participants, and even then, not all right-handed participants were shown to process language in the same hemisphere, or even in a single hemisphere (Geake, 2008). Additionally, in the case of music processing, it is now clear that processing occurs in both hemispheres with areas of activity shifting as musicians gain experience (Peretz & Zatorre, 2005).

Neuromyths are incredibly difficult to dispel, despite a lack of demonstrable efficacy and in the face of contradictory knowledge (Pasquinelli, 2012). The problem exists even in the education world. Dekker, Lee, Howard-Jones, and Jolles (2012) investigated the pervasiveness of neuromyths among two groups of educators. The researchers presented the teachers with 32 statements, of which 15 were neuromyths. On average, the teachers agreed with 49% of the neuromyths, with agreement on the concept of brain lateralization averaging 91% and 86% for the two groups (p. 4).

fig. 1. Media interest in the Mozart effect by year and quarter (expressed as number of articles per million articles). Relevant events are graphed by the quarter of their occurrence (Bangerter & Heath, 2004, p. 613).



The Gap between Neuro-Science and Education

A particularly troubling consequence of the continued presence of neuromyths is that they may devalue truly rigorous research into the cognitive process of learning (and teaching) music and may lessen teachers' trust in successful research partnerships between the fields of neuroscience and education (Christodoulou, Daley, & Katzir, 2009; Dekker, Lee, Howard-Jones, & Jolles, 2012).

For example, the aftermath of the Mozart effect may be one reason why music education supporters are now so cautious about using neuroscientific findings as a tool for advocacy (Peterson, 2011). Whether calling the Mozart effect a neuromyth is justified or not, the repercussions are still being felt (Peterson, 2011). Koza (2006), in commenting on possible connections between music and specific cognitive behaviors, said, "any research involving the brain should be interpreted cautiously" (p. 31).

On occasion, a report in mainstream media that appears to strengthen the argument for the benefits of music education may actually weaken it, as is the case with a recent article from *The Atlantic,* "Using Music to Close the Academic Gap" (Kase, 2013). Kase cited studies that found a number of positive learning associations with music education.

Preliminary results suggest that school- and community-based music instruction not only has an effect on brain functioning but also could possibly make a significant difference in the academic trajectory of lower-income children (para. 7).

Unfortunately, the use of imprecise words (preliminary, suggest, possibly) along with the limited scope of the impact (low-income kids) lessens the effectiveness of the article. Music educators may not find this article helpful in advocating for additional music education resources.

Another issue to consider is the perceived gap between the fields of neuroscience and education. Teachers often feel that neuroscientists rarely venture into the classroom and therefore have little or no appreciation of the real-world knowledge, observations, and challenges of educators (Samuels, 2009). With increased time in the classroom, researchers would be better equipped to design and implement educationally meaningful research (Pickering & Howard-Jones, 2007). On the other hand, neuroscientists counter that educators are not willing to consider research findings that fall short of presenting teachers with concrete steps that will work in the classroom (Goswami, 2006). As a result, constructive conversations between the two groups are few and far between (Hinton & Fischer, 2008).

Evaluating Neuroscience Research

As Kodály-trained educators, we teach under the guidance of a set of flexible, fundamental principles that integrate "many of the best ideas, techniques, and approaches to music education" (Organization of American Kodály Educators, n.d.). Specifically, Kodály is a "philosophy of education and a concept of teaching" (OAKE, n.d.) and not a defined method. While we always try to incorporate the best practices from every field in out teaching, it is still challenging for Kodály-trained educators to know how to best approach neuroscience research.

In recent years, a group of educators tried a new approach to the challenge. In 2002, Kurt Fischer and Howard Gardner began a program at the Harvard Graduate School of Education in Mind, Brain, and Education (MBE; Blake & Gardner, 2007). Kurt Fischer is a professor of education at Harvard Graduate School of Education and the founding president of the International Mind, Brain, and Education Society. Howard Gardner, a psychologist who is also a professor at the Harvard Graduate School of Education, is probably best known for his groundbreaking work *Multiple Intelligences*. In the following decade, a growing number of universities instituted similar programs focusing on educational neuroscience, that is, the nexus of neuroscience, cognition, and learning science (Fischer, 2009). MBE programs train graduates to identify those issues of interest to teachers, to locate and disseminate relevant research, and to develop cognitive theories and models that reflect the contributions of both educators and neuroscientists (Fischer, 2009). Functioning within a school system, an MBE graduate serves as a valuable resource for educators and administrators who would appreciate additional background on neuroscience research. Unfortunately, because of the relative newness of the field, there are not enough MBE graduates to go around.

Without the availability of an MBE expert, how can music educators best evaluate mainstream media reports that link music and neuroscience to learning achievements? Fortunately, there are strategies that can go a long way toward assessing the value of such research. The following recommendations are critical steps in the process.

First, locate the original publication. There is no substitute for reading the actual document. Mainstream media reports necessarily summarize research findings in a way that cannot capture all that is important (Jensen et al., 2013). By locating the original publication, an educator is in a better position to evaluate the research. Unfortunately, very few educators have access to a university-quality academic database. However, there are still many public resources available. Google Scholar offers access to a surprising amount of research. Additionally, many public and university libraries grant free access to several of the larger databases.

Once you have located the original research, you can begin to evaluate it by asking several basic questions. Because neuroscience concerns itself primarily with the gathering of data through brain imaging, these questions are keyed to quantitative rather than qualitative methods.

1. Was the study large enough?

The strength of any finding relates directly to the number of cases in the trial. There are two important figures to consider. The first concerns whether or not the study has "power," that is, can the researchers generalize from this number of cases. The second figure concerns significance. Here the question is whether or not the researchers accounted for a reasonable presence of chance. Those with a basic background in statistics should be able to confidently interpret these figures. For those without a background in statistics, enlisting the expertise of another person may be necessary.

2. Was the study well-designed?

Ascertain whether the study adhered to accepted, rigorous procedures. Again, because of the nature of neuroscience research, the areas of concern are primarily quantitative in nature. Did the researchers employ a control group? How was the sample group selected? Was there a clear hypothesis, and was the study designed to test the validity of the hypothesis? It may be difficult to answer some of these questions without a working knowledge of the field of neuroscience. Again, the use of outside experts, such as an MBE graduate, is advised.

3. Do the length and duration of the study support the claims?

Are the research findings limited to a specific time frame? For example, if a study reported a change in brain activation following a music lesson, did that change persist over time? One hour later? One day? One week? Valid research need not cover all possible time frames, only the time frame referenced in the conclusion.

4. Are there any other explanations for the results that merit consideration?

It is important for researchers to recognize the limitations of their work. High-quality research typically acknowledges and attempts to address alternative explanations for reported results. When evaluating neuroscience research, keep in mind that correlation does not mean causation. Be aware of the possibility that confounding factors may be unaccounted for.

5. What are the qualifications of the reviewers and the journal?

High-quality research requires appropriate peer review. Take steps to determine the status of the reviewers and the journal. Also, be aware of possible conflicts of interest.

Why Teach Music?

Before concluding, an important point must be made. Not all music educators believe in the benefits of discussing the possible cognitive benefits outside of music. According to Winner and Hetland (2007):

> We don't need the arts in our schools to raise mathematical and verbal skills—we already target these in math and language arts. We need the arts because in addition to introducing students to aesthetic appreciation, they teach other modes of thinking we value. (p. 4)

To many music educators, the authors make a valid point. To Kodály-trained educators, the point reflects a key element of the Kodály concept: that appreciating music as a "human sound" adds value to life (OAKE, n.d.). Kodály-based educators believe that the value of music education should not depend on transfer effects, but on its impact on a child's lifelong appreciation of music.

Unfortunately, not everyone shares this fundamental appreciation of music education's intrinsic value. In the world of 21st-century education, many of those who craft curriculum and control resources do so with an increasing consideration of the value of neuroscience research. As frontline advocates for the value of music, it behooves us to ensure that the support we present for our position is scientifically valid, appropriately researched, and relevant. This, along with a commitment to academic diligence when considering the value of neuroscientific research, will help us position ourselves to produce a lasting difference in the world of music in education.

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Congratulations to Colleen Graves on her recent promotion to administrative coordinator. Colleen has played an invaluable role in boosting OAKE's social media efforts as well providing valuable assistance in the transition to our new website. We thank Colleen for her continued efforts in helping OAKE embrace 21st-century resources and thereby making OAKE a stronger organization.

Regarding our new website, we encourage members to opt-in to our green initiative. The green initiative is OAKE's effort to reduce both its carbon footprint and operating costs by sending annual membership reminders and thank you letters through e-mail instead of U.S. mail. Soon members will also have the option to sign up for automatic annual billing online, ensuring that their membership does not lapse. Lastly, we encourage all members to complete their member profile by logging in, clicking My Account, and then clicking the Profile tab. Here you will not only be able to update your contact information, but also be able to fill in demographic information about your teaching that will help OAKE in planning, marketing, and achieving its strategic goals.

Below are our membership numbers as of Aug 1, 2014:

Corresponding	4
Institutional	28
Library	15
Lifetime	46
Professional	1020
Retired	94
Student	193
Student/Envoy	49
Sustaining	10