NEUROEDUCATION: LEARNING, ARTS, AND THE BRAIN

Findings and Challenges for Educators and Researchers from the 2009 Johns Hopkins University Summit




About The Johns Hopkins University School of Education Department of Interdisciplinary Studies in Education Neuro-Education Initiative

Bringing Together Researchers, Educators, and Stakeholders

Located at The Johns Hopkins University School of Education, the Neuro-Education Initiative (NEI) bridges the gap between the brain sciences and education by bringing together an interdisciplinary group of researchers, educators, and stakeholders to explore the intersection and application of brain research in education and to support potential areas of translational research.

Supported by the Johns Hopkins University's Brain Science Institute, the Neuro-Education Initiative spearheads collaborative projects among research and educational faculty from across the University and beyond to advance the science of learning. Such projects include national summits and conferences on topics relevant to education, graduate programs, and research initiatives to bring new knowledge to inform educational practices and policies.

In partnership with The Dana Foundation and as a follow-up to the Dana Arts and Cognition Consortium, NEI hosted its inaugural national summit in May 2009 on the topic of Learning, Arts, and the Brain. This publication captures the spirit of collaboration among summit participants who represented a wide array of disciplines among the research, academic, arts and educational practitioner communities. Future summits will build on this spirit of discovery and communication to bring the practical needs of educators and stakeholders to the research community and the exciting discoveries of the brain sciences to those who teach and nurture children.

For more information and future events visit **www.education.jhu.edu/nei**; or contact the Neuro-Education Initiative Co-Directors Mariale Hardiman at **mmhardiman@jhu.edu** or Susan Magsamen at **smagsam1@jhu.edu**.

About Dana

The Dana Foundation is a private philanthropic organization with particular interests in brain science, immunology, and education.

In 2004, Dana funded the Dana Arts and Cognition Consortium bringing together scientists from seven research institutions to study how arts training in children might affect other learning domains. The results of the study were published in 2008 and became the focus for an all-day summit focused on neuroeducation, hosted by the Johns Hopkins Neuro-Education Initiative, in cooperation with Dana. This publication is an outcome of that summit meeting.

In the science and health fields, Dana grants support research in neuroscience and immunology. As part of its outreach to the public, Dana produces books and periodicals from the Dana Press, coordinates the international Brain Awareness week campaign; and supports the Dana Alliance for Brain Initiatives, a nonprofit organization of more than 250 neuroscientists, including ten Nobel laureates, committed to advancing public awareness of the progress of brain research. The Dana Web site is at **www.dana.org**.

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By Mariale Hardiman, Ed.D., Susan Magsamen, Guy McKhann, M.D., and Janet Eilber

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Dedication

William Safire
1929–2009

William Safire died while this publication was in production. But, in true Safire-style, he met the deadline for his prolegomenon just a week or so before his death. "Deadline, deadline, deadline" was his mantra and he kept to it.

Safire, always the first to realize what would be significant and push for it, believed in the importance of arts education, brain research, and neuroeducation. In 2004, with the approval of the Dana Board of Directors, the Foundation established the Dana Arts and Cognition Consortium. The Consortium, researchers at seven major institutions, was charged with studying the effects of arts training on other learning domains. The results of that study, which showed strong correlative links, but not causal ones, were released in a report in 2008.

Earlier this year, Safire gave his approval for the Foundation to support The Johns Hopkins Neuro-Education Initiative, which planned to hold a summit for scientists, educators, and policy makers on the results of that study and subsequent research. Safire was convinced that this emerging field of neuroeducation, with its strong ties to cognitive research, would ultimately make a difference in teaching and would emphasize the importance of bringing arts back into the classroom.

Safire decided that the Foundation, working with the Neuro-Education Initiative, would publish a book of the highlights of the summit meeting. He told me to "get on it," and get this book out. The time frame was never stated, but certainly implied. Safire hated old news. Enough said.

So, despite the sadness following his death we "got on it." I asked, "What would Bill say?" And I knew the answer would be, "Keep the faith, kiddo." And we will, Bill.

This one's for you.

Barbara Rich, Ed.D.
Editor

Contents

Section 1

The Circuits of Neuroeducation

A Prolegomenon[*]

By William Safire, Chairman, the Dana Foundation

When they get around to remaking the 1974 movie *The Graduate*, the key word whispered into the young man's ear as the secret to success in the coming generation won't be "plastics!" The word in the updated version will be "circuits!"

An early user of that word in its scientific sense was Benjamin Franklin. Franklin described his experiments in electricity in several letters to Peter Collinson, a friend and Fellow of the Royal Society who lived in London. Collinson and others in London thought Franklin's letters contained valuable information, so in 1751 they published them in a book, *Experiments and Observations on Electricity.*

Today, neuroscientists—having used the recent leaps in imaging technology to discover and map the regions of the brain dedicated to perceiving, reacting, remembering, thinking, and judging—are delving into the connectivity among the brain's universe of neurons. In cognitive neuroscience—the study of how the brain learns, stores, and then uses the information it acquires—circuitry has become an ever more exciting challenge.

Because cognition is rooted in the Latin word for knowledge, educators also have a great stake in the idea of circuits. In great universities and in elementary classrooms, the constricted "stovepipe" departments of the past have given way to interdisciplinary approaches. Such connectivity in teaching gives memorable context to learning; equally important, it spurs student creativity. Subjects cross over each other, transferring skills and knowledge, figuratively as they do in the brain.

Let's now apply the metaphor of circuitry to the book in your hand. A circuit has been forming over the past two decades, relatively unremarked, between cognitive neuroscience—the science of learning—and the practitioners of education. What was needed to close the knowledge circuit—to give a jolt of energy to the trend toward neuroeducation—was a field of experimentation familiar and accessible to both disciplines, one that would dispel a sometimes inbuilt mutual wariness.

One connection that presented itself was an area of controversy: the impact of training in

[*] A prolegomenon is a highfalutin word for a brief preface to a lengthy tract. Neuroeducators avoid such words.

WILL KIRK, HOMEWOOD PHOTOGRAPHIC SERVICES

William Safire

the arts—music, dance, drama, painting—on the brains of children. Did intensive study of the piano or violin at an early age have an effect on the brain that would near transfer to motor skills, or even far transfer to the ability to solve mathematical problems? Did dance training increase an aptitude for geometric patterns, ultimately leading to high marks in architecture or interior design? Beyond such specific effects on related academic areas, did rigorous arts training enable the student to better concentrate on any subject? Of course, correlations between, say, music and mathematics talents have long been apparent, but as skeptical scientists rightly pointed out, correlation is not causation.

The neuroeducation circuit has gradually been forming across the country, including the University of California, Santa Barbara; the University of California, Irvine; Harvard; and several smaller colleges. Nowhere has it been more impressive than the explosive start made at The Johns Hopkins School of Education, under the leadership of Mariale Hardiman, Ed.D., Susan Magsamen, and Guy McKhann, M.D. In the coming decade we shall see how further scientific findings strengthen and reaffirm the new science of learning.

Section 2

Executive Summary

On May 6, 2009, the Neuro-Education Initiative of The Johns Hopkins University School of Education, with support from The Dana Foundation, hosted its inaugural national Learning, Arts, and the Brain Summit to explore the intersection of cognitive neuroscience, the arts, and learning. More than 300 educators, scientists, school administrators, and policy makers shared their perspectives on advancing the science of learning through the lens of arts training and its effects on cognition.

The emerging field of neuroeducation explores how children learn and what practices promote and sustain the learning process. Neuroeducation is an interdisciplinary field that combines neuroscience, psychology, and education to help create improved teaching methods and curricula.

Summit presentations expanded on the results of studies included in the Dana Arts and Cognition Consortium report, released in March 2008. The report, based on multiple three-year studies from seven universities, examined whether early arts training can cause changes in the brain that enhance other aspects of cognition. Consortium researchers found "tight correlations" between arts training and improvements in cognition, attention, and learning.

Through this summit, the research and education communities came together to discuss what neuroscience research has demonstrated to date concerning the effects of arts training on cognition and to explore future research priorities and opportunities. The summit's purpose was not to debate whether children need the arts, but rather to explore how studying and practicing the arts might enhance creativity, cognition, and learning.

Three questions guided the proceedings: (1) What do we know from cognitive-neuroscience research concerning the effects of arts training on the brain that could and should be accessible to teachers? (2) What new research is relevant and possibly related to how studying an art form helps students learn better? and (3) How does the process of learning with and through the arts improve academic performance?

Summit Structure

Hosted at the American Visionary Art Museum in Baltimore, the summit provided a full day of proceedings that began with introductory remarks by the summit hosts and university officials.

As articulated by summit hosts Mariale Hardiman, Ed.D., and Susan Magsamen, both of The Johns Hopkins University School of Education, the agenda for the Learning, Arts, and the Brain Summit was organized around a premise and an invitation:

The premise

The empirical classroom experience of arts integration subjectively suggests that carefully structured arts-based pedagogy can improve students' learning and academic experiences, resulting in demonstrably positive outcomes that include deeper engagement in subject matter and better retention of content; greater emotional involvement in the learning process and deeper social awareness; and the ability to apply principles across disciplines.

Arts integration is also important from a national, macroeconomic perspective: graduates are entering the workforce without critical skills that arts-based learning is known to promote—collaboration, creative problem-solving, and the ability to apply learning across different disciplines. Further, exposure to the arts as a participant or observer has the potential to have profound effects on learning and memory, context, and comprehensive creative thinking.

The invitation

Unite the domains of education and neuroscience to identify and design classroom strategies that research suggests may promote the desired outcomes; test whether outcomes improved; and refine the strategies accordingly. What are the mechanisms at work between arts-based learning and improved cognition?

From Classroom to Lab, and Lab to Classroom

To open the day-long program, neuroscientists Guy McKhann, M.D., The Johns Hopkins University, and Kenneth Kosik, M.D., University of California, Santa Barbara, provided insights into the emerging field of neuroeducation. Ellen Galinsky, president of the Family and Work Institute, made opening remarks and introduced a short video from Michael Gazzaniga, Ph.D., University of California, Santa Barbara. Dr. Gazzaniga provided an overview and summary of the findings from the Dana consortium report (see chapter three).

McKhann called for research that tracks one test group over time. When one introduces arts-integrated methodologies into the classroom and observes the resulting learning, he asked, which outcomes are attributable to the new methodologies and which might be ascribed to the intrinsic capabilities of the participating students?

Kosik, a founder of the Learning and the Brain Conference, now in its 12th year, reported some of the lessons learned about marrying the domains of neuroscience and education: "Educators are seriously interested in research; they are hungry for information. Neuroscientists are typically less interested in education; they haven't gotten into the trenches with educators. Conference participants want to know what they can do when they get back to their classrooms." He noted that the scientific community now is beginning to have answers, and is prepared to begin addressing teachers' needs and questions.

Galinsky commented on her research into what happens when students are not engaged and not learning the skills they need. Her studies began with "not learning," that is, when students reported that they were just learning "stuff" to get a job, go to college, and do better in life. In contrast, when students said they were truly learning, they described the experience as "feeling bigger than usual, finding a sense of purpose, and knowing who they were."

Galinsky also noted that the Dana Foundation research suggests arts training can be a jump-starter for students. For example, students who have

theater training in high school often score higher in social aptitude. How then does the larger community make this belief in the arts more credible in teachers' minds? If educators see a substantive body of work affirming the benefits of arts training, they'll be more likely to include and integrate the arts into schools and classrooms, she said.

Scientific presentations were then offered by a panel of researchers. The panel, moderated by William Safire, chairman of the Dana Foundation, was asked to present recent findings on the influence of the arts on learning and to provide direction for future research. The presenters were: Michael Posner, Ph.D., University of Oregon; Elizabeth Spelke, Ph.D., Harvard University; Brian Wandell, Ph.D., Stanford University; Ellen Winner, Ph.D., Boston University; and Gottfried Schlaug, M.D., Ph.D., Harvard University (see section three for edited excerpts of the panel discussion).

There were significant findings to report. Winner and Schlaug discussed recent results from the first 15 months of a four-year study of children who received regular music instruction compared to those who did not. The controlled study was designed to determine whether music training affected near-transfer domains—those skills closely related to the training, such as fine motor control. They also tested for far transfer, that is, transfer to learning in other domains. Analysis of data based on 15 months of training showed that students who were given music instruction performed better in near-transfer domains. Equally important, imaging showed that changes occurred in certain brain structures compared to the non-trained students. This is the first study to show brain plasticity in young children as a function of musical instruction. At this 15-month period, they found no differences between the music and non-music groups in far transfer; the final determination awaits analysis of data from the full four years of the study.

Posner presented research that focuses on the executive attention network, which is involved

COURTESY OF CLARE GRIZZARD

Art from a third grade student at Roland Park Elementary/Middle School, Baltimore

in self-control. He explained that each art form engages a neural network. In children who are open to, interested in, and motivated to practice a specific art form, training focuses their attention and strengthens the executive attention network.

Posner found that controlled training on attention-related tasks in young children increased the efficiency of the executive attention network and also improved other learning domains. When children were given training specifically designed to improve attention, not only did attention improve, but the generalized parts of intelligence related to fluid intelligence increased as well. "Years of neuroimaging have now given us a plausible mechanism by which arts training could now influence cognition and IQ," he said. Posner is also studying candidate genes that may explain

individual differences in interest in the arts, and he is researching the interactions between genes and environment involved in strengthening the efficiencies of attention networks.

Spelke, whose earlier research showed a strong correlation between intense music practice and geometrical representation skills, described her latest research with infants, which explores the possible brain basis of this correlation. She was able to create sounds in different timbres, which were paired with objects of different heights. In some trials, a baby would hear a rising sequence of notes, in others, a falling sequence. But, in both cases the height of the object related to the pitch of the note. (When the notes fell so did the object.) With a second set of infants, the same sounds and objects were shown, but the pairing was reversed. The results showed that the infants learned the pairing of tone and object height when it was congruent, but not when it was incongruent. Spelke said that as early as four months, babies seem to be "sensitive to relationships between the two key properties of a melody and positions in space."

Wandell spoke of his research demonstrating that music training is tightly correlated with phonological awareness—the ability to differentiate and manipulate speech sounds—which is the major predictor of reading fluency. He described how diffusion tensor imaging shows how specific nerve fibers pass through the corpus callosum and connect the two hemispheres. He explained that determining brain connections by seeing how water diffuses in and around those fibers is quite predictive of how well children or young adults learn to read. Properties of these specific nerve fibers are highly correlated with phonological awareness and therefore with reading capabilities. He and colleagues are now looking at research related to correlations between visual arts and math. Wandell made a point of encouraging educators to explore research questions that would be useful to them.

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Art from a third grade student at Roland Park Elementary/Middle School, Baltimore

The afternoon session began with a keynote address by Jerome Kagan, Ph.D., Harvard University, who spoke on the topic "Why the Arts Matter: Six Good Reasons for Advocating the Importance of Arts in School." Kagan outlined the need for children to develop personal agency and tools to acquire, store, and communicate knowledge. He said, "In sum, arts and music have an important role to play in American schools. I suspect that if American teachers devoted one hour each day to art or music, or even one hour two days a week, the proportion of youth who dropped out of high school might be reduced. Moreover, the child's products would provide parents of failing children with an opportunity to praise children rather than criticize them for laziness." (See chapter four for a full transcript.)

A panel of educators and arts advocates focused on the implications of the research for policy and practice. Moderated by Dick Deasy, former director of the Arts Education Partnership, the panel included Sarah Cunningham, Ph.D., director of arts education at the National Endowment for the Arts; Janet Eilber, director of arts education at the Dana Foundation; Mariale Hardiman, Ed.D., assistant dean and department chair at The Johns Hopkins

University School of Education and a former principal; Mary Ann Mears, artist and founder of Arts Education in Maryland Schools; and Betty Morgan, Ph.D., superintendent of schools of Washington County, Maryland.

Deasy discussed the morning science presentations as well as a current movement in education, "action research," through which teachers develop questions and pursue them within the contexts of their lives. The publication, *Critical Links*, edited by Deasy, was referenced throughout the summit as a guidepost for educators and arts organizations throughout the country.

In response to Deasy's queries, Mears noted the work of James Catterall as having significant influence on her way of thinking about arts and education. Catterall's analysis of data from NELS [National Educational Longitudinal Study] addresses the issue of equity by drawing a relationship between correlations, indicating that children from low socioeconomic backgrounds benefit significantly from the arts. "Equity is where the rubber meets the road in this work" Mears said.

Commenting on another Catterall study, Mears explained that the researchers gave two groups of children a prompt about Ancient Egypt. One group drew and then wrote in response to the prompt; the other group just wrote. The students who drew and then wrote had better organized and more detailed written responses. This was particularly true of students with limited English proficiency.

Morgan discussed how important research has been in helping her and others bolster arts in the community. Morgan noted that "the research has strengthened arts-education programs not only in Maryland, but everywhere." She added that she was grateful to those engaged in research because it is critical for "those of us on the front lines … to justify the arts in our programs and the expenditures arts incur."

Cunningham discussed the importance of the research in terms of policy issues, saying that research makes a difference to a funder when you have organizations "that are aware of what in detail is happening to the children." She added that "this conversation with the scientific community demonstrates the richness of the moment. We have an opportunity as a federal agency to take this conversation to the press, the White House … This conversation on the arts expands beyond artistic practice out into our moral effectiveness."

Eilber spoke about how the arts can engage students by providing a different context for learning. She noted a study, "The Power of Art," that looked at the elements of after-school programs that bring art to California youth. Eilber said that the most striking and revelatory point about the study was what these particular after-school programs in the arts offered that other programs, such as sports, did not. "It came down to one thing: responsibility for self expression," she said.

Hardiman described her experience as a school principal: for 11 of her 12 years at one school, she witnessed consistent improvements in students' reading and math scores. But she began to realize that "we were so focused on accountability and scores that there was something that was not as holistic as it should have been." Hardiman developed the Brain-Targeted Teaching Model, which relies heavily on arts integration. "We started to look at how to get children to master key concepts and do repetition through arts-integration so that they didn't think that they were repeating and repeating content, but manipulating it in different ways through the arts," Hardiman explained.

The core of the summit was the roundtable discussion groups. Each roundtable included ten participants who represented the research community, classroom teachers, educational leaders, teacher educators, and policy makers. A facilitator helped shape the discussions and a recorder captured the dialogue. Discussions focused on what teachers want to know about the influence of arts integration on learning and development. They

were charged with generating research questions and determining the best methods for high-quality neuroeducation research. Discussions also focused on how potential findings could shape educational policy and practice. (See section six for roundtable discussion summaries.)

Among the more salient issues that emerged from the discussions were:

- Can the United States afford to abandon the training of creative ways of thinking and learning in the hope that these skills will come from some source other than specific training in the arts?
- What does an arts-integrated curriculum really look like? Teachers said that there needs to be a fully developed pedagogical model that could be applied to multiple subject areas. They asked how the application of such a model would change the teaching profession.
- Are we asking too much too early from the neurosciences? Educators and scientists argued that a conservative approach was needed. Neuroscientists need time to conduct studies and disseminate results.
- Can we study a school model where scientists and teachers collaborate to conduct research based on the needs of the classroom? Can we establish research schools where the teacher could be a co-principal investigator with the scientist?
- How can we bring parents into the conversation, and give them ways to use arts-integration strategies in the home? Families have a tremendous opportunity to support, enhance, and promote the arts at school, at home, and in the community.
- Is it possible to follow students who had arts integration in the early grades throughout high school? Is there a certain age or age group when exposure to music and other art forms produces the best outcomes with regards to learning development?
- What is the role of the arts beyond improving academic performance? How can the arts support social and emotional learning?
- How can the arts help students with special needs?

Implications for Policy and Practice: A View from Science, Education, and the Arts

In this final chapter, the authors look to the future and assess how best the fields of neuroscience, education, and the arts can collaborate to bring change to education policy and practice.

In his essay, McKhann states that the relationship between neuroscience and education historically has been edgy. But this relationship is beginning to change, thanks to interdisciplinary approaches by several groups bringing educators and neuroscientists together, including the summit. From these discussions and the arts and cognition research, several concepts have emerged, including the need for educators to have a central place where they can ask questions. These questions, in turn, may stimulate further studies. McKhann points to research that suggests that there may be genetic factors that influence a child's reception to a particular type of art—music, dance, etc. He also emphasizes the work being done in enhancing attention mechanisms. He states that there is much yet to be learned.

In her piece on the education community, Hardiman says that the purpose of collaboration between the neuroscience and education communities is not to justify having arts in the schools. Educators who have already seen that the arts make students more creative learners do not need research explaining why. But neuroscience does add a level

of confirmation. Scientific evidence on the influence of arts-based learning will add new dimensions to educational practices and policies.

Understanding what makes students better learners, said Hardiman, may remain disconnected from substantive changes in educational policy. Educators will make incremental improvements in curricula, but real policy change has to do with repairing the disconnect between what children can do and our expectations of them, along with the disconnect between official accountability and the clamor for more creative skills. Hardiman offers readers a Neuro-Education Interdisciplinary Research Model that she and Susan Magsamen developed in order to begin answering these questions.

In her commentary, Eilber says that arts-education advocates have always believed intuitively that the arts are a highly effective vehicle for improved learning; scientists support this intuition through a growing body of serious research. The field is deeply involved in translating research findings into teaching practice. Eilber emphasizes that arts education offers a network of partners, working with school systems and building a reputation for alternative learning processes. A growing body of arts-based curricula is accountable to states' learning standards, supported by findings emerging from neuroscience, which can provide models for new brain-based pedagogy.

Summit Outcomes

Several key outcomes emerged from the summit. Educators are largely unaware of new scientific research; scientists typically do not conduct research with educators in mind as end users; and advocates are convinced of the efficacy of arts integration but need hard evidence to promote it. Communication among these constituencies is almost nonexistent; when information is shared it often is synthesized into headlines or neuro-myths. Ongoing discussion and collaboration has yet to evolve.

And yet, the sense was that education, the arts, and brain sciences might give impetus to the new field of neuroeducation, bringing together diverse thinking, invigorating pedagogical practice, and promoting research with relevant applications.

The cautionary message was that one should not confuse the artifacts of brain research (e.g., imaging) with its larger, not-yet developed potential, which is to create a guide for improving teaching strategies based on research about how children think and learn.

The benefits of harnessing these domains are to:

- create new processes to integrate basic and cognitive-science knowledge through translational strategies
- promote flexibility and innovation in instruction design
- explore more precisely the nature of creativity and apply it to encourage the transfer of knowledge and skills
- enhance cognitive development at all ages
- support advocacy with new evidence
- address particular learning differences.

What did we learn at this summit?

Four points clearly emerged from the panels and the roundtable discussions:

1. Educators and researchers must communicate and collaborate.

Meaningful collaboration will require educators and brain researchers to understand one another's language, processes, and outcomes.

Educators want cognitive and brain scientists to work with them to create and conduct research that sheds light on how children learn in forms that can be applied to the classroom.

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Art from a third grade student at Roland Park Elementary/Middle School, Baltimore

Researchers need to understand how teachers teach and which measurements are most useful. Teachers need to understand what research can deliver and how to frame the demands they make on it. Arts educators and proponents of arts-based instruction need to codify the meaning of arts learning so that teachers in other disciplines can understand how it benefits students, making them more prepared and willing to integrate the arts. Universities that train new teachers and provide professional development for experienced ones need to promote research and integrate findings into revised curricula.

Underlying all these conditions is a need for broader communication to engage parents, families, school boards, community-service providers, legislators, and other constituents who determine educational policy.

2. Translation of research must occur in different forms.

At a basic level, translation should involve researchers working hand-in-hand with educators in the classroom to understand and address specific needs and questions. As methodologies emerge and are tested, effective strategies should be published in the form of tool kits for dissemination to teachers. For broader availability and consumption, tool kits and other resources should be posted in central Web-based repositories for interested professionals to consult. Educators should provide this information to parents as much as possible in order to allow parents to be strong educational partners with schools on behalf of their children.

3. Lab schools should be cultivated as authentic settings for research and the development of integrated pedagogical models.

Schools can become laboratories that cultivate relationships between the research and educational communities, with researchers and teachers working side by side in classroom settings. The schools may be organized within a university that trains teachers or may operate with less formal arrangements between higher-education institutions and local schools.

However they are organized, lab schools should bring together scientists and educators in a joint effort to design, perform, and test applications of translational research in the classroom. The involvement of teachers from many different disciplines is critical, as is a focus on topics and problems rather than specific subjects. Of note, The International Mind, Brain, and Education Society (IMBES) has begun to develop standards for the creation of lab schools. This process should continue to build integrated research in academic settings at all age levels.

4. Arts learning must be better understood before we can successfully integrate the arts across the curriculum.

Teachers of music, theater, dance, creative writing, and the fine arts—with the support of researchers—must define what they do in terms of improving students' cognitive development. Educators experienced in successful arts integration should contribute to the development of tool kits.

It is not enough to say that the arts enrich the school experience; individual art forms should be analyzed separately with a view toward the particular outcomes they best support. Which outcomes are measurable, and how are they measured? Do the arts demonstrably improve scores on standardized achievement tests? Can we keep separate the effects of the arts-learning process from the evaluation of the finished product? How much time is required for arts learning and arts integration to show an effect, and does this effect last?

In the end, the summit clearly illustrated the need to bring educators, researchers, and key policymakers together to talk to one another about the importance of the arts in education. The summit brought to light key issues, from simple terminology disconnects to larger policy and implementation challenges. It also demonstrated that when you bring passionate, diverse thinkers together to solve essential learning and social problems, they do so with insight and thoughtfulness, resulting in new directions and potentially transformative outcomes.

Throughout this report there are examples of many new directions and ideas for future research that need further elaboration. Our hope is that the summit, its participants, and ongoing conversation about critical concepts will continue to be revisited, leading to new knowledge, practices, and success for our children.

Section 3

Summary of Neuroscience Research

In 2004, the Dana Foundation began exploring whether training in the arts changed the brain in ways that transferred the benefits of arts training to other cognitive abilities. Dana established the Arts and Cognition Consortium—made up of nine investigators at seven major universities—to take largely anecdotal and correlative observations about the potential role of the arts in enhancing a child's overall cognitive ability and subject these to rigorously designed neuroscientific studies.

Over the next three years, the researchers studied the brain's response to early training in dance, drama, and music. In 2008, the consortium published its results: *Learning Arts, and the Brain: The Dana Consortium Report on Arts and Cognition.*

In the report's opening remarks, Consortium Director Michael Gazzaniga, Ph.D., offered a measured, but ultimately optimistic, introduction:

> Is it simply that smart people are drawn to 'do' art—to study and perform music, dance, drama—or does early arts training cause changes in the brain that enhance other important aspects of cognition?
>
> The consortium can now report findings that allow for a deeper understanding of how to define and evaluate the possible causal relationships between arts training and the ability of the brain to learn in other cognitive domains.

Gazzaniga, director of the Sage Center for the Study of Mind at the University of California, Santa Barbara, summarized eight key highlights of the consortium's findings:

1. An interest in a performing art leads to a high state of motivation that produces the sustained attention necessary to improve performance and the training of attention that leads to improvement in other domains of cognition.
2. Genetic studies have begun to yield candidate genes that may help explain individual differences in interest in the arts.
3. Specific links exist between high levels of music training and the ability to manipulate information in both working and long-term memory; these links extend beyond the domain of music training.

4. In children, there appear to be specific links between the practice of music and skills in geometrical representation, though not in other forms of numerical representation.
5. Correlations exist between music training and both reading acquisition and sequence learning. One of the central predictors of early literacy, phonological awareness, is correlated with both music training and the development of a specific brain pathway.
6. Training in acting appears to lead to memory improvement through the learning of general skills for manipulating semantic information.
7. Adult self-reported interest in aesthetics is related to a temperamental factor of openness, which in turn is influenced by dopamine-related genes.
8. Learning to dance by effective observation is closely related to learning by physical practice, both in the level of achievement and also the neural substrates that support the organization of complex actions. Effective observational learning may transfer to other cognitive skills.

While studies that measure cognitive changes before and after arts training can help determine whether the two are correlated, only through randomly assigning students to receive arts training or some other intervention can studies prove causation. Pragmatism, therefore, is the watchword of consortium researchers, who caution readers to avoid being carried away by the initial promise of the report's findings. "These advances constitute a first round of a neuroscientific attack," observes Gazzaniga, "on the question of whether arts training changes the brain to enhance general cognitive capacities. The question is of such wide interest that, as with some organic diseases, insupportable answers gain fast traction and then ultimately boomerang."

The report has gained considerable notice since its debut in early 2008. In a year's time, eight new scholarly articles cited research published in *Learning, Arts, and the Brain*, including *A Federal Arts Agency at the Center of Reading Research: How We Got Here*.[1] From the April 2008 Neuroscience and Music conference (sponsored every three years by the Pierfranco and Luisa Mariani Foundation) to the Neuroscience Research in Education Summit at the Center for Learning and Memory at the University of California, Irvine in June 2009, consortium contributors met audiences eager for more information about their findings. Consortium and other researchers in the field gathered in May, following the summit, at the Learning and Brain Conference in Washington, DC, where the theme was "The Reactive Brain: Using Brain Research in Creativity and the Arts to Improve Learning."

At the Hopkins summit, Dana Foundation Chairman William Safire declared the report's essential findings now beyond dispute: practice in art forms changes cognition; genes and environment determine the efficiency of the neural networks involved in attention; and advances in neuroimaging allow an ever clearer view of these processes. His address underscored the relevance and timeliness of the consortium findings, calling for continued and concentrated research critical to identifying the causal relationships so eagerly anticipated by educators and scientists alike.

Consortium researchers Drs. Posner, Spelke, and Wandell, along with Drs. Winner and Schlaug, whose research had also been supported by the Dana Foundation, discussed their current work along with research that was published after *Learning, Arts, and the Brain*.

[1] Iyengar, S. (2008). *Arts Education Policy Review, 110* (1), 23-26.

Edited Excerpts from the Research Presentations

Panelists

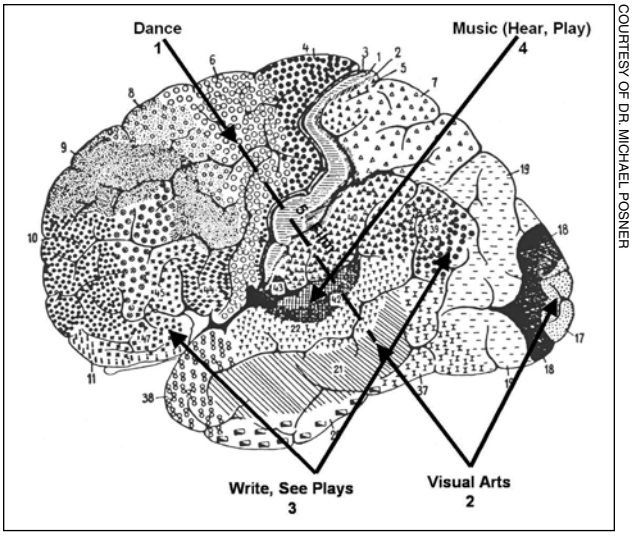
- Michael Posner, Ph.D.
  University of Oregon
- Elizabeth Spelke, Ph.D.
  Harvard University
- Brian Wandell, Ph.D.
  Stanford University
- Ellen Winner, Ph.D.
  Boston College
  Harvard Graduate School of Education
- Gottfried Schlaug, M.D., Ph.D.
  Beth Israel Deaconess Medical Center
  Harvard Medical School

Dr. Michael Posner

Neuroimaging has provided an analysis of many of the cognitive and emotional tasks that people perform. Using various types of imaging, researchers have been able to identify brain areas that are active as a person performs a specific task.

Today we're especially interested in the brain networks involved in various forms of the arts. My Oregon undergraduates show interest in a particular art form more than in the arts as a whole. One may be interested in music, another in dance or theater. And their performance and observation of that art are highly correlated. If you're interested in drawing, you'll also be interested in observing fine arts and other people drawing.

Art forms involve distinct brain circuits, including, of course, sensory networks. For example, music engages the auditory system and the visual arts engage the visual system. Studies have provided a detailed analysis of the many brain areas involved in each of the art forms; these areas are quite distinct, although they may overlap in some cases.



COURTESY OF DR. MICHAEL POSNER

The practice of various art forms involves different sensory and motor areas in the brain. This drawing approximates such areas.

Dr. Daniel Levitin's research identifies various parts of the experience of music (such as emotional, auditory, and so on) and then maps them onto particular areas of the brain. Levitin finds, rather surprisingly, that an area in the cerebellum is involved in some of the emotional aspects of music, probably because listening to and composing music involves movements, which are made precise by the cerebellum.

Research suggests that each art form involves some neural network, although this assertion is not without dispute and requires further study. But it's more or less generally agreed that performance or practice of any art form strengthens the network involved in that art form. So on the question of whether the brain is plastic—can it change with experience—yes, it certainly can.

We know this from neuroimaging, which shows that the connections and activations within various parts of networks involved in specific art forms are changed with experience, with practice. Brain imaging has revealed a plausible process by which practicing an art influences cognition in general.

COURTESY OF DR. MICHAEL POSNER

The image shows the games that each experimental subject participated in during five days of training. On days one and seven, performance on the Attention Network Test was measured and 128 channels of EEG were collected.

We found that our Oregon undergraduates were not only interested in particular art forms, but that their interest was related to a more general propensity to creativity and imagination. Interest in an art form is correlated with the degree to which that person feels interested in imaginative or creative acts. I think this openness to creativity in an art form is important in understanding how practicing an art actually produces changes in cognition.

So, these elements lead to a kind of theory of how the arts might be related to cognitive processes. First, there are neural networks for each specific art form. Second, there is a general factor of interest in the arts due to creativity, openness to that art form. If you choose an art form that a child is interested in and open to through a general factor of creativity, the child will be engaged when he practices that art form. Earlier today, Ellen Galinsky told us that when a child is engaged in the learning process, that's when his or her attention is fully focused.

We now know that training preschool children and adults to focus their attention can produce improvements in general cognitive processes. The network of neural areas involved in executive control or executive attention get exercised and strengthened such that the training will produce improvements in a large number of other cognitive tasks, including general intelligence.

Each neural network is associated with a specific neural transmitter—in the case of the executive attention network, the transmitter is dopamine—and therefore with particular genes involved in producing that transmitter and building the network of brain cells it uses to communicate.

We all have an executive attention network, but some of us have more efficient ones than others. These differences in efficiency are partly related to genetic factors and also to individual experience. We all have the same genes that build these neural networks, but there are alternative forms of these genes, termed different alleles.

In our longitudinal study of children who are followed from seven-months to four-years old, we have seen powerful interactions between their genes and experiences. In this particular case, the experience is the quality of parenting, which influences both a child's behavior and how efficiently his executive attention network functions. For example, in children with one type of variation of a gene, parenting makes a huge difference in the child's impulsivity and risk-taking. This is not the case in children without this specific allele, or gene variation.

In two-year olds with a particular allele, parenting makes a large difference in the child's ability to attend to different visual locations. No such difference occurs in children without this gene variation. As these examples show, genes and environments interact to build the neural networks involved in attention.

There is a great amount of newly published research findings concerning various ways to train people to pay better attention. For example, we have trained children aged four to six over a period of five days by engaging them in tasks that exercise their executive attention network. Now, five days is not very long, but it's crucial.

To establish that the training caused changes in the executive attention network, we randomly assigned the children to a group that underwent systematic attention training or to one that received another kind of training. At the end of those five days we found, by recording from small electrodes that are placed on the children's scalps, that those who received the attention training showed changes in the underlying executive attention network. These changes not only produced better executive attention and executive attention tasks, but the improvements generalized to intelligence and therefore, we think, to other cognitive skills.

Another interesting finding has just come out from Dr. Ellen Bialystok. For a number of years, she has shown that children and adults who have learned multiple languages perform better on executive attention tasks. As state legislatures advocate that lessons be taught solely in English, research is showing that bilingualism leads to better overall executive attention and therefore increased intelligence.

In her most recent study, Bialystok demonstrates that, in addition to bilingualism, vocal and instrumental training also are correlated with improvements in executive attention. Because this is a correlational rather than a random assignment study, we cannot infer causation. But the research nonetheless shows us that changes in executive attention can occur with experiences that one is likely to have in the real world.

We have a plausible way of seeing how the arts may be able to influence cognition, including intelligence. If we are able to engage children in an art form that they are open to and for which their brain is prepared, then we can use it to train their attention, which seems to improve cognition in general.

Dr. Elizabeth Spelke

The first thing we're apt to think of when we ask the question, "What's special about the human mind?" is our extraordinary capacity to understand the world by developing formal systems, technologies, and also mathematics and sciences, activities that archeological and historical records show go back a long way.

But of course, those same archeological and historical records show that our propensities for artistic creation go back just as far. When we look around the world today, I think we see two things. First, that these kinds of activities are ubiquitous. Formal science may be a rather specialized thing, but the tendency to think systematically about the world, to transform it through technology, the visual arts, music, and so forth are characteristics of all living human groups, so in some way they come naturally to us.

The other thing that we see as we look around the world is great variety, both over space as we look from one human group to another and over time as we look within our own cultures. For example, we see enormous change in the technologies and art forms that our children are enjoying relative to those we found joy in as children. That change tells us that although the predisposition may exist for both science and art to be innate within us in some way—part of our human nature is to engage in these activities—the particular activities that we engage in are highly transformed by learning. The particular arts and sciences that we learn depend on the specific places we live and the activities of the people around us. In that context, it's not surprising that education throughout the world has focused on mathematics and science but also on literature and reading and visual arts and dance and music and so forth.

Educators need to take diverse sets of human endeavors and present them to varied groups of students in a way that engages them, enables them to teach themselves, and allows their interest and knowledge to grow. The kind of work that I do, research in human cognitive development, will never give a direct answer to the question, "How

can teachers better teach children?" But I do hope that as researchers, we can provide some insights that could become ideas for new directions in teaching that then could be pursued through further research, engaging researchers and teachers more directly.

One set of efforts, which might be useful to teachers, attempts to take all of the complex things that humans do, like formal mathematics or visual arts, and break them down into simpler component systems that emerge very early in the human mind and that children bring together as they start to master the complex products of our culture.

There have been three lines of research that have been useful in efforts to break down complex cognitive abilities. One compares the cognitive capacities of human infants to those of other animals, both those relatively close to us, like baby chimpanzees, and some more distantly related, like monkeys, other vertebrates, and even a few invertebrates.

This research asks two kinds of questions. First: What basic, evolutionarily ancient cognitive capacities are shared across broad ranges of animals, including humans? And second: What cognitive capacities are unique to us? What sets us apart from other animals on our distinctive paths of development?

That leads to the second line of research, comparing the cognitive capacities of infants to those of children from preschool throughout formal education, and to adults. Questions I think that are most useful to ask are: What are the basic cognitive capacities shared by people across all of these ages? And, what are the capacities that emerge later in development, and which processes lead to their emergence?

I began my research with a third set of comparisons, looking at mature forms of art and science across cultures, asking what's universal and what's variable from one place to another.

Much of my work has focused on developing knowledge of numbers and geometry, and has used these three research approaches to try to distinguish the basic cognitive systems that underlie these complex activities. We've found evidence for three systems that emerge at the beginning of human life, appearing in young infants, that appear to be foundational for the development of numbers, symbolic mathematics, and geometry.

One is a system for representing and reasoning small numbers of objects, for example, the difference between one object and two or three. The second is a system for representing and reasoning numerical magnitudes, a system that might let you, without counting, estimate that there are maybe 50 beads in a jar, with approximately equal numbers of reds and blues, and so forth. The third is a set of systems for representing and reasoning the shape of the surrounding environment, of forms, objects, and the large-scale spatial layout. Our capacities within each of these systems are limited, such as the number of objects that infants can keep track of at once, and the precision of numerical discrimination.

These limits allow us to track these systems over the course of human development. If we devise tasks for older children or adults that require them to make estimates about number or geometry without drawing on their high-level knowledge of mathematics, we find that they have the same abilities with roughly the same limits that we find in infants.

What's more, research shows that schoolchildren draw on these systems when they learn further formal mathematics. We see this in two ways. First, as every mathematics teacher knows, some kinds of problems or principles are easy for kids to see while others are hard. Recent research, some from my lab, and some from the lab of Justin Halberda and Lisa Feigenson at Johns Hopkins, shows that there's a tight relationship between one of these core systems, a system for representing approximate numerical magnitudes, and school achievement. If you separately assess children's sensitivities to approximate numbers and then look at their

symbolic mathematics achievement in school, you find relationships between these two abilities.

Finally, there's a broad array of evidence showing that when adults engage in purely symbolic mathematical reasoning—for example, multiplying two-digit numbers in our heads—we engage these core cognitive processes that we share with human infants. Research involving special populations—for example, patients with brain conditions that damage the core systems—shows that they have corresponding impairments in the symbolic mathematical systems.

Before children begin school, they start bringing core systems together to master some of our culture-specific skills. There are three skills in particular that most children in our culture master somewhere between the ages of three and six. They bring together their representations of small numbers of objects and of large but approximate numerical magnitudes to construct representations of exact number, the system of natural number concepts. Children become highly skilled in the system when they master the mechanics and especially the logic of counting.

Before they get to school, children also begin to develop intuitions about measurement—the idea that numbers can be thought of as positions in space, points on a line. Clearly, most measurement skill is learned by children after they have started school. But intuitions about relations between numbers and space go back to infancy. Evidence suggests that this ability demonstrates that children spontaneously relate their intuitions about number to their intuitions about space.

Finally, we and other investigators find that preschool children are able to bring together their core understanding of space with that of objects to develop early symbolic abilities to use things like simple geometrical maps. In such maps, geometrical relationships among points on a page specify spatial relationships between objects in a real, three-dimensional environment.

I've taken you through this whirlwind tour of some of our work on mathematical development because this was about where we were in our research when Michael Gazzaniga and William Safire approached me with the form of the challenge: Do you really think mathematical development is only a matter of learning about numbers and points and lines? And what's more, do you really think that if you understand mathematical development, or maybe the development of math in relation to science, that that will be enough to give you a real picture of the uniqueness of human nature and human cognition? What about all of those arts subjects that also characterize us as humans? How do they fit into the picture of the organization of cognitive systems in the mind?

I was, of course, struck by the longstanding suggestion that there's a special tie between mathematics and music. Our research had shown that mathematical ability isn't just a single special-purpose system in the human brain, but a process that comes together from multiple systems. What might this relationship between music and mathematics actually come down to? That's the question my lab set out to answer as part of the Dana consortium.

We did three different studies aimed at three distinct populations of children: those in elementary, middle, and high school. All three studies asked whether children who received music training showed any associated advantage on the particular abilities underlying mathematics performance. In different studies, we looked at musical training at different levels of intensity, from extremely weak in the first study, to moderate in the second, and intense in the third. The third study focused on high-school students in a school for the arts; a particular art form was their primary academic interest.

We first assessed the functioning of children in all three groups on each of the three core systems that I described earlier. The first thing we found was that mild amounts of arts training had no effect at all. I

think that's probably because our measures weren't sensitive enough. I wouldn't draw any conclusions, positive or negative, from those findings.

But the children who received moderate or intensive music training showed significantly higher performance on tasks that tapped into just one of the three core abilities: there was a reliable difference in their representations of geometrical properties and relations.

Here's the test that we used in this study: on any given problem, children were shown six different geometrical forms, five of which shared a particular geometrical property that the sixth did not. Across different problems, the particular geometrical property varied from one display to the next, as did the subtlety of the geometrical relationship. This task was hard enough that even the Harvard undergraduates, who were at one end of the age spectrum, were still making errors on some of these problems, but the difficulty was variable enough that three-year-old children were getting some of the problems right.

When we compared students who received music training to a matched group of students who received no special training in any art form, we saw a small but reliable association between music training and sensitivity to geometry.

At the high school for the arts, we compared performance sensitivity to geometry among students specializing in different arts disciplines. We found that intense training in visual arts, music, and dance was associated with better geometric sensitivity performance. Music and dance results looked indistinguishable from each other. Next, we looked at associations between music training and the core skills of counting, using number lines, and reading maps, and found associations between music training and the latter two skills, which tap spatial abilities. Children receiving moderate music training showed a small but reliable effect on the part of a map-reading task that relied purely on geometric skills. Students in the music and dance programs outperformed others on this geometric map task.

We've seen a consistent relationship between music training and three different measures of spatial performance. Many things could produce this relationship; all we have so far is a tight correlation. When you control for a number of other things, like motivation and verbal IQ, you still see this correlation. But the correlation doesn't tell us what the source of this relationship is, which is what we're trying to look at now.

To do that, I'm going back to my roots as an infant psychologist. The hypothesis that I'm exploring is the following: we know that, from birth, infants love to listen to melodies. A melody is a patterning of tones in time. There may be an inherent relationship between a melody's temporal and tonal structures and representation of space.

Our hypothesis is that from infancy, when a child hears a long temporal interval between two notes, for example, they may spontaneously evoke a perception of a long *spatial* interval. When they hear notes going from low to high, they may spontaneously evoke a representation of a change in spatial position from low to high.

The first test that there's a relationship between time, musical time, and space comes from a recently completed study from my colleague Susan Carey and her student Mahesh Srinivasan involving nine- or ten-month-old infants. They presented babies with worms to look at that were either short or long, accompanied by corresponding tones that were short or long in duration. In that situation, children learned the relationship between short objects and tones and long ones. To see whether this was a special relationship, they also tested a second group of infants, who saw exactly the same worms and heard exactly the same tones, but they were reverse-paired. The infants never learned that relationship, suggesting that there's something special about visual length and auditory duration that could underlie a relationship between the

experience of hearing sounds and the representation of space.

In our work with four-month-old infants, we were able to create sounds in different timbres. They were paired with objects of different heights. In some trials, a baby would hear a rising sequence of notes, while in other trials they would hear a falling sequence. But always, as in the case of the study I just described, the height of the object related to the height of the note: when the notes fell, so did the object.

In the second situation, we showed the infants the same objects and we presented the same sounds, but we reversed the pairing. Our findings were similar to those of Srinivasan. Four-month-old infants learned the pairing between tone and object heights when it was congruent but not when it was incongruent. As early as four months of age, babies seem to be sensitive to relationships between the two key properties of a melody and positions in space.

This finding motivates the following hypothesis, for which we do not yet have evidence: from the beginning of life, when an infant hears music, that music not only encourages melodic, but also spatial, processing. It may be that spontaneous spatial processing that gives rise to the relationships found later in life between music and mathematics.

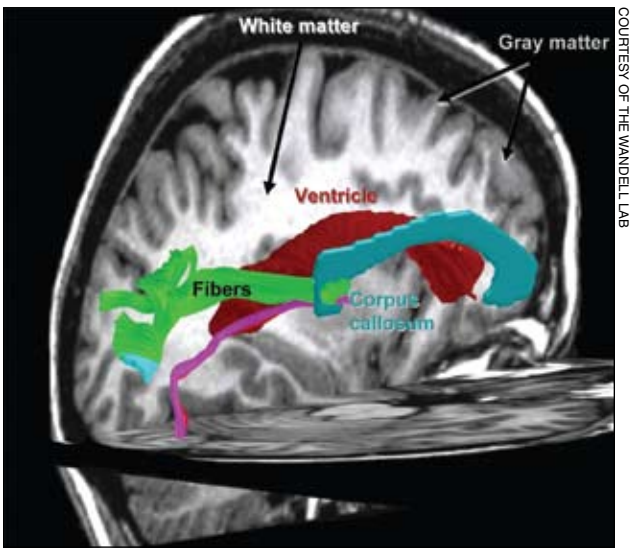
We don't know if that's going to turn out to be the case, but I think it's already enough of an active possibility that it gives us an additional reason for a flourishing arts curriculum in our schools. Connections across the arts and the sciences are rich and varied not only for adults, but also for young children.

Dr. Brian Wandell

I'm fascinated these days by our new ability to measure the connections in the developing human brain through imaging. It's something that couldn't have been done a decade ago.

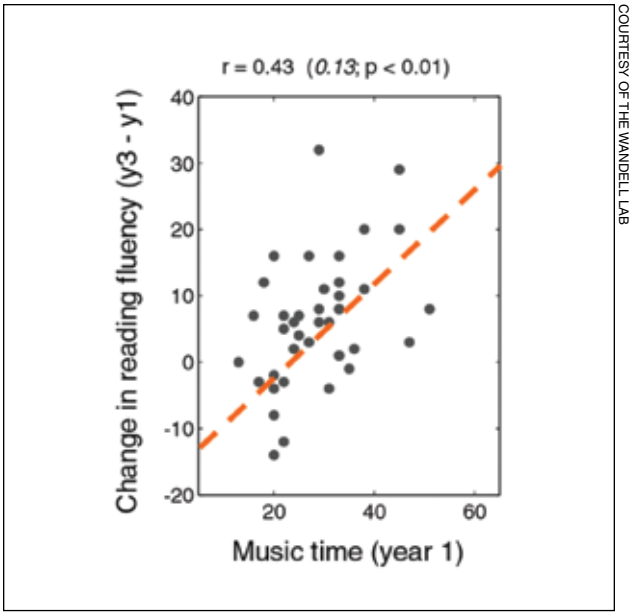
The white matter of the human brain (bundles of brain cell axons that carry messages) connects different regions of cortex, a thin layer of gray matter (brain cells) that covers the surface of the brain where functional activity is measured. Connections between the parts of the cortex are just as important as the cortex itself. Some of these pathways, these white-matter connections, are essential if kids are going to learn how to read, and they're also essential for learning certain mathematical skills.

It has been hard to get data about the white matter in the human brain to determine what is connected to what. You can't pull apart bundles of white matter post-mortem without breaking the whole brain. But now with the development of magnetic resonance imaging techniques, we can measure how water moves around inside the brain in different directions. From these measurements, we estimate (using algorithms developed first by Tom Conturo at Wash. U., Susumu Mori at JHU, and Peter Basser at the NIH) where those major fiber bundles are headed to in the human brain. In



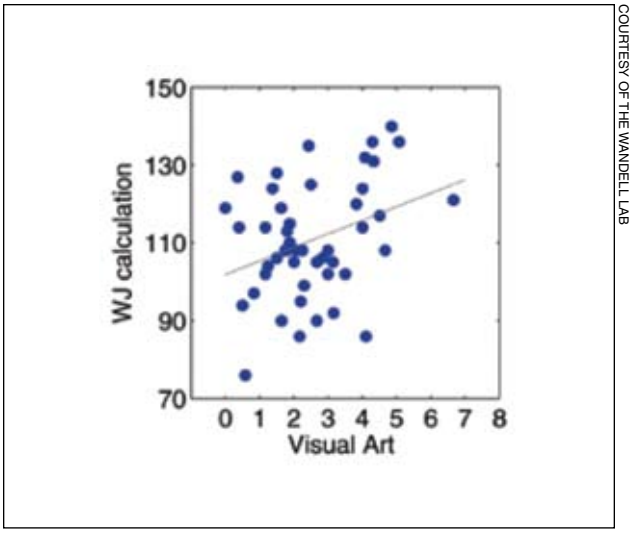
COURTESY OF THE WANDELL LAB

The properties of certain fibers are correlated with specific cognitive abilities. For example, certain fibers in the corpus callosum are correlated with phonological decoding.



COURTESY OF THE WANDELL LAB

Music provided the strongest correlation between arts training and reading. The music training explains 16% of the variance in children's scores. The horizontal axis shows lifetime hours of music training; the vertical axis shows the improvement in reading fluency between years one and three.



COURTESY OF THE WANDELL LAB

We incidentally discovered that visual art experience is correlated with math skills. The horizontal axis shows a weekly average of hours spent on visual art activity in school (year one). The vertical axis shows a measure of math skill. The correlation explains 10% of the variance in children's scores.

diffusion tensor imaging, also called diffusion spectrum imaging, the goal is to learn where the white-matter connections are in the brain.

There are certain fibers that pass through the corpus callosum, the part of the brain connecting the two hemispheres. Looking at how effectively water diffuses in and around those fibers is quite predictive of how well children or young adults learn to read. Their reading capabilities and phonological awareness (the ability to manipulate speech sounds, which is predictive of reading fluency) are very highly correlated with the properties of these specific fiber tracts. The conclusion here is not yet that firm, but it's roughly that the signals carried on these fibers between the two hemispheres are essential for learning the skills of phonological awareness, which is vital for learning the steps involved in reading.

As scientists, we think this is an important part of the learning pathway, and as we were conducting longitudinal studies in children over a period of time, Mike Gazzaniga and Bill Safire approached us. We began to consider whether or not we might make some measures of how much exposure these kids we were studying had to music or to visual arts. We took surveys of the parents, the kids, and so forth and made measurements.

One of the things that we found—that others have found also but that was quite striking in our study—was that in the children who had music training, the amount of this training they had in the first year of our study and over the three years of the study, was correlated with their reading skills. Music training explained 16 percent of the variance in the children's reading abilities compared to those who did not have music training.

As a number of investigators have shown, this wasn't an intervention—we didn't randomly assign

some children to receive music lessons and others to receive some other kind of training. So we don't know how this relationship between music training and reading fluency came about—whether children who had reading skills chose to learn music or the other way around. But now several of the investigators from this group, under the urging of the Dana Foundation, are doing controlled studies to see whether music training causes this effect in kids who hadn't previously had music lessons.

We also discovered a modest correlation between visual arts and math skills, and this really surprised us. Jessica Tsang and Michal Ben-Shachar, collaborators in my Stanford lab, observed that visual-arts training was somewhat correlated with an ability to do certain kinds of mathematical reasoning (called a Woodcock-Johnson calculation). They then went to the literature to say, "Well, what could we as neuroscientists do to try and understand the basis of this?"

Based on work from Liz Spelke and Stan Dehaene on mental arithmetic skills and fibers connected to parts of the parietal lobe, Jessica got the kids in our study to come back and had them do various mental arithmetic tasks, either exact or approximate calculations. Jessica was an education student who started working in our lab because of our focus on the intersecting roles of education, cognitive science, and cognitive neuroscience. Her mom is a teacher in Oakland; one of the things her mom was stressed about was the pressure to teach kids to do approximate arithmetic. She didn't know whether it was valuable or not, or how she should teach these things.

In our lab, Jessica looked for the parts of the brain that we might focus on for studies about visual-arts training and approximate mental calculation skills. She focused her measurements on how water flowed through a particular white matter tract, the arcuate fasciculus, based on work by Dehaene, and we saw that the correlation between this flow with approximate calculation skills was high. Then we said, "Well, maybe this correlation will be seen throughout the whole brain," and so we looked at the adjacent white matter tract, but found no association with this math skill. The brain location that is associated with mental calculations of approximate math values really is quite specific, and is where studies can measure the effects of visual-arts training on this skill.

Brain region connections are another new thing that scientists can measure, even in very young children. We know that the healthy development of these connections is essential for cognition.

Dr. Ellen Winner

I'll begin this talk, and Gottfried Schlaug will complete it, as we describe the study that we've been working on together for at least five years on the cognitive and brain consequences of music training in early childhood.

We're first going to talk about the search for evidence that cognitive skills acquired from structured music-making transfer to other cognitive areas. We're not going to be talking about the Mozart effect or music listening, only about children engaged in making music.

We are currently doing two prospective studies in other art forms. We are looking at the effect of theater on children's ability to gain insight into other people's mental states, empathy, and emotion regulation. That project is being led by my doctoral student, Thalia Goldstein, and was funded by the National Science Foundation, with Joan Straumanis as program officer. We are also looking at doing a prospective study of the effect of visual arts on spatial reasoning, which may improve geometric reasoning.

Today, we have two studies we're going to talk about. The first is a correlational study; I'll discuss the design and our cognitive findings. The second is a prospective study in which we followed children for a period of time. Gottfried Schlaug is

then going to take over and talk about our brain findings and some interesting brain-behavior correlational findings.

I have been very skeptical of some of the extreme claims that have been made that when you introduce the arts into schools, test scores go up, attendance goes up, and everything improves. In 2000, with my colleague Lois Hetland, I reviewed all of the experimental causal studies looking at arts transfer published since the 1950s. We had to conclude that the claims exceeded the evidence.

There was some evidence that music-making improved spatial skills, but the results were mixed. Music was shown to improve spatial performance in some tests, such as the object-assembly test, which is basically a puzzle test, but not on the Ravens test, which is a matrices test that involves some spatial thinking.

In the verbal area, research showed that music training improved phonological awareness in children with dyslexia, but reading was not improved, though we've heard some new evidence since that review. Also, some published studies showed that verbal memory is improved in children and adults. Finally, we found six studies on music and math and conducted a meta-analysis of these; we found that the results were very mixed. It was not at all clear to us whether music would improve math.

Our correlational study asked whether learning to play a musical instrument is associated with higher cognitive skills in non-musical domains. We looked at 41 nine- to eleven-year-old children with three or more years of instrumental music training, along with 18 children in our control group who had no music training.

We had measures in near- and far-transfer domains. Near-transfer domains are those that are very closely related to music; the two we looked at were fine finger sequencing (we called that our motor-learning task) and melody/rhythm discrimination. We developed a task where children had to use their right and left hand separately on a computer keyboard; they had to learn a complicated sequence as fast and as accurately as possible. We also had a music task where children heard pairs of melodies, and had to decide whether the two melodies were the same or different. They also heard pairs of rhythmic patterns, and they had to decide whether the two patterns were the same or different.

For our far-transfer domains, we looked at spatial areas. We had three spatial tasks: the object-assembly task, which is like a jigsaw puzzle; a block-design task, where you're shown a red and white geometrical design and you're given a lot of blocks that are red and white and you have to copy the design with the blocks as quickly and accurately as possible; and the Ravens test, the matrices test.

We also looked at verbal measures, including the vocabulary test, which is often used as a proxy for verbal IQ. And we looked at a phonemic awareness test; we used the auditory-analysis test, in which children would be given a word, like "toothbrush," and they would have to say it without the "r," "tooth-bush." They have to break the word apart into its phonemes and drop out one phoneme. That task is predictive of reading skill. We also looked at mathematics. We gave a standardized math test called the Key Math Test, which breaks down into many different areas of math.

On the two near-transfer domains (the motor-learning finger-sequencing task and the melody/rhythm discrimination), we found that the instrumental children were significantly and reliably ahead of the control children. In our far-transfer tasks, we found that the instrumental children were ahead of the control children in verbal ability, as measured by the vocabulary test, and in nonverbal intelligence, as measured by the Ravens test. These scores were predicted by the duration of music training. However, we did not find any superiority in the music group in the block design, the object assembly—our spatial measures—the phonemic awareness, or in math.

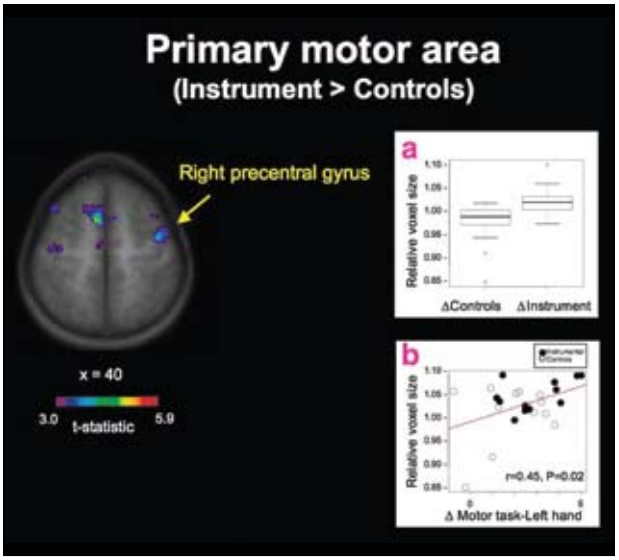
In our prospective study, we asked: can we demonstrate near and far transfer from structured music-making in a causal intervention study? We gave our study participants a pre-test, had a four-year intervention with a music group and a control group, and then administered a post-test.

We did not randomly assign these children to the music instruction because we did not have the funds to do so, so we found children who were about to begin taking lessons on an instrument at age five, six, or seven, and we followed them for four years. We found other children who were not learning to play a music instrument, and we followed them as well.

The study started with 50 children between the ages of five and seven who were beginning piano or violin. They had 30 minutes a week of private instrumental lessons; we also measured how much time they practiced. Concurrently we followed 25 children of the same age who were not studying a musical instrument. By the 48th month—four years, a long time to keep kids in a study—we had 50 percent attrition, which is what often happens with longitudinal studies and why they are so difficult to do.

We tested every child at baseline, and we repeated assessments at 15 and 48 months; today we're just going to talk about the 15-month analysis. Our measures were the same as those I described to you from the correlational study. Also, we used functional and structural brain imaging, and Gottfried's going to present our results on that.

After 15 months, we had a small subset of children from the study, because we had to include only the children with usable MRI data. We had 15 children in our music group that were a little over six years old at baseline, and a control group of 16 children, who were about the same age at baseline and matched the children in the music group on several factors: verbal intelligence, as measured by the vocabulary part of the standard IQ test; gender distribution (we had the same number of boys and girls in each group); and interval length, the time between the first battery of cognitive and brain tests and the second battery, which was on average 15 months.



Longitudinal group brain deformation differences and brain-behavioral correlations in the primary motor area. (Hyde, K., Lerch, J., Norton, A.C., Forgeard, M., Winner, E., Evans, A., & Schlaug, G. (2009). Music training shapes structural brain development. *Journal of Neuroscience, 29*(10), 3019-3025.)

We found, first of all, no differences at baseline between our two groups on any measures. That's good, because we weren't able to randomly assign, but we want to be able to say that at baseline there were no preexisting differences.

Fifteen months later, on the near-transfer domains, we found that the instrumental group was reliably ahead of the control group on the finger motor-sequencing task with both their right and left hand, and they were also ahead in melody discrimination. However, on our far-transfer domain tasks, we had not found a superiority of the instrumental group over the control group after the first 15 months of the four-year study. Gottfried's going to mention at the end of his talk why that might be, and he's now going to present our brain findings.

Dr. Gottfried Schlaug

Those of us who play a musical instrument sometimes don't think about what it all involves. Music-making is a multisensory motor experience, but it also involves attention networks, the motivation and reward system. I would challenge everybody to come up with another activity that engages as much real estate in the brain as music-making does.

What we have been exploring is whether or not the intense practice and early beginning of music-making lead to plastic changes in the brain, which in turn would support a nurture hypothesis, or whether professional musicians select themselves at a very early age because they have atypical brains to start out with, which make them predestined to become musicians. That's one of the main questions that we have been trying to answer in this particular study.

I want to review with you just a few findings from the studies of adult musicians. One of our earliest studies looked at the corpus callosum, which is, as we have heard, a major fiber tract in the brain that connects the right and the left hemispheres. This major fiber tract is actually larger in adult musicians than in the matched non-musician.

We also found, in this adult group, that the earlier they began learning a musical instrument, and the more intensely they practiced, the more of a difference we actually saw. Some people take this as a marker in the absence of longitudinal studies that an early beginning and long duration of practice will actually lead to more brain differences and brain changes.

We've also looked at differences within musicians, to examine some of the hypotheses that suggest that this is really a selection bias, that musicians have brains that are conducive to making music. If you look at the motor region of the brain in keyboard players, you can see that it is enormously developed on both sides. Across the entire group, the motor region was more developed on the left compared to the right side of the brain, because fine motor control over the right hand is something that's very important for a keyboard player. When you look at a string player, you see an opposite pattern, where the brain's right side is much more developed than the left. Already we see a specialization in that part of the brain.

I want to provide a few other examples of differences that we have seen in some parts of the brain to demonstrate that the brain can really change not just in function but also in structure, and that these structural changes can be actually quite enormous.

These data were acquired from our studies in children, although we haven't analyzed everything yet to see what kind of changes we might have over time. But I can tell you that our initial data indicate that there are very profound brain changes over time in relation to musical training.

First, I want to give you an example of functional changes in the brain before I discuss the results of our longitudinal study. In people with traumatic limb amputations, the brain's motor region has been remodeled. This region has a little knob configuration—part of the precentral gyrus region—where the hand-movement region is localized. This knob configuration disappears on the affected side of the brain in people who have lost a limb, but remains on the unaffected side. There's a complete remodeling of this normal anatomy on the affected side. It's no longer disputed that the brain adapts in cases of injuries or loss of sensation. But whether or not a regular activity that one would do on almost a daily basis over many years would change the brain obviously needed to be proven.

As part of our longitudinal study, we asked our group of five- to seven-year-old children to do a rhythmic and melodic discrimination task. The children primarily activate temporal lobe regions when they do this task.

As we get older, the same task seems to activate more regions in the brain. When we look at our adult group performing the same simple task, they seem to be activating a lot of other regions, mostly

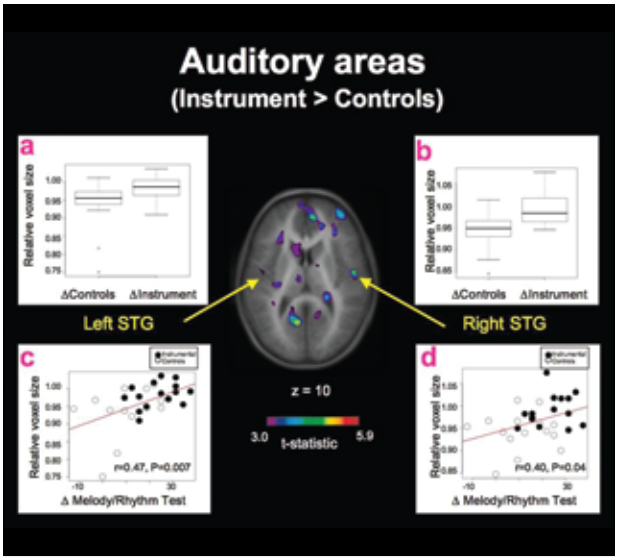
multimodal, polysensory integration regions. Some of that greater activation could actually be related to performance, but it's also that we're using other regions of the brain to solve the same task.

We paid attention to some of the regions in the parietal lobe surrounding the intraparietal sulcus, which is one of the multisensory regions in the brain that integrates information coming from different domains. Closely related to what Liz Spelke was talking about, one of the theories we have is that the coactivation of some of these regions in the brain—and potentially the changes that music brings about in some of those regions—could be related to the association between music and math.

We don't have direct proof of this, but we intend to follow up by determining whether or not the cognitive enhancements that we see are related to areas in the brain that are coactive or that have shared resources between different cognitive tasks.

When we look at our rhythmic-discrimination task, we didn't see any significant change within the two groups at baseline. But by the time the second measurement was made, the activated areas seemed to be enlarged, not just in the temporal lobe, but also in different regions of the frontal lobe, and also in the cerebellum. We can actually see some of the changes that occurred between the two different time points in the temporal lobe, frontal lobe, and cerebellum when we do direct comparisons. We did not see these changes in our non-instrumental group.

Research results are increasing our understanding of the importance of the inferior frontal gyrus in various ways; this area might also be involved in some of the enhancements seen in other domains. Previously, many neuroscientists thought that the inferior frontal gyrus was mainly a region having something to do with speaking. But it's actually much more complicated than this; it probably does tasks that we don't fully understand yet in addition to playing a role in speaking. But its potential significance is broader than this.



Longitudinal group brain–deformation differences and brain-behavioral correlations in auditory areas. (Hyde, K., Lerch, J., Norton, A.C., Forgeard, M., Winner, E., Evans, A., & Schlaug, G. (2009). Music training shapes structural brain development. *Journal of Neuroscience, 29*(10), 3019-3025.)

We think it is a region that has something to do with mapping auditory sounds. Vanessa Sluming at the University of Liverpool showed that these regions located in the front of the brain seem to have more gray matter that is more fully preserved in musicians compared to non-musicians as they get older.

She was also able to show that this brain region is particularly active in musicians compared with non-musicians as they perform what we call a mental rotation task. Musicians seem to be using these regions to their full advantage, in some way affecting the sequential ordering of particular motor or sensory motor actions.

With regard to our morphometric findings, we developed a map of the differences that we found in adult professional musicians compared to adult non-musicians and amateur musicians. We found that primary motor regions, parietal regions, temporal lobe regions, and cerebellar regions all were different.

Those were the regions that we primarily concentrated on in our longitudinal study in kids.

Over time and across the entire brain, we saw differences in the motor regions and supplementary motor regions of the brain (more pronounced on the right side of the brain, which controls the left hand, because the left hand is the less skilled and needs more training). Within these regions, we found differences that were correlated with behavioral changes. So the better the instrumental children got in their hand tasks or their hand motor tasks, the more changes we actually saw.

We also found in a longitudinal study comparing instrumental kids with controls that the corpus callosum differentially changes. In particular regions that are located around areas where motor fibers, pre-motor fibers, and sensory fibers cross, we find the closest correlations at 29 months between the intensity of training and motor skills, and the relation of motor skills to the brain changes.

These changes are in the cerebellum and are related to auditory changes, or those involved in the melodic- and rhythmic-discrimination tasks, as well as to motor changes. Changes occurred in the brain's auditory regions as well in the instrumentalist children compared to the control group, and the changes related to the behavioral gains that these instrumentalist kids showed in auditory- and rhythmic-discrimination tasks.

We consider this to be the first study that shows brain plasticity in young children as a function of instrumental music training. The amount of practice was related to the degree of changes, although the amount of practice was actually much less than we had initially anticipated. Nevertheless, we found that amount of practice was a predictor and that we have brain and behavioral changes that co-vary over time.

As Ellen already indicated, at 15 months we have not seen any clear far-transfer effects, the transfer to other academic domains. We have been debating why this is the case. Our tests may not be sensitive enough. There's also quite a lot of variability in the testing. If we test kids in the afternoon or on the weekends, or if we test them while they are off in the summer break, the results are affected. While we were doing this longitudinal study we learned how one could potentially do it better, but I think some of the lack of far-transfer findings might potentially be related to the difficulty that these longitudinal studies impose on us.

Some of the brain changes were outside areas where we expected to find them—there were, for example, brain changes in areas typically associated with the attentional system. We would need to devise tasks that would specifically test or be related to some of these brain changes that we did not predict.

Last but not least, these additional brain changes in regions which are not currently correlated behavioral or cognitive factors obviously can be the basis for new research that we're planning to do with these data.

Keynote: Why the Arts Matter

Six Good Reasons for Advocating the Importance of Arts in School

By Jerome Kagan, Ph.D.

Jerome Kagan, Ph.D., the Daniel and Amy Starch research professor of psychology, emeritus at Harvard University, is a pioneer in the field of developmental psychology. He has spent 45 years studying children and their development; his most recent work has been on temperaments in children. Dr. Kagan has shown that an infant's temperament is stable over time; certain behaviors in infancy are predictive of other behavior patterns in adolescence.

It is a rare roll of the dice that places me as luncheon speaker at a conference on arts education. You have to know that for four long years, from the first to the fourth grade, I lived with the dread of the hour after lunch when every day, Monday to Friday, our class had art and I sat with two or three children, often girls, who were far more talented than me. I concealed my imperfect drawings while waiting desperately for the painful hour to end. Here I am 70 years later advocating the importance of the arts in the elementary school years. However, the intervening years have taught me at least six good reasons for advocating art in the schools that are easy to articulate. But, as with most other interventions, the power of some of the reasons depends on the social class of the child's family.

The first advantage is that the arts boost the self confidence of children who are behind in mastery of reading and arithmetic. Today's children live in an economy where a high school diploma is absolutely necessary and a college degree advantageous for success. This was not the case a century or two earlier. Neither Benjamin Franklin nor Abraham Lincoln had more than two years of formal schooling. If we eliminate the estimated five to eight percent of American children who have a serious compromise in their cognitive abilities, due to genes, damage to their brain before or during the birth process, a postnatal infection, or a pregnant mother who abused alcohol or drugs, the remaining 92 to 95 percent are psychologically able to obtain both degrees. Therefore, we have to ask why the high school dropout rate is excessively high among youth from poor and working-class families, and why the average scores of all American youth on tests of academic skills are below those of many other developed nations.

An important reason for this sad state of affairs is that children, like adults, are vulnerable to becoming discouraged when they sense that a goal they desire is probably unattainable. Each year, a large number of juniors at my university majoring in mathematics or physics because of a profound attraction to these domains change their concentration because they realize that they do not have the talent needed to be creative in these difficult fields. I gave up playing the trumpet at age 17, after a decade of lessons, when I realized I could never play as well as Harry James.

The main source of evidence that elementary school children rely on to decide if they are able to master reading and arithmetic is the performance of the other children in the classroom. This brute fact means that, in most American classrooms led by teachers of average skill, many children who score in the bottom third of the distribution on these skills decide by the third or fourth grade that this assignment is too difficult. There are about 20 million children in grades one through five and, therefore, about seven million are vulnerable to arriving at this faulty inference.

Teachers in many Asian countries care more than American teachers about reducing the gap between the top and bottom quartiles. They appreciate that an excellent predictor of juvenile crime in a town or city is the magnitude of the difference in reading and arithmetic achievement between the top and bottom quartiles. Moreover, the size of this difference is also an excellent predictor of the incidence of adult criminality, depression, and addiction to alcohol or drugs. America has one of the largest gaps between the top and bottom quartiles, as well as the largest percent of incarcerated juveniles and adults of any developed society. Japan has low values on both variables.

One strategy to mute a child's discouraging evaluation of self competence is to provide the child with opportunities to be successful at some classroom task. Art, dance, film, and music are perfect candidates. An eight-year-old having difficulty learning to read at grade level whose artwork or musical instrument performance is far better than many of the children in the top 30 percent on reading or arithmetic will experience a sudden boost of confidence that, in some cases, is generalized to the formal academic domains. Simply telling college-aged women that there is no sound scientific basis for the stereotyped belief that women are inferior to men in mathematics boosts their scores on tests of this talent. This is the theme in the *Wizard of Oz* when the Wizard tells the Scarecrow that all he needs is a diploma in order to feel more intellectually competent. A recent report in *Science* magazine revealed that having seventh and eighth graders write brief essays on the importance of a personal value raised grade point averages, especially among the economically disadvantaged students.

However, it is important that these artistic products not be graded or ranked, as we do for the academic subjects, or we may not reap the benefits of the program. The idea to be communicated is that each child's drawing or musical performance is acceptable because it reflects their attempt to create something of beauty. The first president of Stanford University, Leland Stanford, understood the downside of ranking intellectual efforts. This practice often crimps the desire to be original and different by forcing individuals to copy the style of those who receive the top ranks from authority figures. This practice is having unfortunate consequence in contemporary science.

Ten years ago one of my graduate students, who came from an immigrant background, knew nothing about the brain and had shown no interest in brain processes, but decided to do research for his Ph.D. thesis that required measuring in the brain. When I asked why, he said he had to "transcend his family background." This is not a good reason for the selection of a thesis topic.

A second reason for an arts/music curriculum, which has a more recent history, may help middle-

class children who have been infantilized by over-protective parents excessively concerned with their grades and talent profile. When I was ten years old, as World War II began, my parents and those of my friends did not worry about their children being kidnapped or going to the home of a friend whose parents were away in order to raid their liquor cabinet or have sex in a bedroom.

Equally important, there was no television, cell phones, or Internet. Each of us was free to choose how to spend the afternoon; the games we played, as a group or alone, helped us acquire a sense of agency. I remember getting on my bicycle and exploring the areas of my town of 20,000. When a friend was not available, I often played a game with dice and a cardboard football field for which I made the decisions for both teams. If I had been born in the year 2000, I probably would have spent some of that time watching television or text messaging my friends.

Today's middle-class parents worry too much about their child's accomplishments in many domains. Some children interpret this intrusive concern as indicating that their achievements are necessary for the parents' happiness. The combination of excessive parental worry over a child's safety and achievements and the restriction of a child's free time together with television and the Internet, which promote conformity to peer values, have impaired, to some degree, the integrity of the sense of agency that all children must develop. The opportunity to invest effort in the service of completing a drawing or musical performance that pleases the child might help the child develop the personal agency that seems to me to be eroding.

A third advantage to an arts/music program, which might help all children, is based on the fact that the mind uses three distinct forms, or tools, to acquire, store, and communicate knowledge. The balance among the three has changed over time. For most of the first 100,000 years of human presence,

WILL KIRK, HOMEWOOD PHOTOGRAPHIC SERVICES

Jerome Kagan, Ph.D.

the most important knowledge was contained in motor skills, such as planting, harvesting, molding, building, cooking, and hunting. The artisans of earlier societies were a critical component of the burgeoning middle-class, especially after the European Renaissance. The Industrial Revolution changed much of this by moving the role of builder from artisan to machine. You and I can order a prefabricated house and purchase most of the artifacts we need for living by shopping at Walmart. The knowledge that psychologists call procedural has become less important for successful adaptation than it was two centuries ago. Art and music require procedural knowledge.

A second tool consists of perceptual representations, which psychologists call schemata, which are called up at will when the mind creates an image of a scene, object, face, or melody. Schemata are critical tools for the artist and musician, and all of us rely

on this form of representation to some degree. The 19th-century German chemist Friedrich Kekulé determined the molecular structure of benzene through a dream in which he imagined the six carbon atoms connected in a ring. One of Einstein's great insights, which was the basis of relativity, occurred when he imagined he was riding a light wave.

James Watson and Francis Crick beat Rosalind Franklin in detecting the correct structure of DNA because the two men built a mechanical model of the molecule and could see the spatial relations among the four nucleotides of DNA. The physicist George Gamow anticipated Crick's and Watson's insight that DNA was a helical structure of four bases. But because Gamow thought in terms of the mathematical concept of symmetry rather than with schemata, he assumed that mRNA transcribed DNA equally well from left to right or from right to left. Because mRNA only reads the DNA molecule in one direction, Gamow missed being the first discoverer of this life molecule.

A Radcliffe student who had been raped in a poor neighborhood in New York City decided for her senior thesis to return to the area to photograph the callous faces of 24 men who inhabited the space. She submitted the photos, without any words, as her thesis and won a prize.

COURTESY OF CLARE GRIZZARD

Art from a first grade student at Roland Park Elementary/Middle School, Baltimore

The third tool, language, has come to dominate life in developed societies and their schools. Most contemporary science is conceptual, resting on complex semantic networks, often penetrated with mathematics for ideas like black holes, molecules, genes, mutation, and diseases. However, biologists now define a gene not as a string of nucleotides one can draw, but by what the gene does; these functions are described in semantic networks. Economists, businessmen, and social scientists deal primarily with knowledge described with words, not with actions or schemata. Adolescents who consult Google or Wikipedia typically obtain semantic knowledge, not procedural or schematic understandings. The films made by Italian, Swedish, Japanese, Chinese, and Iranian directors enrich our comprehension of these cultures in ways that are distinctive from the effects of books. Rent and view De Sica's *The Bicycle Thief*, Bergman's *The Seventh Seal*, the Japanese film, *The Suicide Club*, the Chinese film, *To Live*, and the Iranian film, *Leila*, and you will appreciate this claim.

The heavy reliance on semantic networks is unfortunate because words, especially English words, do not specify phenomena with the detail that permits differentiation among distinct members of a concept. The problem is that very diverse events are given the same name. The word "bird" is an example. Robins, ducks, hawks, and penguins are very different members of the same semantic concept. An epidemiologist who conducted telephone interviews with 5,000 adults in order to learn about depression has a far leaner understanding of this syndrome than a clinician who, for the past 30 years, has seen and heard depressed patients describe their symptoms in a whisper as they slumped listlessly in a chair with pale cheeks, uncombed hair, and a stained blouse. Our respect for schematic and procedural knowledge is revealed by the fact that we are willing to pay extra money to see a specialist when we are ill because we know that the specialist has schematic and procedural knowledge that the novice does not.

Art and music require the use of both schematic and procedural knowledge and, therefore, amplify a child's understanding of self and the world. I had read a great deal about Venice over the years, but only after visiting and seeing the relation between the canals and the land did I fully comprehend this city. I borrow William Jennings Bryan's phrase "Do not crucify America on a cross of gold" to suggest that we should not crucify America's children on a cross of words. The combined use of hands and imagination makes an important contribution to what it means "to know" something. You cannot learn to play tennis by reading a book.

The Japanese distinguish between two modes of interacting with another. When one is in the mode called *tatemae*, politeness and suppression of any comment that might anger or embarrass the other is always required. When one is in the mode called *honne*, which is appropriate with intimates, it is permissible to be honest. I had read about the meanings of these concepts, but understood them more fully when I visited a Tokyo art museum and saw the many paintings that made them the theme of the art. For example, one artist painted two people, one facing the viewer and the other with his back to the viewer. Another illustrated two flying gulls; one with its feet showing and the other with its feet hidden. These pictures enhanced my appreciation of the contrast.

Howard Gardner's popular book, *Frames of Mind*, was celebrated by many educators who sensed that I.Q. test scores did not measure procedural and schematic knowledge, but mainly semantic knowledge. Recall Eliza Doolittle in the musical *My Fair Lady*, who says to Freddy, "Don't talk of love lasting through time … show me now."

The brain sciences confirm these suggestions. Verbal products rely mainly on sites in the temporal cortex in the left hemisphere. Schematic knowledge relies more heavily on the parietal cortex in the right hemisphere, and procedural knowledge requires neuronal clusters in the premotor cortex, cerebellum, and the structures called the basal ganglia. All three sources of knowledge contribute to the healthy development of a brain.

Niels Bohr was, after Einstein, the outstanding physicist of the first half of the last century. His model of the atom was the one I read as a student. Thus, I was surprised to learn recently that there were no equations in his research notebooks, only words and pictures! He illustrated the discovery of the fissioning of the uranium atom as a water drop being deformed in the middle to the shape of a peanut and then splitting into two parts.

I believe that a major reason why I was so poor at drawing in elementary school, and continue to be incompetent today, is that I was delivered by a pair of forceps that damaged the cornea of my left eye. As a result, my vision in the left eye is 20/200. I began life using only my right eye, which meant that events in my right visual field were given greater salience. Because events in the right visual field are more elaborated by the left than by the right hemisphere, my left hemisphere, where language is dominant, developed at the expense of my right, where schemata dominate. I suspect this is one reason why I have always had great difficulty with art and music. I still sing off key and remember that, although I had the lead speaking role in the fifth grade operetta, my singing teacher, Ms. Collier, told me to open my mouth but make no sounds—a cruel request to an 11-year-old who liked to sing.

A fourth advantage lies with the opportunity to provide all American youth with some values they feel warrant consistent loyalty. Most youth from earlier generations were relatively more certain of the ethical values they believed had to be honored under all usual circumstances. I was certain as an adolescent that loyalty, perseverance, and work that would benefit humanity were ideals that were immune from challenge. Too many of today's youth are more loosely tied to these ethical ideas and a bit more confused over the imperatives that demand reflex obedience. This void in their psyche is unfortunate,

for humans demand that some acts and some people are good or bad in an absolute sense. They resist the scientists' argument that nature has no special moral favorites, only survival and begetting the next generation. Many youth feel uncertain and are looking for heroes and heroines who might represent some ideals for which they are willing to exert effort.

Humans place a high value on correctness as the primary criterion when reading, solving arithmetic problems, and mounting a logical argument. But humans also want to know what is "right," where right refers to judgments of products that automatically evoke a morally proper feeling without first passing through a conscious intellectual censor checking for errors. That is why so many Americans were upset by the torture of Iraqi prisoners by our soldiers trying to obtain confessions that might protect America from another attack. The latter motive may be logically defensible, but morally it was not right.

The arts and music provide an opportunity to persuade children that investing effort to create an object of beauty is an ideal worthy of celebration. Making beauty has an advantage over obtaining "A" grades because others can share in the enjoyment of a beautiful product; only the self enjoys high grades. My daughter, who lives in Chapel Hill, North Carolina and works in public art, persuaded city officials to allow the art of Chapel Hill pupils to be mounted inside metropolitan buses. The children experienced extraordinary pride from knowing that their products were displayed in a public place and were reassured that the adult community valued qualities other than academic excellence on the formal skills. The community took pleasure from learning that this set of talents was being developed in their children.

The fifth advantage of an arts curriculum is that it allows a number of children to work as a cooperative unit, as when they compose a mural or play in the school band or orchestra. American society has always been more individualistic than most European nations, but in the past this individualism was balanced a little with the requirement to be loyal to friends and the community. The imperative for loyalty has been eroding over the past 50 years, leaving every individual with the recognition that, in the end, they are alone and on their own. The men and women who persuaded poor families to take on mortgages they could not afford, the lack of commitment between employees (including professors and lawyers) and employers, and the deception of close friends by Bernard Madoff are only three blatant examples of the blizzard of lies and corrosive mistrust that have penetrated our society and are captured in the pop songs youth listen to and sing. I am certain that this loss of an appropriate balance between concern with self and concern for others is not healthy.

When a dozen children complete a mural or play an orchestral piece, the group, not the individual, is the target of praise. My friends who sing in choirs report an intense feeling of exhilaration when they are singing together in front of an audience. This emotion is not exactly like the feeling evoked when one receives a grade of 100 on a test. The problems facing the contemporary world demand some subversion of self interest in order to lift the interests of the larger community into a position of ascendance. Perhaps participation in a school orchestra is a useful preparation for the stance that will be required in this century.

Finally, art and music provide opportunities for all children to experience and express feelings and conflicts that are not yet fully conscious and cannot be expressed coherently in words. A child who is afraid of the class bully, angry at a harsh father, or jealous of an attractive older sister, but cannot put these feelings into words might be able to express these feelings in art. A psychologist in Texas asked one group of undergraduates to write, anonymously, for 30 days on any theme they wished and then to throw away the piece of paper. A control group did nothing. The former, who were allowed

to put down their worries and hostilities each morning, had fewer colds and reported fewer aches and pains during the period.

I kept a diary from 1965 to 2000, and confess that the morning after a very tense day at the university, the opportunity to write down my thoughts altered my mood considerably. Suppose every American classroom began with a 10-minute interval in which every child was told to draw the way they felt that morning on a piece of paper and then to toss the paper into a wastebasket.

In sum, arts and music have an important role to play in American schools. I suspect that if American teachers devoted one hour each day to art or music, or even one hour two days a week, the proportion of youth who dropped out of high school might be reduced. Moreover, the child's products would provide parents of failing children with an opportunity to praise children rather than criticize them for laziness.

The argument for arts and music in the curriculum does not have to be sentimental, but can rest on pragmatic grounds. Americans reserve their respect for pragmatic products and associated skills that make money, cure disease, or permit a gain in status, and believe that art and music are luxuries with no useful consequences. However, if an arts program helped only one-half of the seven million children who are behind in reading and arithmetic by providing them with a sense of pride and the belief that they might have some talent, the high school dropout rate would fall. This program might also help children gain a richer appreciation of their emotional life and what it means to be human. The film *Saving Private Ryan* provokes a set of emotions over the horrors of war that most novels could not accomplish. Allowing youth to make short films dealing with their sources of tension could have benevolent consequences for them and for the larger community.

Americans and Europeans, but not the Chinese, have always celebrated a rational, logical approach

COURTESY OF CLARE GRIZZARD

Art from a fourth grade student at Roland Park Elementary/Middle School, Baltimore

to important decisions because of a fear of relying on values and sentiments that were closely associated with an ethnic group or particular religion. But America has matured to a point where most are now tolerant of all ethnic and religious affiliations and, therefore, we can relax a little and permit some sentiment to enter our deliberations on human affairs. It is not possible to live by rationality alone. The human conscience relies on empathy for others and the anticipation of anxiety, guilt, or shame for violating a community norm. Children need a deeper understanding of these feelings and the arts contribute to this goal.

The current economic crisis occurred because too many bankers trusted the rational analyses of computer programmers who set the risk of credit default swaps too low. The rationally based advice was terribly wrong and the bankers should have trusted their gut feelings. Some of you may remember that Robert McNamara, the secretary of defense during the Vietnam War who

also worshipped at the altar of rational analysis, confessed years later that this premise was flawed. Alan Greenspan made a similar confession last year as the economic crisis accelerated.

It will be difficult to persuade school boards and superintendents to change the curriculum and devote an hour a day to arts and music as a replacement for reading or mathematical instruction because empirical proof of my optimistic claims is lacking. Moreover, these claims are based on rational deductions from my knowledge of children, and, therefore, are vulnerable to the flaws trailing all rational analyses. Thus, I could be wrong. But I believe it is worthwhile to test the validity of these predictions. Perhaps some of you will implement demonstrations of these ideas next year. It is worth trying. They are as deserving of a clinical trial as a new drug for cancer that has not yet been proven to be effective.

Section 5

Edited Excerpts from the Educators' Panel

Implications of Research for Educational Practice

Panelists

- **Richard (Dick) Deasy**, moderator,
  retired director of the Arts Education Partnership (AEP)
- **Mary Ann Mears**,
  Arts Education in Maryland Schools (AEMS) Alliance
- **Elizabeth (Betty) Morgan**, Ph.D.,
  superintendent of schools, Washington County, MD
- **Sarah Cunningham**, Ph.D.,
  National Endowment for the Arts
- **Janet Eilber**,
  The Dana Foundation
- **Mariale Hardiman**, Ed.D.,
  The Johns Hopkins University School of Education

Richard (Dick) Deasy: The first question I want to ask this elite group is what's been important to you in your work? I'm going to start with Mary Ann, as an artist and as someone who has made an enormous impact in this state due to her commitment to advocacy.

Mary Ann Mears: When I was on the train coming back from the event at which the Dana consortium research was released, I started thinking about conversations I've had with the absolutely wonderful arts educators that I've met across Maryland. They're wonderful not only because of the great work they do with kids, but also because of the way they think about what they do. I immediately said I would love to bring their questions to the attention of researchers.

Dick Deasy's work has been enormously important to everyone in this field all across the country. At the meeting of art supervisors from around the state last week, Nelson Fritts from Cecil County was talking about a great new program he's putting together, hiring 15 dance and theater teachers for that school system. He talked about using *Critical Links* in his conversations with the decision makers to win their support for the program.[2]

Two of my favorite studies are James Catterall's work.[3] One was—and this is old but I still use it—his analysis of NELS [National Educational Longitudinal Study] data. It's a view from 30,000 feet, and it addresses the issue of equity by drawing a relationship between correlations in terms of children from low socioeconomic backgrounds having a significant benefit from the arts. Equity is where the rubber meets the road in this work.

Another study he did is a small-scale, finer grained thing I have always loved, which he presented at a 1998 symposium for superintendents in Maryland. He gave two groups of kids a prompt about Ancient Egypt. One group drew and then wrote; the other group just wrote. The students who drew the sarcophagi and the cartouches and so forth and then wrote about them had better organized and more detailed written responses. This was particularly true of the students with limited English proficiency.

I like that the study is partly about visual art and it addresses equity. It's very concrete and kind of elegant. There's insight for practitioners and a good story for advocacy. I really think it's important that whatever research is done is valuable for practitioners and brings insight and clarity for teachers.

Ever since getting a computer I've used the metaphor that we're hardwired for the arts as a species. I've always drawn on cultural historical information to back that up. But now when I'm talking to people I say the neuroscientists are beginning to discover how that works.

Deasy: Betty, you are the superintendant of a school district that has a great love for the arts. How have you drawn research into your career?

Elizabeth (Betty) Morgan: I believe that the research has helped us to build better arts programs in school systems. There's no question. I've worked in four different school systems, and it's been interesting to see how the development of programs in the arts has varied a great deal across Maryland. I

[2] Deasy, R. J. (Ed.). (2002). *Critical links: Learning in the arts and student academic and social development*. Washington, DC: Arts Education Partnership. http://www.aep-arts.org/publications/info.htm?publication_id=10

[3] Catterall, J., Chapleau, R., & Iwanaga, J. (1999). Involvement in the arts and human development: General involvement and intensive involvement in music and theatre arts. In E. B. Fiske (Ed.), *Champions of change: The impact of the arts on learning* (pp. 1-18). Washington, DC: Arts Education Partnership and The President's Committee on the Arts and the Humanities. http://artsedge.kennedy-center.org/champions/pdfs/ChampsReport.pdf

think the research has strengthened arts-education programs not only in Maryland but everywhere. We've been able to use the research to be age appropriate in what we're doing in the arts, understanding, for example, the young neurons in early childhood, understanding what kids who are ten or older can accept. According to all the research, by about the age of ten your arts brain is becoming pretty developed; at the onset of adolescence your brain matures.

There's no doubt that elements we now include in various arts programs have come out of research. We've learned from the research, too, the effect of arts on cognition. Research has helped me as a superintendent to sell programs in a place like Washington County, in Appalachia. Fifty-four percent of our elementary school students qualify for free and reduced-price meals. I'll be perfectly honest with you, until I got to Washington County, I didn't even know that it had a world-class museum. That it's the home of the Maryland Symphony Orchestra. None of our school children were being given the opportunity to go through the museum or to symphony productions. I'm pleased to say that the link between the arts and cognition has helped us not only provide these opportunities for students, but also to sell the arts better in that community.

We're not an affluent suburb of a city, and we are not dealing with people who see the arts as part of their daily life—many people are struggling to survive. Many people don't see the arts as enhancing their lives. I like to feel that we've made a dent in that.

Being able to use the research really helps because it resonates with some people who wonder why we should have these programs. There are kids who are having difficulty learning how to read—why are you spending money on orchestral music in the elementary school? The research has helped us say that by introducing a violin to a child having difficulty in reading, we're helping that child develop his or her brain and form links between different areas of the brain.

COURTESY OF CLARE GRIZZARD

Art from a fourth grade student at Roland Park Elementary/Middle School, Baltimore

We have a program through which students in various grade levels go to the museum and do a language-arts activity from the voluntary state curriculum of Maryland. We find teachers' eyes are opened when kids are at the museum and suddenly they're talking and they're able to write or want to write when they don't normally want to in the classroom. They've been inspired, and are getting input from what they see visually.

I really am very grateful to those of you who are steeped in the research because it helps people like me who are on the front lines—dealing with swine flu, dealing with kids being bullied, dealing with disciplinary issues and everything else—to justify the arts in our programs, and the expenditures the arts incur. It helps us create programs that are successful, because nothing succeeds like success. Success breeds more success and more willingness to engage in some of these programs.

Deasy: Sarah Cunningham, you are at the federal level deciding how to allocate dollars in support of arts education. How has research factored into your work and your thinking?

Sarah Cunningham: In terms of policy issues, research makes a difference to a funder when you have organizations that are aware of what in detail is happening with the children. To know that organizations really have a sense of what is happening with kids in the classroom is so important. But I would also nudge a little bit in another direction—as we build our knowledge, it's going to be so important to share this information with teachers and schools of education. It's so valuable to have this scientific investment to validate what a lot of us have known for a long time.

What's exciting is that it starts to generate conversations that have happened over the centuries, to generate a lot of excitement in the world that we live in. We revisit those conversations so that we can understand what's happening with young children as they make meaning out of the world and they begin to understand how to navigate space and time in playful ways. I think the fact that we actually have other tools to begin to understand these things is tremendous, because we're asking these questions: What is knowledge? How do we know? How do young people know? What kind of knowledge do we lose as we become adults? Are we scared to be playful as adults? Why are we scared?

This conversation with the scientific community demonstrates the richness of the moment that we're in. We have an opportunity as a federal agency to take this conversation to the press, the White House, the West Wing, and the East Wing, to engage in that conversation about where we can go with our young people. This conversation on the arts expands beyond artistic practice out into our moral effectiveness, our ability not to be depressed in high school, for example.

The final end is not utility, but it's doing things that are ends in themselves. It's things that are beautiful, it's laughter, it's these moments that we in the arts strive every day in our studios to practice or to at least reach for. From a federal point of view, this is an extremely exciting conversation. I think there are open ears right now. I don't have my political appointee senior staff in place, but I think that this conversation is very welcome federally from the NEA's point of view.

Deasy: Janet, we ought to allow you to talk about your role at Dana, your career in dance, and your other activities. What's the research meant to you?

Janet Eilber: I've been very excited about this summit and particularly this panel about the implications for research. About five years ago, I attended the Learning and the Brain conference in San Francisco. I went to Dr. Patricia Wolfe's session for educators about strategies to use, what we know about the brain, and learning in the classroom. She spoke about how students access information better if it's presented to them with some context and in an emotionally engaging way. And I said, well that's what arts education does.

She wasn't talking about the arts. She was strictly talking about engaging education. But I recognized that these things had a relationship, that these were functions of what the arts could give us. There was little being done at that time. While there was some research, there really wasn't any momentum to how the arts might intersect with brain research and how that might be taken into the classroom.

Dana's arts-education granting began about ten years ago. It has been about delivery, how we get better arts learning into the classrooms. We assessed the pipeline. What's the role of the classroom teacher? What's the role of superintendents, policy makers, and parents? We looked for areas of need, the place to most effectively put the Dana Foundation's money to make these things happen.

But when we launched the arts and cognition study, we had to take a page from our colleagues who were overseeing the medical research and

not impinge on the research with anticipation, with a wish for outcomes. We couldn't impede the process with the fact that we wanted Betty to be able to use the research as ammunition or Mary Ann to be able to use the research as credible material in her advocacy efforts. It's been very difficult to sit on our hands and wait for the day when we can look at how to take this stuff into the classroom. I'm not here to wave the flag of caution any longer. I really would like to get going and affect what seems to me a sort of glacial pace. I'm hoping the discussion today will not only support the momentum of the cognitive science and inspire future research, but will allow us to look at other types of research that may help us use what we already know more effectively.

Just as Dana began funding in arts education, the Surdna Foundation released a study called *Powerful Voices*, which very clearly articulated the essential elements of a successful arts program.[4] It included an assessment tool so that you could assess your arts program looking at using a rubric that they had set up of the essential elements.

A study commissioned by the California Endowment called *The Power of Art* parsed out the elements of after-school programs bringing art to youth.[5] Students were art makers, they had sustained participation, and they were in secure spaces. The thing that I found most interesting and revelatory about that study was they asked, what do these after-school programs in the arts offer that sports or vocational work programs don't offer? It came down to one thing: responsibility for self expression. The students were required to make art, and the programs ended in a performance or an exhibit that they were responsible for producing. This was the main difference—the students gained confidence and self awareness through personal expression.

Deasy: That work, as many of you know, is further elaborated by Dr. Shirley Brice Heath in her ten-year study of out-of-school experiences, finding those same things.[6] But Shirley also impressed upon us that that type of engagement with the arts develops persistence and resilience in young people.

Mariale, you're the person who ran a school based on your understandings of the brain. How did that come about?

Mariale Hardiman: It is really ironic that I have spent the last year planning a conference on learning, arts, and the brain when I spent 15 years as a school principal focused on test scores. If you go around and start asking principals, "What's more important to you, test scores or art?" I don't think anybody would question what they'd say.

I will tell you about my experiences, especially at Roland Park Elementary/Middle School, which is a large school—1,300 kids and a fishbowl school in Baltimore. I was there for 12 years; after my second year, we had 11 years of improvement in reading and math. We analyzed our data through every lens. We got Maryland performance award after award. We just kept growing in scores, and that was wonderful. I worked hard and my staff worked hard at doing that. It takes so much energy to meet those accountability measures.

[4] Surdna Foundation, Inc. (2002). *Powerful voices: Developing high-impact arts programs for teens.* New York, NY: Author. http://www.surdna.org/resources/resources_show.htm?doc_id=343592&attrib_id=12040

[5] Anderson, S., Walch, N., & Becker, K. (2003). *The power of art: The arts as an effective intervention strategy for at-risk youth*. Los Angeles, CA: The California Endowment. http://www.calendow.org/uploadedFiles/Publications/By_Topic/Disparities/General/The%20Power%20of%20Art.pdf

[6] Brice Heath, S. & Soap, E. (1998). Youth development and the arts in nonschool hours. *Grantmakers and the Arts, 9*. http://www.giarts.org/library_additional/library_additional_show.htm?doc_id=505992

COURTESY OF CLARE GRIZZARD

Art from sixth grade students at Roland Park Elementary/Middle School, Baltimore

Yet I started to see that there was probably something wrong. We were so focused on accountability and scores that there was something that was not as holistic as it should have been about the school. Mary Ann Mears started talking to me about integration, and then [Deasy's] publication, *Critical Links*, was released. I was especially struck by the studies that showed how theater seemed to influence students. I started a full-time theater program, one of the first schools in the area to do that, and brought in a full-time theater teacher with whom I'd worked in a previous school. We started to see some really neat things happening with kids involved with theater.

But the real research came from the teachers. A social studies teacher, Susan Rome, came to me one day and said, "Dr. Hardiman, I want to do an arts-integrated unit with the art teacher." I looked at her and I said, "Susan, are the kids going to learn any social studies? They're not going to just be doing two periods of drawing, are they? We have to get some content taught." Susan assured me that there would be teaching involved, that she would get the content taught. And I was blown away by what those two teachers were able to produce, how much the children enjoyed what they learned, and how much better they learned the information.

As I began to look at cognitive neuroscience and came up with the Brain-Targeted Teaching Model,[7] we relied heavily on arts integration, especially when we knew that repetition was required for children to acquire and have mastery of information. If you're teaching the same lesson over and over again, repetition isn't going work very well. Kids are going to be bored out of their minds. We started to look at how to get children to master key concepts and do the repetition through arts integration so that they didn't think that they were repeating content, but rather manipulating it in different ways through the arts.

Clare Grizzard, an arts-integration specialist at Roland Park, with teachers Catherine Gearhart and Amanda Barnes, started to write units in the Brain-Targeted Teaching Model. What we started to see really was the school transforming, the halls coming alive with the children's work, the children talking about what they were learning in school, parents coming to me and saying, "What's going on at the school? Instead of my child saying nothing when I ask what they've learned, they start to talk in a very excited way about the content that they learned." They were learning it through art forms. We continued to become an arts-integrated school, and now a demonstration school, in Baltimore.

I also have been intrigued by a study done by Dr. Charles Limb at Hopkins about jazz musicians.[8] He found that when jazz musicians were improvising, the part of their brains that controlled impulses seemed less active. It made me think about what happens in schools. We spend a lot of time

[7] http://www.braintargetedteaching.org/

[8] Limb, C.J. & Braun, A.R. (2008). Neural substrates of spontaneous musical performance: An FMRI study of jazz improvisation. *PLoS One, 3*(2). http://www.plosone.org/article/info:doi/10.1371/journal.pone.0001679

controlling children in school—they walk down the hall, they sit in their seats (and if they have ADHD we try to fix that). Charles, could you just say a little something about your study?

Charles Limb: I do research that's designed to try to understand how the musical brain works. The thing that frustrated me the most was that a lot of scientific studies, with good reason, deconstruct music into its elements and make it very sterile to the point where there's no music left in it. You almost can't tell it's a musical study anymore.

And so I said, what I really want to look at is how creativity happens in real time in a way that has what we call ecological validity, meaning you can recognize that it's a jazz musical performance that's being done. To make a long project very, very short, I took jazz musicians, brought them into an fMRI scanner, had them improvise or play something memorized, and looked at their brain activity.

The part of the brain that was really active during improvisation was a self-knowledge, autobiographical area. The parts that went way down or kind of shut off were the self-inhibitory lateral prefrontal regions. When you're improvising, these regions shut down because you want to generate novelty, you want to turn off the rules.

I'm not quite convinced that waiting for neuroscientists to come up with a study that's intriguing or helpful to the arts or education is efficient. Scientists are not supposed to be agenda-based with what we do. We often don't know what's important until maybe a decade later. Something that we can bring to the table is a systematic quantitative approach that social sciences traditionally have not had and that art has really very little need for.

Deasy: A current movement is action research. That is to have teachers, for example, develop their own questions and pursue and study them within the context of their daily lives. It's an enormously important development tool for teachers.

Mears: In conversations with artists and teaching artists, creativity, how it emerges in kids, and how to foster it was really important. Being able to find from some of the neuroscientists the potential methodologies for us to examine creativity would be fabulous. Doing it in collaboration would also be wonderful. But turning some of the teachers loose to do it through action research would be great and liberating for them.

We've talked a lot about arts integration. One of the things that came through for me is the transformative impact on teachers when they're trained in arts integration. I think we need to do some research about what happens in transforming the teachers. One of the most wonderful things teachers say is that they see the kids differently. I think that merits some attention from researchers because to understand that would be tremendously important and have a huge impact.

Many artists say that the creative spark at the beginning of an idea actually occurs as a visual image. I would love to talk to somebody about how we could do more research around visual thinking and visualization.

Deasy: Let's go back to Janet.

Eilber: Brain scientists often talk about the idea of repetition and drilling in a certain subject; maybe that's just as effective as surrounding a subject with integrated arts education. If Michael Jordan had practiced neuroscience for as many hours as he practiced his free throw, maybe he'd be a great neuroscientist.

In thinking about drilling and confidence, at what point do you have enough comprehension of the system that you're working in to have the

COURTESY OF CLARE GRIZZARD

Art from a sixth grade student at Roland Park Elementary/Middle School

confidence to be creative, to take risks? In training dancers, there's a long period of imitation and drilling and understanding the physical vocabulary. Some dancers never take the leap to have ownership of personal expression or make creative decisions about a role. Some of them are stuck with the drilling while others transcend it.

Deasy: Dr. John Bransford's work in cognitive science about how people learn grapples with that.[9] How do you spark the imagination and make it the basis of a leap forward? Betty, any thoughts?

Morgan: In these really tough economic times, we need some practical tools to help us sell arts programs in the school systems. Advocacy groups can work with you and against you. I've probably faced every advocacy group that works against you in Washington County.

I'd be fascinated to look at research that would show the effect that music has on special-education students in specific special-education areas, such as autistic kids. Does it help autistic kids to communicate more? Does it help kids who are severely learning disabled respond to certain kinds of things that teachers are doing? What effect does it really have specifically?

I'd like to see research that ties the arts to academic excellence and growth very specifically. This group of kids was exposed, this group was not, and they advanced in their reading ability. It's not just about the scores, but it is about programs that work, and it is about how we want to spend money.

In my experience with the high school for visual and performing arts in Washington County, I've been vilified by advocacy groups, I have been excoriated in the press. The team and I have been through hell in putting the school together, and I'm not exaggerating. The day of the groundbreaking, a gentleman picketed with a placard against the money that was being spent on the school for the arts. The building was donated by a local businessman in memory of his wife who was an art teacher in Washington County who died at a young age of cancer.

Any research on the role of the arts at the high school level would have really helped me with the advocacy groups that were against this project—and generally they're against everything. There's a real paucity of research at the high school level. I would love to see the effects on kids who participate in arts programs in high school. I would love to see research on high schools for the arts across the country. I would like the tools to have the arts recognized as an important discipline, a discipline that makes a difference. Anything in

[9] Bransford, J.D. & Franks, J.J. (1976). Toward a framework for understanding learning. In G. Bower (Ed.), *The psychology of learning and motivation* (Vol. 10). New York: Academic Press.

the arts that shows a tie to increased cognition, academic growth.

Cunningham: I work right now with 19 states developing state teams to talk about how public education can put arts at the core and how to develop creative state design teams. Every state has a different microclimate for arts education, which means that it also has tremendous resources that can't be drawn through all those states. These state teams include lieutenant governors, state superintendents of schools, etc.

These folks want the information because they're making decisions on the ground about how to design all parts of public education. We need as much information as we have to give our students the best possible experiences. We don't apply this information across the board in the same way. But we aim to delicately understand its complexity and its shortcomings and find ways to get information to creative teachers who are doing a lot of inventive things and who are opening up to arts education in different ways.

What we advocate today in education are two representational languages, math and reading; maybe we should be educating kids to have multiple representational abilities. I think expanding our understanding of the human representational capacities that have been neglected is really important. And part of that is the conversation with artists with disabilities who have representational capacities that we don't fully appreciate. I think they should be at the table in a big way here.

The NEA recently did a reading-at-risk report where we did a secondary analysis of everything that's out there about literature.[10] If we could also collaborate in creating secondary analyses that are useful to the field and that help us apply this information well, it would bring together all these different studies that allow us to see the bigger picture. It could be that the new research isn't as pressing as drawing together the existing research and getting it out in the field so the field can make intelligent choices about it.

Deasy: That's great. Mariale, do you want to make comments?

Hardiman: I would like to bring it back to the school level. I would like principals and schools not to have to decide between the arts and other content areas. I'd like to know if children who learn content through the arts have better long-term retention and are better at applying that content than children who learn in a traditional way. I'd like to know if children are going to be better long-term learners if we embed art forms into our teaching techniques.

I really wonder, coming back to Charles' study on creativity, whether or not we're squeezing creativity out of our children by trying to control them so much in our school environments. What would it look like if we studied that? Could we study children in the same sense that Charles studied jazz musicians, looking at their creativity versus their impulse? I think that might be an interesting study.

[10] National Endowment for the Arts. (2009). *Reading on the rise: A new chapter in American literacy*. Washington, DC: Author. http://arts.endow.gov/research/ReadingonRise.pdf

Section 6

The Roundtable Discussions

The purpose of the roundtable discussion groups was to provide a venue for communication and collaboration among educators, researchers, and advocates focused on cognition and the arts. The anticipated outcomes included: educators generating research questions based on the real needs of the classroom; researchers understanding the practical needs of education practitioners; and researchers and educators collaboratively planning how studies could be designed and conducted in authentic settings to inform educational practice.

The roundtable discussions involved more than 270 summit participants, with approximately ten participants per table.

Roundtable participants included:

- Educators from pre-K through higher education
- Summit panelists
- Neuroscience researchers from JHU and other universities
- Educators of pre-service teachers
- University professors and researchers of other disciplines
- University administrators
- Artists
- Artist-educators
- School administrators and leaders
- Advocates from arts organizations
- Museum directors
- Policy makers
- Businesspeople interested in education
- Other professionals related in some capacity to education or neuroscience

Given the heterogeneous mix of attendees and panelists, the leaders of the summit arranged the discussion groups to create the richest possible variety of interests, voices, and expertise.

Each table was chaired by a facilitator who was assisted by a recorder to capture as much of the discussion as possible. Prior to the summit, facilitators and recorders attended work sessions to discuss how to frame questions and lead discussions to enhance the collaboration of the education and research communities. While the facilitators were prepared to move the conversation along a common thread of discussion, they also knew that

they should allow the group to flow into conversation that was relevant to the day's earlier panel discussions and the group's interests.

Roundtable Discussion Summary

The invitation to the groups was kept intentionally broad: "…to explore and test how the arts might contribute to improving students' academic experience and learning." While the roundtable proceedings ultimately focused on the generation of research questions or proposals, much of the discussion included broader topics. The many different points and issues that arose in the roundtables have been organized into six major categories (among which there is some overlap and interconnection):

1. **The questions educators need to have answered.** What should be the role of arts integration and arts in education? How can neuroscience research promote arts integration in the classroom?
2. **The bridging of the tactical gap between neuroscience and education.** How can the neuroscience and educational research communities come together to address the questions of educators?
3. **The arts as an agent for behavioral change.** What are the most important outcomes we should consider to evaluate the effectiveness of an arts-inclusive curriculum?
4. **The arts as impetus for engagement.** How do the arts influence attention and engagement in learning?
5. **The need for evolved skills.** How can we address ongoing training and professional development for educators now and in the long term?
6. **The need for communication.** How do we ensure the critical communication of researchers with educators; educators with educators; colleges and universities with their students and prospective educators; educators and researchers with parents, administrators, and policy-makers; and arts advocates with educational and community stakeholders?

The common thread among all these categories is a focus on children in the classroom. Rather than looking to neuroscience or the arts for a magic formula to explain the learning process, roundtable participants sought to segregate cause and effect. Educators experienced with arts integration were convinced of its benefits, but they (and their principals and school boards) are under pressure to show hard evidence. Will arts-integrated curricula lead to students who demonstrate creativity and higher-order thinking? Will arts-integrated curricula help students learn course content better? Will it help them become more engaged in learning? Will it result in higher standardized test scores? Is there support from educators across all disciplines? What is the pedagogical basis for building curricula on principles that transcend the empirical success of overt practice?

The text that follows is a synthesis of the teachers' discussions from each of the 27 roundtables; the questions and comments are organized according to the six themes above. **Bold text** indicates questions asked by educators participating in the discussions.

1. The questions educators need to have answered

Despite provocative findings from the brain scientists, teachers wanted to first clarify their expectations. There was certainly no consensus among educators about what was needed from neuroscience or how to move forward with arts integration. Perhaps the only common ground was that creativity and creative moments are wonderful in

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Roundtable participants at the summit.

themselves (and good for learning), but almost impossible to orchestrate.

A general and very representative question from educators was, "What can I do now? I feel overwhelmed."

There were at least two sources of this frustration: first, educators don't know where to go to learn what is available, especially in terms of arts integration and brain research, and second, not all of the educators present at the summit were familiar with arts integration.

What are the societal attitudes toward education and arts education?

The diverse constituencies of the roundtables guaranteed that there was no single answer to this question. Many artists and artist-educators were confident that in general, the public wants art in schools; some teachers and administrators were not so sure. This doubt was not linked to current budgetary constraints.

As was pointed out during the educators' panel, school administrators feel mounting pressure to increase test scores. Many are choosing to hire additional teachers in remedial reading and mathematics in place of art teachers.

The role of parents in accepting and promoting the arts in education permeated discussions throughout the summit. Confusion and intimidation about research, its usable practical applications, and reasons why the arts are important for cognitive development exists in the home.

Yet, as Dick Deasy points out, in a recent survey conducted by the Imagine Nation advocacy group, 91 percent of all voters say the arts are necessary to build imagination.

What will it take to prove that arts integration is valuable for improving performance on tests as well as for providing enjoyment?

It should be noted that the core argument here is not about whether to offer the arts in schools, but whether educators should pursue the integration of learning methodologies that are characteristic of drama, the visual arts, music, and writing into the curricula of other disciplines.

Several roundtable participants pointed out that art is no longer taught in their schools. According to the Alliance for Childhood's *Crisis in the Kindergarten* report, 48 percent of kindergarten classrooms in New York and 64 percent in Los Angeles have decided there's no time for art activities; 60 percent in New York and 67 percent in Los Angeles reported not enough time for dramatic play.[11] The larger question is inherently economic: Can the United States afford to abandon the training of creative ways of thinking and learning in the hope that these skills will come from some source other than specific training in the arts? The economic basis for teaching children critical skills through arts integration is perhaps an argument worth developing through research.

If we know that using the arts can create a deeper learning experience and enrich the curriculum, how can we prove that the arts help to keep kids in school?

The tone of the roundtables was pragmatic, as revealed in frequent discussions of the question, what is it that keeps children in school? For some it's athletics, and for others it's the arts. That is a testable phenomenon. Scientists are more apt to provide the approach for testing, but educators need to provide the questions.

Many teachers shared stories of students who became more engaged in school once they joined the cast of a play, a choral group, or a musical ensemble. The interest in school seemed to be generalized to all classes, not just those in the art form. Students had a greater sense of purpose and felt more connected to the school culture when they were engaged in an interactive art program. This was also the theme of Dr. Kagan's speech.

Many participants wondered if data were available to support these stories. Do we have longitudinal studies that show the immediate and long-term impact of arts programs in schools? If engaging in arts programs can be shown to have a substantial contribution to retaining kids in schools, then reducing the high school dropout rate would be a strong reason to keep arts programs. As participants reported, many districts appear to be dropping arts programs and adding remedial classes in reading and math to increase test scores and school engagement. Unfortunately, this practice may be producing the opposite effect. Studies show that the number one feeling that students report they experience in school is anxiety; they also frequently report boredom.[12]

Both within the roundtable discussions and during the panel presentations, a recurring theme was the joyfulness of learning and how the arts can promote such an atmosphere. Preliminary research on the nature of improvisation suggests that creative learning is inspired when inhibitions and formal rules are suppressed. Engaged, playful learning in the arts makes for better educational practices, but do we have evidence that this may be more effective learning?

[11] Miller, E. & J. Almon. (2009). *Crisis in the kindergarten: Why children need to play in school*, p. 31. College Park, MD: Alliance for Childhood. Retrieved from http://www.allianceforchildhood.org/sites/allianceforchildhood.org/files/file/kindergarten_report.pdf

[12] Pekrun, R., T. Götz, Titz, W. & Perry, R.P. (2002). Academic emotions in students' self-regulated learning and achievement: a program of qualitative and quantitative research. *Educational Psychologist*, *37*, 91–105.

How do tactile experiences affect the emotional, social, and psychological well-being and development of children? What are the neurological implications of the arts?

Would increasing creativity through the arts correlate with improvement in other subjects?

The research shared at the summit is a first step in connecting the arts to learning outcomes; however, the focus of educators seemed to be more involved in moving beyond how the arts help achievement in reading and math. They believed that new research should focus on how the arts can influence and potentially improve broader domains associated with schooling. Teachers know intuitively that the arts can have a profound effect on emotions. The arts, especially the performing arts, also foster group collaboration, which would have an impact on psycho-social development. Teachers were clear that these are the types of research question that neuroscience and cognitive science researchers should address.

The research on creativity has begun to show differentiated neural networks at work using electroencephalogram (EEG) and cerebral blood flow (CBF) measurements when subjects are engaged in divergent versus convergent thinking tasks. Participants suggested that similar studies be designed using real classroom strategies. For example, a study could look at the cognitive mechanisms involved in filling out a worksheet in class (a very common activity in classrooms today); this condition could be compared to executing a plan of action or engaging in a hands-on activity on the same topic. Educators were curious to know if the current studies could be crafted to address these real educational topics. If students are creative in an art form, say the visual arts, we should study how those skills might transfer to creativity in writing an essay or interpreting a poem.

What criteria, if any, should be applied in evaluating art products?

The fact of iterative discipline (repeated practice) that is intrinsic to the arts surfaced many times. There was explicit concern that too much focus on the finished product might overshadow the benefit of the creative learning process that led up to it. Teachers wanted to know how to develop test measures to assess cognitive performance in areas thought to be related to artistic development but not explicitly related to artistic output. There was discontent with current standards in the arts, which were said to be controversial and, as currently written, not necessarily able to promote creativity.

How do you quantify whether arts integration is working? You can quantify attendance, but attitude is hard to measure.

The most important issues to come directly from educators had to do with clarifying what an arts-integrated curriculum might look like (i.e., a fully developed pedagogical model that could be applied in multiple subject areas); how the application of such a model might change the profession of teaching; and how to assess learning, creativity, and cognitive development through arts integration beyond content test scores.

How do the arts help redefine teaching? How do you reframe teaching as a creative profession that increases student and teacher engagement? What are the outcomes? If we improve the creative aspect of teaching, how will test scores be affected?

The idea of an arts-integrated curriculum seemed to resonate with educators as a way to redefine the

teaching profession. The arts foster the engagement of children with others in collaborative projects and also engage the teacher as both a guide and a participant, thereby increasing the personal connection and engagement between teachers and students. Research shows that students benefit when they believe that they are connected to caring adults in the school environment.[13]

Clearly, teaching with and through the arts will demand that the measures of learning outcomes match the methods of teaching. Therefore, state accountability measures will need to change to reflect a more creative, collaborative kind of teaching—more open-ended divergent thinking as opposed to the convergent thinking that current educational strategies and testing programs require. Divergent thinking and creative problem solving were identified by The Partnership for 21st Century Skills as required competencies for the future workforce. How can school practices and workforce requirements be so disconnected?

2. The bridging of the tactical gap between neuroscience and education

Participants spoke of the need for an effective translator to bridge the gap between science and its application in schools.

Neuroeducation research can shed light on cognitive-development processes. What do those familiar with cognitive development notice when teachers use strategies from the arts that deepen engagement? How might they explain why these strategies work or suggest other strategies? What do they notice in students who are deeply engaged in arts activities? How is this different from what happens when students are engaged in more traditional learning activities?

The desired benefits of such analyses are greater insight into how parents and teachers can foster cognitive development; a better understanding of students who are spatial/kinetic learners; and insights that can help teachers deliver on the promise of the arts.

Representatives of both domains voiced concern that we are asking too much too early from the neurosciences. A conservative approach was called for, in which neuroscientists should be given time to conduct research and disseminate the results. In the meantime, educators would continue to use what they know from the biological sciences to inform education.

What should be the relationship between neuroscientific findings and arts-integrated coursework?

Some of the findings that relate music and math pique my curiosity about the role of research. But how do we maintain the current learning model as we begin to shift toward integration?

Educators familiar with arts integration and convinced of its benefits questioned whether neuroscientific evidence was required to justify it. If educators are convinced of the positive effects of the arts, why wait for scientific substantiation of those effects?

This question of which should come first is critical to sorting out the relationship between the two domains. Should biological analysis be performed first, generating utilitarian conclusions later, or should educators continue to practice what they believe is effective pedagogy, analyzing it through the lens of research as it is released, to improve on the utility that was already known?

The discussion clearly focused on the dilemma that teachers face when they want to implement

[13] Blum, R. (2005) *School connectedness: Improving students' lives*. Baltimore, MD: Johns Hopkins Bloomberg School of Public Health. http://cecp.air.org/download/MCMonographFINAL.pdf

art-infused instruction and creative problem solving and still cover all of the content in the curriculum. The mismatch between this style of teaching and how students are tested dominated the conversation. Educators feel powerless to change the system; they feel that the most convincing way to demonstrate the benefits of arts-infused pedagogy is through scientific research. They believe research from the brain sciences could provide the portal for policy makers to change the current system of assessing reading and math largely through multiple choice tests.

Educators acknowledged that schools are dominated by accountability, but the metrics do not indicate if learning has occurred. They wondered if neuroscience could provide a counterbalance against the often unreliable metrics that drive education and educational policy. Broadly, educators would like to know some of the specific underpinnings of cognitive science that can be applied immediately, along with what neuroscience can tell them about how people learn.

Do brain images really measure things that are applicable to the classroom? Could researchers start in the trenches with the people who are teaching kids rather than starting with imaging?

In addition to questioning the emerging nature of the neurosciences, some educators felt that neurological research is bound by technologies, such as imaging, that measure brain impulses, structures, neural networks, and blood flow. Educators would like to know what technologies exist that are able to measure the outcomes of applied research in the classroom. Such measurements, it was suggested, might be useful in teaching students social-emotional skills, such as self-regulation and attention to task. An almost universal question among the roundtables was whether fMRI scanning reveals patterns of brain activity that are characteristic of certain experiences and generalizable for larger populations.

Some of the participants who heard Dr. Kurt Fischer from Harvard speak at the event the day before the summit spoke of the research schools he has instituted. Dr. Fischer described how neuroscientists were working with teachers in a school setting to frame research questions and design studies. Participants wanted to suggest that this model be expanded to focus on the influence of the arts on student performance.

Translational research (having a neuroscientist alongside the teacher in the classroom) was discussed today; can we study this translational model to compare arts-integrated schools and non-arts-integrated schools?

Discussions across multiple roundtable groups touched on the notion of the "research school," where scientists and teachers collaborate to conduct research based on the real needs of the classroom. In this model, an educator would be a co-principal investigator along with the researcher, working collaboratively to craft the research question, determine the dependent and independent variables, and test the intervention of arts-integrated programs against control schools that are equally matched demographically but do not integrate the arts. Participants wondered how EEG or neuroimaging might enhance this type of study.

Does retention of learning objectives increase as a result of arts integration? What about long-term memory and the ability to apply learning?

The arts seem to be cross-modal, experiential, and emotional; how does that relate to memory? What happens at the brain level in skills-based learning versus experience-based learning?

COURTESY OF CLARE GRIZZARD

Art from a third grade student at Roland Park Elementary/Middle School, Baltimore

What's happening when students are engaging in multi-sensory learning versus more traditional learning activities?

Anecdotally, educators discussed how retention of content seemed to increase when teachers used the arts to teach and reinforce learning objectives across multiple content areas. They speculated that, like the EEG creativity studies, when students are engaged in artful activities, more neural networks would be engaged than in learning during traditional rote tasks. The participants were also very curious about how the arts influence long-term memory and how that could be studied. Would measurements of curriculum-based assessments, along with measures of brain activity, inform the field? Are we able to measure long-term memory systems versus working memory systems through imaging?

If the arts evoke emotion, then there would seem to be activity in the limbic system as well as the frontal lobe. How far along is the research community in being able to map how input, which in this case is arts-infused learning, changes brain structures to result in lasting memories? Participants discussed the phenomena of flash-bulb memories that are created by sudden emotional events. These memories usually last a lifetime. Yet many people often say that when they were involved in some art form or hands-on activity in school, their memory was akin to a flash-bulb memory. For example, people often remember when they participated in a play in school, or built a science project, or attended a concert. They don't typically remember the quizzes they took or the worksheets they completed. If arts-infused learning does produce more lasting memory for content, skills, and concepts, that would be a powerful impetus for complete change in how we teach and what we measure in schools.

Such arts-infused experiences often occur in the home, yet most parents do not have a basic understanding of the potential impact of the arts on cognition, social-emotional development, executive function, or memory development. "Many parents resort to the 'because I said so' school of parenting because they don't have the answer to why the arts matter" said one educator. "It might seem like the right thing to do, but parents need to know why." Whether it is encouraging a child to practice a musical instrument or paint a picture, understanding this information will influence how parents support and guide their children's artistic decisions.

Are museums important places for providing subject matter or interactions that promote the most learning and brain development? We should observe children in museums (and other less structured environments) and develop methods of quantifying their learning.

Looking at learning in out-of-school contexts seemed important to participants. Assessing how museum experiences contribute to learning, memory, and attention could be in the domain of cognitive scientists as well as educational researchers. Because of the

constraints of conducting studies within the school day, looking at after-school and museum experiences as a way to assess the power of the arts seemed to be a popular notion among the participants.

In an activity like creative writing, what happens to the brain as students use words and metaphors to engage in something outside themselves? How are different parts of the brain engaged?

Participants wanted more research focused on creative writing, drama, and the visual arts. A good deal of the morning discussion (the research panel) focused on music; they wondered if music is used because its effects are more easily quantifiable. They also wanted to see a comparison of what happens in students' brains when they are engaged in a kinesthetic learning activity versus a computer activity to engage the same subject matter. When should kinesthetic activity be used to enhance the learning process?

What is different in the brain when children with learning disabilities approach a reading task completely differently—either from whole to details or from details to whole? What's happening in the brain, and what are the implications for how to teach these types of children?

Dr. Spelke's presentation on the spatial/temporal perceptual abilities of infants resounded in the roundtables. It raised an important question about the timing and timeliness of intervention, and spurred other questions about the presence and duration of certain skills and abilities in the lives of children.

It was noted that the hardwired propensity for the arts during the early grades is extinguished in the middle-school years. Educators wondered if this loss of connectivity in middle school was the reason for the lack of transfer of skills learned in the arts to other academic domains.

Yet again, there was a call for the scientists to provide something concrete that teachers can use. For many educators, the implications of brain research (as presented in the research panel and elsewhere) were unclear. We know that students who practice music have different brain images, but is that good? What is the value to the student; what is the ultimate desirable outcome? High-level neuroscientific researchers should come up with a practical tool kit and create opportunities for interacting with schools to practice and implement the ideas put forth in the research.

3. The arts as an agent for behavioral change

This category comprises a discussion of the most important outcomes to consider as we evaluate the effectiveness of an arts-inclusive curriculum. Dialogue focused on assessing the effects of creative engagement on emotional and social developmental stages and the teacher's role at every level. Areas in which improved outcomes were discussed at many roundtable discussions included attendance; student and teacher engagement; attention; emotional involvement; heightened sensory perception; transferable skills, especially analytical and creative problem solving; and students' perceptions of patterns across disciplines.

Is it possible to follow students who had arts integration in the early grades throughout high school?

Is there a certain age or age group when exposure to music or other art forms produces the best outcomes with regard to learning development?

Much of the discussion at the summit focused on younger children. What about high-school students? Is it too late to help them? Do specific arts disciplines (e.g., instrumental music) offer greater potential in the later years?

The effects of arts-based curricula as they relate to age or developmental stages were persistent topics. Chronological limits to brain plasticity and the optimal time for exposure to certain arts forms were also discussed. At one extreme, there were issues of early childhood and the value of creative play in the early-childhood classroom. The importance of this issue is underscored both by the recent focus on academic objectives in early-childhood classrooms and the role of early-childhood teachers in children's play. At the other extreme was the question of whether an arts-based curriculum in high school might come too late to impact a child's learning.

How do the arts help students become more socially active and less self-involved?

I'm interested in how and why students who participate in the dramatic arts score higher in social development. How could you create a controlled study situation for students doing drama?

I'd like to see more research on what we as teachers can do to develop empathy through the arts. A big part of this is teacher education: how do we know the best methods to get teachers to engage with students?

What is the role of the arts beyond improving academic performance? How can the arts be used to foster creativity?

Social and emotional skill building is essential for meaningful, deep learning. Brain research shows that memory is impacted by social and emotional situations; they are integral parts of large units of memory that comprise what we learn and retain. As schools look to the arts to support social and emotional learning (SEL), they can provide conditions that allow for deeper engagement in the learning process.

Because arts education involves personal agency, divergent thinking, activities that promote social interaction and collaboration, and metacognitive activities, even the most at-risk students find a setting and language of expression that allows them to learn. Participants in the discussion defined the characteristics of emotional and social development that they felt could be encouraged through the arts and perhaps tested through research: self-management, problem solving and decision making, self respect, honesty, motivation to work, non-linguistic communication, respect for property, and awareness of social norms and responsibility. In addition, anecdotal reports of the effects of the arts on creativity were abundant, but experienced educators wanted a much more stringent analysis of what we know about creativity and how it can be fostered before ascribing causes.

Educators, policy makers, and researchers also agree that bringing parents into this conversation has the potential to change children's skills, attitudes, behavior, and outcomes (some of this is already happening through back-to-school arts nights, portfolio assessments, free museum admission, and access to other cultural arts programs).

Many of the roundtable participants were interested in using theater to promote empathy in students. Theater is highly collaborative and encourages the kinds of habits of mind associated with highly developed thinking. Role-playing promotes taking on multiple perspectives and engenders genuine open-mindedness; it facilitates construction of more fully elaborated and unique problem-solving models, and it encourages cognitive and personal flexibility.

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Brian Wandell (Stanford), Jeffrey Sharkey (director, Peabody Institute), and Nancy Grasmick (Maryland state superintendent of schools) at the roundtable discussions.

How can teachers of students with attention difficulties be taught to be more creative in practice?

Would it be possible to study the cognitive abilities of exceptional learners through fMRI imaging and compare these results to the same abilities as measured psychometrically and with standardized achievement tests?

Language and communication are often limited in students with autism, but we can tell if a student is engaged through movement. We'd like to see research about the age at which autism is diagnosed or reveals itself, and the effect of the arts on educational, creative, and social development.

I work in a multilingual school where 20 percent of the students have learning disability issues. Where is the research on how to improve learning for these students?

Of particular interest to many roundtable participants was the effectiveness of the arts-integrated curriculum for increasing and improving learning among students from special populations. This group included special-needs and special-education students, students who speak English as a second language, and students in disadvantaged environments. Many commented on the need for new directions for training, especially for teachers of low-income children. They suggested that arts-based teaching and SEL were strongly indicated as an important area for research.

Roundtable participants homed in on the potential effectiveness of different ways to present the arts to various groups of students. They wanted to know what could be learned by comparing special-education students' exposure to art through alternative methods with regular-education students' exposure to art through traditional methods.

In *Critical Links*, a research compendium of 64 studies published by the Arts Education Partnership, Deasy states that the influence of the arts may be greater on the academic learning for special-needs students, such as those with disabilities, living in poverty, and learning English as a second language, than for the general population of students. For example, for children with autism who lack impulsivity control or have language difficulties, music and movement seems to break through some communication barriers.

One teacher stated, "I've observed that impulsivity goes down when students are engaged in hands-on activities. For example, when students engage in a weaving activity they stay focused, chaos is reduced, and students talk nicely to each other. We need more information about the connections between creativity and impulsivity. What are the critical components of arts exercises that decrease impulsivity?"

4. The arts as impetus for engagement

Engagement is certainly an outcome of the arts, and it suggests a transcendent experience that frees the child from inhibiting norms and allows for self-expression.

Pedagogical best practices become better when they adopt a component of self-expression. Can we identify the resulting benefits in terms of improved student engagement, improved behavior, and more active learning outside the arts? Can neuroscience suggest the mechanisms related to these improvements?

Is there any way to measure the effect of an interest in the arts on attention? What is the relationship between concentration in the arts and concentration in other activities or subjects? How can we measure or evaluate the correlation between focus and attention and the outcomes?

Participants were keenly interested in Dr. Posner's work on attention, and wanted to know how his research could be expanded to measure the effects of arts integration on attending behaviors in the classroom.

A roundtable discussion group brought up the point that while it can be argued that arts training increases attention, attention training does it more quickly. The arts may not be as good at improving attention as explicit attention training, but the arts also help with self-expression, collaborative ability, and many other things. The arts give meaning to content, which leads to student engagement, motivation, and success. If studies show that the arts can assist in engagement with other learning tasks, teaching methodologies would be greatly informed.

We haven't talked enough about how children's learning styles and natural intelligences may predispose them to benefit from exposure to the arts. Given the iterative discipline that is intrinsic to artistic practice, will children who lack strong natural intelligence or a specific learning style reap the expected benefits?

How do teachers engage students who are not artistically inclined?

Some leading cognitive scientists are now saying that while students may prefer one mode of processing over another, little evidence exists that teaching to that style is particularly effective. Yet teachers are told that they are supposed to adjust

lessons to teach the visual learner, the auditory learner, or the kinesthetic learner. It appears that students are more alike than different in terms of how they learn. Given that, participants discussed that rather than focusing on one learning style over another, perhaps the focus becomes teaching with the arts, which would be a great way to infuse all modalities at once. It seems that this is more efficacious than trying to pinpoint how one student likes to learn versus how his peer likes to learn.

When discussing the engagement of students who are not artistically inclined, participants felt that given proper support and non-evaluative activities, all children can find some degree of success while participating in the arts. The focus, however, must be on the process and not the product.

What methodologies from arts integration help special-needs students, like those with ADHD, stay focused?

As the roundtable participants focused on how the arts might affect attention, often the discussion led to how the arts might address strategies for helping children with ADHD. Participants felt that more research on this topic would be helpful to all educators and parents. If students are more engaged when they are learning through an arts-based teaching style, as many teachers believe, then school practices must reflect this style of teaching. Yet, without empirical evidence, this could just be another neuro-myth that teachers buy into because they are desperate for answers.

5. The need for evolved skills

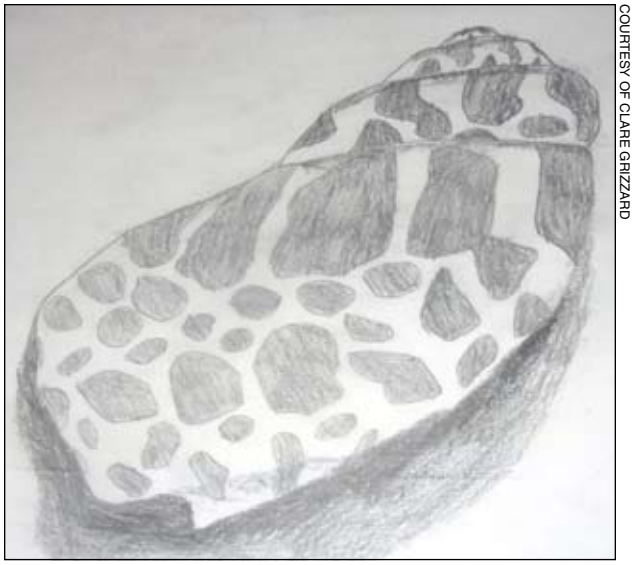
There was much talk about the 21st-century skills that students need, that the business world requires, and that the nation demands. These skills need to be better defined to further their promotion and development through an arts-integrated curriculum. The roundtable discussions made clear that skill development is required on multiple fronts: students must learn more creative ways to solve problems, and they must also retain what they learn and apply it to different subjects; educators must revise curricula and methodologies to encourage a new kind of learning; and the training of educators must change to inculcate revised pedagogical models.

Many roundtable participants were stymied by this issue, as it invokes fundamental change on many different levels. Such a curricular revision involves huge amounts of research and the discovery of new knowledge. It invites the participation of neuroscience without a clear view of shared responsibility. Neuroeducational research is widely perceived as a divining rod that can identify, record, and make judgments about brain activity, but by itself neuroscience cannot be held responsible for prescribing environments that trigger creative learning. The challenge of defining creativity and incorporating it into teaching and the training of teachers are not problems that can be laid at the doorstep of neuroscience.

The times are changing. A whole new set of benchmarks is on the horizon, and it's obvious that the arts will have to be included. Teachers will have to be more than conveyors of content; they will also have to demonstrate manners of thinking and problem solving.

When you take away the valuing of the art or arts-integrated product and focus on the relevance of the project or process, what does that do for the classroom community? Does the framework of our assessment reach the differing levels of understanding that may exist in a heterogeneous classroom?

The educators asked about a new structure of assessment in response to an arts-based curriculum that



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Art from a third grade student at Roland Park Elementary/Middle School, Baltimore

fairly evaluates growth and sustained effort rather than grading a finished product. They wanted assessments and training that moved beyond measuring the end product and instead looked at the process of meaning making. The arts allow for process and performance portfolios. Benchmarks of growth along the way—like reflection, dispositional thinking, and revision—are valuable assessment points for gauging understanding. Professional development must be robust in addressing the process-versus-product approach.

How do we teach arts learning to pre-service educators?

Art educators at the summit offered comments like the following that reflected a marked change in the pedagogy of arts education: "We can no longer just teach processes and skills. The 21st-century classroom is a laboratory for the creation of intellectual content where teachers are actively promoting higher-level thinking."

Art educators defined new goals that move away from elements and principles of the art form to a discipline-centered inquiry, where knowledge is constructed by students and teaching and learning must connect with the world beyond the classroom. The implementation of creative expression and imagination into the general curriculum was agreed upon as a primary objective. The real question becomes, how do we impact teacher-preparation programs? The answer was to begin with professional development through conferences and arts organizations. Schools of higher education would need to buy into and promote this new way of educating teachers. Policy change may need to be the driving factor that starts the change process.

Are any professional-development programs incorporating arts-integrated curricula and current brain-science findings?

How do you train teachers to invest in an arts-integrated program?

Educators felt that there was not enough translation of knowledge in the brain sciences into accessible language for teacher training. General-education training programs do not routinely include the pedagogy of arts education that would help bridge the gap between the two fields. Art educators are taught that through planning, collaboration, and specific strategies, teachers can encourage all students in creative expression and critical response. Several educators mentioned the Brain-Targeted Teaching Model, which provides an effective instructional model for teacher planning that connects the fields of brain science and education.

Many classroom teachers feel intimidated when asked to integrate the arts. It is critical that arts-integration programs provide training for all those

involved. A story was shared by one of the panelists about how an arts-integrated program was unsuccessful at first because of lack of training and lack of expectations and goals. Once those were established, the school was transformed by arts integration. A well thought-out program, initial training, and constant evaluation and refinement are key components for teaching with the arts.

Arts integration is extremely beneficial and valuable but hard to do well on a consistent basis. Are there methods that allow children to maintain knowledge over a longer period of time? What is the long-term effect of using the arts versus not using the arts?

Where does change on such a massive scale begin? An educator pointed out that the model of higher education will have to change. It seems inevitable that higher education will require input from multiple sources, including neuroscience, to reinvent itself. Once we have better defined arts learning and adapted it and tested it across the curriculum in partnership with neuroeducation researchers, the designers of educational theory will have the evidence by which to guide practice.

Roundtable participants cited the need for tool kits. Sometimes this referred to compilations of neuroscientific research and learning that could be applied directly in the classroom. At other times it referred to teaching methodologies informed by arts education. We also need to use the resources we already have more wisely. One possibility is the current thinking about the unified curriculum, through which different disciplines are combined to teach students. Since there are some schools that have been recognized for expertise in arts integration (see page 63), having a synthesis of best practices would be helpful, followed by robust training programs.

6. The need for communication

Impact, understanding, and ultimate internalization of content are very difficult communications goals to obtain. These goals are especially difficult when one is attempting to communicate with a wide variety of constituencies, including policy makers, educators, researchers, advocates, administrators, and parents. Who needs to know what, and who needs to know what first? Roundtable participants were not shy about establishing priorities for information dissemination:

1. Understand one another's expertise, processes, and terminology.
2. Create and use a common, agreed upon, and well-defined language.
3. Determine what is already known by educators, education school faculty, neuroscientists, artists, and arts advocates, and make this knowledge available across disciplines.
4. Keep parents abreast of arts-integration strategies. For too long, parents have felt they have not had a strong voice in this growing and important conversation. They have not been partners with researchers or educators to better understand what is known or to help shape new research and practices. Roundtable participants expressed a strong belief that while the issues of communicating to parents and families are difficult, it is essential to the long-term growth and healthy development of children.
5. Create new, consistent communication channels through which to share knowledge about the arts and learning and to ask questions about what we don't know. This forum should be developed for multiple audiences, including researchers, educators, and parents. This triad is critical. Researchers must better understand the classroom.

Educators need to share what is working and ask questions about what they need to better understand. Parents need to have a basic working knowledge of learning and how the arts can enhance cognition so they can understand and reinforce what is happening at school and develop simple strategies to use at home.

6. Expand professional-development opportunities, including university certificate programs, at which researchers are part of the conversations.
7. Expand programs like the Learning and the Brain and International Mind, Brain, and Education Society conferences where there are opportunities to discuss content and share new ideas.
8. Capture hard data about arts learning in the classroom—developed in collaboration with educators and brain researchers—and systematically put it into the hands of administrators, school boards, delegates, representatives, and arts advocates to inform policy decisions. Develop relationships with members of the legislature for hearings and briefings.
9. Initiate longer-term studies that will fuel sustained interest in this subject, generate further research, and involve broader audiences of stakeholders.
10. Communicate consistently with members of the academic, professional, and mainstream media about learning and the arts.
11. Work with schools of education, public health, and social work across the country to integrate the arts and learning into course work.

Today we discussed only school, ignoring the third domain—home. How do we galvanize parents' interest?

Educators have done a very poor job of explaining to parents how children learn in general, let alone how the arts might be an important aspect of cognitive, social, and emotional development. While bookshelves are full of parenting books about special needs, ADHD, bullying, and other problems, there are few texts for parents who want to understand how their child learns and how they can provide support. Parents are mostly kept out of the educational system.

Teachers, schools, and school districts need to bring families up to speed on the importance of arts and learning; parents must be convinced on their own terms to incorporate the arts, especially through creative examples and experiences. For example, invite parents to a hands-on lesson on the Civil War rather than to a classroom observation. Make the holiday concert a sing-a-long. Invite national experts to talk about creativity, imagination, 21st-century skills, collaboration, and teamwork. Bring artists, educators, children, and researchers together for a day of arts and play. These social and educational events are opportunities to show why the arts matter. Like their children, parents don't all learn the same way; it will require different strategies and multiple events to begin to see parents change their attitudes and behavior.

Start an online newsletter that shares the arts and learning accomplishments of the school. Research has shown that when people in authority believe in an idea and consistently share it with others, attitudes begin to shift. Schools and staff committed to arts education are the best advocates for getting the word out and changing opinions. Share the research, but do it in ways that can be easily grasped.

Several initiatives were shared at the summit that showed promise in bringing parents into the conversation on a national level. One project taking shape to bring together families, educators, and researchers is a communications internet portal called *Learn.* Being created through a consortium of institutions including The Johns Hopkins University School of Education, Harvard

University's Mind, Brain, and Education program, Temple University's CiRCLE program (Center for Reimaging Children's Learning and Education), the International Mind, Brain, and Education Society, and the Bloomberg School of Public Health, *Learn* will apply the science of learning to topics such as arts, play, stress, and more, plus share practical applications and allow for ongoing communications.

The Ultimate Block Party: The Arts and Science of Play is another example of bringing the science of arts and learning to communities, families, parents and educators. Scheduled in the fall of 2010, this Central Park-hosted event marries arts, play, and learning. The Ultimate Block Party will reach more than one million American families with strong messages about the value and science of the arts and play.

Several schools were cited for their proven achievement in arts integration: Italian schools in Reggio Emilia; the Lab School of Washington; the Baltimore Lab School; A+ Schools in North Carolina and Oklahoma; Chicago Arts Partnerships; Big Thought in Dallas; and Montgomery County, Maryland Arts Integration Schools. What can we learn from what they're already doing that works?

There was broad concern among roundtable participants that due to lack of communication, we are reinventing too many wheels. How much are we, in fact, reinventing? In terms of the practice of arts integration, why not investigate examples like the schools listed above and begin to develop a blueprint of best practices? What are they doing that works, and why are they doing it better? What is generally applicable to all schools? Are neuroscientific findings being brought to bear and, if so, how? Are there insights about creativity that have yet to become common knowledge?

Participants noted that there is a tremendous amount of information that is not being shared, and some of the information that is being shared is inaccurate. What is needed is an accessible, user-friendly communications portal that enables stakeholders to learn about what is happening at other schools and what researchers are studying. There also needs to be a way for different audiences to communicate with each other to share and learn.

How do we overcome translation problems to foster true interdisciplinary conversations? Academic journals contain research data and analysis but very little application to practice.

How do you take the research that has already been published and do a full-court press? How do we get education policy makers' attention and bring the importance of creativity to the forefront of their minds?

Advocates want information, but how do we make it objective and persuasive?

We expect researchers to not only do excellent research, but to translate it for a variety of other audiences. This is fundamentally an unrealistic expectation. There are a few researchers who have the time or expertise to communicate effectively to a wide audience, including educators. One way to address this is to have researchers speak with educators and others to learn how to best present their research.

Short-term correlations between pedagogical cause and neurological effect are often provocative, but there needs to be more information about how to effectively use this information.

For broader change in education practice and policy, scientific advances about learning must be examined, tested, and sanctioned by institutions that train teachers. This sort of legitimization will build credibility and confidence and generate momentum that reaches up to the legislatures and down to the classrooms.

Many universities are adding courses to their programs that help scientists do a better job of communicating to a variety of audiences. In addition, a growing number of journalism programs now teach education and science writing.

Roundtable Participants' Ideas for Future Research Studies

A major goal of the summit was to bring researchers, educators, and stakeholders together to frame research questions and determine areas of research that would be relevant to educators and possible for researchers to test. The entries below demonstrate a sampling of potential research drawn from discussions of the roundtable participants:

Sample Study #1

fMRI can help assess the creative act. Much of the discussion at the summit emphasized the potential of the arts to inspire creativity. It is just as plausible that solving math problems may have the same effect.

- What can you do to foster a creative approach?
- Is it possible that students who are creative are not creative by accident, but know they have this ability and can apply it to more than one subject?
- What are the implications of this for meta-control and meta-awareness?

1. Sample testing populations would not be limited to children. For example, compare the brain activity of a math professor to that of a sculptor—each of whom engages in math and sculpting activities.
2. For students, test a math group, a cello group, and a visual-arts group and analyze/compare the brain activity of each group.

Sample Study #2

The fruits of interdisciplinary work are realized only through translation. Effective translation must serve three audiences: researchers, funders, and educational practitioners.

- What is the impact of an arts-based training tool kit that integrates neuroscientific cognitive research to improve an educator's ability to develop reading and language skills?
- What do we know from neuroscience that affects pedagogy?
- How can we create lines of communication between the research and arts-education communities in order to move significant findings from the lab to the classroom?

1. Define the tool kit.
2. Create and test a model for early integration.
3. Create, refine, and test a model for early-elementary students.

Sample Study #3

We should agree on what the desired 21st-century skills are, how best to develop them, and how to test for them.

The Partnership for 21st Century Skills has offered to help schools teach the skills that will "enable their students to compete in the global market."

Students in schools that integrate the arts into their curricula have higher achievement levels in the area of 21st-century skills than students in schools that do not.

- Can we design a randomized trial that tests the integration of the arts across certain content areas, such as science, social studies, math, and literature? Our dependent variables will include measures of creativity, acquisition of content knowledge on curriculum-based

assessments, the level of student engagement in learning tasks, and student satisfaction and self-confidence in learning.
- Can brain imaging add another dimension to this work?

1. Do a comparative study of all students in the first, fourth, and eighth grades at two demographically similar schools—one with arts integration and the other without.
2. Using standardized tests and the acquisition measures promoted by The Partnership for 21st Century Skills, research the differences in student achievement, acquisition of skills, and transfer of cognitive skills across the curriculum.
3. Test subjects every year for four years.

Sample Study #4

Are we a creativity-deprived nation?

Engaged, playful learning—as through the arts—prepares the brain to be more receptive to learning throughout life; this sort of learning should be integrated into current educational pedagogy.

- Neuroscientific research shows that brains have optimal malleability between birth and age six.
- The nation is moving toward an era of increased attention and resources dedicated to the learning experiences and needs of children in this age group.
- There is strong evidence that shows long-lasting gains and positive outcomes from appropriate and meaningful interventions with children in this age group.

1. Create a body of fMRI data for children 0-6 at play.
2. Study the effectiveness of playful learning for insight into creativity and how to foster it and the development of executive functioning.
3. Publish the findings to a broad audience.

Sample Study #5

Exceptional learners may exhibit inattention, poor executive functioning, or antisocial behavior.

Focusing on improvement in one skill area may improve not only that skill, but may also have positive repercussions for other areas of the students' lives.

We need research to back up what we know about how the arts stimulate children. We need to connect some of what is known in the neurological sciences with the practice of teaching, parenting, and learning.

- How does the integration of the arts across the curriculum with a population of low-performing eighth-grade students improve the students' reading growth?
- Can neurological analysis—on top of the arts-integrated activity—suggest which parts of the brain are involved?
- Will such an intervention result in higher standardized test scores, improved attendance, or lower dropout rates for these students?

1. Use a three-time-point model to test a group of eighth-grade remedial reading students. Pre-test; apply the split-half methodology for one semester, then re-test; swap groups and re-test.
2. Design factors to analyze the differences between more improvisational arts-integrated teaching versus standard (less student-created work) arts-integrated teaching.
3. Develop material to guide teachers and parents, with the understanding that this is not a graded activity.

Section 7

Implications for Policy and Practice

Part 1: A View from Science

By Guy McKhann, M.D.

The relationship between those in neuroscience and those in education historically has been somewhat edgy. Those in education would like to know what neuroscience can tell them in a practical way—what can help them in the classroom now. Those in neuroscience have little concept about what those in education would like to know. What questions are educators asking? What ideas or myths are out there that neuroscience might be able to clarify? Most importantly, those in neuroscience have little idea about the limitations involved in modifying a tightly controlled curriculum. Finally, it is apparent that the level of knowledge about the brain among educators, even by science teachers, is quite low.

All of this is starting to change now that several different groups have initiated interdisciplinary approaches to bringing educators and neuroscientists together. These include a discussion of K-12 education as part of the NIH *Blueprint for Neuroscience Research* in 2008; a conference on neuroeducation sponsored by the Society for Neuroscience in 2009; the summit, which is the basis for this report; and a recent discussion in a Decade of the Mind symposium in Germany.

From these discussions several concepts emerged:

1. There is a need for a source of reliable information for educators so they will have a place to ask their questions. Such questions may be readily answerable, but also might stimulate ideas for research.
2. There may be genetic factors that influence a child's reception to types of input—some to music, some to art, and some to dance.
3. Exposure to a type of input in the arts may have an effect by enhancing attention mechanisms. But could these mechanisms also be affected by other exposures? For example, is exposure to music having specific effects? Or is playing a computer game doing the same thing?

Does exposure to the arts change the structure of the brain?

Previous studies have suggested that the structure of the brain is different in accomplished musicians

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Guy McKhann, M.D.

than in non-musicians, particularly in the corpus callosum. (See Dr. Gottfried Schlaug on this topic, chapter three.) What these previous studies could not determine was whether the "musician brain" had always been different or whether the differences were acquired. The longitudinal studies of Dr. Schlaug and Dr. Winner started with children whose brains looked the same, and indicate that exposure to music is associated with changes in the brain. This is the first indication from a prospective study that music induces specific brain changes.

One should not underestimate how difficult these types of longitudinal, controlled studies are to do. Ideally one would recruit a pool of subjects and then randomly assign a group to exposure to music and another group to some other, non-music exposure. From a practical point of view, such a study would be impossible to perform over a longer period of time. How many mothers are going to sit still while an investigator tells them their kids can't take music lessons or have music in school? Schlaug and Winner did the next best thing; they recruited a group already planning to take music, and then recruited a control group. Fortunately, the brains were all the same at baseline, or the studies would be uninterpretable. As more sophisticated forms of imaging are used, as discussed by Dr. Wandell, the specificity of the effects of music, or other arts, may be more precisely defined.

Does music acquisition enhance performance in other cognitive areas?

This is the major question that this research would like to answer. Investigators use terms such as near transfer and far transfer. Near transfer applies to skills that are an integral part of music training, such as finger dexterity or rhythm discrimination. Clearly there are near-transfer effects.

One possible near-transfer effect is enhanced attention. Attention, however, is a complicated area. Music may positively affect attention mechanisms, but so may other activities, such as computer games. Any proposed effects of music must be evaluated within the concept of the question, "Compared to what?" In the next phase of studies of the effects of the arts on the developing brain, choice of control groups might include kids spending equal time on computers as other kids do with their musical instruments. How you keep kids from doing both, I leave to the investigators and parents, and not to grandparents like me.

Far transfer is where many of the unsubstantiated claims lie. The studies to date suggest that transfer may occur in mathematics, as outlined by Dr. Spelke, but only in specific mathematical functions associated with spatial performance. The other

aspect of Dr. Spelke's work relates to how early these effects of music may occur, possibly indicating to educators that preschool or early school exposures to music and other arts may be more important than previously thought.

But possibly not for all children. The studies of Dr. Posner suggest what many parents already know—some kids respond to music and others to visual arts. Determining how to sort these kids out at an early age, possibly by genetic testing rather than cognitive performance, may set the stage for the education of the future.

Where are we?

The studies of the Winner/Schlaug group and of Spelke indicate the feasibility of controlled studies over time. It is not clear that such studies can be performed within the educational system. Perhaps comparing one school to another is more likely. Pilot projects within a school system are another possibility. The emphasis needs to be on improving education and not "experimenting with our kids."

How to move forward is the next challenge!

Part 2: A View from Education

By Mariale Hardiman, Ed.D.

As we consider next steps and implications for the information disseminated at the summit, it is important to consider exactly *which* implications we want to address. As the summit revealed, the answer is not so simple.

At the highest level, we are talking about the implications of collaboration among cognitive scientists, neuroscientists, educators, applied researchers, and faculty from schools of education. Critical input will also come from artists, arts educators, and advocates of the arts who have already built a strong case for applying methodologies that make the process of education more engaging and effective.

Collaboration is the big-picture objective, but what exactly do we expect this collaboration to yield? And how will it work?

As we heard again and again at the summit, educators are seeking research that sheds light on how children learn translated in ways that are relevant and useful in authentic school settings.

What are the requisite conditions of this collaboration? Researchers must understand how teachers teach and which measurements are most useful. Teachers need to understand what research currently can deliver and how to frame the demands they make on it. Arts educators and proponents of arts integration should codify the meaning of arts learning so that teachers in other disciplines understand its benefits and are more prepared to accept and use it. Universities that train teachers, provide in-service professional development, and develop new curriculum models need to understand their key role: higher education won't bear this burden alone, but it should be a leader in redefining the standards of success.

Underlying all these conditions is the need for communication to engage parents, families, school boards, legislators, and others who determine educational policy.

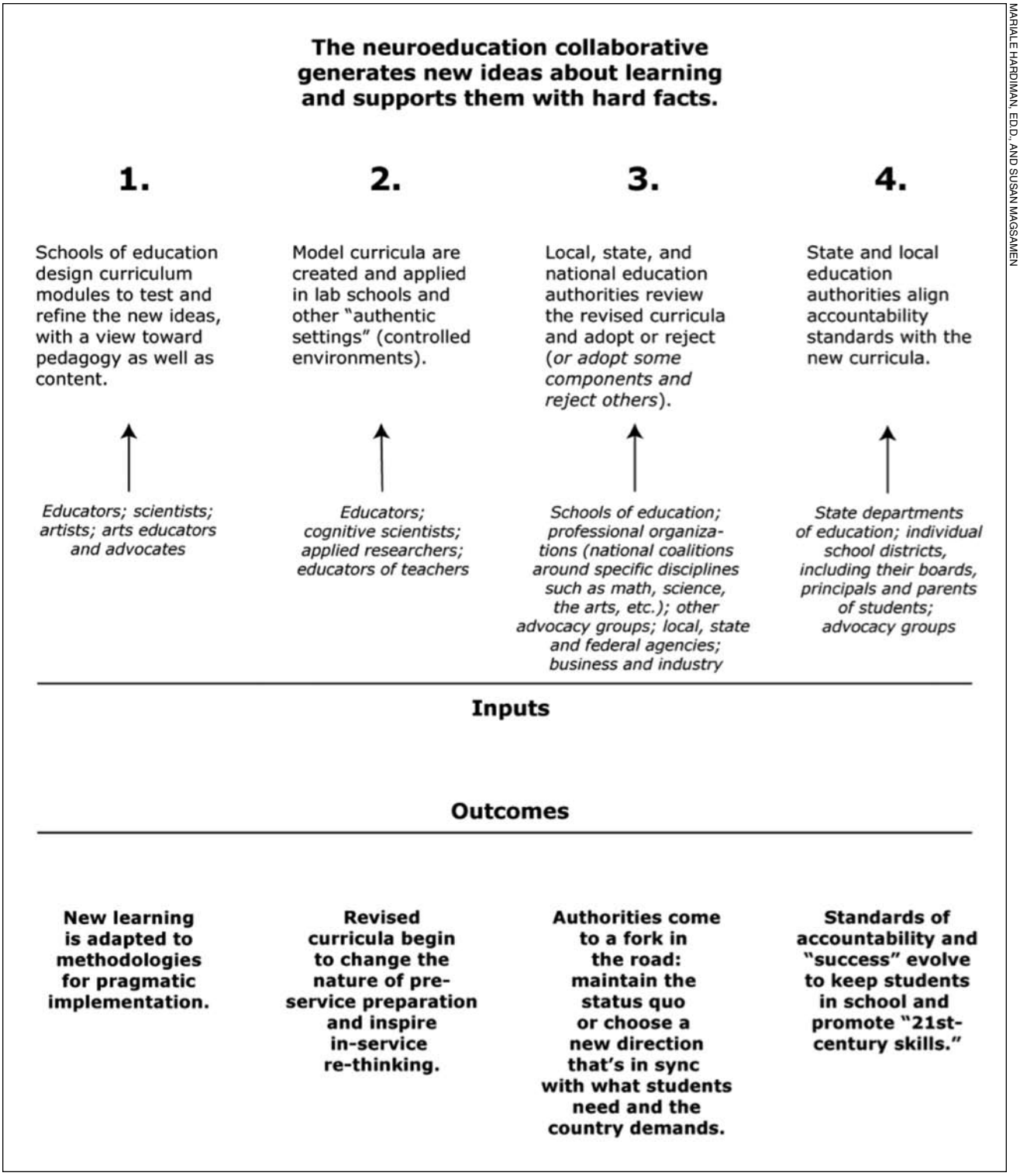
Now What?

Improving instructional quality is the ultimate objective of the collaboration between the education and scientific communities. We believe that it is critical to begin this collaboration through the emerging field of neuroeducation and organize it as a discrete field of study.

The already emerging field of neuroeducation will explore how children learn and what practices and interventions promote and sustain the learning process.

Neuroeducation is the collaborative discovery and application of new knowledge to:

- More effectively engage students in content and the process of acquiring and retaining content
- Explore the benefits of arts-based learning and recommend strategies for its inclusion in the classroom and across the curriculum
- Design instructional strategies that imbue the learning experience with greater meaning and purpose, and equip students with a more diverse set of skills
- Train new teachers to leverage the new knowledge and new curricula, and inspire experienced educators to employ new methodologies for engaging their students



MARIALE HARDIMAN, ED.D., AND SUSAN MAGSAMEN

Figure 7-1

- Create new benchmarks for how we define the success of our schools and students by moving beyond the narrow lens of math and reading scores.

Accomplishing this objective will take time. Building the field of neuroeducation is a hugely important task, but there is little agreement on how to proceed. Diverse professional and advocacy interests must align with the public's notion of effective education. And, as Howard Gardner has pointed out, there is no tradition of practice on which to base this movement.[14]

Educators will have to deal with extreme opinions about the relevance and utility of biological and cognitive research for pedagogy from both skeptics, who think there is none, to enthusiasts, who overstate and misinterpret the research.

Agents of Change: Who Will Get Us Where We Need To Be?

As students are the ultimate beneficiaries of this effort, educators are natural partners in neuroeducation. At the grassroots level, effective change will come from classroom teachers. They want to know how children learn, and how the new research they are hearing about can play out in the classroom.

To many educators, the question is not whether we should have arts in the classroom, but how the arts influence learning. How do the arts enhance attention and connect to content, and how do they create emotional connections? What is testable and what questions are educators asking that neuroscience has not yet developed the means for studying?

The purpose of this collaboration is not to justify having the arts in school. Teachers are intrigued by the reported neurological phenomena, but they're really interested in the potential for realizing pragmatic outcomes. Educators who already know that the arts make students more creative learners do not need research explaining why. But neuroscience does add a level of confirmation. Scientific evidence on the influence of arts-based learning will add new dimensions to educational practices and policies.

Most educators are aware that curriculum changes come about through revised perceptions, programs of accountability, and the demand for specific skills. Research and teacher-training institutions have the potential to develop and test individual modules for sample grades and subjects. Testing will reveal if students respond to integrated methodologies—does their retention improve, and are they better at applying what they learn? Testing standards determine both curricula and instructional methodologies. Today, teaching is constrained due to the mushrooming burden of prescribed content and accountability, which is largely misaligned with real workforce needs.

Summit participants frequently mentioned the need for translation—getting from the lab to the classroom. Collaboration among multiple fields will be critical, with a focus on topics and problems rather than disciplines. Bringing together scientists and educators in lab schools and other forums will encourage a joint solution to problems that neither domain could answer alone.

Hinton and Fischer have already begun to create such teaching laboratories.[15] University-based researchers design and develop research in response to the practical needs of teachers; they test new methodologies, evaluate the effectiveness of interventions, and provide real-time opportunities for teacher development. Based on the medical-school model, researchers spend a residency period integrating theories about learning with practical applications in real classroom settings.

[14] Gardner, H. (2008). Quandaries for neuroeducation. *Mind, Brain, and Education, 2*(4), 165-169.

[15] Hinton, C., & Fischer, K.W. (2008). Research schools: Grounding research in educational practice. *Mind, Brain, and Education, 2*(4), 157-160.

At Johns Hopkins, through the School of Education's Neuro-Education Initiative and courses leading to its Mind, Brain, and Teaching certificate, scholars share knowledge from the brain sciences with educators to inform their teaching and identify the questions that will shape translation research in the future.

Such university programs, including the Mind, Brain, and Education degree at Harvard, will produce a new generation of scholars who will bridge the division between scientists and educators. These translational researchers will move beyond individual disciplines and approach learning from a more inclusive perspective—testing hypotheses in authentic settings, designing and evaluating best practices, and training educational practitioners.

Higher education will be a core driver of change, but not the only one. Leadership will also come from such organizations as the International Mind, Brain, and Education Society and the Society for Neuroscience, whose 2009 Presidential Initiative relates to the intersection of neuroscience and education. The National Institutes of Health has included in its *Blueprint for K-12 Efforts* an exploration of how to apply neuroscience to teaching and learning. The U.S. Department of Education has offered research grants to support the study of how the cognitive sciences apply to and promote student learning.

As neuroeducation takes shape and develops momentum, leaders must emerge to encourage dialogue and guide the collaboration, focusing strategically on improving four major components of the education system: teacher preparation, the curriculum, pedagogy, and school governance.

Wagging the Dog

We have outlined our view of what has to happen in education now, but this process will not be one of quick fixes.

Ironically, understanding what makes students better learners may remain disconnected from substantive changes in educational policy. Certainly educators will make incremental improvements in curricula and teaching methodologies, but real policy change has to do with repairing two fundamental breakdowns, the disconnect between what children can do and our expectations of them, the disparity between official accountability, and the clamor for more creative skills and abilities.

Educators can adjust to teaching to the test. But the preoccupation with limited measures has distracted them from a clear view of what they should expect and how best to measure real success. This should be the concern of educational policy; neuroeducation can help re-center the field of education.

In a recent seminar at The Johns Hopkins School of Education, Martha Bridge Denckla, M.D., of the Kennedy Krieger Institute and the Hopkins School of Medicine, shared with teachers her research and clinical experience in the area of executive function. She explained how children's brains develop, pointing out that educational practice is frequently inconsistent with students' cognitive development. Because of curricular demands, we start reading instruction in preschool and require that young adolescents take algebra before many are ready for conceptual thinking. The timetable for what we teach is often out of sync with what some students are ready to learn.[16]

Business and industry leaders say they need creative thinkers and problem-solvers, and they complain that U.S. schools are not delivering them. But policy makers are assessing an opposing set of skills: both our curricula and our pedagogy hold students and schools accountable for far-too-narrow achievement in quantitative and literacy abilities. There is obvious misalignment between what

[16] Hardiman, M. & Denckla, M. (in press). The science of education: Informing teaching and learning through the brain sciences. *Cerebrum*. Washington, DC: Dana Press.

workers need to be successful in the 21st century and how policy makers are holding schools accountable for effectiveness.

As educators have been slow to take the lead in defining success, politicians and policy advocates have done it for them. Given what we know today, can we continue to justify such an exclusive focus on reading and math? Or should we broaden the base of our expectations, and test accordingly?

Standardized tests are a sacred benchmark for evaluating schools and students. There is risk in changing the playing field and how we keep score, but if we know better we are obliged to use everything we know to change our practice and our policy.

T.S. Elliott once said, "Anything worth doing is at first impossible." Below is a model for how to make the impossible take root for the field of neuro-education, developed at Johns Hopkins University's Neuro-Education Initiative to begin to address the dynamics of multiple disciplines, domains of learning, and constituencies.

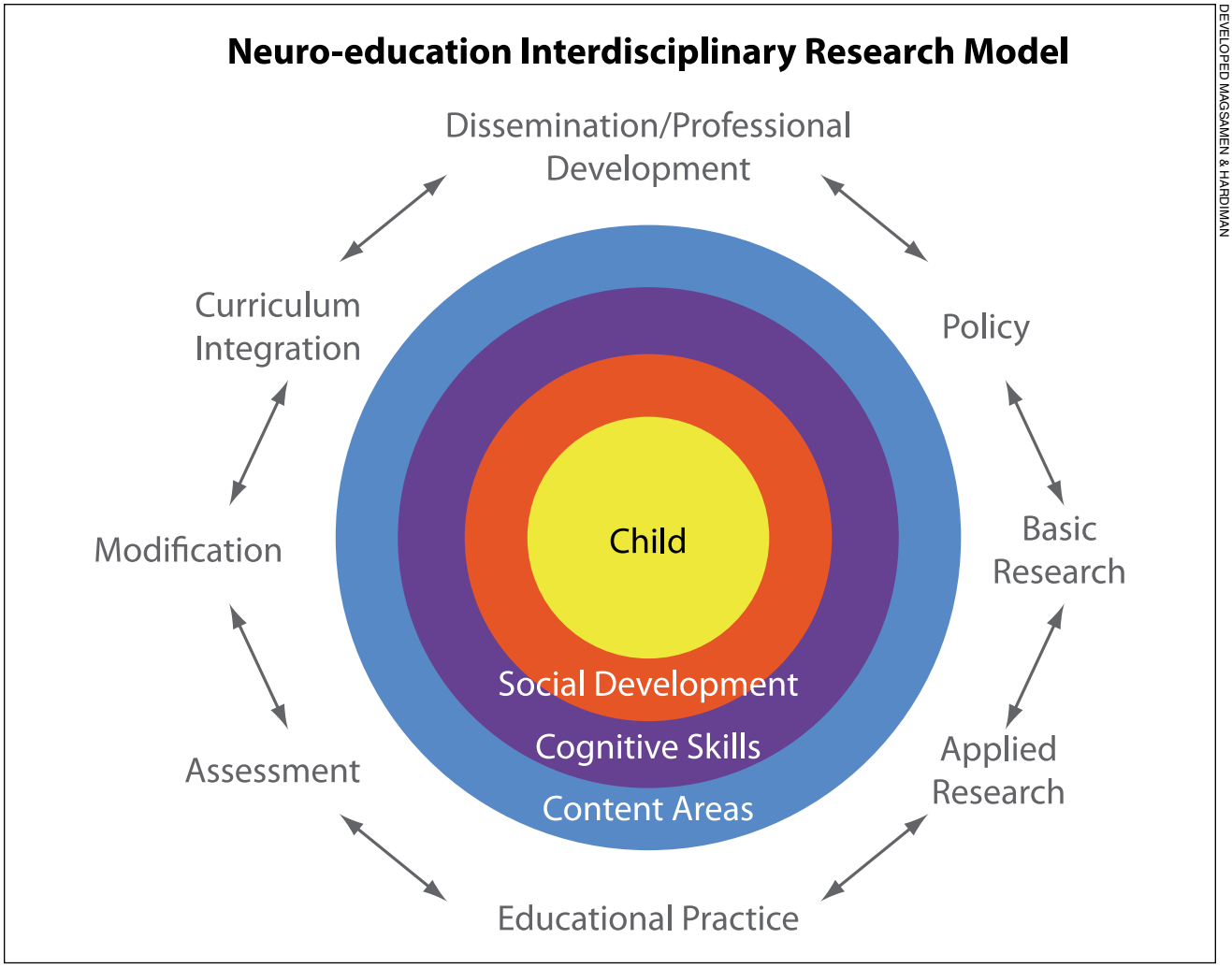


Figure 7-2

Part 3: A View from Arts Education

By Janet Eilber

"Arts, Creativity & Other Outrageous Education Ideas," a workshop for Maryland educators which preceded the Hopkins summit, provided an appropriate launch for the work of the next day. The afternoon's presentations and panel discussion gave the educators an inside look at diverse approaches to learning based on the arts and the creative process.

Presenters included Alice Wilder, Ed.D., creator and producer of a number of interactive television shows for young children, such as *Blue's Clues* and *Think it, Ink it*. Kathy Hirsh-Pasek talked about her book, *Celebrate the Scribble: Appreciating Children's Art*, and the importance of process and discovery for young minds, while Keri Smith, author, illustrator, and guerilla artist, presented a decidedly less conventional approach. Her books, *Wreck This Journal* and *Living out Loud – Activities to Fuel a Creative Life*, have inspired a devoted following of educators who use her techniques to engage students in middle and high school. The afternoon closed with John Tarnoff, an executive at DreamWorks Animation, who demonstrated how the process of developing an animated film offers a template for dynamic teaching and learning in other subjects.

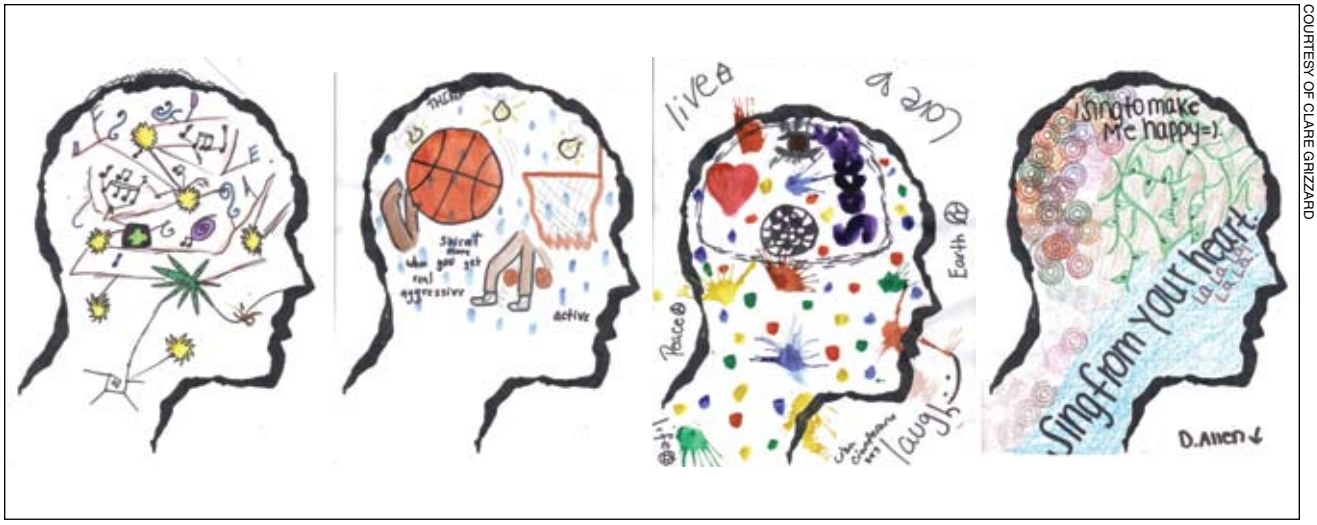
These approaches are just the tip of the iceberg when it comes to new teaching and learning methods using the arts. Arts-education advocates have always believed intuitively that the arts are a highly effective vehicle for improved learning, and scientists are now showing us how this intuition is supported by a growing body of serious brain research. The field is deeply involved in translating research findings into teaching practice; its wide array of curricula are being retroactively "vetted" as new findings in cognitive science emerge.

Neuroeducation advocates are now asking the "how" questions needed to launch this new field: How will this collaboration between scientists and educators work? How will we get these new ideas into the classroom and ultimately into the minds of students?

Arts education has been pro-active about its own "how" question (How can we get more arts learning into the schools?) since it lost ground in the late 1970s. The better strategies that have emerged for developing and disseminating research-based arts curricula will offer useful models to neuroeducators, but the field has also honed methods outside the classroom that neuroeducation advocates will need: for example, how to increase public awareness and support, and how to influence national and local educational policy.

By the turn of the millennium, most parents, policy makers, and school leaders no longer needed to be convinced of the value of arts education. Although there was a call for more "hard science" that initiated many of the studies reviewed at the Hopkins summit, there was also growing realization that success rested not only on the proof of research or the demonstration of best practices. More was needed. Arts education began to recognize the need for its own bridge between the science of learning and the practice of teaching.

Focus shifted to fostering new relationships with a much wider range of constituents, resources, and policies. Arts-education advocates looked for better ways to connect with all stakeholders, from helping classroom teachers by aligning



COURTESY OF CLARE GRIZZARD

Art from eighth grade students at Landon School in Bethesda, MD depicting "What Happens to the Brain When You Create."

arts-education curricula with state learning standards to creating support groups for principals and superintendents that help incorporate arts learning into the school day.

Arts-education advocates and organizations began creating better connections with higher education to improve arts training for pre-service classroom teachers. We worked with school systems to provide better professional development for teachers already in the classroom. We are pressing for stronger relationships between schools of education and schools of the arts, and for better tools for measuring the impact of arts learning so that the arts can be as accountable as other core subjects in schools.

In the last few years, this drive for more productive collaborations has led to projects that incorporate the views of all stakeholders at the earliest stages of the planning process. Listening to all voices—including the contrarian voice—has emerged as a rewarding strategy. For example, it has provided solid foundations for influential projects such as Arts for All, the ten-year plan to secure sequential arts learning in every K-12 classroom in Los Angeles County. On the national level, the Education Leaders Institute, created by the National Endowment for the Arts, brings together teams of diverse constituents from each state to hammer out new support for arts in the schools. Neuroeducation has already reaped the benefits of this technique. The Hopkins summit gave educators and scientists the rare opportunity to interact face to face. The ideas developed through this cross-pollination provide fertile ground for the next steps in the field.

This kind of activity has primed the landscape for neuroeducation. As the new field works to answer the question of "how" and to develop the bridge between the lab and the classroom, it will do well to take advantage of the resources already in place.

Arts education now offers a network of partners that are working with school systems and building a reputation for alternative learning processes. A growing body of arts-based curricula is accountable to the states' learning standards, supported by the findings coming out of neuroscience, and can provide models for new brain-based pedagogy. With cohesive advocacy efforts and a range of approaches

to education policy and reform, arts education stands ready to champion some of the basic elements needed for the brave new world of neuroeducation.

The summit at Hopkins this year, the unofficial launch of the new field of neuroeducation, underscored the ways that the arts can play a larger, more integrated role in what research is telling us about quality education, school improvement, and effective teaching methods. Arts education has orchestrated a shift in its reputation in recent years, from a special interest group to an important catalyst in helping children learn. As neuroeducation reframes the most essential questions of education, the arts are poised to help provide answers.

Learning, Arts, and the Brain Summit Agenda: May 6, 2009

Opening	Mariale Hardiman and Susan Magsamen, Neuro-Education Initiative
Welcome	Scott Zeger, Acting Provost; Michela Gallagher, Vice Provost; Ralph Fessler, Dean, School of Education
Overview	Guy McKhann, JHU School of Medicine
Gazzaniga Video	Ellen Galinsky, Family & Work Institute
Neuro-Education	Ken Kosik, Neuroscientist, Univ. of California at Santa Barbara

Researchers Panel

"Research in Arts and Cognition: Future Direction for the Research Community"

Opening remarks; panel moderator – William Safire, The Dana Foundation

Michael Posner, University of Oregon, *How Arts Training Influences Cognition*

Elizabeth Spelke, Harvard University, *Effects of Music Instruction on Developing Cognitive Systems at the Foundations of Mathematics and Science*

Brian Wandell, Stanford University, *Training in the Arts, Reading, and Brain Imaging*

Ellen Winner, Boston College, Gottfried Schlaug, Harvard University, *Music Training in Early Childhood Alters the Brain*

Lunch and Keynote Address By Jerome Kagan

Introduction of speaker by Martha Denckla, director, Developmental Cognitive Neurology, Kennedy Krieger Institute; professor of neurology, pediatrics, and psychiatry, JHU

Speaker: Jerome Kagan, Daniel and Amy Starch Professor of Psychology at Harvard University and former director of the Mind/Brain Behavior Interfaculty Initiative; author of *Galen's Prophecy: Temperament in Human Nature and Three Seductive Ideas.*

Educators' Panel

"Implication of Research for Educational Practice"

Opening remarks; panel moderator – Dick Deasy, past director, Arts Education Partnership

Sarah B. Cunningham, director, Arts Education, National Endowment for the Arts

Janet Eilber, director, Arts Education, The Dana Foundation

Mariale Hardiman, Johns Hopkins University, School of Education; past principal

Mary Ann Mears, Artist and Founder, Arts Education in Maryland Schools Alliance

Betty Morgan, superintendent of schools, Washington County

Roundtable Sessions

Each roundtable will include ten participants who represent the research community, classroom teachers, educational leaders, teacher educators, and policy makers. Each roundtable will include a facilitator to shape the discussions and a recorder to capture the dialogue. Facilitators will lead discussions pertaining to the agenda for future research. Discussions will be targeted to generate research questions and determine the best methods for high-quality research. Discussions will also focus on how potential findings could shape educational policy and practice.

Final Wrap-Up Session

Remarks from Nancy Grasmick, Maryland state superintendent of schools. Dick Deasy and Guy McKhann conduct the final session for summary discussion with roundtable participants and panelists.

About the Authors and Presenters

Sarah Bainter Cunningham, Ph.D., has been director of the National Endowment for the Arts' Division of Arts Education since September 2005. She provides national leadership in the field of arts education, directing leadership initiatives, the NEA Learning in the Arts grants program, and national initiatives, including Jazz in the Schools, Poetry Out Loud, and Shakespeare for A New Generation. Dr. Cunningham directs a number of leadership initiatives, including The Arts Education Partnership (a partnership with the U.S. Department of Education), SEADAE (the network of state education agency directors of arts education), SNAAP (the Strategic National Arts Alumni Project, spearheaded by Indiana University, Vanderbilt University, and the Surdna Foundation), and professional development for arts education managers at state arts agencies.

Dr. Cunningham has spearheaded the NEA Education Leaders Institute, a project to design public education with arts as a central feature of education reform. This project includes state leadership teams from 19 states, with teams composed of state superintendents, lieutenant governors, teaching artists, principals, business innovators, and others. In cooperation with WestEd, Dr. Cunningham leads the first collection of national data related to practices in arts assessment, examining student learning in schools, cultural organizations, and community centers. She also designed the NEA Big Read Teachers Guides and continues to serve as editor and writer.

The core NEA education investment remains grants to arts-education programs nationwide. Dr. Cunningham chairs the peer-panel process for the review of more than 500 applications and eight panels each year, resulting in over 200 grantees annually. In addition, Dr. Cunningham speaks and presents nationwide, and has served as government liaison to a number of task forces on arts education.

Richard Deasy is the recently retired director of the Arts Education Partnership (AEP), a coalition of over 100 education, arts, business, philanthropic, and government organizations that demonstrates and promotes the essential role of arts education in enabling all students to succeed in school, life, and work. Under his leadership, AEP published seminal research studies and reports that are credited with major advances in arts education in the United States. He commissioned and edited AEP's widely acclaimed compendium of research, *Critical Links: Learning in the Arts and Student Academic and Social Development*, and subsequently commissioned the research for and co-authored the resulting book *Third Space: When Learning Matters*, a study of the transformative effects of the arts in high poverty schools.

Upon his retirement from AEP in 2008, the National Endowment for the Arts, the U.S. Department of Education, the Council of Chief State School Officers, and the National Assembly of State Arts Agencies created The Richard J. Deasy Award for Partnership in Education and the Arts in his honor. The award will be presented annually to an individual who has significantly advanced arts education in America. Mr. Deasy was also presented with the NEA Chairman's Award for Distinguished Service to the American Public through contributions to the arts. Prior to his leadership of AEP, Mr. Deasy had been a senior state education official in Maryland and Pennsylvania, president and CEO of the National Council for International Visitors, and a prize-winning reporter on politics and government in Philadelphia and the surrounding metropolitan area. He was nominated for a Pulitzer Prize for reporting on slum housing conditions in suburban Philadelphia.

Janet Eilber has developed and overseen the Dana Foundation's support to and initiatives in arts education since 2000. Dana makes grants to organizations that train artists to teach the performing arts in public schools, and supports workshops, publications, and conferences that provide access to promising practices in the field. Ms. Eilber has contributed to two of Dana's arts-education books, oversees Dana's quarterly publication *Arts Education in the News*, and helped launch the Dana-supported research study on how the arts influence cognition.

Ms. Eilber became the artistic director of the Martha Graham Center of Contemporary Dance in 2005, providing artistic oversight to the three divisions of the Center: the Martha Graham Dance

Company, the Martha Graham School of Contemporary Dance, and Martha Graham Resources. Her role includes providing artistic direction to the famed dance company, sharing the works of Martha Graham with other arts and educational organizations, and exploring new partnerships and models that utilize the extraordinary collection from Graham's legacy.

Earlier in her career, Ms. Eilber had a close working relationship with Martha Graham. As principal dancer with the Martha Graham Dance Company, she soloed at the White House, was partnered by Rudolf Nureyev, and starred in three segments of *Dance in America*. She danced many of Graham's greatest roles, had roles created for her by Graham, and has since taught the Graham technique and directed Graham ballets internationally. Ms. Eilber has also performed in films, on television, and on Broadway, directed by such greats as Agnes deMille and Bob Fosse, and has received four Lester Horton Awards for her reconstruction and performance of seminal American modern dance. Ms. Eilber, a graduate of the Interlochen Arts Academy and the Juilliard School, is also a trustee of the Interlochen Center for the Arts.

Mariale Hardiman, Ed.D., joined the faculty of The Johns Hopkins University in 2006 as assistant dean of Urban School Partnerships and chair of the Department of Interdisciplinary Studies after serving in the Baltimore City public school system for more than 30 years. Under Dr. Hardiman's tenure as principal of Roland Park Elementary/Middle School, the school was designated a Blue Ribbon School of Excellence. While principal, Dr. Hardiman devised a teaching framework, The Brain-Targeted Teaching Model, which connects research-based effective instruction with elements from the brain sciences that can inform teaching and learning. A central feature of the model is the integration of the arts into content instruction.

Continuing her interest of bringing relevant findings from the brain sciences to educators, Dr. Hardiman collaborated with colleagues from across the university and community to develop the JHU School of Education's Neuro-Education Initiative, supported by the JHU Brain Science Institute. The Neuro-Education Initiative includes a new certificate in Mind, Brain, and Teaching, one of the few university programs in the country focusing on the science of learning.

Dr. Hardiman has also continued her interest in supporting urban educators by designing courses and professional development for

urban teachers and school leaders. Academic and professional development programs within the Department of Interdisciplinary Studies include STEM education, earth and space science, adult learning, out of school time learning, urban education, and the Baltimore City Leadership Academy.

Jerome Kagan, Ph.D., one of the key pioneers of developmental psychology, is Daniel and Amy Starch Research Professor of Psychology, Emeritus at Harvard University. Dr. Kagan has spent 45 years studying children and their development; his most recent work has been on temperaments in children. Dr. Kagan has shown that an infant's temperament is quite stable over time, in that certain behaviors in infancy are predictive of certain other behavior patterns in adolescence. Dr. Kagan is a member of the Institute of Medicine of the National Academy of Sciences and a fellow of the American Academy of Arts and Sciences. His most recent books are *The Three Cultures*, *What is Emotion*, *An Argument for Mind*, and *The Long Shadow of Temperament*.

Dr. Kagan was born in Newark, New Jersey. He earned a B.Sc. from Rutgers University, a master's degree from Harvard University, and a Ph.D. from Yale University. Dr. Kagan spent a year as an instructor in psychology at Ohio State University. Then, after two years as a psychologist at the U.S. Army Hospital at West Point, he did research in developmental psychology at Ohio's Fels Institute (1957-64) before beginning his career at Harvard University. Dr. Kagan has won the Hofheimer Prize of the American Psychiatric Association and the G. Stanley Hall Award of the American Psychological Association (APA), among many other honors.

Susan Magsamen is an award-winning writer and advisor on family and children's issues. Ms. Magsamen's work is widely recognized as fostering and enhancing the ways people learn, play, create, and grow as individuals, families, and communities. She is the co-founder of The Johns Hopkins School of Education Neuro-Education Initiative. She also developed and chaired the editorial and scientific advisory council for *Wondertime Magazine*, an award-winning monthly publication for families with an emphasis on child development.

Ms. Magsamen is the founder of FamilyStories, a multimedia resource featuring books, workshops, a Web site, and a radio series. She is also the creator of Curiosity Kits, supplemental educational activities that enable children to learn through multisensory experiences in the arts, sciences, and world cultures. Ms. Magsamen has developed successful partnerships and collaborations with many organizations, including Scholastic Inc., the National Geographic Society, Sylvan Learning Systems, the Public Broadcasting Company, the Discovery Channel, and The Walt Disney Company. Her body of work has earned hundreds of national awards and recognition from child-development experts and parenting associations, including Oppenheim Awards, Parents' Choice, Family Fun, and the National Association of Parenting Publications Awards.

Guy M. McKhann, M.D., is professor of neurology and neuroscience at The Johns Hopkins University. Dr. McKhann is the founding chairman of the department of neurology at the Johns Hopkins School of Medicine and also the founding director of The Zanvyl Krieger Mind/Brain Institute at The Johns Hopkins University. Dr. McKhann attended Harvard University and received his M.D. degree from Yale University School of Medicine. His most recent research has been in the cognitive and neurologic problems after heart surgery.

Dr. McKhann has authored over 200 publications. He is the co-editor of a successful neurology textbook, *Diseases of the Nervous System: Clinical Neurobiology*, which is in its third edition. He and his colleague (and wife) Marilyn Albert, Ph.D., have published a book about aging and the brain for the general public, *Keep Your Brain Young*. A noted teacher, he is the only person at Johns Hopkins to win awards for being the best teacher of medical students and the best teacher of college undergraduates.

Dr. McKhann has been involved with a number of scientific organizations. He is a past president of the American Neurological Association and an honorary member of the Royal Society of Physicians. He is currently the scientific advisor to the Dana Foundation. In addition to his work in this country, Dr. McKhann has been involved in research in China related to epidemics of a paralytic disease in children. He has also been an advisor to the Vatican on issues relating to the end of life, particularly brain death.

Mary Ann Mears is a sculptor who has been commissioned to create site-specific art for public sites across a number of states, including Florida, North Carolina, Michigan, Illinois, Connecticut, New York, and Washington, D.C. In her home state of Maryland, her commissioned works are located in Bethesda, Rockville, Cheverly, Belair, Glen Burnie, and at several locations in Baltimore. Her most recent major project, *Lotus Columns*, was just installed in Silver Spring.

Ms. Mears is also an arts advocate. Her achievements include being a founder of Maryland Art Place and helping to craft and successfully lobby for Maryland's public art bill. She is a trustee of Maryland Citizens for the Arts and the founder of Arts Education in Maryland Schools (AEMS) Alliance. Ms. Mears serves on the Maryland State Department of Education's Fine Arts Education Advisory Panel. She is the recipient of an honorary doctorate in the fine arts from University of Maryland, Baltimore County (UMBC).

Elizabeth M. Morgan, Ph.D., is currently the superintendent of the Washington County (MD) Public Schools, having served in the position since 2001. She is also very involved in the community, serving on the boards of directors of the Washington County Museum of Fine Arts, the Maryland Symphony Orchestra, the Hagerstown/Washington County Chamber of Commerce, and Pen Mar Development. Dr. Morgan is a member of the Greater Hagerstown Committee and the Hagerstown Rotary. She serves on the Governor's P-20 task force and was recently appointed by the Governor as a commissioner of Maryland Public Television.

Michael Posner, Ph.D., is professor emeritus at the University of Oregon and adjunct professor of psychology in psychiatry at the Weill Medical College of Cornell, where he served as founding director of the Sackler Institute. Dr. Posner is best known for his work with Marcus Raichle, M.D., on imaging the brain during cognitive tasks. He has also worked on the anatomy, circuitry, development, and genetics of three attentional networks underlying alertness, orientation to sensory events, and voluntary control of thoughts and ideas. Dr. Posner's methods for measuring these networks have been applied to a wide range of neurological, psychiatric, and developmental disorders and to normal development and school performance. His current research involves a longitudinal study of young children designed to understand the interaction of specific experience and genes in shaping attention and self regulation.

William Safire served as the Dana Foundation chairman until his death in September 2009. He was active with the Dana Foundation since 1993. He joined the *New York Times* in 1973, won the Pulitzer Prize for distinguished commentary in 1978, and served nine years on the Pulitzer board. He continued to write his Sunday column, "On Language," which appeared in *The New York Times* Magazine from 1979 until just before his death. This column on grammar and usage led to the publication of 14 books, including the recent *Safire's Political Dictionary*; Mr. Safire was the most widely read writer on the English language. He was awarded the Presidential Medal of Freedom, the nation's highest civilian award, in a White House ceremony held December 16, 2006. Before joining *The Times*, Mr. Safire was a senior White House speechwriter for President Nixon. He had previously been a radio and television producer, a U.S. Army correspondent, and began his career as a reporter for a profiles column in *The New York Herald Tribune*.

Gottfried Schlaug, M.D., Ph.D., is associate professor of neurology at Beth Israel Deaconess Medical Center (BIDMC) and Harvard Medical School, chief of the Division of Cerebrovascular Disorders at BIDMC, and director of the Music, Neuroimaging, and Stroke Recovery Laboratories at BIDMC. Dr. Schlaug's major research interests include the neurobiology of music perception and music making; brain plasticity using instrumental musicians as models; the development of musical skills in children; and the use of innovative musical interventions, including singing and instrumental music making, to facilitate recovery from brain injuries and neurodevelopmental disorders. Dr. Schlaug has published over 130 peer-reviewed manuscripts and more than ten book chapters. His research is supported by grants from the National Institutes of Health and National Science Foundation, as well as private foundations.

Elizabeth S. Spelke, Ph.D., is the Marshall L. Berkman Professor of Psychology and co-director of the Mind, Brain, and Behavior Initiative at Harvard University. She studied at Harvard and Yale and received her Ph.D. in psychology from Cornell University in 1978. She studies the origins and nature of knowledge of objects, persons, space, and numbers through research on human infants, children, human adults in diverse cultures, and nonhuman animals. The author of more than 100 research articles, Dr. Spelke is a member of the National Academy of Sciences and the American Academy of Arts and Sciences and a fellow of the American Association for the Advancement of Science. Her honors include the Distinguished Scientific Contribution Award of the American Psychological Association, the William James Award of the American Psychological Society, the IPSEN award in Neuronal Plasticity, and honorary degrees from the University of Umea, Sweden, the École Pratique Des Hautes Études, Paris, and the University of Paris-René Descartes.

Brian A. Wandell, Ph.D., is the first Isaac and Madeline Stein Family Professor at Stanford University. He joined the Stanford faculty in 1979, where he is also chair of the department of psychology and a member, by courtesy, of the electrical engineering and radiology departments. Dr. Wandell's research projects center on how we see, including topics like visual disorders, reading development in children, digital imaging devices, and algorithms. Dr. Wandell's work in visual neuroscience uses functional and structural MRI, along with behavior testing and modeling, to understand the action of the visual portions of the brain. His research includes studies of the organization of the visual field maps in the human brain, color and motion processing within these maps, and the potential for reorganization following injury or developmental disorders.

The Wandell lab is applying diffusion tensor imaging and functional MRI to study human brain development. It is carrying out a longitudinal study measuring the development of structures and signals in the visual cortex of children aged 8-12 as they become skilled readers. The lab's measurements of developmental changes during the acquisition of skilled reading are intended to understand how visual signals become rapidly identified and classified in the process of learning to read. Among recent awards, Dr. Wandell was named Electronic Imaging Scientist of the Year by the SPIE/IS&T in 2007, and he was awarded the Tillyer Prize from the Optical Society of America in 2008. Dr. Wandell was elected to the US National Academy of Sciences in 2003.

Ellen Winner, Ph.D., is professor of psychology at Boston College and senior research associate at Project Zero, Harvard Graduate School of Education. She received her Ph.D. in psychology from Harvard University in 1978. Dr. Winner's research focuses on learning and cognition in the arts in typical and gifted children. She is the author of over 100 articles and four books: *Invented Worlds: The Psychology of the Arts*; *The Point of Words: Children's Understanding of Metaphor and Irony*; *Gifted Children: Myths and Realities* (translated into six languages and winner of the Alpha Sigma Nu National Jesuit Book Award in Science); and *Studio Thinking: The Real Benefits of Visual Arts Education* (co-authored with Lois Hetland, Shirley Veenema, and Kimberly Sheridan).

Dr. Winner received the Rudolf Arnheim Award for Outstanding Research by a Senior Scholar in Psychology and the Arts from the American Psychological Association. She is a fellow of the American

Psychological Association (Division 10, psychology and the arts) and of the International Association of Empirical Aesthetics. She is currently studying the cognitive and social skills learned from experience in the visual arts and theater, cognitive and perceptual strategies underlying talent in drawing, and the effects of music training on children's brain and cognitive development.

About the Editors

Barbara Rich, Ed.D., a vice president at the Dana Foundation, is responsible for the news, IT, and web office and helps oversee arts education at the Foundation. Rich was a co-editor of *Learning Arts and the Brain: The Dana Consortium Report on Arts and Cognition*; *Transforming Arts Teaching: The Role of Higher Education*; *Acts of Achievement: The Role of Performing Arts Centers in Education*; and editor of *Partnering Arts Education: A Working Model from Arts Connection*.

Dr. Rich's background in communications and education includes posts at Rutgers University and Marymount Manhattan College, where she was dean and then a vice president. She was senior vice president at the Scientists' Institute for Public Information (SIPI) prior to joining the Dana Foundation.

Dr. Rich has published articles on science and education, and has served often as a discussant on both media and arts education. She earned a B.A. from City College of New York, M.A.s from Rutgers University and Teacher's College, Columbia University, and an Ed.D. from Teachers College, Columbia University.

Johanna Goldberg has worked at the Dana Foundation since 2005 and now serves as its public information officer. She copy edited the Dana Foundation publications *Learning, Arts, and the Brain* and *Partnering Arts Education: A Working Model from Arts Connection*, and was associate editor of *Transforming Arts Teaching: The Role of Higher Education*. Ms. Goldberg received a B.A. in English from Goucher College and an M.L.I.S. from Pratt Institute's School of Information and Library Science.

Resources

National Agencies and Organizations

Americans for the Arts

http://www.americansforthearts.org

Americans for the Arts (AFTA) is dedicated to representing and serving local communities and creating opportunities for every American to participate in and appreciate all forms of the arts. AFTA has offices in Washington, D.C., and New York and has more than 5,000 organizational and individual members. Local arts agencies comprise the core constituency. A variety of partner networks are also supported. The Web site offers a broad overview of their field services, including an arts and education network, public art, united arts funds, and emerging leaders.

ArtsEdge

http://www.artsedge.kennedy-center.org

ArtsEdge was developed more than ten years ago through a cooperative agreement among the U.S. Department of Education, the National Endowment for the Arts, and the John F. Kennedy Center for the Performing Arts. This online resource center aims to connect people, provide resources, and build a new base of knowledge in the area of arts education. To achieve these goals, ArtsEdge offers teaching materials, resources for advocacy, and media-rich, student-friendly activities.

Arts Education Partnership

http://www.aep-arts.org

Arts Education Partnership (AEP) is a national coalition of arts, education, business, philanthropic, and government organizations that demonstrate and promote the essential role of the arts in the learning and development of every child and in the improvement of America's schools. AEP was formed in 1995 through a cooperative agreement among the National Endowment for the Arts, the U.S. Department of Education, the National Assembly of State Arts Agencies, and the Council of Chief State School Officers. AEP's Web site contains resources for partnerships, a state policy database, a research compendium, evaluation and assessment information, publication tool kits, a library of arts-integration programs, and publications that can be easily accessed or ordered.

The Dana Foundation

http://www.dana.org

The Dana Foundation provides the latest information on brain research, arts education, and neuroeducation. The foundation offers free books and publications, including *Brain in the News* and *Arts Education in the News*, *Transforming Arts Teaching*, *Learning, Arts, and the Brain*, and this publication. A Webcast of the release of the Dana Arts and Cognition Consortium findings is available on the Web site.

Edutopia

http://www.edutopia.org

Edutopia, a print and online magazine created and maintained by The George Lucas Educational Foundation, is dedicated to promoting positive change in education. The Web site offers interactive resources, advice, examples, and contributions from practitioners. An archive of best practices is maintained for all education stakeholders. Of particular interest is the arts-education section, which contains articles, blog posts, videos, and slide shows of the latest in arts-education news.

Grantmakers in the Arts

http://www.giarts.org

Grantmakers in the Arts is a membership organization focused on arts philanthropy discourse within a diverse community of grantmakers. Members include private, community, corporate, and family foundations, as well as public sector grantmakers, regranting organizations with the primary purpose of arts grantmaking, and individual donors who give through eligible organizations. GIA programs include an annual conference, a major periodical, research, and other convening and communication services.

Keep Arts In Schools

http://www.keepartsinschools.org

In August 2007, Douglas Gould and Company launched keepartsinschools.org, funded by the Ford Foundation. The Web site includes the latest news, events, case studies, research, and hands-on advocacy support in the form of sample letters, petitions, and testimony, highlighting the efforts of arts-education organizations throughout the country and making tools and resources available to those seeking to make the arts top priority in public schools and communities.

Lincoln Center Institute

http://www.lcistitute.org

Founded in 1975, the Lincoln Center Institute (LCI) is the educational cornerstone of the Lincoln Center for the Performing Arts, Inc., and a global leader in education and the arts. Since its inception, LCI has reached over three million students and some 50,000 educators. Students learn about and through the arts by focusing on works of art, including performing arts, visual arts, and architecture. The Institute works

in partnership with pre-K-12 educators and degree-granting teacher-education programs, and provides numerous professional-development opportunities.

MENC: The National Association for Music Education

http://www.menc.org

The mission of MENC is to "advance music education by encouraging the study and making of music by all." MENC's Web site contains links to resources that discuss the benefits of arts education for "success in society, success in school and learning, success in developing intelligence, and success in life."

National Assembly of State Arts Agencies

http://www.nasaa-arts.org

The National Assembly of State Arts Agencies (NASAA) is a membership organization that unites, represents, and serves the nation's state and jurisdictional arts agencies. NASAA's mission is to advocate and promote a meaningful role for the arts in the lives of individuals, families, and communities throughout the United States. NASAA's Web site offers links to every state arts agency, major grantmakers in arts and culture, arts and learning resources, and to information about cultural tourism policy, creative economy, and arts as a public policy asset.

National Endowment for the Arts

http://www.arts.endow.gov

The National Endowment for the Arts (NEA) is a public agency dedicated to supporting excellence in the arts, both new and established; bringing the arts to all Americans; and providing leadership in arts education. NEA was established by Congress in 1965 as an independent agency of the federal government and is the largest public funder of the arts, bringing art to all 50 states, rural areas, inner cities, and military bases. The NEA provides funding through a variety of discipline-specific program areas, as well as for special national initiatives. The NEA's Web site highlights each funding area and the opportunities therein.

Neuro-Education Initiative

www.education.jhu.edu/nei

Located at the Johns Hopkins University School of Education, the Neuro-Education Initiative (NEI) bridges the gap between the brain sciences and education by bringing together an interdisciplinary group of researchers, educators, and other key stakeholders to explore the intersection, knowledge, and current application of brain research in education, and to identify and support potential areas of translational research.

Project Zero

http://www.pz.harvard.edu

Project Zero is a research group at the Harvard Graduate School of Education. Its mission is to understand and enhance learning, thinking, and creativity in the arts, as well as humanistic and scientific disciplines, at the individual and institutional levels. Project Zero has maintained a firm research commitment in the arts, and has gradually expanded to include education across all disciplines. Its work is documented extensively on its Web site through a variety of publications, papers, and articles. Artful Thinking, a program developed by Project Zero in collaboration with the Traverse City, Michigan Area Public Schools, aims to develop a model approach for integrating art into classroom instruction. Its Web site (http://www.pz.harvard.edu/tc) contains lesson plans and resources for K-6 classroom teachers.

State Education Agency Directors of Arts Education

http://www.seadae.org

The State Education Agency Directors of Arts Education (SEADAE) supports the professional effectiveness of individual members and provides a collective voice for leadership on issues affecting arts education. Its purpose is to achieve quality, comprehensive, sequential, standards-based arts education for all pre-K-12 students. SEADAE identifies and responds to key issues in arts education, strengthening arts-education policy at national and state levels, and maintaining a network to exchange ideas and information. It also collaborates with other organizations to support vision and leadership in arts education. SEASAE is supported by NASAA and the NEA.

UC Irvine Center for Learning Through the Arts and Technology

http://www.clta.uci.edu

The Center for Learning Through the Arts and Technology brings together faculty and researchers from various departments within UC Irvine to "study the reciprocal impact of the arts on the Center's focus areas, including the formulation of new public policy." Its Web site features several articles that relate arts and learning.

U.S. Department of Education and the Office of Innovation and Improvement

http://www.ed.gov/oii

The U.S. Department of Education promotes student achievement and preparation for global competitiveness by fostering educational excellence and ensuring equal access. Key aspects of the Department of Education's focus include collecting data on America's schools, disseminating research, and focusing national attention on key educational issues. Together with the National Institute of Education, the U.S. Department of Education sponsors the Educational Resources Information Center (ERIC), which provides free access to more than 1.2 million citations on education topics.

The Office of Innovation and Improvement (OII) makes strategic investments in innovative educational practices through discretionary grant programs. It coordinates public school choice and supplemental educational service provisions of the Elementary and Secondary Education Act, as amended by No Child Left Behind.

Young Audiences Arts for Learning

http://www.arts4learning.org

Young Audiences, Inc. is a nationwide arts-education programming and service organization. Arts for Learning is a supplemental literacy program that brings together students, classroom teachers, and teaching artists to engage in arts-integrated literacy learning. The Web site offers a keyword search for best practices in arts education and a Web library of curricula developed at schools and organizations across the country.

Acknowledgements

Acknowledgements from the Neuro-Education Initiative

It has been a privilege to work on such an important project as The Johns Hopkins University Learning, Arts, and the Brain Summit that brought together educators, researchers, policy makers, parents, and other important stakeholders to share their thoughts and ideas about the influence of the arts on learning.

Deepest thanks go to the following organizations for their support and guidance: American Visionary Art Museum, Arts Education in Maryland Schools Alliance, Baltimore Lab School, The Dana Foundation, Edutopia, The Johns Hopkins University Brain Science Institute, The Johns Hopkins University Council on K-12 Education, L. Robert Kimball & Associates, Learning and the Brain Conference, Maryland Public Television, Maryland State Department of Education, Roland Park Elementary/Middle School and the summit's host, The Johns Hopkins University School of Education.

There are a number of individuals that the authors feel must be acknowledged for their enormous insight, wisdom and impact on the Learning, Arts and the Brain Summit. Thank you first to Kurt Fischer, Kathy Hirsh-Pasek, Alice Wilder, Keri Smith, and John Tarnoff who, with energy and purpose, launched the summit with pre-conference presentations to several hundred educators. Rebecca Hoffberger, founder and director of the American Visionary Art Museum, made it possible for the summit to be held among the stunning art of the exhibit, *The Marriage of Art, Science and Philosophy.* The tour of the exhibit that she conducted with JHU neuroscientist David Linden brought the arts home to our hearts.

We wish to thank the esteemed facilitators of the research and education panels, who were among those who inspired this summit and provided guidance and support from the very start. First, Dana Foundation Chairman William Safire brought his wisdom and experience to planning and executing the summit from its

inception. Similarly, Richard Deasy, former director of Arts Education Partnership, helped us to conceptualize the connection of the science and arts communities.

The Neuro-Education Working Group and the Learning, Arts, and the Brain Summit committee, too large to mention all members by name, were instrumental in directing the development of the summit. Two members in particular, Mary Ann Mears and Carolee Stewart, have our gratitude for their efforts both in brainpower and in brawn.

The Johns Hopkins University leadership has strongly supported the work of the School of Education's Neuro-Education Initiative as well as this summit. Jack Griffin and Rick Huganir of JHU School of Medicine and co-directors of the Brain Science Institute; Scott Zeger, acting provost; Michela Gallagher, assistant provost; Ralph Fessler, dean of the School of Education, Jeffrey Sharkey, director of Peabody Institute; Gary Goldstein, president and CEO of Kennedy Krieger Institute; and Johns Hopkins University President Ronald Daniels have all encouraged this interdisciplinary work.

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We also want to thank the participants of the roundtables and the authors of the posters for sharing their knowledge and doing so with honesty, patience, and good-intentions. Their contributions are reflected in these pages and are the base on which we will build new research and educational practices.

There are no words to properly thank Jerome Kagan for his torchlight keynote address that galvanized the issues around arts and learning. "Why the Arts Matter" is included in this report and is a narrative that should be read again and again to ensure we don't lose our way.

Thank you to those whose logistical assistance before, during, and after the summit was invaluable, including Chris Godak, Jim Campbell, John Robinson, Lisa Hamm, Mary Bonner, Clare O'Malley Grizzard, Thomas Grizzard, Linda Tsantis, John Castellani, Henry Smith, Ann Kolakowski, Susan McLean, Carolyn Combs, Brendan Russell, and all roundtable facilitators and recorders.

Thank you to Barbara Rich and her editorial team for making the development of this book a true collaborative process.

Finally, the authors want to thank the person who has inspired, shaped and supported, not only the Learning, Arts, and the Brain summit, but the seminal work that has been done to date on this important topic. A heartfelt thank you to Johns Hopkins University's Guy McKhann.

Mariale Hardiman and Susan Magsamen, co-founders,
Neuro-Education Initiative and Learning, Arts, and the Brain Summit.

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Barbara Rich, Ed.D., vice president, the Dana Foundation

Index

D

E

F

G

H

I

J

K

L

M

N

O

P

R

U

V

W

Neuroeducation: Learning, Arts, and the Brain
is posted in its entirety in PDF format
on the Dana Web site: **www.dana.org**.
Information about ordering additional copies
is available on the Web site.

For information on
the Neuro-Education Initiative,
visit: **www.education.jhu.edu/nei**.


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