KIDLAB’s STORY Program: A Transdisciplinary Model for Scientific Literacy and Community Involvement in Developmental Neuroimaging Research

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This article will introduce the reader to a model that has matured with the growth of my career encompassing expertise as a middle school teacher, special educator, educational psychologist, and cognitive neuroscientist. It is a model enriched by my experiences, training and education early in life as a performing and visual artist (vocalist, actor, poet, photographer, and ice dancer) and student of literature (with particular interests in the Transcendentalists and the Imagists). That time, though seemingly distant from the pursuit of science, allows me to appreciate the relationship between art and science, and to attempt to summarize here in a succinct way why, from my point of view, the emerging field we call ‘educational neuroscience’ is necessary and dear.

To this end, my presentation of this model will center around three main points. First, an emphasis on inter and transdisciplinary collaboration as a means to appropriately identify and position important research questions grounded in the learning sciences. Second, within this strategy, my pursuit of the empirical basis of twice exceptionality and constructivist learning. And, finally, how my training and conceptual influences have grown to include a grounding in cross species expertise and anthropology that has produced a practical and powerful model for practicing cognitive neuroscience, promoting scientific literacy, and engaging the community at large.
Dr. Kalbfleisch and participants act up in the STORY Workshop race car skit.

**Becoming Transdisciplinary**

My doctoral training began in 1996. During that year, I came across a monograph published by the Santa Fe Institute that addressed the brain as a complex adaptive system (Morowitz & Singer, 1995). It is a series of essays by prominent figures from multiple disciplines such as physics, artificial intelligence, neurobiology, cognitive psychology and philosophy that attempted to address how mind arises from the brain. It was the publication that set the tone for my interdisciplinary doctoral training which ultimately included medical school, psychopharmacology research with hyperactive rats, clinical psychometric training, psychological studies of intelligence and creativity, and the exploration of the physiology linked to divergent thinking in gifted boys and those with ADHD. Little did I know that 5 years later I would find myself an assistant professor working in the institute that was, in part, conceived from that monograph, the Krasnow Institute for Advanced Study at George Mason University in Fairfax, VA. During my first few weeks there, Dr. Harold Morowitz, co-editor of that monograph and founder of the institute, read my doctoral composition exam, a treatise on differentiated instruction justified from theories and philosophies of constructivist learning and empirical evidence from the neurosciences. One day he jumped from his office and exclaimed with great excitement that I had taken on the mind/body problem. I laughed and explained to him that I had been at it since high school when I chose to do a thesis on Descartes and EEG biofeedback as a part of unique college-preparatory course during my senior year.

When I encountered the notion of transdisciplinarity (Koizumi, 2001) during postdoctoral work, I realized that the potential to ignite a paradigm shift in the learning sciences could best be pursued within this perspective and space,
defined by the synthesis of fields beyond an interdisciplinary collaboration. As a dually-trained educational psychologist and cognitive neuroscientist, transdisciplinarity christened my legitimacy during a time when education and neuroscience were still only considering a partnership (Sarter, Bernston, & Cacioppo, 1996; Bruer, 1997). Again, I would be treated 6 years later to an introduction and acquaintance with the person credited with defining that idea, Dr. Hideaki Koizumi, during a neuromathematics conference in Copenhagen, Denmark. Some of his own transdisciplinary demonstrations have resulted in the invention of the neuroimaging method near-infrared spectroscopy (NIRS), a large longitudinal study in Japan of the infant brain, and a deep interest in the spiritual definitions of human compatibility.

As a transdisciplinary scholar, the neuroimaging experimentation in the laboratory I founded in 2003, KIDLAB (short for Krasnow Investigations of Developmental Learning and Behavior), is based on the methods of functional magnetic resonance imaging (fMRI) and electroencephalography (EEG). KIDLAB’s experiments draw from and seek to preserve the ecological validity of aspects of cognitive function in the real world and principles of educational psychology centered around the study of constructivist learning (Vygotsky, 1928, 1978; Bruner, 1960; Piaget, 1970, 1980). Holding true to these tenets allows us to push the envelope on the limits of experimental design, with the ultimate goal of moving the brain behavior relationship a step closer. For example, we incorporate task requirements to induce emotional states during high level reasoning, exploring the impacts of time-dependency to mimic a condition where true fluid reasoning is required to make a decision (you have all the information you need to make a decision but not enough time) (Kalbfleisch et al., 2006) and of perceptual visual complexity when processing basic elements of objects and environments in the real world (Stoneham et al., 2008, DeBettencourt et al., 2009). Despite the additional complexity that biological knowledge about human ability and performance is yielding and the methodological challenges associated with cognitive neuroscience, we have in our grasp the potential to inform how we educate, support, and enrich human ability and performance across the lifespan. Though scientific methods stem from studies of medicine and biology, they are being adapted to frame questions motivated by learning and training environments.

Engaging the Science
My scientific mission involves cracking open the definition of neural plasticity to incorporate empirical data based on idiosyncratic but prevalent aspects of human behavior and performance we currently only assign to medical models of disability and disease. For instance, hemispherectomy, phantom limb, and synaesthesia are plastic phenomenon that currently frame our understanding of functional plasticity (Kalbfleisch, 2009). However, giftedness, in its many forms (domain specific or general, intellectual or creative, or in tandem with learning disabilities), is a type of plasticity we know very little about. The nature of talent, super-ordinate to definitions of intelligence and creativity, is only primitively understood through studies of sensory and motor expertise (Kalbfleisch, 2004). Within education, multiple questions remain despite our current understanding of how the brain reads, performs mathematics, and pays attention. Territory yet to be mined involves how physical and social environments inhibit or support the acquisition and expert performance of perceptual skills and higher level cognition. KIDLAB has been using fMRI to explore these aspects of the environment and their impact on complex reasoning. A complete science of learning incorporates interrogations of these problems on multiple levels with many disciplinary experts in concert with one another.

Complimentary to that, a contemporary synthesis of knowledge about twice exceptional children in general (Kalbfleisch and Iguchi, 2007) and gifted children with ADHD (Kalbfleisch and Banasiak, 2007) illustrates that this kind of neural plasticity is largely empirically unexplored. My own research efforts explore the various conditions we assign to the word “fluid” when we talk about cognitive processing and higher level reasoning (Kalbfleisch et al., 2006). The summary of my own attempts to explore the nature of human ability and performance, both empirically and theoretically, (Tomlinson and Kalbfleisch, 1998; Kalbfleisch, 1998; Kaufman et al., 2000; Kalbfleisch, 2004; Kalbfleisch et al., 2006; Jung et al., 2007; Kalbfleisch, 2009) have lead me to conceptualize the human nervous system as an “endogenous heuristic” for understanding meaning making (Kalbfleisch, 2008), though that knowledge will not necessarily make our understanding of learning and how to best support it any less complex. There is a seductive underlying expectation that knowledge of our functional neurobiology will simplify things. While our endogenous heuristic will permit us to tap learning with unrivaled sensitivity and specificity, our jobs will remain complex as we work to tie those insights
into real and virtual settings that are socially, culturally, and environmentally dynamic and rich.

**Engaging the Community**

Trying to tell the story of the functional brain cannot happen without the enthusiasm and involvement of the public. While most science happens in spaces apart from the mainstream, the future and widest applicability of cognitive neuroscience research lie with a direct and transparent engagement of those in public and private educational institutions and the community at large. One of the ways KIDLAB does this is by engaging scientists and volunteers alike in the idea that the brain wants stories. We engage in each other’s stories to create communities and shared experiences. When we don’t give the brain stories with what we are doing in the world, it makes its own. For example, the active resting state of the brain, referred to as the default mode network (Raichle & Snyder, 2007) is partially based on active language networks. In otherwords, the brain “talks to itself” when we are not actively engaged in the world around us. I extended this neurobiological insight into a community mission whose purpose is two-fold: (1) to de-mystify the scientific environment in order to make what we do in the lab more approachable and contextually-relevant to how the brain functions in educational and social environments, and (2) to promote the development of scientific literacy in the public to help people digest and be critical consumers of new and tentative knowledge being generated by human neuroimaging.

**My Approach**

In 2008, I created KIDLAB’s community STORY Program. At KIDLAB, we engage our young MRI participants in an exercise of the imagination. Stories transmit emotional states, history, culture, tradition, and personal connections. Every family that comes to us has a story to tell and hearing it is often the first thing we do before starting down the path of participation in our studies. This is particularly meaningful for families with special needs children as each has their own journey, set of challenges, and tales of triumph to share.

To view a 10-minute video about our experimentation with children with Asperger’s Syndrome and the creation of our STORY program please go to
the following link - http://krasnow.gmu.edu/kidlab - and click on “fMRI Documentary Summer 2008”.

My inspiration for the STORY program came during a visit in December 2007 with the bonobo colony at the Great Apes Trust in Des Moines, Iowa. During an ice storm that shut down the entire city, I was treated to a visit that included two research assistants and four bonobos. I gazed at the bonobo family (mom, Panbanisha, and three youngsters, Elikya, Nathan, and Nyota) playing in their compound and watching a very large flat screen LCD television – much bigger than the one in my own living room! I asked what they were watching? The research assistants said that Panbanisha was watching a movie that the staff had produced for them based on their requests for a story. I was puzzled. They calmly explained that the mother, Panbanisha, would go to the lexigram board and point to a series of icons that would indicate characters and events she wanted them to sequence together into a story. As she watched the homemade video, I was told that today, she was not particularly happy with the final product. It was a stunning moment to witness what looked like direct, effortless, meaningful communication across species. And it drove home to me the notion that stories have a primal fundamental power to transmit message and emotion that we can harness to simultaneously frame and expand our explorations of human ability and performance. We are all in this together.

KIDLAB’s STORY program was borne out of that moment of exchange. Our STORY program consists of 6 community partners that stand up for KIDLAB and recommend our activities to their families.
Clockwise from upper left hand corner: GMU art students and KIDLAB staff create the STORY mural; a mother and son participate in a KIDLAB fMRI scan; STORY Mural past to present; Dr. Kalbfleisch and participants act up in the STORY Workshop race car skit; Theatre artist, Oran Sandel (orange shirt), leads Laura Connors Hull founder of Creative Cauldron and KIDLAB participants in interactive theatre exercises.

Not only does this help us recruit volunteers for our studies, it also provides us with the opportunity to educate the general public about neuroscience methods and practice, an important step in literacy as neuroimaging breaks out into the popular press and the desire to inform how we remediate, medicate, educate, and heal. KIDLAB’s partners include an intergenerational community arts organization (creativecauldron.org), a youth-support partnership (loudounyouth.org), a neuropsychology clinic (mindwellpsychology.com), a handbag vendor (asifbags.com, short for ‘Asperger’s in the Family’), a children’s book author (humblepiepublishing.com), and a local private school (nysmith.com).

June 2008 marked the initial kick-off of the STORY program.
Above, both images: Oran Sandel and STORY participants drawing on their creative impulse

One of our STORY partners, Creative Cauldron (creativecauldron.org), brought us a wonderful theatre artist, Oran Sandel (pictured in the orange shirt), an affiliated teaching artist at the Shakespeare Theatre Company (http://www.shakespearetheatre.org/about/index.aspx) and former Artistic Director of Robert Alexander’s Living Stage Theater Company (The Arena Stage’s former improvisational community engagement theatre), a company whose mission by founder Robert Alexander was to empower children living with disability, impoverishment, and incarceration, teaching them skills of performance art and affirming their creative potential. Oran, KIDLAB staff and students, STORY partner organizations, and 17 children and families gathered for a workshop designed to elicit stories from the kids to inspire the creation of a mural that would drape the MRI in the lab. My idea was that these stories should come from the community and be for the community, that based on what I had seen with the bonobos, this model would resonate simultaneously from social, environmental, and clinical perspectives and provide a strong basis for our relationships with our volunteers.

For over two hours, Oran led us through our imaginations and drew out performance vignettes displayed through costumes, props, and shared ingenuity. At the end, there were so many good stories, that we decided to take a problem-based learning approach to the MRI mural. The mural that was created and inspired from this day of STORY contains images of past and future against a rainbow colored background to mark the portal and support the stories of our participants.
Above: STORY Mural Creation led by KIDLAB benefactor Virginia Pomata (pointing in yellow)

Above: KIDLAB STORY Mural – ‘Future’ being painted by KIDLAB intern Meghan Donohue
Thus, when children come to KIDLAB, they are presented with an ill-structured problem: The world is in trouble and they are here to help save it. They must choose a time to go forward or backward to do that (will they go to the Jurassic period with dinosaurs? dive the ocean to find Nemo? jet into the future on Earth or go to another planet?). Based on their choice, we craft an experience for them involving puzzles, books, and movies to engage their imagination around the games we teach them to play (designed to investigate their reasoning and attention capacities) prior to going into the MRI. On the days we scan children, the actual MRI, draped with the mural, becomes their time portal.

Below: Today, the KIDLAB STORY Mural covers the MRI scanner transforming it into a time portal, the culmination of a problem-based learning exercise that begins with the query, “The world is in trouble and you are here to help us save it. In order to do that, you will travel forward or backward in time. Choose where you will go.” Shown here, a content subject and his mother during an fMRI scanning session.

The fact that a child can choose their time era provides multiple entry points for engagement that help make a difference for the child’s experience with us at KIDLAB and help us maintain a high standard of data quality (lots of movement destroys imaging data and we find that the more engaged the kids
are, the more still they are during MRI scanning).

Now, we plan an annual STORY workshop, inviting back our volunteers and families to participate in an ice cream social (requested by the parents of our kids with Asperger’s Syndrome) and a preview of our data and what they have helped us learn so far. Because we do not give clinical diagnosis and support in research, this is a way for them to see tangible results of their time with us. As the STORY program grows, we hope to expand its base to help increase understanding, good will, and scientific literacy in our community.

Last year, we sponsored a booth during the Washington, D.C. Walk for Autism Speaks. This year, we have had opportunities to work closely with parents from our partner school, Nysmith School for the Gifted, and the Girl Scouts.

Right: KIDLAB research assistants Ashlee Loughan, Lauren Serpati, and Dorothy Zhang share information during the 2009 Autism Speaks Walk in Washington, D.C.

Moving across the domains of research and practice, it is my hope that the empirical stories KIDLAB will tell about twice exceptionality and human ability and performance across the lifespan will help enable policy-level support of stronger models of healing, enrichment, and support in training, education and medical domains. When I talk with audiences of laypeople, I pose the question, “why does it look like we know so much when we know so
little?” First, because much of what is known until very recently comes from studies of learning and memory in animal species. Second, findings from neuroimaging studies are oftentimes based on group averages. That is why MRI is not used to “diagnose” ADHD or dyslexia in individuals. While MRI is a costly, highly technical, and sophisticated method, its sensitivity is not at a level where it can reliably illustrate the nature of individual differences on an individual level. Like definitions of intelligence, creativity, and other phenomena related to learning, our definitions and models of giftedness and disability alike are not unitary (ADHD is defined by category, autism as a spectrum) and are embedded in the social contexts where we observe them. This is evident in the constant challenge to align identification and programming practices.

In closing, it is an exciting and energizing time to pursue deep questions related to learning and performance. My vision instantiated to-date in KIDLAB and its STORY program have begun to spin a thread that we hope has extraordinary tensile strength with the capacity to contribute new knowledge about human learning and performance and promote the literacy and ethics surrounding the practice of human neuroscience in the general public. I leave you with a final thought, articulated by Meghan Donohue, a KIDLAB undergraduate summer intern during 2007 and 2008, and invite your ideas and feedback.

**What's your STORY?**

*In a magic kingdom, a damsel in distress cries for the help of a handsome prince.*

*Deep in swamp land millions of years ago, an ancient dinosaur glimpses its next prey.*

*On a distant planet, a martian child drives his new flying saucer for the first time. And in your own backyard, an ant queen is overthrown by her tiny subjects.*

*We all love a good story. And it turns out, our brains do, too.*

*Throughout history, humans have imagined worlds far from our own full of strange, colorful, and even sometimes familiar characters. We create books, movies, music, and art that convey the stories of our lives and the lives of those past and future. Our creations fulfill a need in us. They allow us*
to dream and to explore.

At Dr. Kalbfleisch’s lab, we love stories too.

We thought it would be fun to merge the creativity of science and art through stories. And so we consulted the experts: Kids!

On June 1st, 2008, we hosted our first STORY Workshop. Community families came together with theatre artists and scientists for an afternoon of creativity and fun. We played games, sang songs, ate brain-related snacks, and created stories to act out. Kids became scientists, and scientists truly became kids for a day.

We use fun stories to help kids (and adults!) feel more comfortable in a scientific setting. We worked with talented community artists to create a beautiful story mural to decorate our state-of-the-art MRI suite. We compiled a video library so you can watch cool stories in the MRI during part of your visit. We even built a mock-MRI so that you can feel what it’s like and practice some activities before your scan.

At the lab, we love science, but we also love to have fun.

So, we want to know...what’s your story?

References


University of Toronto, CA.


Photos were taken during KIDLAB STORY Workshop (June 1, 2008) and Mural Creation.

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