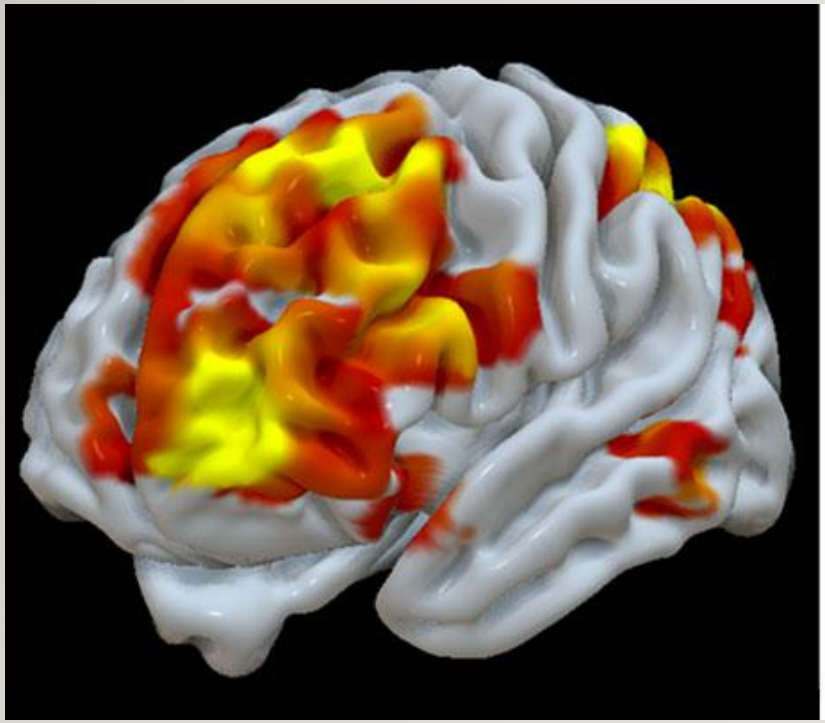
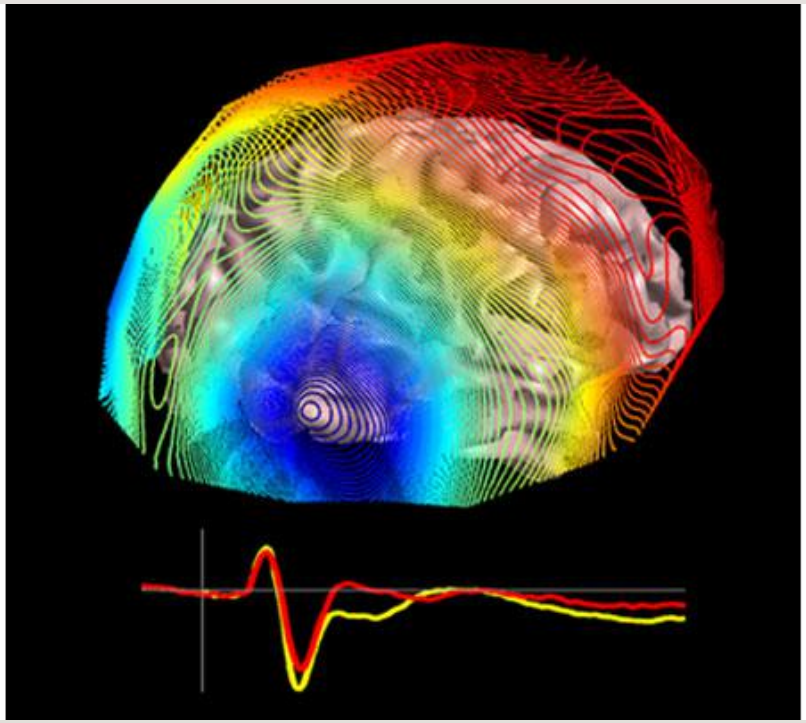
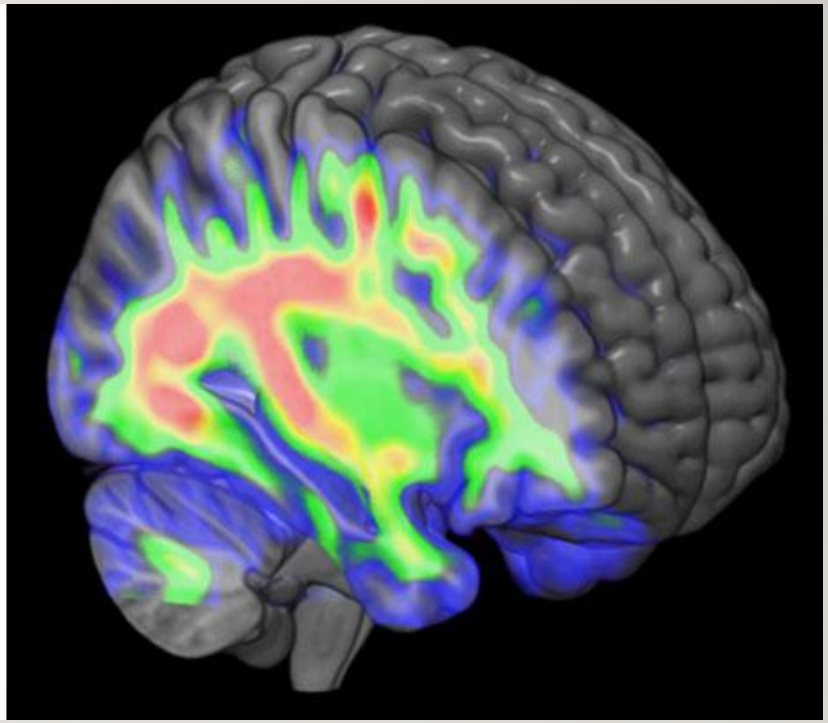
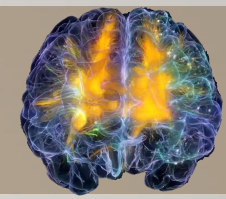




COGNITIVE NEUROSCIENCE

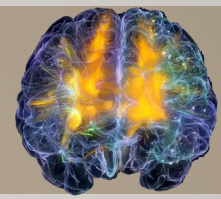
By YAN Zhixiong Ph.D

BRAIN AND EDUCATION

The story of Nico



Nico had his right hemisphere removed when he was 3 years old to prevent recurring severe epileptic seizures. Based on the neurological literature, his family was told that he would have poor visual-spatial skills, such as drawing, and poor control of language intonation because these skills are believed to be localized in the right hemisphere. Despite this information, Nico's family and schools provided strong support for his development in many areas, including physical activities, drawing, and speech. With the extensive support that he received, he developed good motor skills, such as running skateboarding, and riding a bicycle. Nico was interested in drawing, which his parents and teachers also supported, and remarkably he became skilled at sketching, as shown in Figure 1, his sketch of the guesthouse where he stayed in Cambridge at age 12 during a visit to our laboratory. Now, as a young adult, he is known for his skill as an artist—contrary to the neuroscientific predictions that he would never have good visual-spatial skills.



Re-thinking about the Brain...

The Story of Nico-
a case study and reflections about deeper issues

Sumitava Mukherjee,
CBCS, Allahabad

Case of Nico published in
Battro M. Antonio, Half a Brain is Enough, Cambridge University Press, 2000

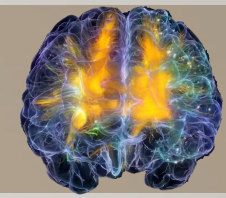
After Hemispherectomy..

Nico has lost a hemisphere.
But, Nico goes to school.

Nico was studied : 5-8 years(KG to std.III)

Nico's Background

- Nico Had :
Congenital Hemiplegia, Intractable Epilepsy
- What was done?
Right Functional hemispherectomy
- Age:
3 years 7 months



History : More details..

- Suffered congenital hemiplegia,
but; managed to walk before 1 yr. 7 months

- First 2 epileptic seizures: when Nico was 22 months

- Then, disappeared for 8 months,
later recommenced with repeated convulsions and loss of consciousness

- Medications were useless

- EEG : Extended epileptic focus in right cortex
(RT Temporal,frontal,parietal areas)

Operation (!)

Initial Surgical idea (1) :
Limited resection of RT Temporal lobe and disconnection of RT frontal lobe under corticographic control

Final Surgery:
After (1), spikes and discharges persisted..Then,
central cortical region, cingulate gyrus, temporal lobe, amygdala, hippocampus were removed.

Remaining portions of parieto-occipital lobe and frontal lobe was disconnected from brain stem and LT hemisphere.

Nico's brain after the Surgery

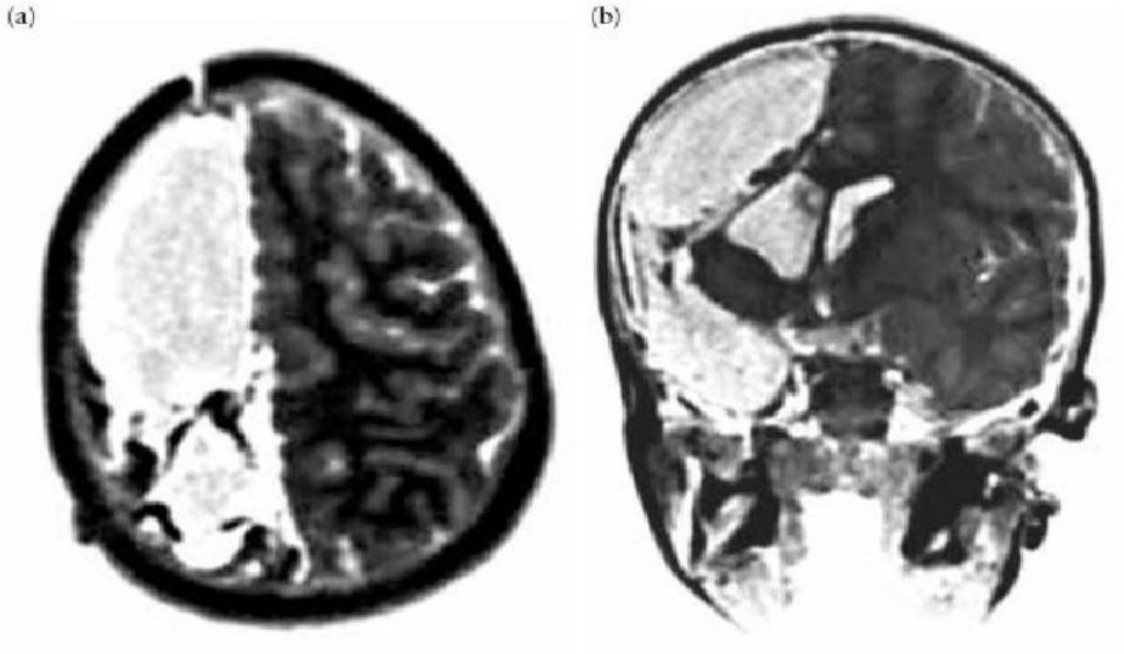
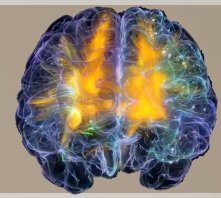


Figure 1.1 Two images of the functional right hemispherectomy. (Nico: three-years-and-seven-months): (a) horizontal (axial) view, (b) frontal (coronal) view. Only the left hemisphere is seen, most of the right hemisphere has been removed.

Nico's Mind after the surgery

- Seizures disappeared
- Never lost his speech
- Within a few days, he started to walk
- Normal social and affective behavior

- He limps and cannot move his left arm
- Has left hemianopia and has difficulty focusing on a visual target
- For spoken and written English, he is among toppers



Question 1 :
How Can half a brain sustain a full mind?

How do we correlate the huge reduction in Nico's gray matter in his brain

WITH

his normal cognitive, social, affective development

?

On trying to answer Ques. 1..

The right hemisphere is a 'minor' brain ("the excision of the right hemisphere under local anesthesia gives rise to no loss of the patient's consciousness or self-awareness"-Popper, Eccles, Self and the Brain, 1977)

The earlier the brain damage occurs, the less the behavioral loss (Analysis of the Margaret Kennard doctrine, Corbalis, 1983)

No report of serious language impairment for RT half-brained adults & children

Most had average/above average visual and face processing abilities (only one case of prosopagnosia, [Reported bySergent & Villermure, 1989])

A bigger issue :
The Mind-Brain controversy

What is the Mind-Brain dichotomy?

Basic Idea : Mental phenomenon are in atleast in some aspects non-physical

General Neuroscience premises :
Mind is manifested or is an emergent property of the brain OR
mind doesn't exist

But, wait..
How do body and mind interrelate in life and in knowing?
How thoughts can cause actions or how unconscious fantasies can cause psychosomatic illnesses such as ulcers, asthma and colitis.
How do thoughts impact on particles of matter and how do material impacts cause thoughts, including the thoughts which lead from sensation to knowing?

We are left wondering not only how we know anything for certain but how we have any experience at all, especially the experience of other minds.

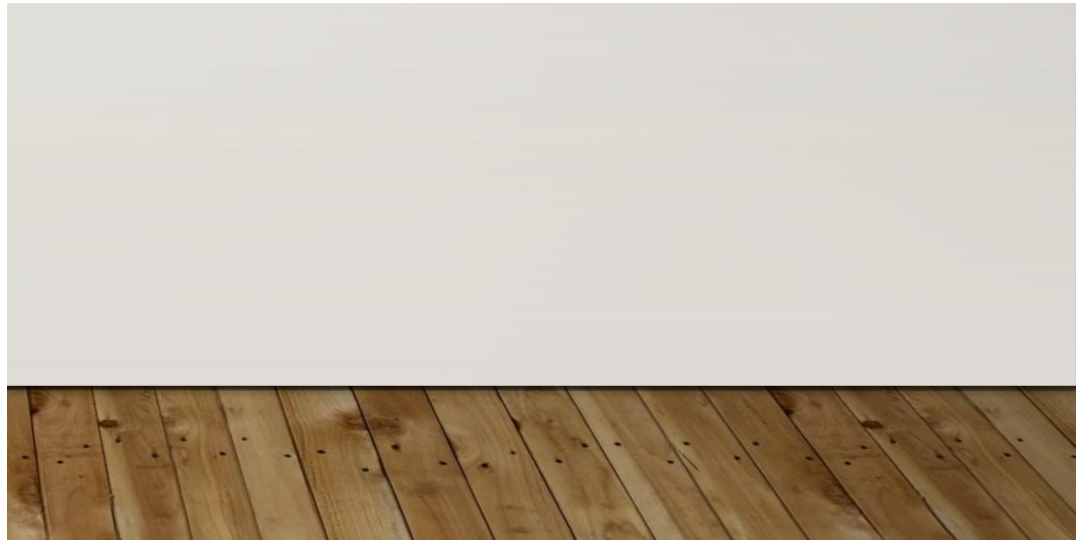
More dirty questions..
Brain and the Mind (cont.)

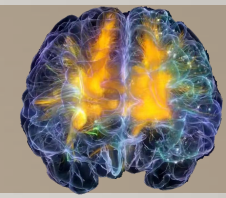
- Whales and elephants have larger and heavier brain than humans but neither has been proved to be capable of producing a rich human like language (Side note: Do you think whales can hypothesize about a possible alien attack in 2100 AD?)

- With half of neuroencephalic tissue, a child does just fine.. Do we need so many neurons for 'higher' cognition?

- What is half of a brain ?

- A neurocognitive illusion – What is the meaning of 'She has brains' ?





Issue :Hemisphere specialization

Interview snippets of Dr. Freeman,Director of the Johns Hopkins Pediatric Epilepsy Center.

Questioning hemisphere localization..

“Memory and understanding seem to be coded on both sides of the brain. When you take out half of the brain, you don't forget anything you've learned before and you're still able to understand things perfectly well,"

“If the left side of the brain is taken out, most people have problems with their speech, but it used to be thought that if you took that side out after age two, you'd never talk again, and we've proven that untrue,"

"The younger a person is when they undergo hemispherectomy, the less disability you have in talking. Where on the right side of the brain speech is transferred to and what it displaces is something nobody has really worked out."

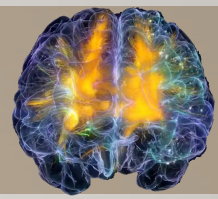
[Case: Kacie with Rasmussen's encephalitis, Left hemispherectomy at 13 years of age. No speech loss after surgery, unable to verbalize a thought but after therapy she is a full time sophomore. She leads a normal life apart from a slight limp while walking and no pactical usage of right arm]

Conclusion

Through the case of Nico ,
major questions were introduced based on
counter-intuitive cases of hemispherectomies.

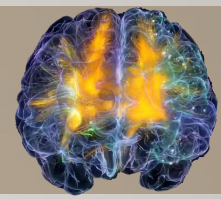
Hemispherectomy and Imaging
(to trace changes during post-operation therapy)
could modify our view and beliefs about the brain.

Size does matter.., but how is size related to cognition?
How is mental related to physical?
Is there a reason why our brain circuits are the way they are?



Perhaps even more impressive is the case of Brooke, who had his left hemisphere removed at age 11 for severe epilepsy. This age is late for such surgery because the brain's ability to recover from such severe intervention and to adapt to needs for new learning generally decreases with age (Bailey, Bruer, Symons, & Lichtman, 2001). Brooke and his family were told that he would never speak again after his hemisphere was removed, and immediately after the operation, he was indeed unable to speak. However, he began to speak some words soon afterward, and over some months, he gradually learned to speak English again, becoming skilled enough at both speech and reading that he could attend a normal school and eventually a community college. This recovery was shocking to doctors and neuroscientists working with Brooke and gratifying to him and his family (of course).

RECOMMEND READING



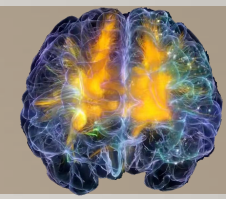
MIND, BRAIN, AND EDUCATION

Mind, Brain, and Education: Building a Scientific Groundwork for Learning and Teaching[1]

Kurt W. Fischer[2]

ABSTRACT—The primary goal of the emerging field of Mind, Brain, and Education is to join biology, cognitive science, development, and education in order to create a sound grounding of education in research. The growing, worldwide movement needs to avoid the myths and distortions of popular conceptions of brain and genetics and build on the best integration of research with practice, creating a strong infrastructure. This foundation requires a new approach to connecting research and education, with a two-way collaboration in which practitioners and researchers work together to formulate research questions and methods so that they can be connected to practice and policy. The traditional model will not work. It is not enough for researchers to collect data in schools and make those data and the resulting research papers availa-

RECOMMEND READING



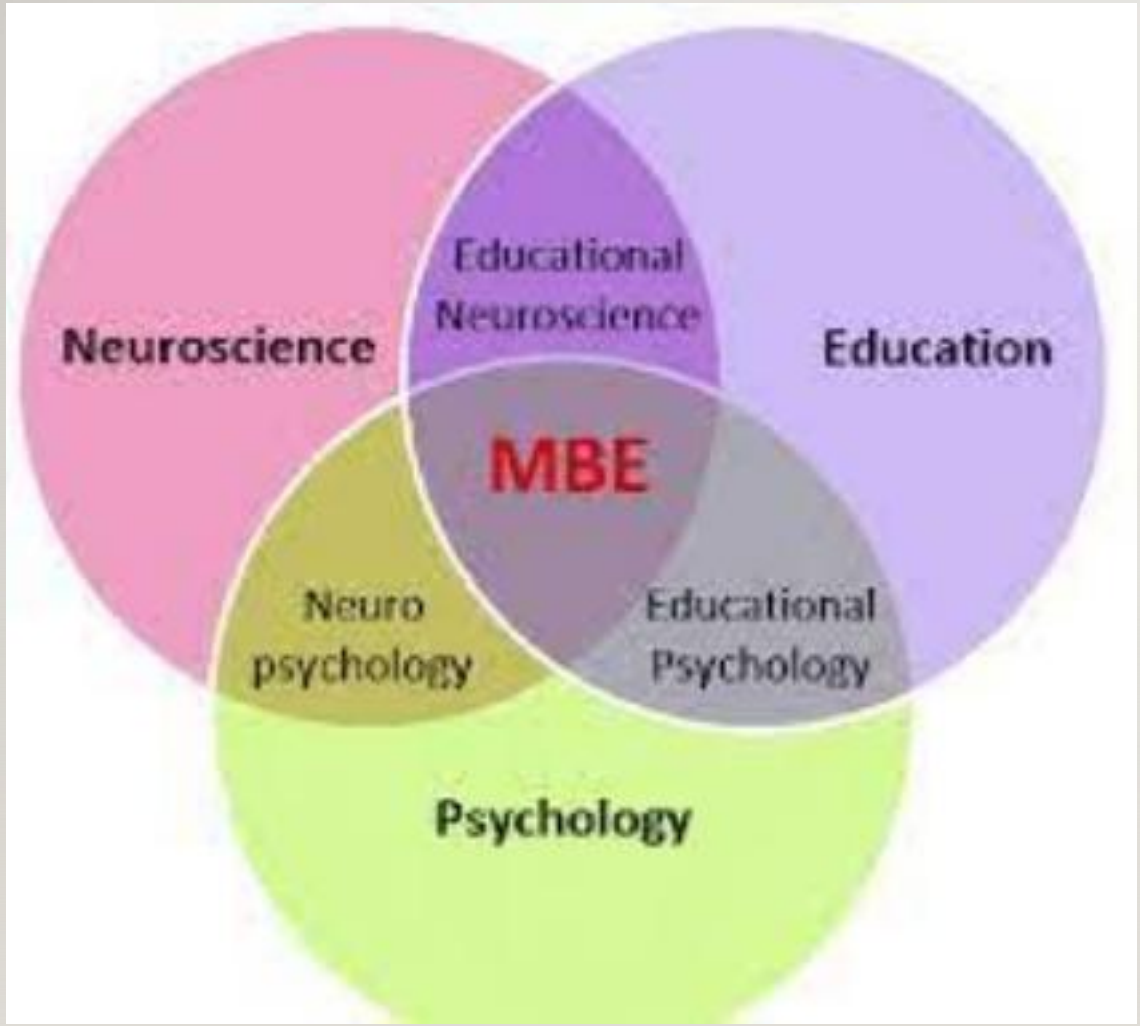
MIND, BRAIN, AND EDUCATION

We Feel, Therefore We Learn: The Relevance of Affective and Social Neuroscience to Education

Mary Helen Immordino-Yang[1] and Antonio Damasio[2]

ABSTRACT—Recent advances in neuroscience are highlighting connections between emotion, social functioning, and decision making that have the potential to revolutionize our understanding of the role of affect in education. In particular, the neurobiological evidence suggests that the aspects of cognition that we recruit most heavily in schools, namely learning, attention, memory, decision making, and social functioning, are both profoundly affected by and subsumed within the processes of emotion; we call these aspects *emotional thought*. Moreover, the evidence from brain-damaged patients suggests tions between decision making, social functioning, and moral reasoning hold new promise for breakthroughs in understanding the role of emotion in decision making, the relationship between learning and emotion, how culture shapes learning, and ultimately the development of morality and human ethics. These are all topics of eminent importance to educators as they work to prepare skilled, informed, and ethical students who can navigate the world's social, moral, and cognitive challenges as citizens. In this article, we sketch a biological and evolutionary account of the relationship between emotion

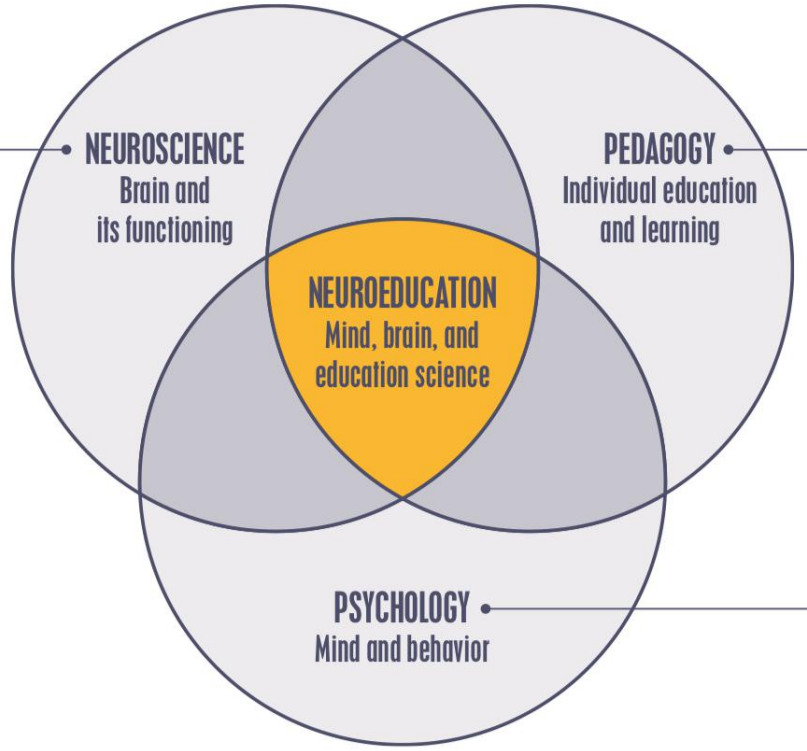
Mind, brain and education (MBE)



The Three Disciplines of Educational Neuroscience

Educational neuroscience is the discipline that combines **neuroscience, pedagogy, and psychology** bringing the current research from how the brain learns, behaves, and relates to instructional practices in the classroom. Every class, assignment, and experience shapes the human brain. Understanding how the brain processes information into learning and knowing more about what it takes for students' brains to be engaged, responsive, and alert are fundamental to the teaching and learning process.

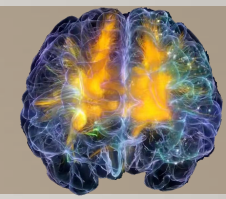
Neuroscience is the study of the brain's development, structure, and function. The goal of educators is to have successful students and one of the ways to promote success in our students is to understand how the learning process occurs. The process of learning involves changing the brain. The selection of instructional techniques and the designing of lesson plans can be aided by understanding how the brain responds and through applying principles from the neuroscience research in the classrooms.



Pedagogy is the study of the art and science of the teaching and learning process. Educators need to understand how the environment, poverty, boredom, support systems, substance abuse, and all emotional, social, and cognitive facets affect the brain and how it learns, relates, and behaves. Educational neuroscience is the active engagement of purposeful strategies based on the principles derived from neuroscience and educational psychology.

Educational **psychology** is the study of developmental mental processes responsible for cognition and behavior. Teachers in training benefit greatly when they understand the development of the brain and how the environment, genetics, and perceptions of students intimately affect mental and behavioral processes.

Within this discipline, pre-service teachers will understand how stress affects the brain's ability to process information and how to create and design instruction and engagement strategies so that we are addressing the critical emotional, social, and cognitive developmental stages in every classroom.



The Relationship Between Learning and the Brain

The brain is wired for novelty, patterns, questions, relationships, and survival. When we instruct our students building on the impact of “connection” with one another, subject matter, and their own expertise “learning” feels relevant and meaningful and is sustained.

The implicit goal of all education is to change students’ brains, by improving both their knowledge base and their understanding of information they acquire.

Every class, assignment, and experience shapes the human brain. Understanding how the brain processes information into learning and how stress responses affect the developing executive functions in the brain, as well as knowing how to create capacity for maximal responsive student receptivity are critical to all subject areas and grade levels. Educational neuroscience is the active engagement of purposeful strategies based on principles derived from research in the above mentioned areas.

Five Research-Based Principles That We Know Affect Learning and Behaviors in the Classroom

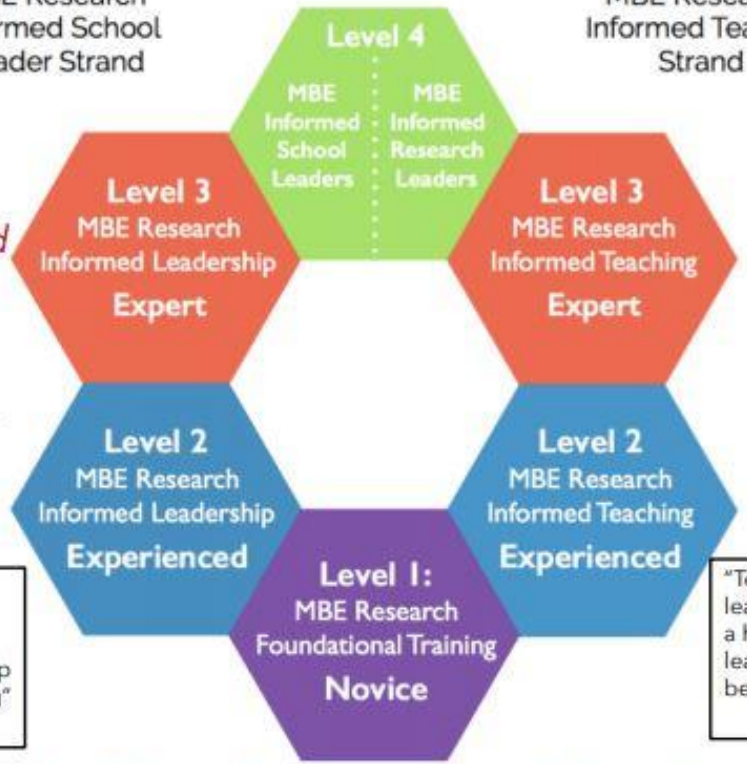
1. Movement enhances learning and memory. Movement brings additional fuel-carrying blood to the brain. It allows the brain to access more long-term memory areas (an ancient survival strategy), thereby helping students make greater connections between new and prior learning. Exercise was shown to be strongly correlated with increases in brain mass and cell production, as well as improved cognitive functioning and mood regulation.
2. Emotions have a great impact on learning. Students cannot focus on the curriculum unless they feel physically safe and emotionally secure.
3. The varying pace of brain development helps to explain the behavior of children and adolescents.
4. The school’s social and cultural climates affect learning. A school’s culture is characterized by openness of communication, level of expectations and appreciation for effort, involvement in decision-making, and degree of caring.
5. Brains can grow new neurons in the hippocampus. The hippocampus encodes long term memory.

THE CENTER for TRANSFORMATIVE TEACHING & LEARNING
at ST. ANDREW'S EPISCOPAL SCHOOL

leading research throughout a division/school/district

MBE Research Informed School Leader Strand

MBE Research Informed Teacher Strand



developing a culture of being a research-informed school/teacher

looking independently at research and conducting classroom-based disciplined inquiry to gauge impact

understanding the teacher, adult learner's brain and effective professional development

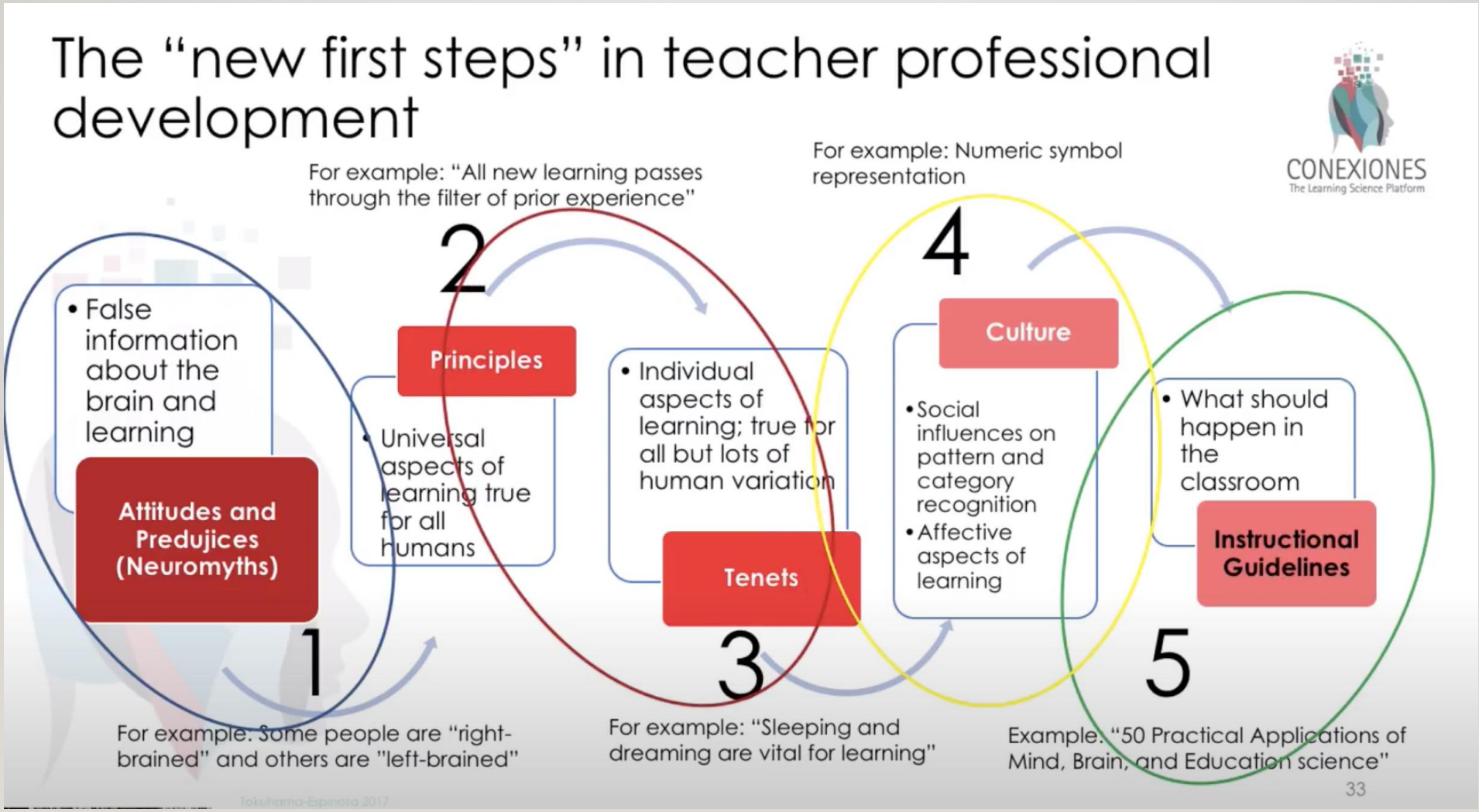
discipline, grade-level specific application of MBE research

"Leadership is second only to teaching among school influences on student success."
-The Wallace Foundation, "How Leadership Influences Student Learning"

"Teaching without an awareness of how the brain learns is like designing a glove with no sense of what a hand looks like. If classrooms are to be places of learning, then the brain–the organ of learning–must be understood and accommodated."
-Hart, Human Brain and Human Learning

brain plasticity, mindsets, emotion and cognition, social and emotional learning (SEL), neuromyths and neuroanatomy

PRINCIPLES


The "new first steps" in teacher professional development
CONEXIONES
The Learning Science Platform
For example: "All new learning passes through the filter of prior experience"
For example: Numeric symbol representation
• False information about the brain and learning
Attitudes and Predujices (Neuromyths)
1
2
Principles
• Universal aspects of learning true for all humans
• Individual aspects of learning; true for all but lots of human variation
Tenets
3
4
Culture
• Social influences on pattern and category recognition
• Affective aspects of learning
• What should happen in the classroom
Instructional Guidelines
5
For example: Some people are "right-brained" and others are "left-brained"
For example: "Sleeping and dreaming are vital for learning"
Example: "50 Practical Applications of Mind, Brain, and Education science"
33

Principles about *human* learning …

CONEXIONES
The Learning Science Platform

1. **UNIQUENESS:** Human brains are unique as human faces. While the basic structure of most humans' brains is the same (similar parts in similar regions), no two brains are identical. The genetic make-up unique to each person combines with life experiences and free will to shape neural pathways.

How does this information impact teaching?

CONEXIONES
The Learning Science Platform

- Testing requirements?
- Standards vs. Mastery or Standards and Mastery?
- In a related principle, the flipped classroom addresses the fact that ***not all brains are equally good at all things***, and therefore **some will need more rehearsal** on certain concepts, while others will need more attention to different points.

Policy change: Differentiated evaluation processes; flipped classroom flexibility?

Principles about *human* learning …

2. **DIFFERENT POTENTIALS:** Each individual's brain is differently prepared to learn different tasks. Learning capacities are shaped by the context of the learning, prior learning experiences, personal choice, an individual's biology and genetic make-up, pre-and peri-natal events, and environmental exposures.

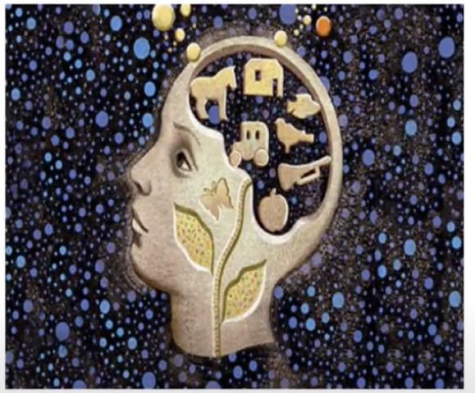
How does this information impact teaching?

Principles about *human* learning …

3. **PRIOR EXPERIENCE:** New learning is influenced by prior experience. The efficiency of the brain economizes effort and energy by ensuring that external stimuli are first decoded, compared, both passively and actively, with existing memories.

How does this information impact teaching?

- Do you know your students well enough to capitalize on their past experiences and make the teaching moment authentic in their lives?



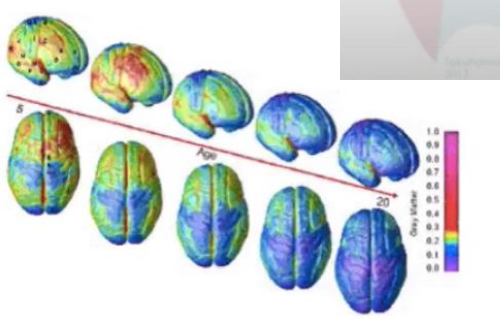
How does this information impact teaching?

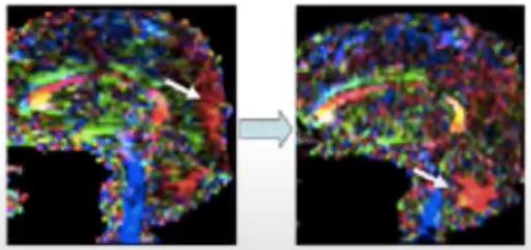
- Are we permitting learning cycles to run their course, or do we expect too much too fast?
- Are we providing enough opportunity/time for rehearsal for all students in the class, even those with little prior knowledge?

http://courseimage.com/90224-learning-cycle

Principles about *human* learning …

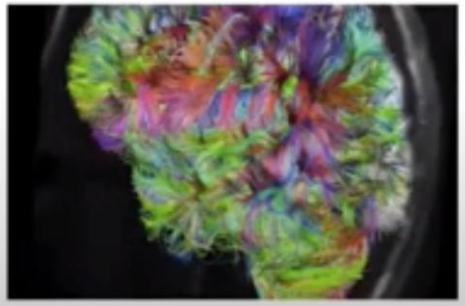
4. **CONSTANT CHANGES IN THE BRAIN:** The brain changes constantly with experience. The brain is a complex, dynamic, integrated system that is constantly changed by individual experiences. These changes occur at a molecular level either simultaneously, in parallel, or even before they are visible in behavior.





Principles about *human* learning …

5. **PLASTICITY:** The brain is plastic. Neuroplasticity exists throughout the lifespan though there are notable developmental differences by age.



How does this information impact teaching?

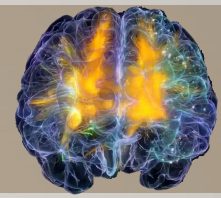
- Do you believe that all of your students can learn (and that few, if any, are incapable of improvement)?
- Learning is fluid, not fixed.

Principles about *human* learning …

6. **MEMORY+ATTENTION=LEARNING:**
There is no new learning without some form of memory and some form of attention. Most school learning requires well-functioning short, working and long-term memory systems and conscious attention. However, procedural learning, habituation, sensitization and even episodic memory can occur without conscious attention.

How does this information impact teaching?

- Are you creating the appropriate learning environment in class to ensure that positive emotions rein and that negative ones are reduced to a minimum?



The end!