Brain Research Is Popular!

- Researchers, teachers and parents are looking for evidence of "what works" in helping children to be successful in school.
- Brain Research a popular basis for justifying instructional approaches & educational technologies.
- Touting "brain research" sells new curriculums and books.
- Many of the popular beliefs about "brain functions" are not correct, incomplete, or simply wrong.

Brain Myths:

- You Only Use 10% of Your Brain
  www.csicop.org/si/9903/ten-percent-myth.html
  - Resulted in 42,600,000+ sites for "you only use 10% of your brain".
  - Very popular topic.
  - But research does not support this view....

Medical Myths Even Physicians Believe
ScienceDaily (Dec. 21, 2007)

- People only use 10 percent of their brains.
- Hair and fingernails continue to grow after we die.
- Eating turkey makes you sleepy.
- People should drink at least eight glasses of water a day.
- Shaving hair cause it to grow back faster or coarser.
- Reading in dim light ruins your eyesight.

These are myths – there is no definitive research support.
People make things up.

Brain Myths:
The Learning Process Takes A Long Time

[Graph showing pretest and posttest with two wavy lines, one with a steeper curve labeled to the other.]

Hollins, Hume & Peters, 1986

****
10 min delay for 5 days.
Dynamic Brain Development

Brain components develop at different rates, different times at every level of nervous system.

- Brain anatomy
- Cortical layers
- Gray (Neuron) & White (Fiber Tracts) Matter
- Functional interactions change
- Synaptic density
- Impact of Developing neurons

How To Be A Brain Myth Buster III

- Ask whose research is being referenced
- Ask where the research is published (science/education journals)?
- Ask for details, not just generalization
- Make Google one source of information for gathering facts

Gross Brain Anatomy Changes During Development
Neuron Structure & Density Change With Age

From Conception Different Brain Regions Grow at Different Rates

Growth Rates of Neurons (Gray) & Nerve Tracts (White) Change Across The Lifespan

Synaptic Density in Auditory, Visual & Prefrontal Cortex
Summary - Brain Development

Brain components develop at different rates, different times at every level throughout the lifespan.

a. Anatomical brain changes occur at different rates, times
b. Cortical layers
c. Gray Matter & White Matter
d. Interactions between different layers, structures & regions
e. Synaptic density differs by layer & region
f. Developing neurons impact neural functioning

Overall Brain-Behavior Development Model

Divergence - Convergence - Emergence

DIVERGENCE - Brain development proceeds at different rates across the brain at different times

CONVERGENCE - At different points in time increasing integration between neural areas and cognitive dimensions they support occurs

EMERGENCE - New levels of integration, increases in processing speed, reductions in neurocognitive effort, increasing plasticity
Static and Dynamic Views of Cognitive Skills

- Static views are prevalent
  - Diagnostic labels - "dyslexia" or "struggling" readers
  - Brain sites (left brain, prefrontal lobe, "10% of your brain")
  - Domains, such as language skills, reading skills
- Dynamic views should be more prevalent
  - Diagnostic labels are expected to change with intervention (dyslexia, ADHD, autism): this is the expectation
  - Intervention should lead to changes in brain function and functional "efficiency"

Questions To Ask: Why Are There Persistent Reading Differences?

Summary from Joseph Torgesen

- Struggling readers miss opportunities to learn to recognize individual words and words in context — they read inaccurately and they don’t read very much.
- By 3-4 grade, their "sight word vocabulary" is severely restricted compared to good readers the same age.
- After they become more accurate readers, there is a huge gap in the number of words they can recognize by sight.
- They can’t catch up because good readers are continuing to add words to their sight vocabulary at a fast rate.

Maximizing Skilled Reading - Many Skills Are Involved

Questions To Ask: What Matters Most In Understanding How Reading Begins?

- What we know about reading from research
  - Practice is important
  - Good reading requires
    - Accurate perception of phonemes (speech sounds)
    - Linking phonemes to letter symbols (encode), and recognizing those letter symbols as phonemes (decode).
    - Oral Language Skills - vocabulary, language knowledge, reasoning
Dynamic System View

- Changes in speech perception skills and phonological processing skills in beginning readers (or younger) impact the development of language and reading skills.

- Information processing during reading is reflected in brain processing.

- Differences in reading skills is reflected in brain processing.

What Do We “Know For Sure” About Early Brain Activity & Later Language?

Event-Related Potential – ERP

Event-related potential (ERP) reflects the neural processing in the brain.

Rapid temporal information (ms) developmentally sensitive correlates with cognitive abilities predictor of later development.
Long Known That Brain Responses of Reading Impaired Children Differ From Normal Readers

8- and 12-Year Olds Reading 4-Letter Words

Right Ear Dominant  Left Ear Dominant

Findings from Longitudinal Studies

- Infants were recruited at birth
- Children were tested yearly on their birthdays - or within 2 weeks - on behavioral assessments of cognitive skills and ERP measures of speech perception
- Parents provided information on home activities, child health, and demographics.

The Question is

How early do such difference occur in development and can we do anything to bring about change?
Methods

Infants < 36 hours, re-tested yearly
CV syllables: (Set 1) bi, di, gi
ba, da, ge
bu, de, gu
(Set 2) ba, ge + 2 NSP controls

- Duration = 50 ms + 250 ms
- Intensity = 80 dB SPL (A), Free field, Varied ISI (3 - 8 sec.)
- Blocked random order (25 repetitions)
- Procedures: Electrodes referred to linked ears (A1, A2);
  Matched impedances < 5 k Ohm, IEI < 1 k Ohm

8-Year Olds' Responses to Speech & Later Reading Skills

Newborn Responses to Speech Predict Later Reading Skills

Newborns vs. 8-year-olds' responses to speech and later reading skills. (Pictures of 3 line graphs showing the performance at 8 years of age.)
Predicting Language Skills Become Easier With Age: Speech Processing Becomes More Automated

Finding from Other Laboratories Also Show Links Between Early Brain Responses to Speech and Later Language Skills
Familial Risk & 5 Year Olds

Children with familial risk of dyslexia were identified using parental responses to a multiple-choice Parental Learning History Questionnaire.

N = 20, 14 males, Mean age = 61.6 months (SD=7.39)

10 Risk Children’s parents indicated history of reading & writing difficulties.

ERPs recorded to speech syllables.

Regression analyses indicated strong relationship between the ERP responses to speech and familial risk.

| Model | N | Age | Speech | Reading | Writing | RH | LH | Regression
|-------|---|-----|--------|---------|---------|----|----|----------------
| 1     | 20 | 61.6|        |         |         | 0.39| 0.46| Regression model summary.

Take Away Message

Brain responses at birth differ between normal developing children and children at risk for later reading and language problems.

Such differences persist into adolescence.
Concurrent Study of Reading Skills: Evidence of Processing Differences

- School District contact
- New reading program was planned
- Children and families with different reading skills wanted to understand how reading skills could be impacted by the new program

Children Participating  N = 27

<table>
<thead>
<tr>
<th>Reading Groups</th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above (2 years +)</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Average</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Below (2 years -)</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

Ages: 9 yrs. 3 mos. - 12 yrs. 1 mos.

Word & Non-word Reading Task

Examples:

- BAG
- KAT
- DAK
Take Away Message

Automatic processing in normal readers - some brain areas involved trial to trial (stable, less effort, faster)

Struggling readers invent new ways to process from trial to trial (unstable, more effortful, slower)

Difficult for poorer performing children to make transition to more automated, consistent and faster processing

- Result is usually accurate decoding for simple tasks BUT at cost of poor fluency & comprehension

Impact of Brain Organization on Acquiring Other Skills

- Preschoolers differing in literacy skills were engaged in a brain study involving discrimination of shapes

- Hypothesis - do children with different emergent literacy skills also exhibit differences in brain organization on an unrelated task?

GET READY TO READ (GRTR)

http://www.getreadytoread.org/

Screening scale for 4 year olds
Child points to one of four pictures in response to a question

Taps
- phonological skills
- letter/sound/word recognition
- literacy (book knowledge, writing conventions)

Shape Matching Task

Same

Different

Matthew et al, Hyman
Take Away Message

Differences in speed of processing - 1/2 sec difference between when brain responses occur for children with different prereading skills when making SHAPE judgements.

Prior experiences (learning) change the brain's organization so that NEW tasks and skills are mastered differently and engage different brain networks.

Normal Reading Development

Normal Learning Time 1

Normal Learning Time 2

Brain Model For Concept & Skill Acquisition
Normal Learning Time 3

Normal Learning Time 4

Normal Learning Time 5

Normal Learning Time 6
At Risk Reading Development

Impaired Processing Time 1

Impaired Processing Time 2

Impaired Processing Time 3

Impaired Processing Time 4
No Transition to Fewer Areas Engaged, With Predictable Temporal Links Between Areas

Impaired Processing Time 4

Impaired Processing Time 5

Impaired Processing Time 6

The Learning Process & the Brain

**The Learning Process & The Brain**

- **Initial Learning**
  - Extensive but unstable multi-area involvement
  - Temporally disorganized
- **Intermediate**
  - Area involvement reduced but some instability
  - Temporal relationships more stable
- **Expert Level**
  - Further area reduction
  - Temporal and spatial relationships stable
  - Increased speed
  - Organizational flexibility
When to Intervene?
As Early As Possible

Early intervention should apply to all at risk for developmental disabilities.

Implications - Brain-Behavior Development

Individual differences (resilience) impact behavior variations in response to environmental and neural factors.

Different neural organizations can produce similar behavior patterns.

Sensory information processing issues impact cognitive and neural development (which impact use of sensory information).

Implications - Brain-Behavior Development

Acquisition of new skills alters brain-cognitive organization and impacts:
- brain areas involved
- brain organization and efficiency for acquiring new skills

Environmental, physiological and cognitive changes impact genetic expression (phenotype).

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QUESTIONS ???

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