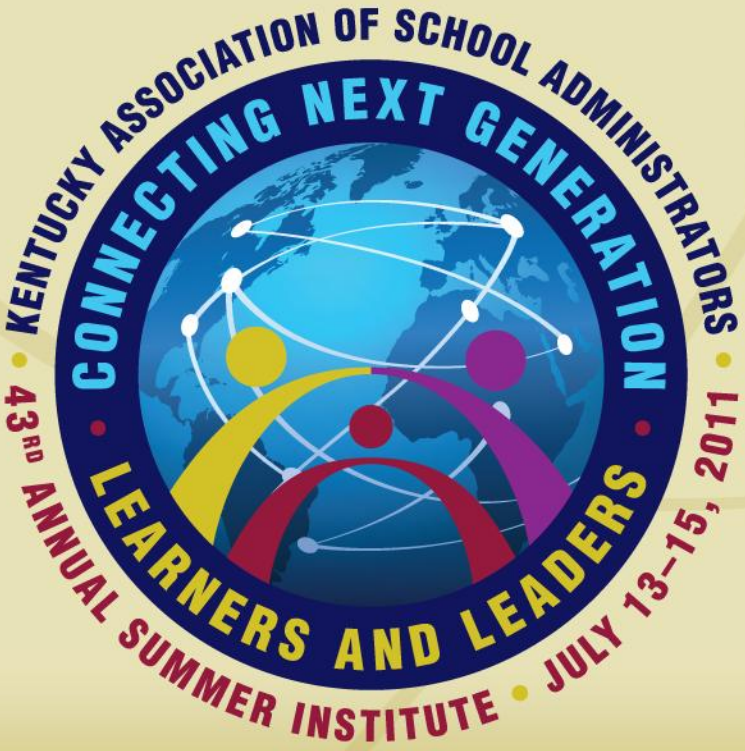
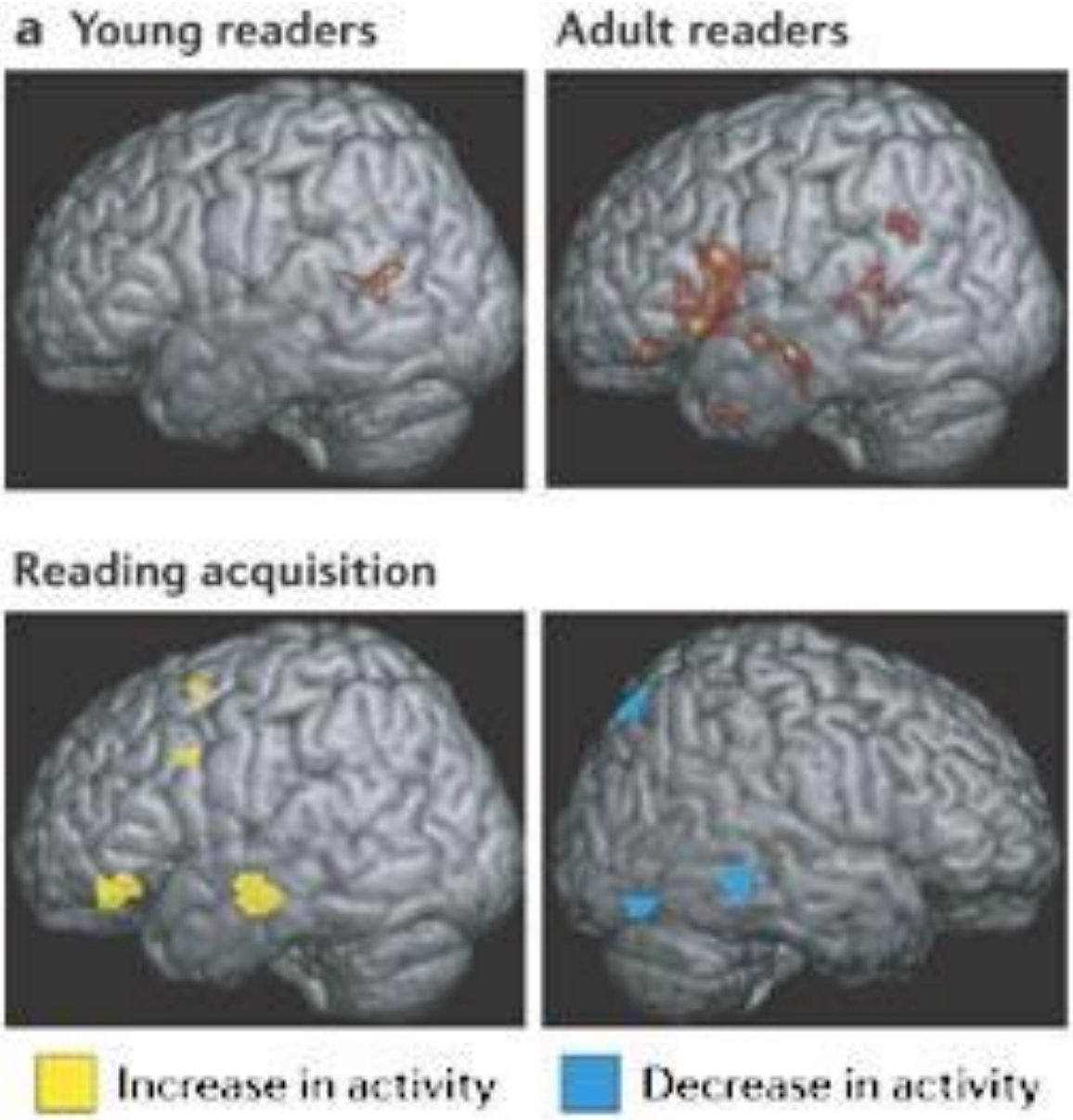
WELCOME

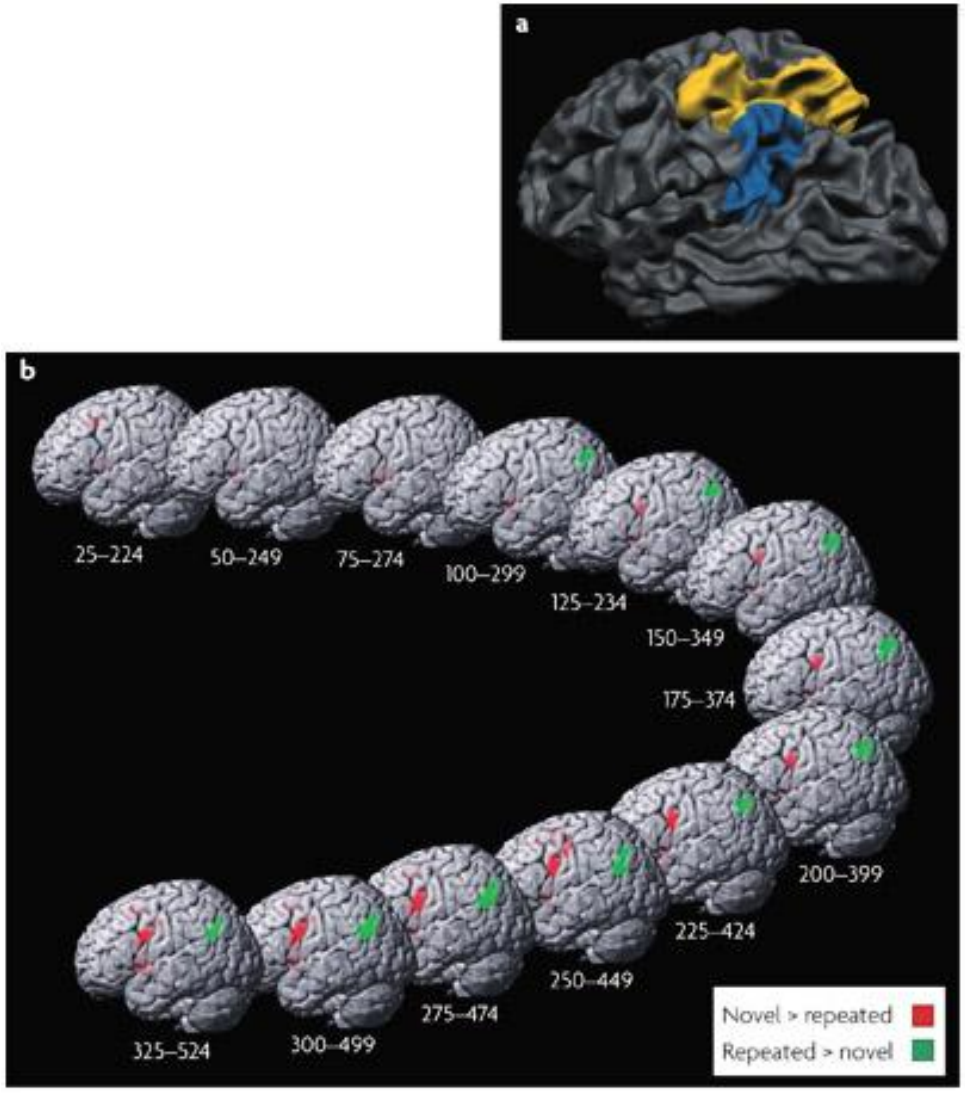
Neuroscience as a Foundation for Educating the Next Generation Learners: Including Possible Dropouts





Turkeltaub et al *Nature Neuroscience* 2003

nature REVIEWS NEUROSCIENCE



Nature Reviews | Neuroscience

a | Training for arithmetic problems leads to decreasing engagement of the inferior parietal cortex (shown in yellow) and increasing recruitment of the angular gyrus (shown in blue).

b | a moving time window of 200 scans and reveals that there are significant changes in activity of the angular gyrus (shown in green) after only approximately 8 repetitions of a problem

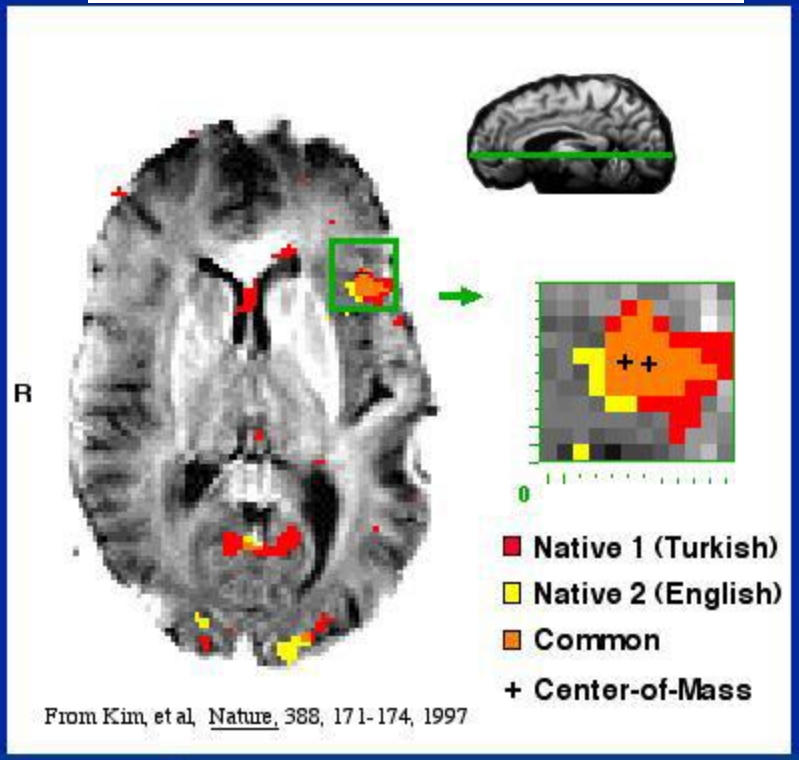
ELL

- Need to build the ability to perceive internal detail to words
- Phonics instruction is a much less transparent in English than many other languages
  - Much easier to learn to read Spanish than English (DeHaene, 2009)

Second Language Learning

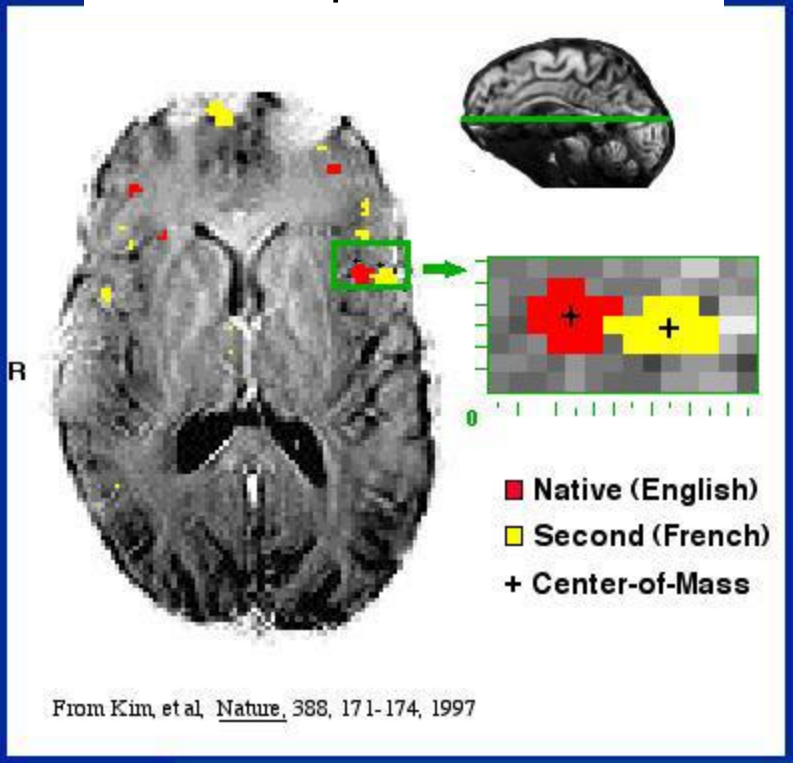
- Affects the way the brain is organized for language
- Differs depending upon when the second language is learned
- After the critical period requires the same developmental criteria as the first language

Learning a second language during the critical period



From Kim, et al, Nature, 388, 171-174, 1997

Learning a second language after the critical period



From Kim, et al, Nature, 388, 171-174, 1997

Richardson and Price, 2009

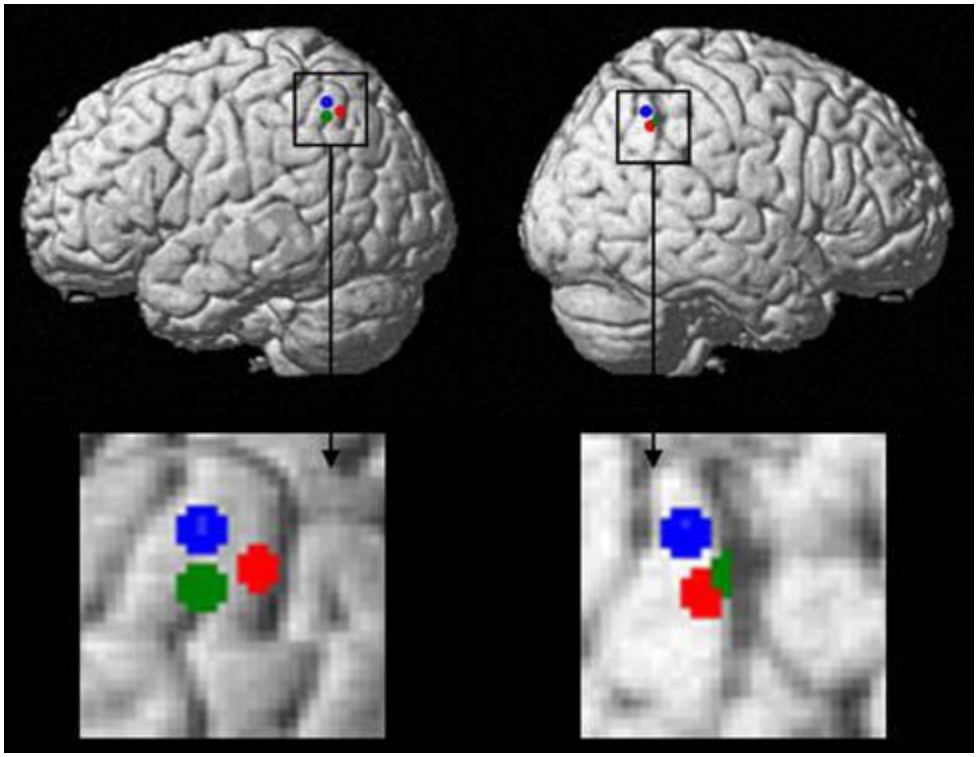


Fig. 1 Structural variance with vocabulary knowledge in the posterior supramarginal gyrus. Locations of the peak co-ordinates from the following studies: red Mechelli et al. (2004), blue Lee et al. (2007), and green Richardson et al. (2009).

The correlation of vocabulary knowledge with grey matter in the left posterior supramarginal gyrus in teenage years, but not later in life, suggests that **this region is engaged in learning more typically exploited within formal education**, e.g.learning to link new words with specific lexical equivalents.

Ability to easily learn a foreign language (Richardson and Price, 2009)

- Those who were able to learn an unknown foreign language
  - showed a greater **left hemisphere** asymmetry in the parietal lobes
  - and also had **more white matter** (fiber tracts) in left hearing and language temporal lobe region
    - Affirms other research that found **increased grey matter** in the auditory cortex in those with good auditory perception
      - Also observed in musicians (Gaser and Schlaug 2003; Schneider et al. 2002)
      - as well as for those with an aptitude for learning tonal languages such as Mandarin, where pitch is particularly important for distinguishing between words (Wong et al. 2008)

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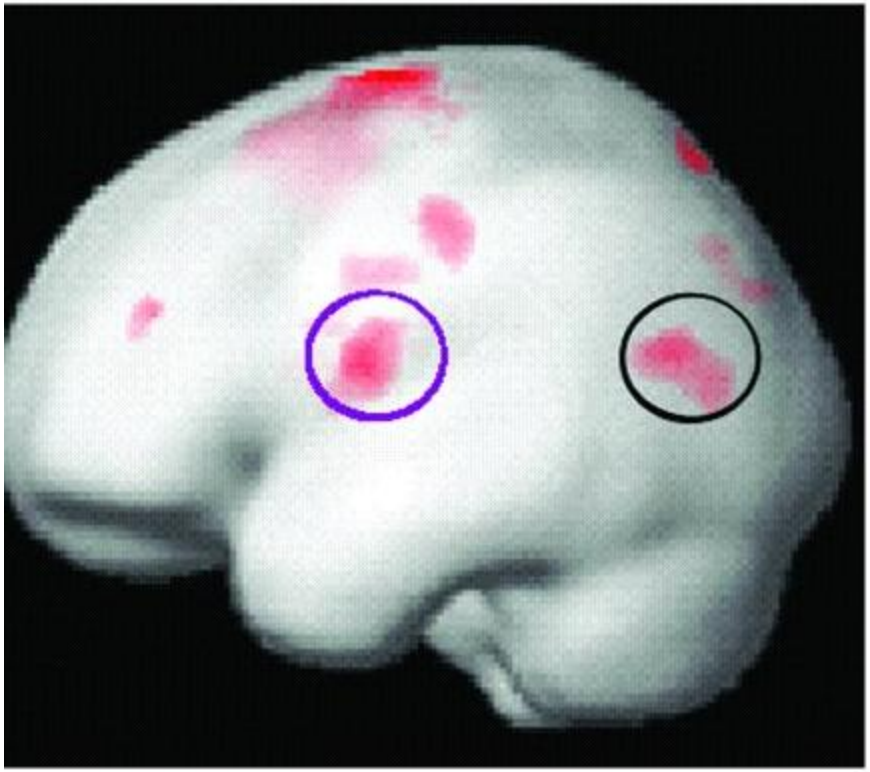
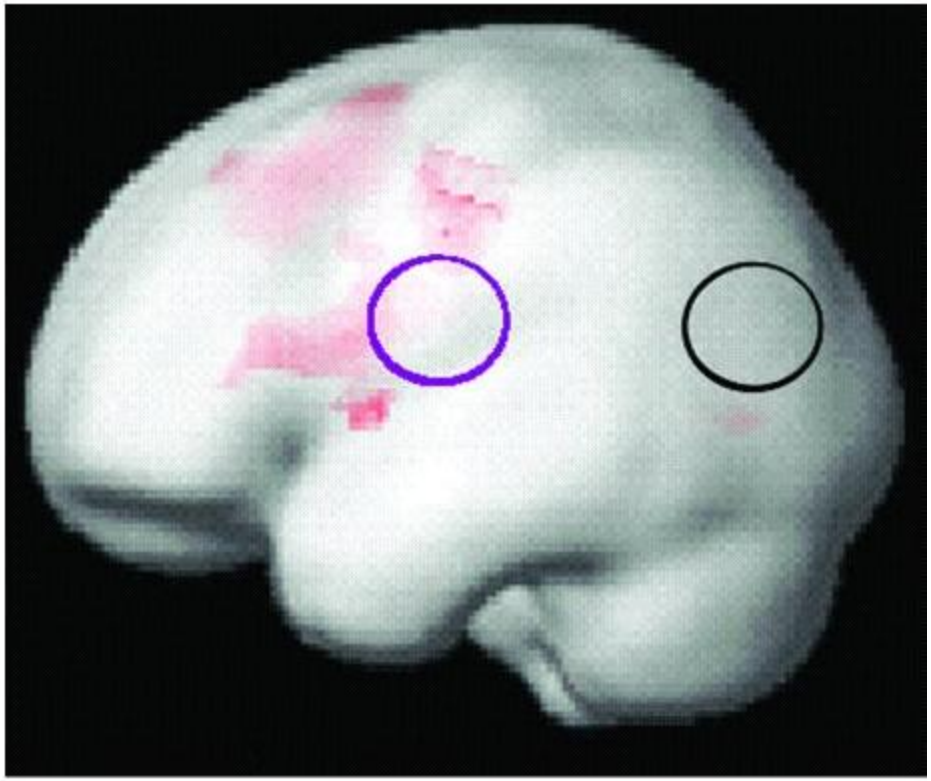
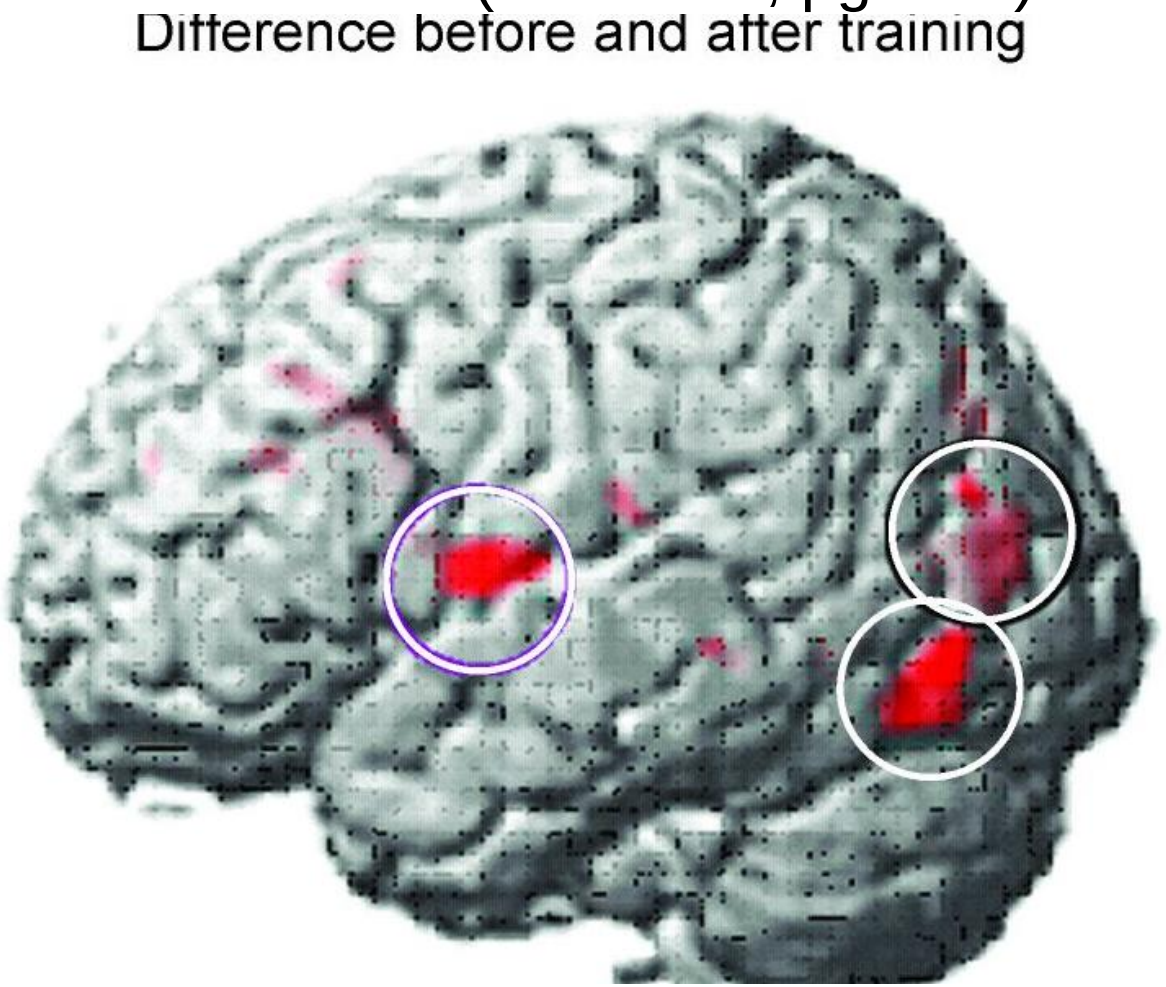
Normal readers



Dyslexics
before training

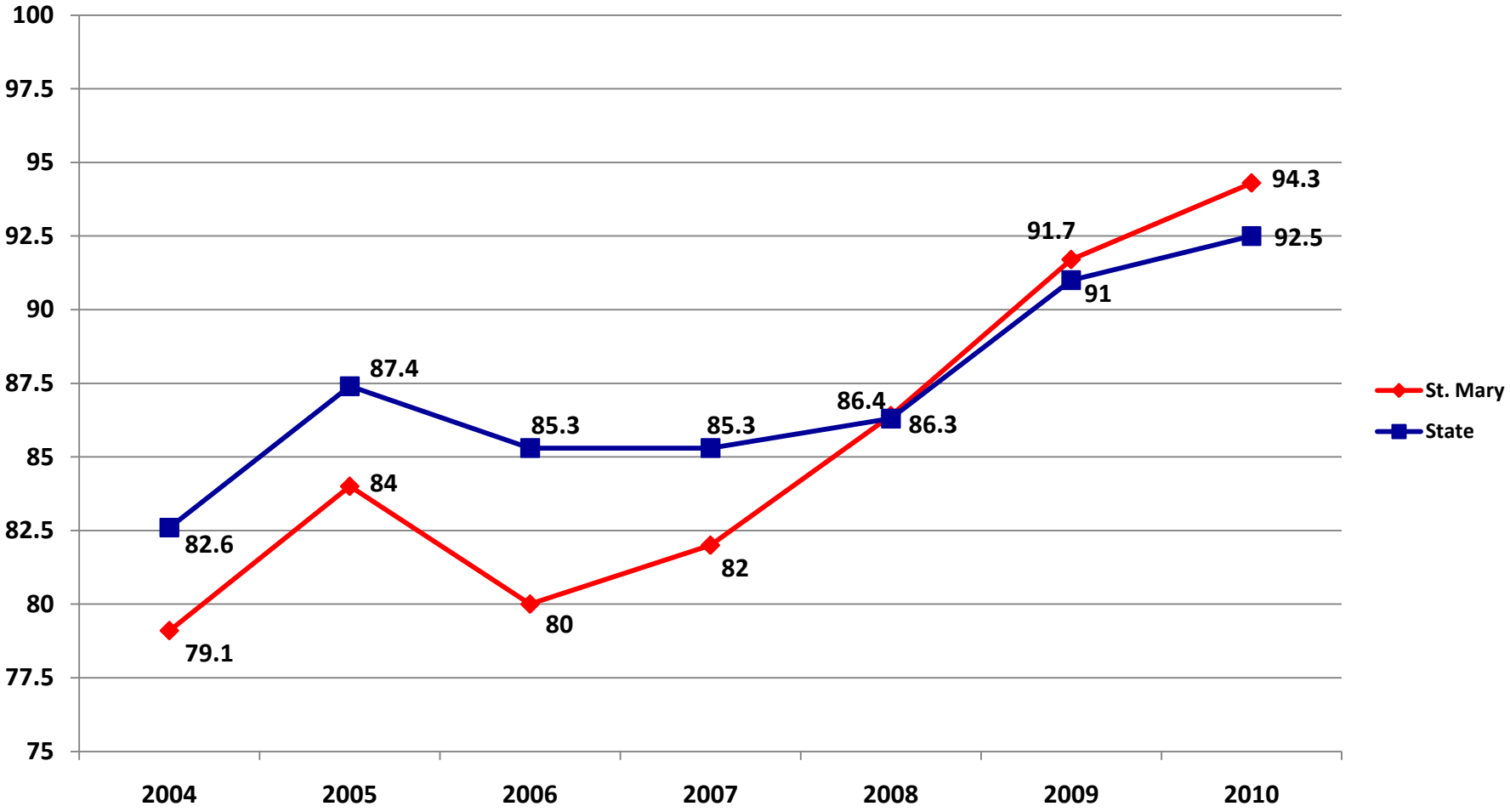


And so, what is the intervention for the left temporal and frontal deficits (DeHaene, pg. 260)?



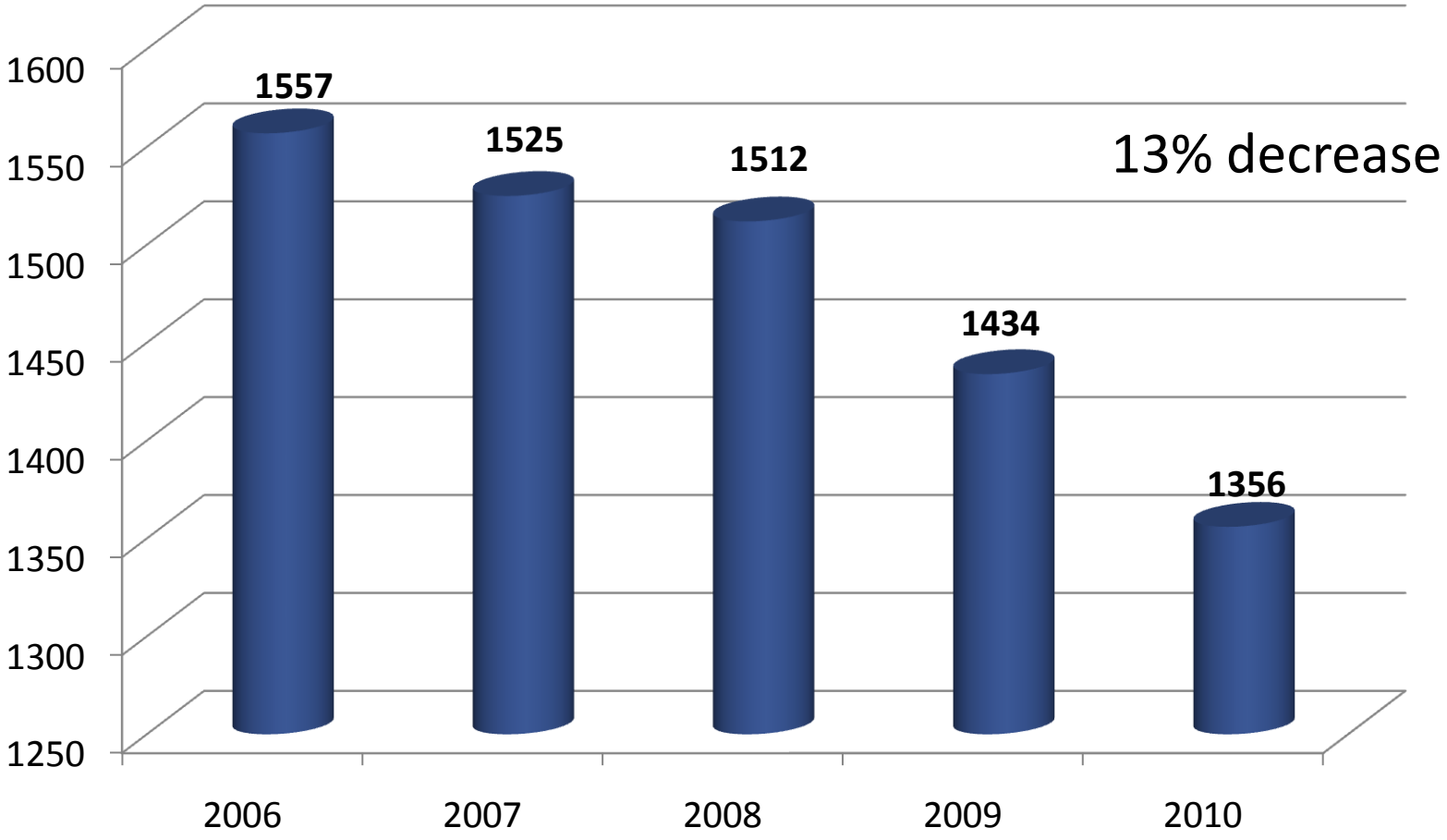
St. Mary Parish District Performance Score (DPS)

Plotted Against State Average

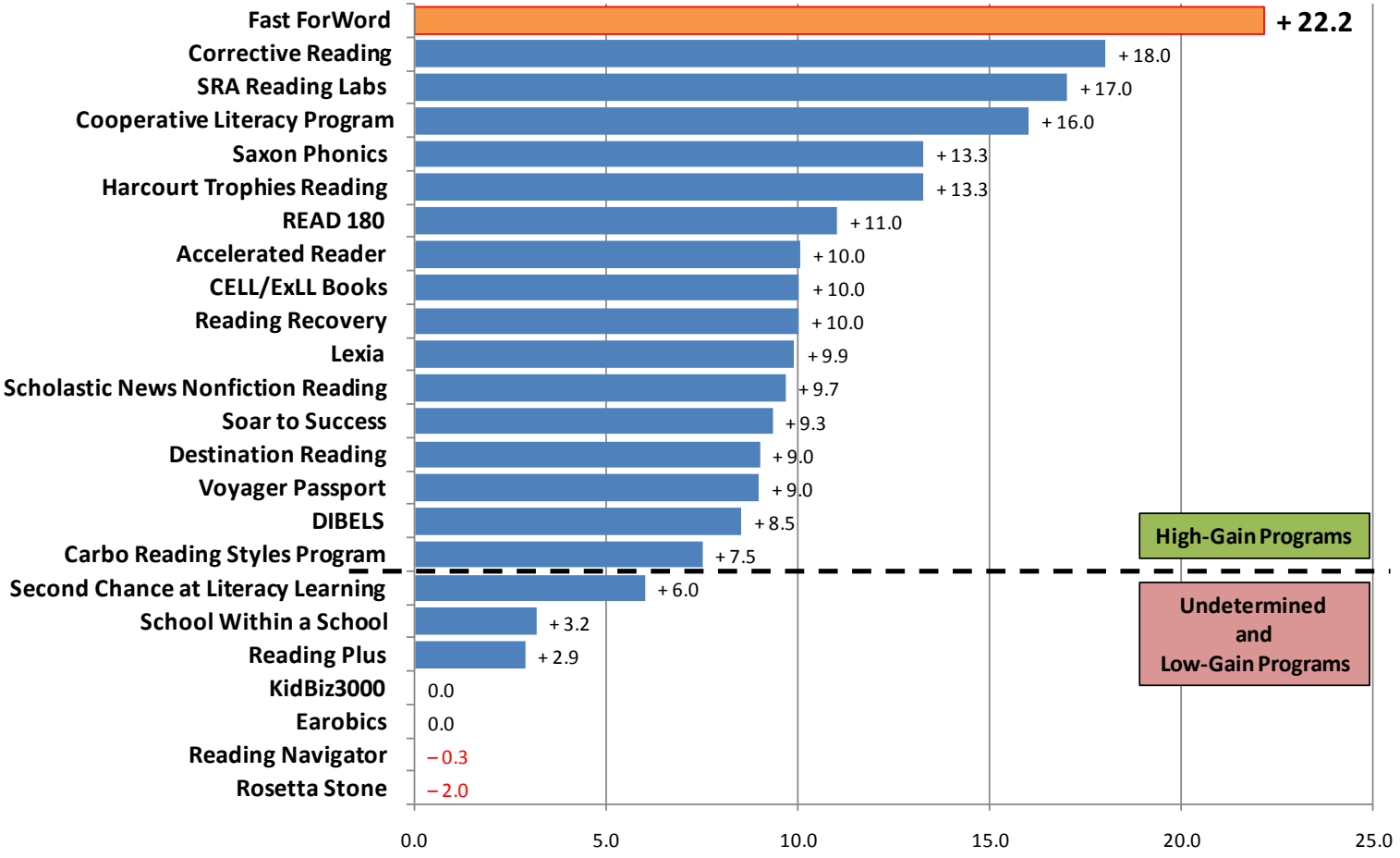


Students Being Served By Exceptional Children Program

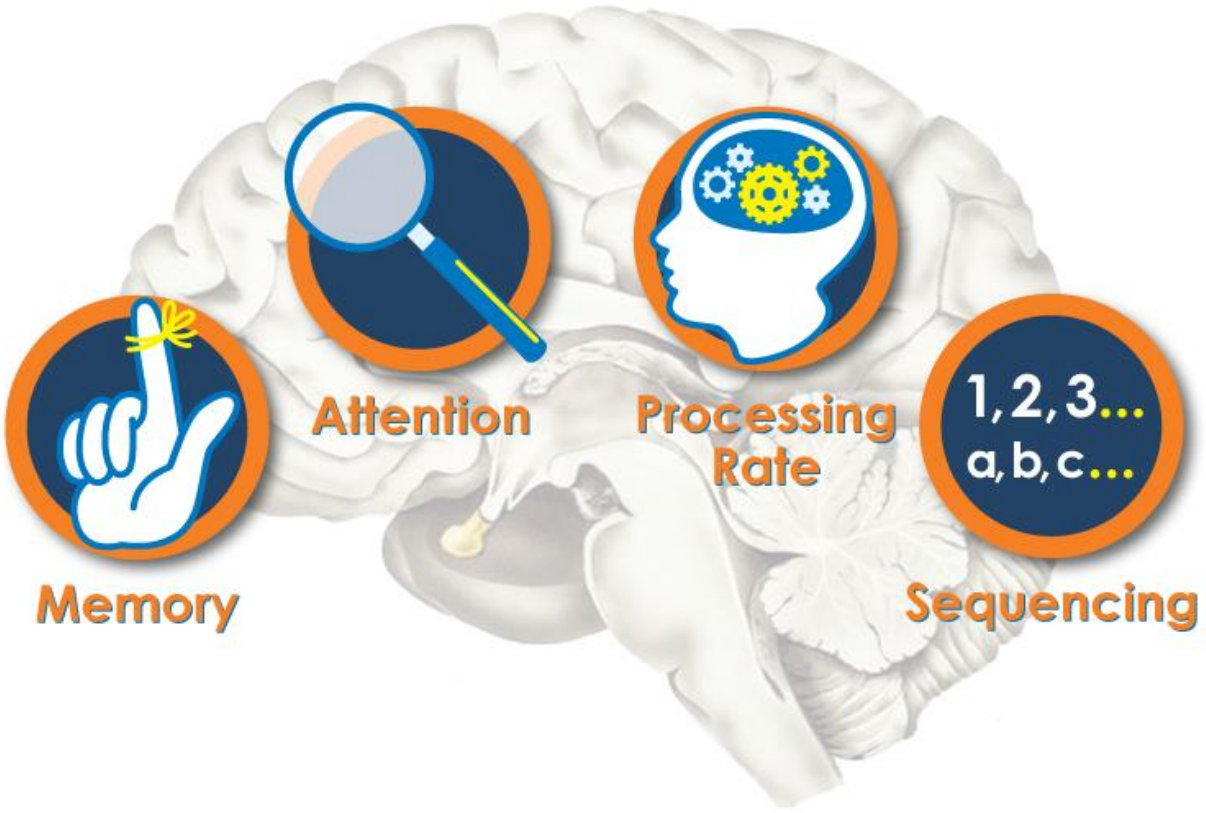
(No. of students excluding Gifted and Talented)



Mean Student Achievement Gain
Percentage Points (Longer Bars are Better)



Brain Fitness



Memory

Brain Fitness: Word List Challenge

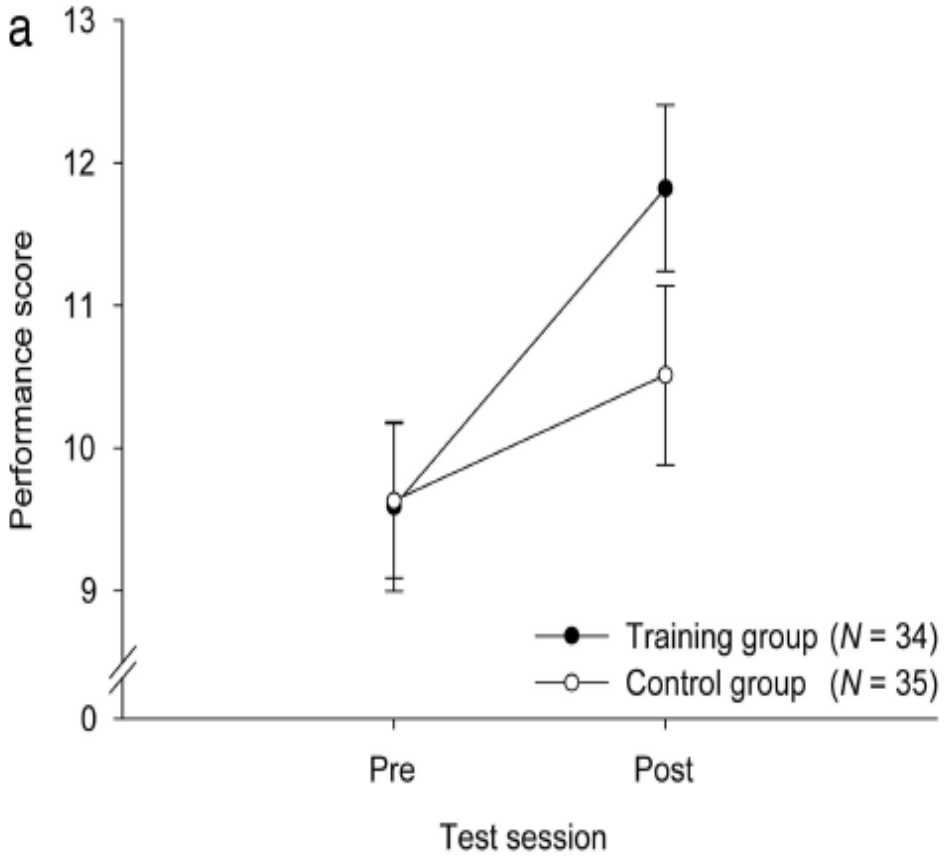
Now write down as many words as you can recall. You have one minute.

Improving fluid intelligence with training on working memory

Susanne M. Jaeggi*†‡, Martin Buschkuehl*†‡, John Jonides*, and Walter J. Perrig†

Proceedings of the National Academy of Sciences

May, 2008



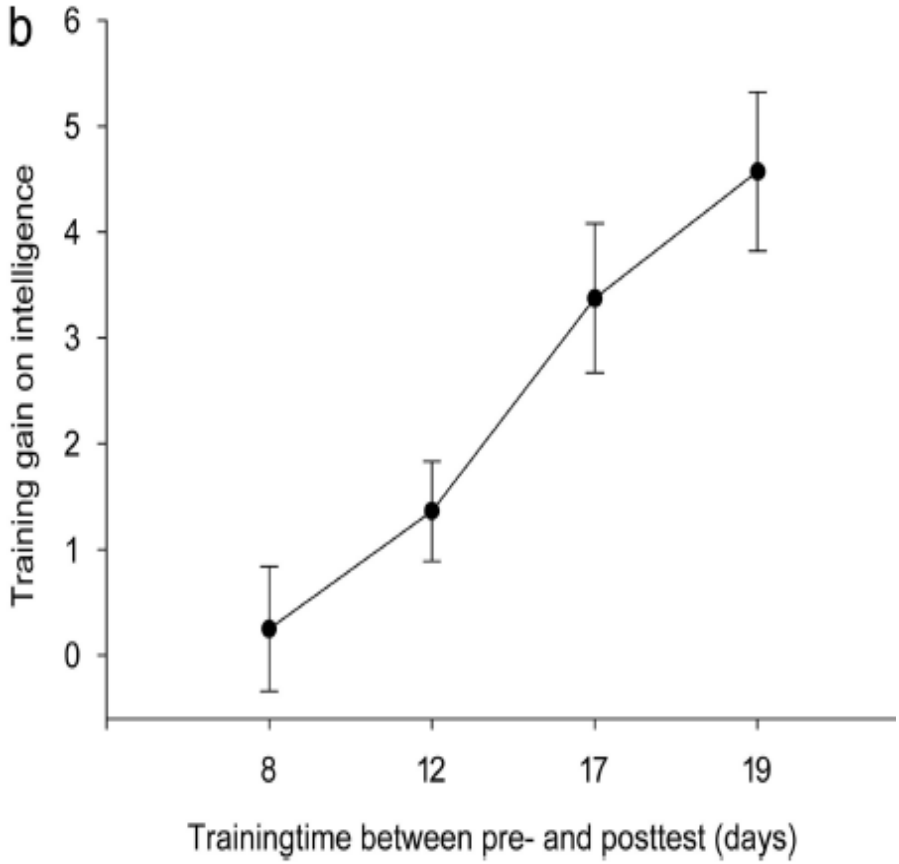


Fig. 3. Transfer effects. (*a*) Mean values and corresponding standard errors of the fluid intelligence test scores for the control and the trained groups, collap
over training time. (*b*) The gain scores (posttest minus pretest scores) of the intelligence improvement plotted for training group as a function of training t
Error bars represent standard errors.

How working memory problems present in the classroom

- Slow on multiple choice tests even though they know the material
- Re-read passages frequently
- Trouble with memorization activities but get the key ideas
- Take much longer to complete homework and in class assignments
- Word-finding problems
- Problems with spelling

Classroom activities that improve working memory

- Practice one-time chance for information
  - multiple choice questions without ability to re-read questions
    - Put a question on the board, projector or computer screen then remove the question
    - Show one answer at a time, again removing
    - Do not allow students to make notes
  - Then have students practice on their own

Jane is older than Susie
Susie is older than William.
Lily is older than William but younger than Jane.
Betsy is older than Susie but younger than Lily.

Who is the youngest?

A. William
B. Lily
C. Susie
D. Can’t tell from the information given

Who is the oldest?

A. Betsy
B. Lily
C. Jane
D. Can’t tell from the information

Which is the correct family order?

A. Jane, Betsy, Lily, Susie, William

B. Jane, Lily, Betsy, Susie, William

C. Jane, Lily, Susie, Betsy, William

D. Can’t tell from the information

A few things to notice from this activity

- Allowing plenty of time at the first item to make sure you have all the information is helpful
- A strategy for holding the information the first time might help – a mnemonic

Classroom activities that build working memory

- Language Arts teachers
  - Reading comprehension as long as the student cannot review the text
  - Demo Book Monkeys
- Math teachers
  - Sudoku (without notes)
  - Ken Ken
  - Word problems
- History teachers
  - Timelines (use timelines for short-term discussion and solving what-if questions)
- Science teachers
  - All lab experiments involve working memory

The key to building working memory skills is not to emphasize the outcome, but rather the process. So, don’t penalize students who struggle with working memory – rather give them opportunities to practice and be successful

Different dimensions of adult cortical plasticity are enabled by the behaviorally-context-dependent release of:

- acetylcholine (focused attention/reward) (Kilgard, Bao)
- **dopamine (reward, novelty) (Bao)**
- **norepinephrine (novelty) (Bollinger)**
- **serotonin (Bollinger)**
- **et alia**

In infants, exposure-based plasticity is relatively uniform.
In older children, learning-induced changes are complexly "nuanced" by differences in behavioral context that result in the differential release of 6 or 7 modulatory neurotransmitters.

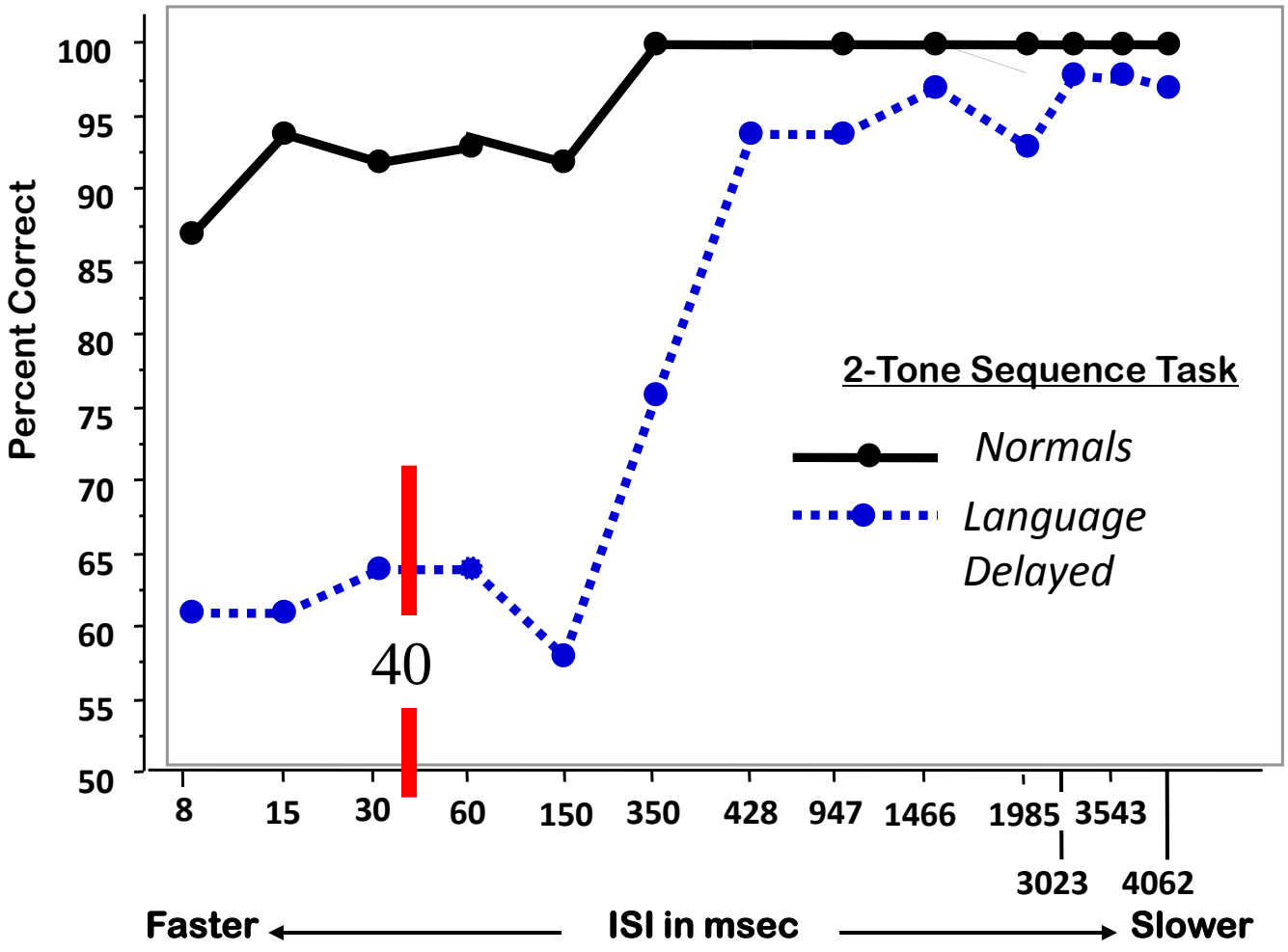
Processing

Processing Speech

- Students need to distinguish speech sounds correctly so they can learn the rules of language and associate sounds with letters
- Speech sounds can differ by as little as 10 milliseconds
- Computers can emphasize the differences in sounds to make them easier to distinguish

Scientific Learning

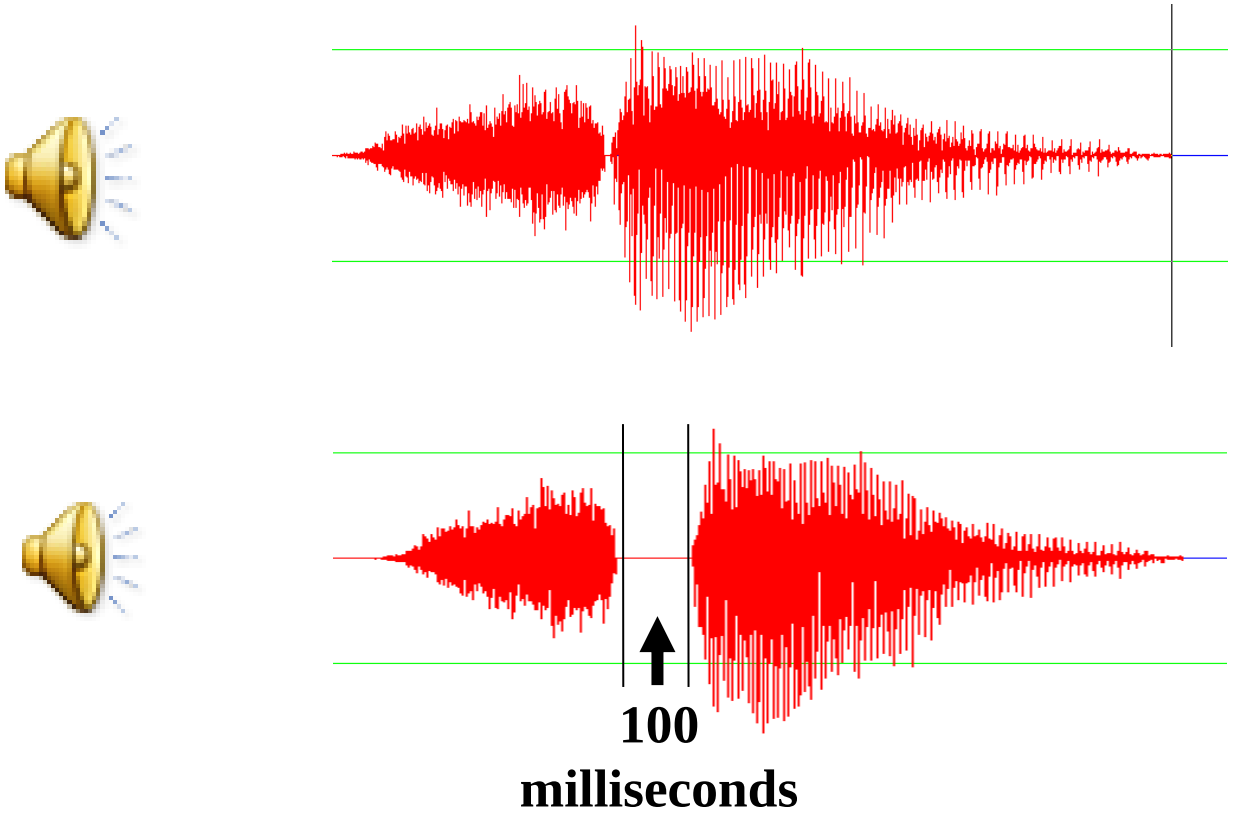
Faster Auditory Processing



Tallal, P & Piercy, M (1973) Nature, 241

Small Changes in Timing

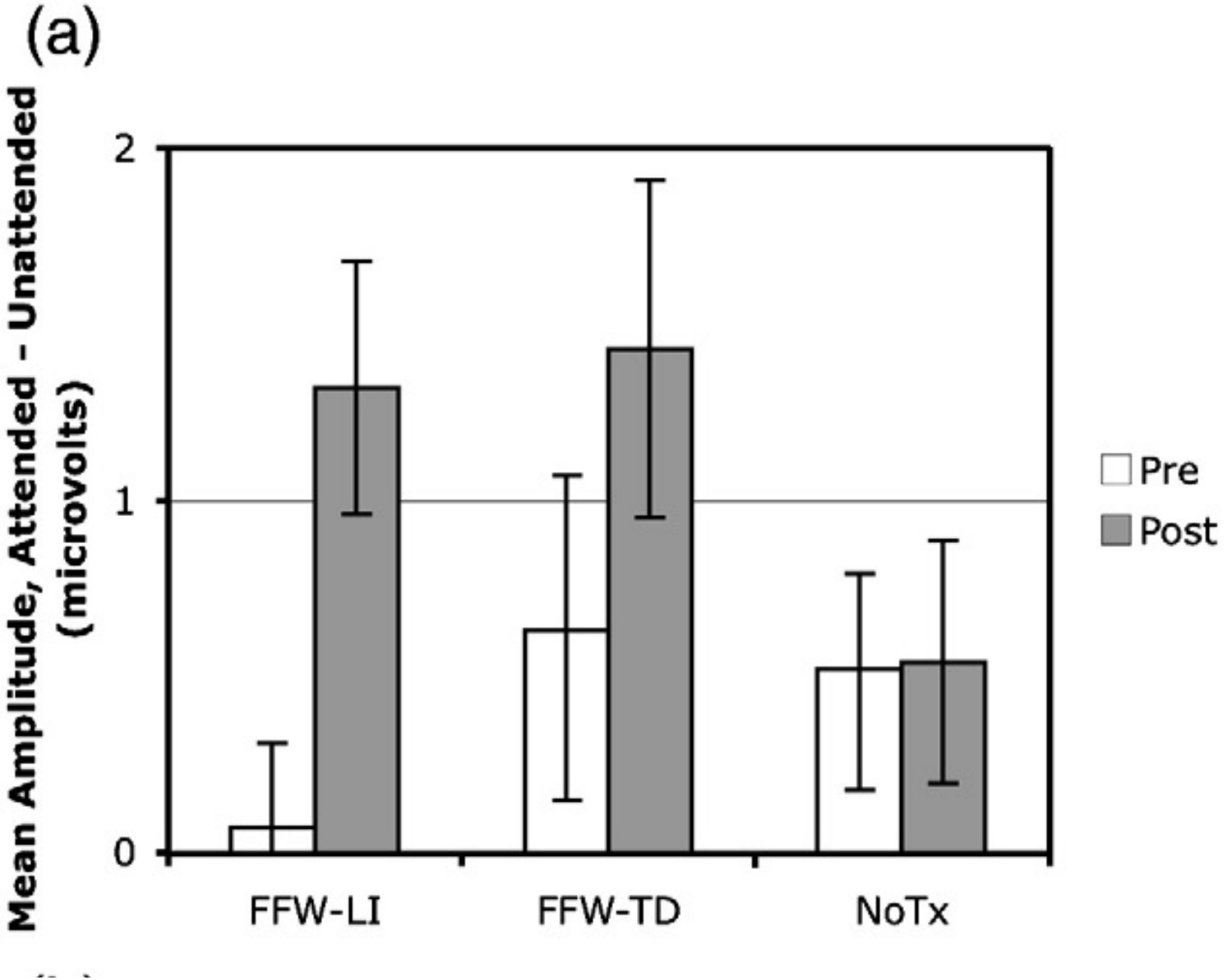
. . .Big Changes in Meaning



Attention

Neural mechanisms of selective auditory attention are enhanced by computerized training: Electrophysiological evidence from language-impaired and typically developing children

- Courtney Stevens,, Jessica Fanning, Donna Coch,, Lisa Sandersa,, Helen Neville B R A I N R E S E A R C H 1 2 0 5 (2 0 0 8) 5 5 – 6 9



ERP attention effect for the FFW-LI, FFW-TD, and NoTx control groups, separately for pre- and post-testing

Consequences in the Classroom

Problems with processing spoken language lead to difficulties with:

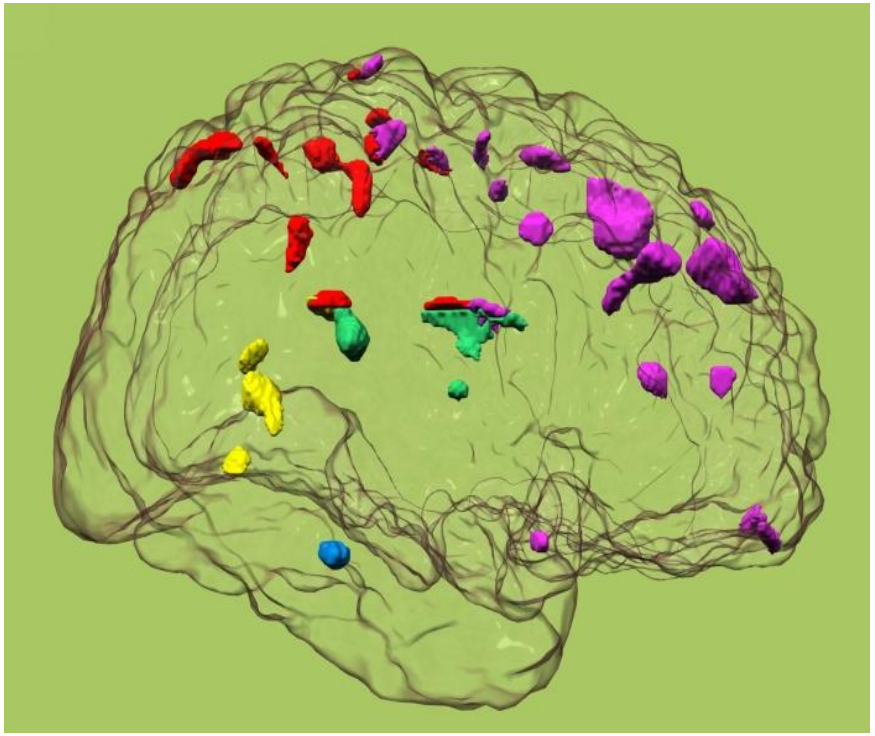
- Following directions
- Doing multiple choice tests
- Reading paragraphs
- Understanding pronouns
- Understanding embedded clauses

For written material this is exaggerated by slow labored decoding

The Learning Brain (Brain Plasticity)

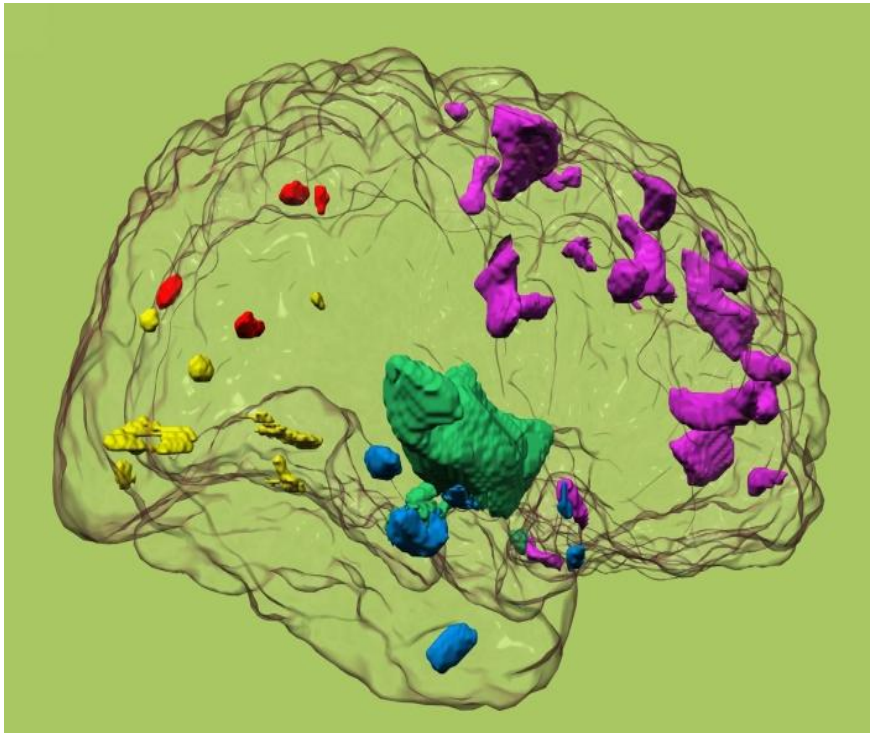
- Conditions in the brain are dynamic. They change and "rewire" at any age.
- The brain's ability to change, or be trained, is known as **brain plasticity**
- The brain can change and learn at any age, and certain conditions encourage learning

Changes in Brain Structure in Maturing Young People



Childhood to Adolescence

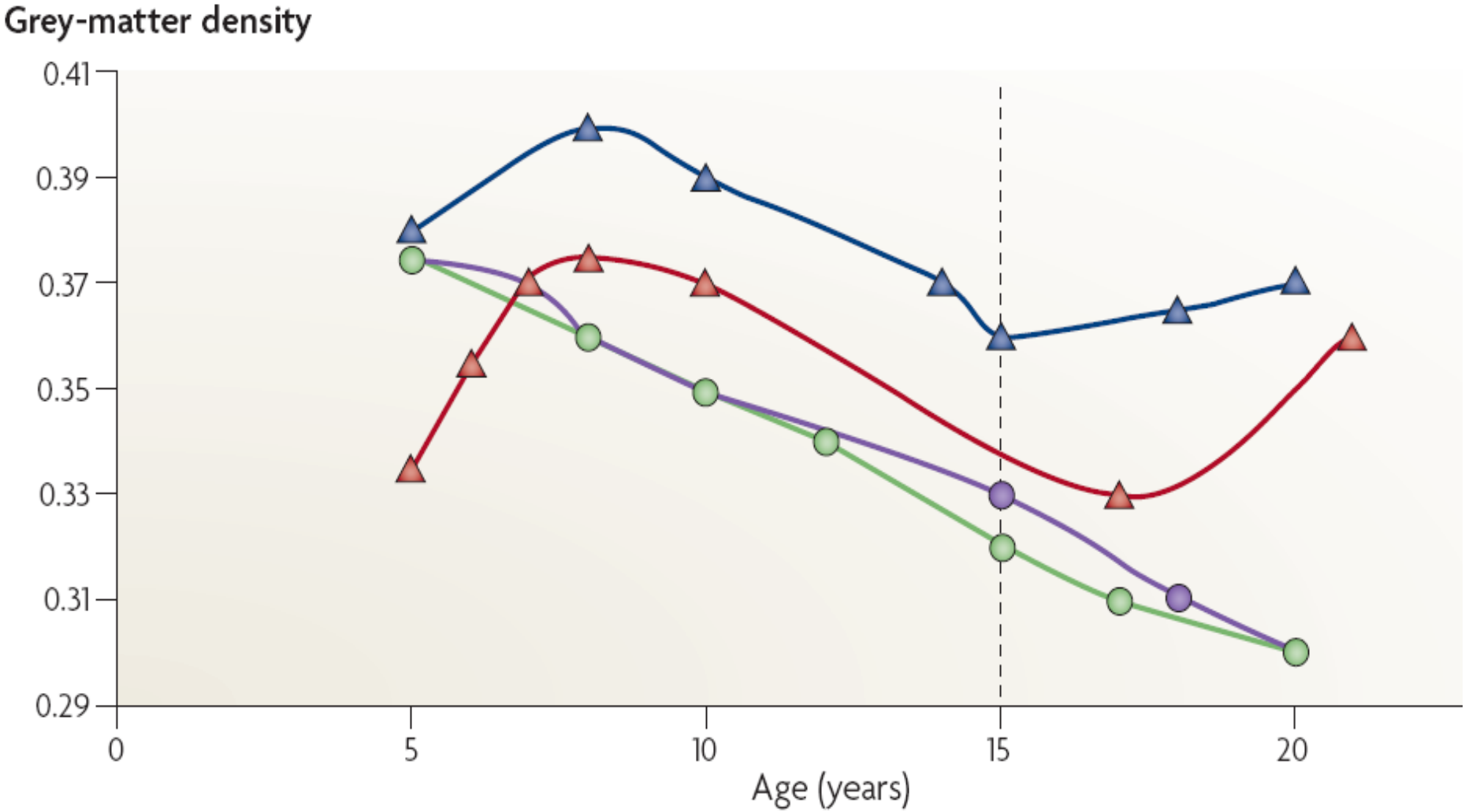
(Sowell et al, NeuroImage, 1999)



Adolescence to Adulthood

(Sowell et al, Nature Neuroscience, 1999)

Plots of grey-matter density are based on data by Gogtay *et al.* 2004 and illustrate the local grey-matter density in the mid-dorsolateral prefrontal cortex in red, in the angular gyrus of the parietal cortex in blue, in the posterior superior temporal sulcus of the temporal cortex in purple, and in the occipital pole in green.



Normal brain development versus ADHD

- In ADHD development, especially of the prefrontal lobes (and perhaps right hemisphere significantly lag behind) – especially during adolescence (Shaw, 2007)

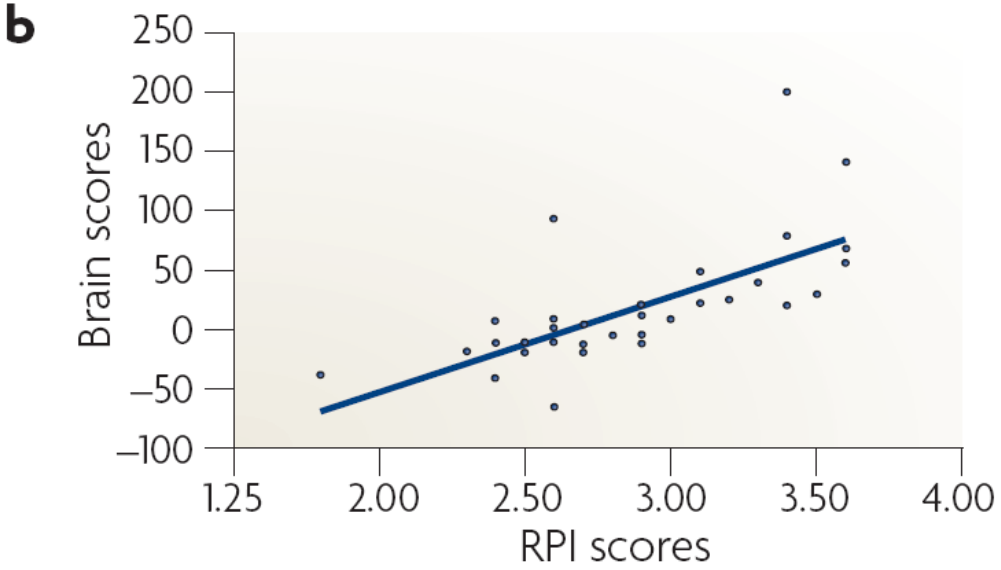
Resistance to Peer Influence

- Possible neural substrates of resistance to peer influences (RPI) in early adolescence
  - probability with which an adolescent follows the goals set by peers or those set by themselves
  - might depend on the interplay between three neural systems
    - **action-observation network** – Mirror mechanism
    - **biological-motion processing network** (also known as the superior temporal sulcus (STS) network)
      - Important role in extracting socially relevant cues,
      - imparted by the movements of eyes or hands
    - **the executive network**

Resistance to Peer Influence

- Children with high RPI scores showed stronger inter-regional activity correlations in brain activity across the three networks while watching angry hand actions than the children who had low RPI scores

Neuroscience and Technology to Accelerate Learning.



Control Yourself!

Two different information-processing systems in the brain battle for control of our response to temptation: impulses aimed at immediate gratification, and reason, which helps us pursue long-term objectives.

Drains on cognitive resources, such as working memory, can render us less able to withstand temptation.

Fortunately, a number of training methods can bolster self-control. It is possible to strengthen our mental resources and turn our impulses for good.

How Self-Control Works

It's a skill, we are learning, that profoundly shapes lives. How does it work? Where does it come from?

By Dan Ariely | April 12, 2011 |

Ways to enhance cognitive control in the classroom

- The key is learning to set goals and delay gratification
  - It is best when parents practice it in the home (eg. you can watch ½ hour of T.V. now or after your homework is finished and I check it for accuracy you can watch 1 hour)

Cognitive Control in the classroom

- Phrasing goals in terms of incentives or advantages rather than penalties for being late helps students learn to self-reinforce goal attainment
  - Some of your students are so used to being penalized for being late, that it becomes the status quo for them.
  - Knowing what incentives work best (eg. group pizza parties if everyone gets something in on time, or personal bests) can be very effective ways of changing behavior

Cognitive Control

- Teaching goal setting works best with major projects and assignments
  - Rather than assigning a due date, try giving incentives for dates before X
    - Due June 21 – but ten extra credit points are added for students who hand their projects in more than a day early
  - Try a sign-up sheet where students sign up for a due date with specific advantages for earlier sign up and/or earlier dates