Effects of Poverty and Adverse Childhood experiences on Language, Cognitive Development and School Achievement: Research and Best Practices

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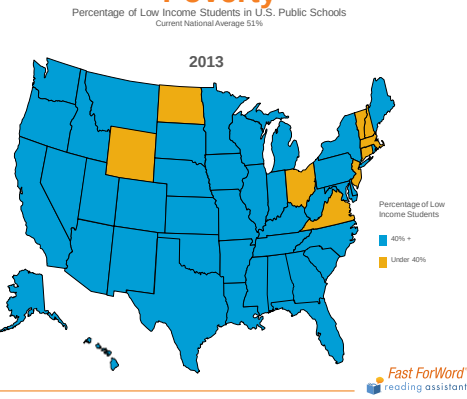
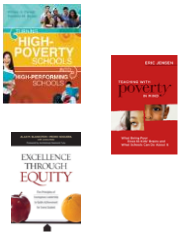
Rapid Increase in Students from Poverty



Recently ASCD focused on

- **Addressing the Effects of Poverty**
- Poverty—with its widespread effects on learning and well-being—is a multifaceted problem without a simple solution.



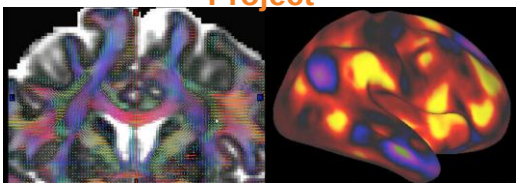
Key Points

- The brain is an experience dependent organ – poverty, stress and adverse experiences change the brain
- Children raised in poverty are exposed to millions of fewer spoken words at home
- Income level negatively impacts cognitive functions
- There are links between family income and memory and attention
- Poverty is associated with chronic stress which can have a toxic effect on brain architecture
- ELL's often have a triple jeopardy – language barrier to learning, history of poverty, learning disabilities
- Computer games designed to target the skills that are impacted can turn around some effects of poverty

The Human Brain is an Experience-Dependent Organ

Exactly how does experience drive neuroplasticity?

NOW! Human Connectome Project



Author: Jenn Elam
Published: Mar 01, 2017
Study: HCP Young Adult

The Human Connectome Project (HCP) WU-Minn consortium is pleased to announce the 1200 Subjects Release of HCP image and behavioral data, its final release of new HCP Subjects.
The 1200 Subjects release includes behavioral/demographic and 3T MR imaging data from 1206 healthy young adult participants collected August 2012–October 2015

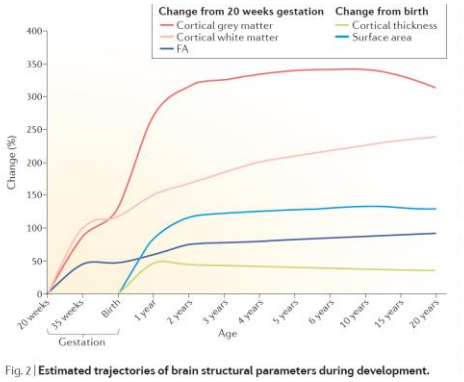


Fig. 2 | **Estimated trajectories of brain structural parameters during development.**

Much of the change in brain structure occurs early in life. But…..

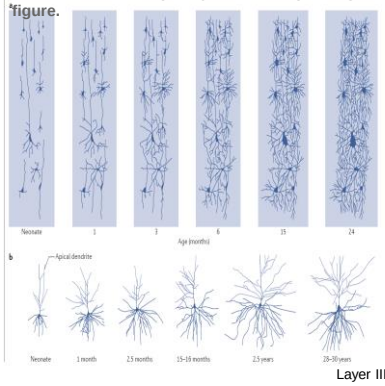
Gilmore, Knickmayer & Gao, 2018

The HCP Tools and Support Help Researchers Understand How Information is Coded and Travels in the Brain

- Microscale – edges and nodes

- Macroscale – connectome

Microscale- Grey Matter: **Conel's classic survey of cortical neuron development in children found that the overall complexity of cortical neurons increases quickly after birth, peaking at 2–4 years Part a of the figure.**



-At birth, layer V neurons have more complex basal dendritic trees, which integrate synaptic inputs, than do layer IIIC neurons.
Layer V neurons reach maximum complexity at 16–30 months after birth, before layer IIIC.

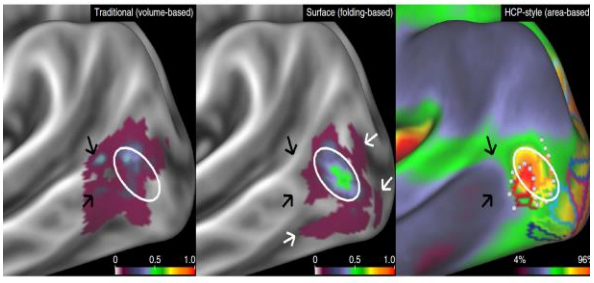
Synaptic spine density in the prefrontal cortex also peaks by 2–5 years and falls in adolescence. Part b of the figur

Layer III de

Gilmore, Knickmayer & Gao, 2018

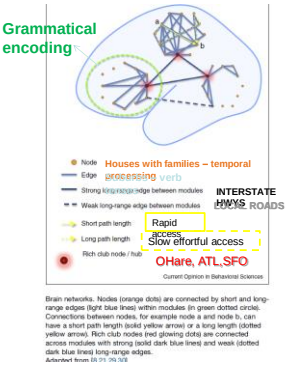
Martha S. Burns, Ph.D.

HCP Microscale Measures Provide Open Access Research Tools



lity of localizing area MT+ (architectonic area hOc5) when mapped to the cortical surface by different methods. Left: volume-basec
ic cytoarchitectonic area hOc5 (ref. 104) from 10 post-mortem subjects mapped to a cortical atlas surface. Black arrows, locations
l mapping spreads across gyral and sulcal folds. Center: Surface-based registration of hOc5 from the same 10 subjects mapped to i

Nodes, Edges and Modules Close Up



Brain networks. Nodes (orange dots) are connected by short and long-range edges (light blue lines) within modules (in green dotted circle). Connections between nodes, for example node a and node b, can have a short path length (solid yellow arrow) or a long length (dotted yellow arrow). Rich club nodes (red glowing dots) are connected across modules with strong (solid dark blue lines) and weak (dotted dark blue lines) long-range edges.

Adapted from Haartsen, R., Jones, E. & Johnson, M. (2016) Human brain development over the early years. Current Opinion in Behavioral Sciences 2016, 10:149–154 .

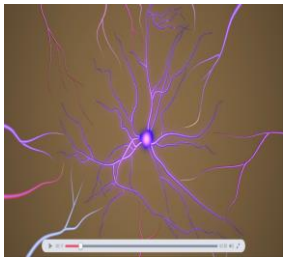
- **Nodes** (orange dots) are connected by **short and long range edges** (light blue lines) **within modules** (in green dotted circle).
- Connections between nodes, for example **node a and node b,** can have a short path length (solid yellow arrow) or a long length (dotted yellow arrow).
- **Rich club nodes** (red glowing dots) are connected across modules with **strong** (solid dark blue lines) and weak (dotted dark blue lines) long-range edges.

Example of Brain Level Microstructure Research - Max Planck Florida Institute

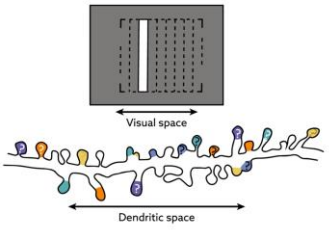
- Benjamin Scholl, Daniel E. Wilson, David Fitzpatrick (2017) **Local Order within Global Disorder: Synaptic Architecture of Visual Space.** *Neuron.* Volume 96, Issue 5, p1127–1138.e4, 6 December 2017
- http://www.youtube.com/watch?v=Raxch9I6_p8

Synaptic Architecture
(Scholl, Wilson and Fitzpatrick, 2017)

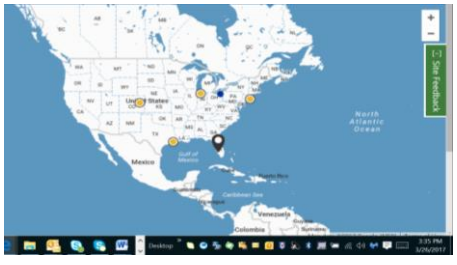
- To do anything – e.g. think, touch or see
- individual neurons need to organize inputs
- One microscale brain organizational strategy is spatial clustering of receptors on a dendritic spine



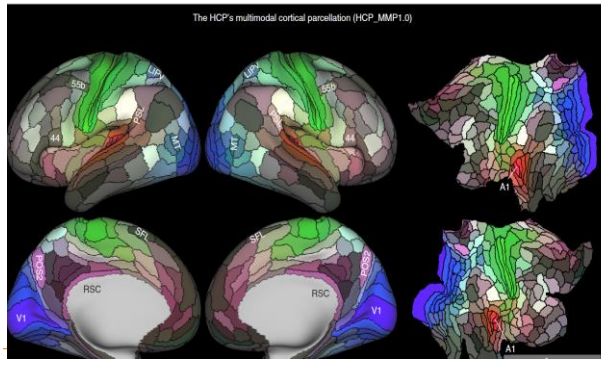
Spatial Clustering of Synaptic Inputs (Scholl, Wilson and Fitzpatrick, 2017)



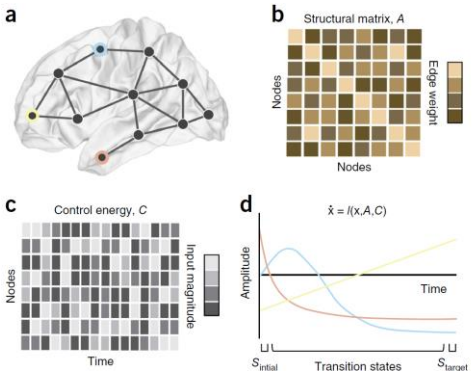
Mesoscale – Informs on Individual Nodes and Circuits Within the Connectome and How We Control Them



HCP Macroscale – Helps Clarify Multimodal Cortical Parcellation

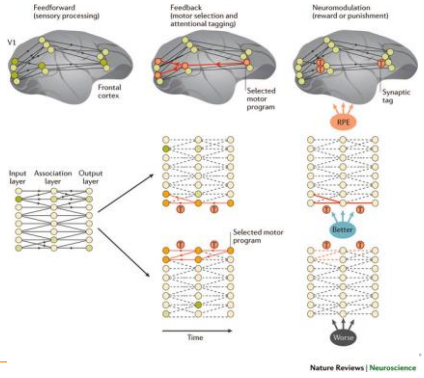


Controlling Brain Networks (Bassett and Sporns, 2017) Micro -Macroscale



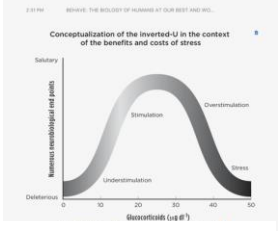
Roelfsema and Holtmaat, 2018 (*Nature Reviews Neuroscience* volume 19, pages 166–180) doi:10.1038/nrn.2018.6

Marcroscale effects of network neuroplasticity from Feedforward (bottom up) and Feedback (top down) processing with neuromoduatory control



There Are Other Effects on Plasticity Like Stress (Sapolsky *Behave* 2017)

- Inverted-U effect on change
  - Moderate or transient stress (or exposure to the equivalent glucocorticoid levels) increases spine number in the hippocampus while
  - Sustained stress or glucocorticoid exposure does the opposite
- Depression and anxiety – two disorders associated with elevated glucocorticoid levels – can reduce hippocampal dendrite and spine number- that arises from decreased levels of BDNF

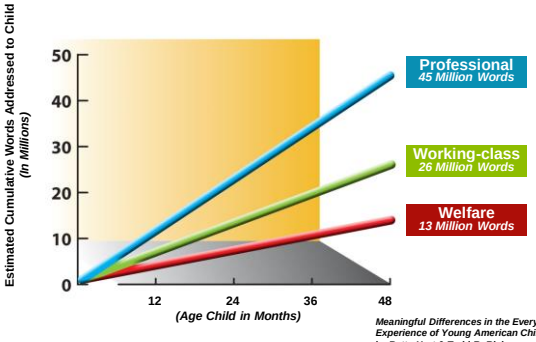


All of This Varies by Location and Modifies the Effect (Sapolsky, 2017)

- Acute and chronic stress strengthen connectivity and increase spine number, respectively, between the frontal cortex and motoric areas, while weakening frontal-hippocampal connections –
  - Form habits that can be inflexible to new learning
- Sustained stress increases BDNF and expands dendrites in the region of the amygdala – increasing anxiety and fear conditioning

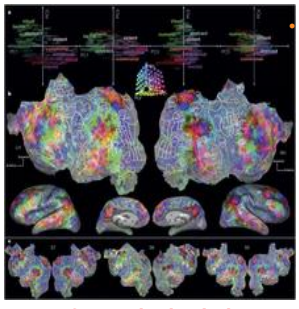
Language Experiences

Language Experiences by Group



Meaningful Differences in the Everyday Experience of Young American Children by Betty Hart & Todd R. Risley. Paul H. Brookes Publishing Co. (1995).

What we now know about the importance of language and brain maturation



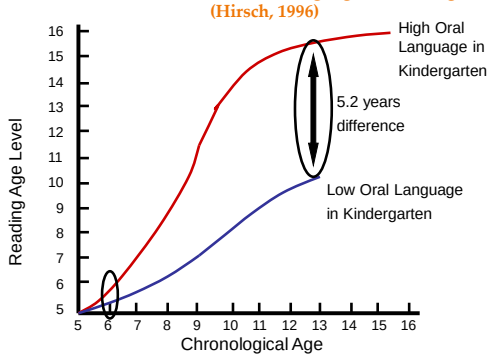
Huth, A., DeHeer, W., Griffiths, T., Theunissen, F. & Gallant, J. (2016)Natural speech reveals the semantic maps that tile human cerebral cortex. *Nature* 532, 453–458 (28 April 2016)

As far as the brain is concerned - Language is everywhere

The Brain Dictionary – How language exposure builds the entire brain

- http://www.nature.com/nature/videoarchive/brain-dictionary/index.html
- Huth, A., DeHeer, W., Griffiths, T., Theunissen, F. & Gallant, J. (2016)Natural speech reveals the semantic maps that tile human cerebral cortex. *Nature* 532, 453–458 (28 April 2016)
- Explore the brain model for yourself here: http://gallantlab.org/huth2016

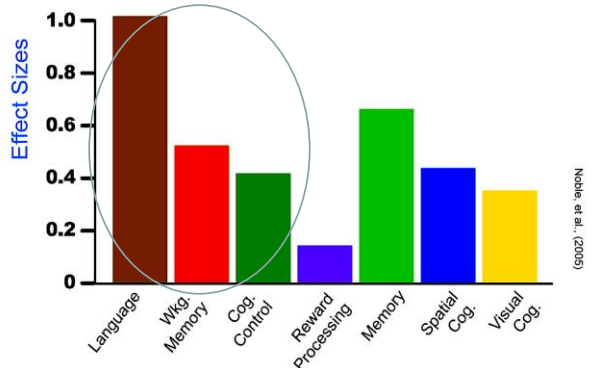
The Effects of Weaknesses in Oral Language on Reading Growth (Hirsch, 1996)



We have known that income level negatively impacts cognitive functions for over a decade

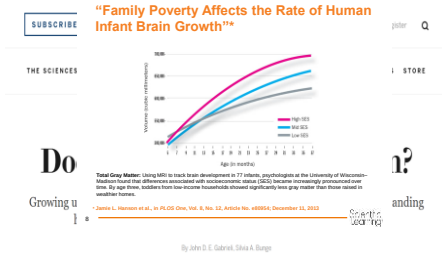
There are links between family income and memory and attention

How are the brains from poverty different?



But newer research is specifying why and how the impact of poverty affects learning

Research Continues to Show that Poverty Negatively Impacts the Brain

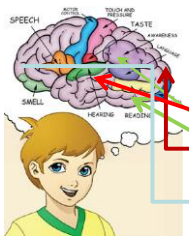


https://www.scientificamerican.com/article/does-poverty-shape-the-brain/

Family income, parental education and brain structure in children and adolescents Noble, et. al. *Nature Neuroscience* 30 March 2015

- Among children from lower income families,
  - small differences in income were associated with relatively large differences in surface brain area
- Among children from higher income families, similar income increments were associated with smaller differences in surface area.

Brain structure and poverty (Noble et al, 2015)



- Brain Structure and income level relationships were most prominent in regions supporting
  - ***language***
  - ***reading,***
  - ***executive functions***
  - ***spatial skills***

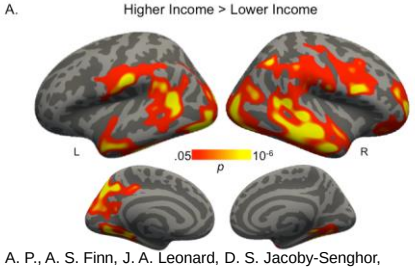
Noble et al 2015 Conclusion

- This research implies that ***income relates most strongly to brain structure among the most disadvantaged children.***

April 2015 – Dr. John Gabrielli's Lab at MIT

- Published research that corroborates Noble 2015 and clarifies the income/achievement gap
- Showing that High Income versus Low Income achievement differences directly correlate to measures of cortical thickness in adolescents

Neuroanatomical Correlates of the Income-Achievement Gap



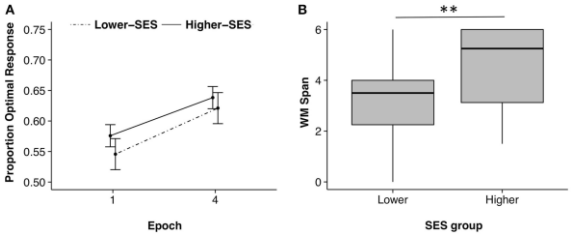
Mackey, A. P., A. S. Finn, J. A. Leonard, D. S. Jacoby-Senghor, M. R. West, C. F. O. Gabrieli, and J. D. E. Gabrieli. (2015) "Neuroanatomical Correlates of the Income-Achievement Gap." Psychological Science (April 20).

Corroborated by Pollak et al, in June

- 20 percent of the gap in test scores between poor children and middle-class children may be a result of **poor brain development in the frontal and temporal lobes**

Pollak, S., et al. (2015) *JAMA Pediatrics*

In October, differential effects of SES on kinds of memory (working versus procedural memory)

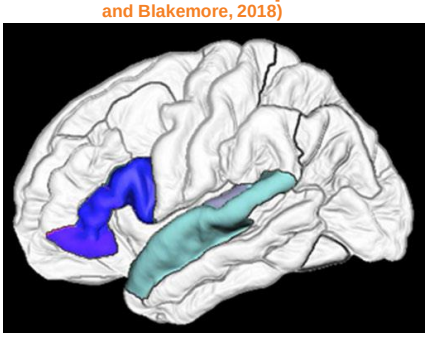


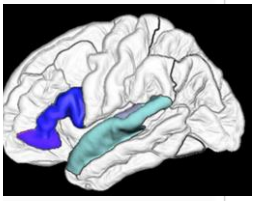
Procedural Memory (probabilistic learning)

Working Memory

Leonard, J., Mackey, A., Finn, A. & Gabrielli, JE (2015) Front. Hum. Neurosci., 08 October

Studying Individual Differences in Adolescent Brain Development (Foulkes and Blakemore, 2018)





(Foulkes and Blakemore, 2018)

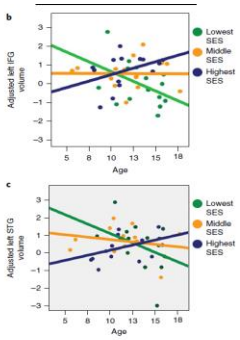


Fig. 4 | SES-by-age interaction in left inferior frontal gyrus (IFG) and left superior temporal gyrus (STG) volume. a, The left IFG (dark blue) and left STG (light blue). **b**,**c**, Plots of the SES × age interaction in (**b**) the left IFG and (**c**) the left STG. Reproduced from ref. [35], Wiley-Blackwell.

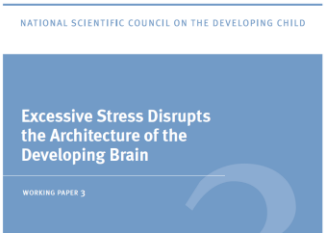
Fast ForWord reading assistant Scientific Learning

So… SES does not affect intelligence or ability to learn in general

- Rather SES affects those types of learning important for academic success
- But, why????

Scientific American Mind May 2016

Fast ForWord reading assistant Scientific Learning



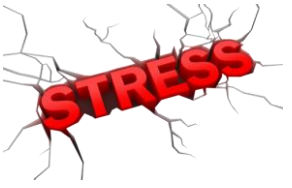
http://developingchild.harvard.edu/resources/wp3/

HARVARD UNIVERSITY

Effects on Brain Development

- **The neural circuits for dealing with stress are particularly malleable (or "plastic") during the fetal and early childhood periods**
  - the regions of the brain involved in fear, anxiety, ar impulsive responses may overproduce neural connections
  - those regions dedicated to reasoning, planning, and behavioral control may produce fewer neural connections

Damage to health and well-being



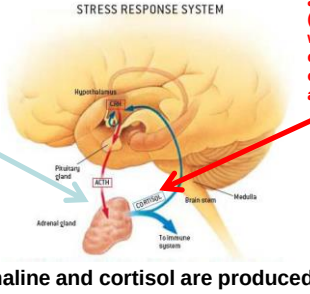
This wear and tear increases the risk of stress-related physical and mental illness later in life

- Extreme exposure to toxic stress changes the stress response system
  - **Responds at lower thresholds** to events that might not be stressful to others,
  - **Activates more frequently and for longer periods** than is necessary, like revving a car engine for hours every day.

Biology

(1) the sympathetic-adrenomedullary (SAM) system, which produces adrenaline in the central part of the adrenal gland

(2) the hypothalamic-pituitary-adrenocortical (HPA) system, which produces cortisol in the outer shell of the adrenal gland



Both adrenaline and cortisol are produced under normal circumstances and help prepare the body for coping with stressors.

Adverse Childhood Experiences (ACES) (*n* =1007) [Jimenez et al, 2016)

Variable %	(No.)
Child maltreatment	
Psychological	16 (162)
Neglect	13 (132)
Physical	15 (154)
Sexual	0.6 (6)
Household dysfunction	
Maternal depression	12 (121)
Substance use	15 (149)
Incarceration	18 (181)
Violence toward mother	11 (111)

Total ACEs	
0	45 (451)
1	27 (275)
2	16 (158)
3	8 (84)
4	3 (25)
5	1 (11)
6	0.3 (3)

Jimenez et al. Adverse Experiences in Early Childhood (ACES) and Kindergarten Outcomes
PEDIATRICS Volume 137, number 2 , February 2016

Table 3 Teacher Ratings of Below Average Academic Skills – percentages (Jimenez et al, 2016)

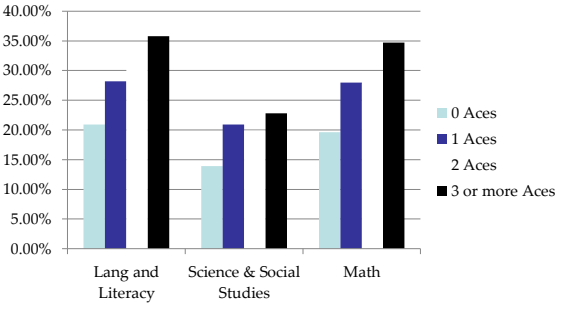
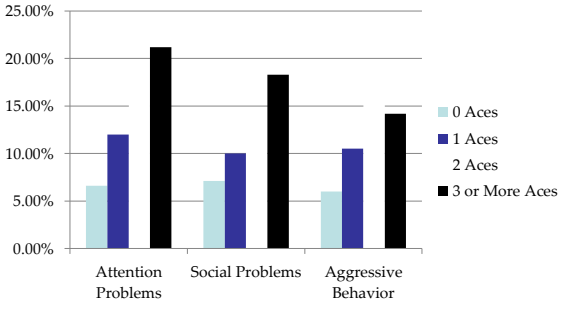


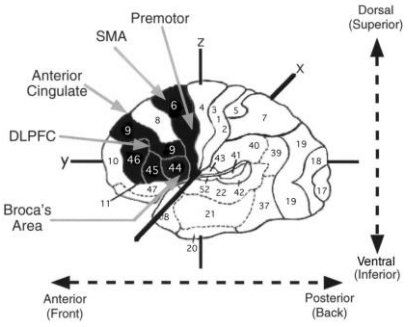
Table 5.Teacher Ratings of Behavior – Percentages (Jimenez et al, 2016)



Conclusion (Jimenez et al, 2016)

- Children experiencing adverse childhood experiences (ACES) places students at significant risk for
  - Poor school achievement
  - And is associated with poor health
- Exacerbates Chronic Stress

Dorsolateral Pre-frontal lobe – Executive Functions



Smith E &Jonides J, *Science* (2009)

Basics: anatomy and physiology

BA 44 and 45 (and their cortical-cortical pathways) are not specific to aspects of human speech – they participate in the neural processing role shared by human and non-human primates that ultimately evolved into the human capability for speech.

The existence of area 44 and 45 in the monkey ventro-lateral frontal lobe implies fundamental role is not limited to human language, rather a general cognitive role that was adapted in humans to serve linguistic processing as well

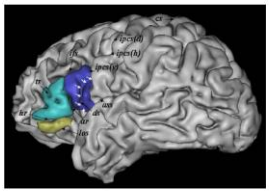
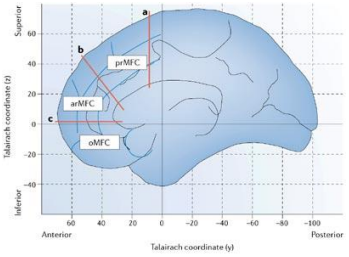


Fig. 3. The Pars opercularis (blue), Pars triangularis (turquoise) and pars orbitalis (yellow) of the left inferior frontal gyrus in a MR data set of a healthy brain. Cerebral hemisphere (grey-white matter interface) extraction and rendering (automated), and demarcation (manual), rendering and projection of the inferior frontal gyrus were performed using Brainvoyager software (www.brainvoyager.com). White arrows indicate an indirect connection between the inferior precentral sulcus and the Sylvian fissure via the diagonal sulcus. Abbreviations: ar, ascending ramus of the Sylvian fissure; ass, anterior subcentral sulcus; cs, central sulcus; ds, diagonal sulcus; hr, horizontal ramus of the Sylvian fissure; ifs, inferior frontal sulcus; ipcs (d), dorsal segment of the inferior precentral sulcus; ipcs (h), horizontal segment of the inferior precentral sulcus; ipcs (v), ventral segment of the inferior precentral sulcus; los, lateral orbital sulcus and ts, triangular sulcus (For interpretation of the references in colour in this figure legend, the reader is referred to the web version of this article.)

Behavioral Self-Regulatory Functions

- VMPFC – emotional processing including:
  - Reward processing
  - Behavioral self-regulation
  - Social Cognition

Ventromedial Pre-frontal Cortex



Amodio *et al. Nature Reviews Neuroscience* **7**, 268–277 (April 2006) | doi:10.1038/nrn1884

Summary data

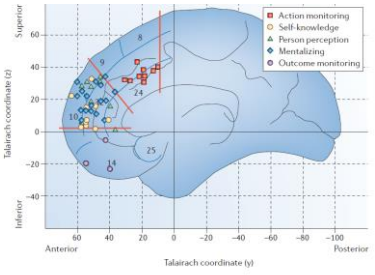


Figure 3 | **Mapping of medial frontal cortex activations observed during action monitoring, social cognition and outcome monitoring.**

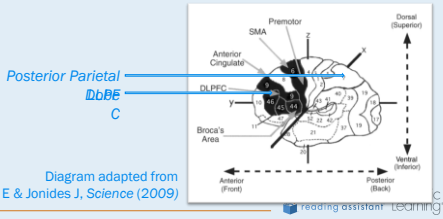
A meta-analysis of medial frontal cortex (MFC) activations suggests that social cognition tasks, which involve person perception, and mentalizing– activate areas in the anterior rostral MFC (arMFC). By contrast, activations from action-monitoring tasks occur in the posterior rostral regionof the MFC (prMFC), and activations from tasks involving the monitoring of Outcomes occur in the orbital MFC (oMFC).

Activating Regulatory Functions

- Providing initiative and energizing behavior
  - At a level appropriate to the situation
  - Appropriate to attaining individual's goals
- Limited medical pathology results in disorders of activation and drive
- Clinically known as apathy or abulia

Components of the Dual Systems Model of Self-Control – High Level: Dorsolateral Pre-frontal Cortex (DLPFC) (Albert & Steinberg, 2011)

- Prolonged refinements over the course of childhood (Too et al., 2014) and adolescence (Casey et al, 2008) in (DLPFC) and posterior parietal lobe associated with Cognitive Control are thought to support reasoned behavior and adolescents' emerging capacity for behavior regulation



Posterior Parietal
DLPFC
C

Diagram adapted from Smith E & Jonides J, *Science* (2009)

#SPEDAhead

But Children With Attentional Problems Also Exhibit Problems With Cognitive Control!

- Two different information-processing systems in the brain battle for control of our response to temptation:

1. **Impulses:** aimed at immediate gratification
2. **Reason:** helps us pursue long-term objectives.

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

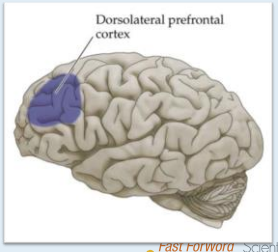
The dual-systems model of self-control

1. Failure at low levels of self-control may stem from strong impulses *regions involved in reward (e.g.,ventral striatum) and social information (e.g., medial prefrontal cortex)*
2. Failure at higher levels (DLPFC) may result from weak control
   See especially, Albert &Steinberg, (2011) Too, Wong, Fan and Goo (2014)

#SPEDAhead

Attention: Typical Maturation Allows for Changing from Global to Focused (Selective Attention)

- **Attentional maturation** depends upon maturity of the dorsolateral prefrontal cortex
  —It is a core component of cognitive control



#SPEDAhead

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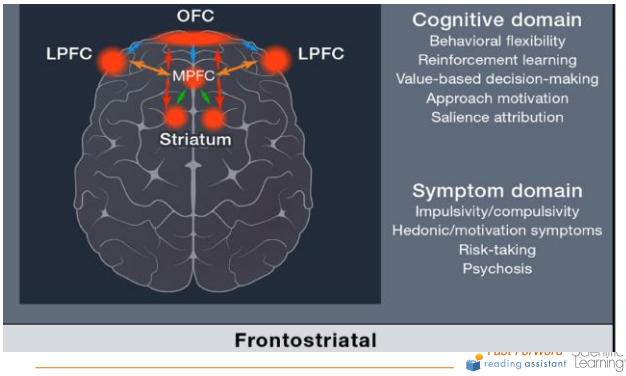
#SPEDAhead

Buckholtz and Meyer-Lindenberg (2012) Connectomes patterns with developmental disorders

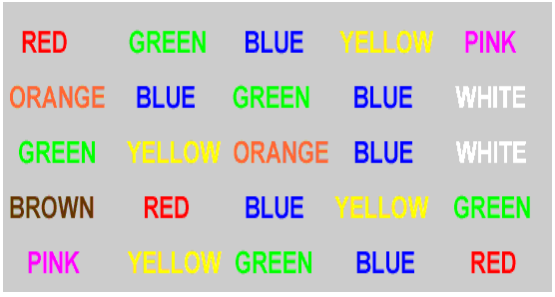


Task Switching

- Card sorting
- Go/no-go (Simon says)
  - Can increase complexity to increase task switching

- http://www.nytimes.com/interactive/2010/06/07/technology/20100607-task-switching-demo.html

Response inhibition – stroop test



REsponse inhibition – Stroop Test

Disorders of Attention

ADHD and ADD

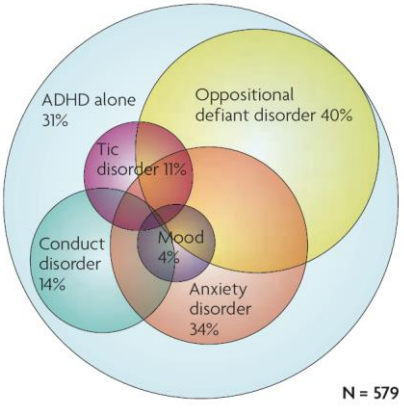


Figure 1 | **co-occurring disorders in the Multimodal treatment study of children with Adhd.** Participants in the National Institute of Mental Health Multimodal Treatment study for attention-deficit hyperactivity disorder (ADHD) reflect the complex mental-health profiles of Us children with ADHD. Only a third of the children in the study had a diagnosis of ADHD alone. More than half of the children had conduct or oppositional defiant diagnoses in addition to having ADHD, and a significant proportion of those with conduct and oppositional diagnoses also had an anxiety disorder.

Neurobiology of ADHD Vs. ADD

Diamond, A. (2005) *Dev Psychopathol*. 2005 ; 17(3): 807–825.

- Core problem in ADD is in working memory
  - Complex span and dual task dichotic listening can detect this
  - Rather than being distractible they may be easily bored, their problem more in underarousal than inhibitory control
  - Primary disturbance in the frontal-striatal loop of ADHD
  - Primary disturbance in ADD is a frontal-parietal loop

ADHD Vs ADD (Diamond, 2005)

ADHD

- Hyperactive, always on the go, impulsive
- Primary deficit in response inhibition

ADD

- A significant subset are hypoactive and sluggish and have slow response speeds
- Primary deficit in working memory, *especially prominent in auditory processing because of the demands it places on working memory*

ADHD VS ADD (2)

ADHD

- Often insufficiently self-conscious
- Social problems because too assertive and impulsive: intrude, take things belonging to others, fail to wait their turn, and act without first considering the feelings of others

ADD

- Tend to be overly self-conscious
- Social problems because too passive, shy, or withdrawn

ADHD vs ADD (3)

ADHD

- Tend to be extroverted
- Externalizing behaviors, such as conduct disorder, aggressivity, disruptive behavior, and even oppositional defiant disorder are far more commonly comorbid with ADHD than with ADD.

ADD

- More likely to be introverted
- Internalizing disorders, such as anxiety or depression, are somewhat more common in children with ADD than those with ADHD. ADD children tend to be socially isolated or withdrawn.
- Reading and language deficits and problems with mental mathematical calculations are more commonly comorbid with ADD than with ADHD

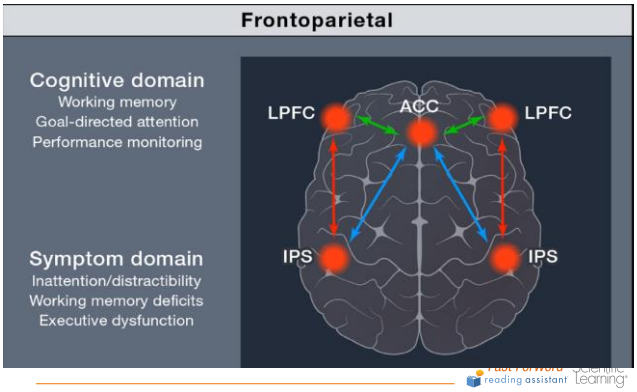
Inhibition/distractibility

- Holding information in mind while inhibiting a prepotent response
  - Day-night
  - Tapping (When I tap once you tap twice)
  - Appearance-reality (clouds)
- http://www.nytimes.com/interactive/2010/06/07/technology/20100607-distraction-filtering-demo.html?th&emc=th

Differential Diagnosis (Chermak, et al, 1998)

- Rank order ADHD
  - inattentive
  - distracted
  - hyperactive
  - fidgety/restless
  - hasty/impulsive
  - interrupts/intrudes
- Rank order CAPD
  - difficulty hearing in background noise
  - difficulty following oral directions
  - poor listening skills
  - academic difficulties
  - poor auditory assoc..
  - Distracted
  - inattentive

Buckholtz and Meyer-Lindenberg (2012) Connectomes patterns with developmental disorders - ADD



Neuron
NeuroView

Neuroscience and the Future of Early Childhood Policy: Moving from Why to What and How

Jack P. Shonkoff[1,*] and Pat Levitt[2]
[1]Center on the Developing Child, Harvard University, Cambridge, MA 02138, USA
[2]Zilkha Neurogenetic Institute, Keck School of Medicine of the University of Southern California, Los Angeles, CA 90089, USA
*Correspondence: jack_shonkoff@harvard.edu
DOI 10.1016/j.neuron.2010.08.032

There is a need for greater synergy between advances in neuroscience and the formulation of innovative policies to improve life outcomes for children experiencing significant adversity. Translational developmental neuroscience can inform new theories of change to catalyze more effective interventions that lead to a more productive and healthier society.

Executive Functions - Definitions

- Four domains (Cicerone, et al., 2006)
  - Executive cognitive functions
  - Behavioral self-regulatory functions (cognitive control)
  - Activation regulating functions
  - Metacognitive processes

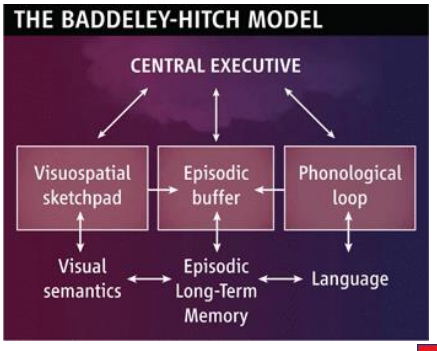
Executive Functions

- Most of what is known about EF is based on patients with DLPFC lesions
  - However, because of connections between lateral-frontal and posterior brain regions, DAI can cause Executive dysfunctions
- Control and direction of lower level automatic functions for
  - Planning
  - Monitoring
  - Activating
  - Switching
  - Inhibiting
- Working memory (limited capacity process for short-term storage, monitoring, and manipulation of information) are fundamental processes that mediate EF

WORKING MEMORY

M. Balter Science 328, 160-163 (2010)

Published by AAAS



M. Balter Science 328, 160-163 (2010)

Published by AAAS

Attentional vs. Memory or Auditory Processing Problems

- Poor listener or tunes out (could be an auditory processing problem)
- Frequently asks – Huh? or What? when given instructions – working memory
- Looks around to see what others are doing when teacher provides instructions – working memory or APD
- Fidgets, impulsive, intrusive, yells out answers, lack of self control -- ADHD

Disorders of Memory

Understanding Memory Problems in Children

- There are essentially three types of memory
  - Short Term repetition span – tested with repetition tasks
  - Short Term working memory – Alan Baddeley
    - Part of executive function
    - Involves strategies
    - Can occur over minutes, even days
  - Long term memory – storage (learning)
- Children can have problems with both

Best test for assessing memory

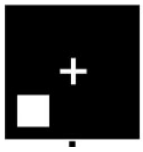
- **Ages:** *6-0 through 17-0*
  Testing Time: *40 minutes-2 hours*
  Administration: *Individual*
- The *Detroit Tests of Learning Aptitude–Fourth Edition* (DTLA-4) is the oldest and most venerable of the tests of specific mental abilities.
- The test includes 10 subtests.
- The results of the subtests can be combined to form 16 composites that measure both general intelligence and discrete ability areas..

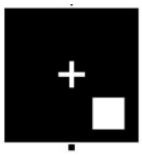
This test not only measures basic abilities, but also shows the effects of language, attention, and motor abilities on test performance

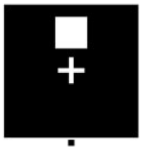
Improving fluid intelligence with training on working memory

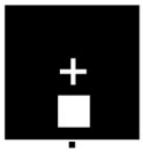
Susanne M. Jaeggi*†‡, Martin Buschkuehl*†‡, John Jonides*, and Walter J. Perrig†

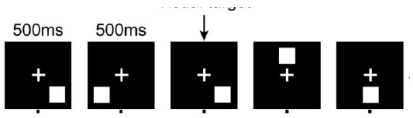
Proceedings of the National Academy of Sciences
May, 2008











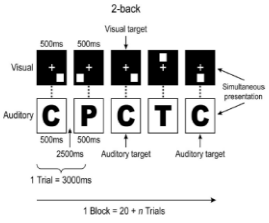


Fig. 1. The *n*-back task that was used as the training task, illustrated for a 2-back condition. The letters were presented auditorily at the same rate as the spatial material was presented visually.

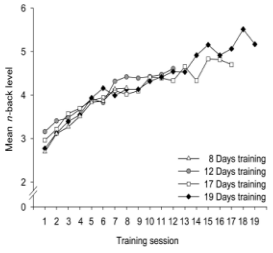


Fig. 2. Performance increase in the trained task shown separately for each training group. For each session, the mean level of *n* achieved by the participants is presented. The level of *n* depends on the participants' performance.

using a newly developed training paradigm consisting of a very demanding working memory task, illustrated in Fig. 1. In this task, participants saw two series of stimuli that were synchronously presented at the rate of 3 s per stimulus. One string of stimuli consisted of single letters whereas the other consisted of individual spatial locations marked on a screen. The task was to

$P < 0.05$; Cohen's $d = 0.25$), the improvement in the groups that received the apparent benefit of training was substantially superior ($t(33) = 5.53$; $P < 0.001$; Cohen's $d = 0.65$), which was

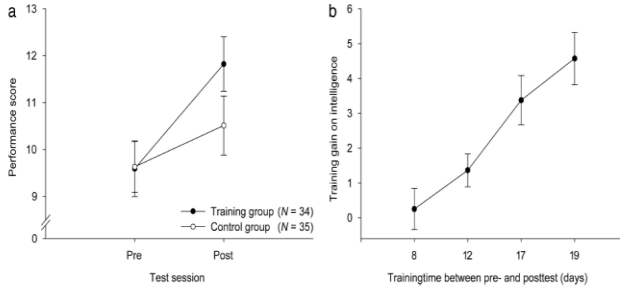


Fig. 3. Transfer effects. (*a*) Mean values and corresponding standard errors of the fluid intelligence test scores for the control and the trained groups, collap over training time. (*b*) The gain scores (posttest minus pretest scores) of the intelligence improvement plotted for training group as a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

session. However, the training-time-dependent gain in *Gf* remained intact after controlling for the gain in working memory

that the strong relationship between working memory and primarily results from the involvement of attentional con

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

Executive Function Skills

Attentional Control
Working Memory

Promote the capacity to:

follow classroom rules, regulate affect, sit still, and learn-on demand through listening and watching (McClelland et al., 2007)

Adele Diamond 2011

"Children with worse executive functions benefit most from [executive function] activities; thus, early executive-function training may avert widening achievement gaps later"

Part III Assessments

- Objective – isolate deficient processes and guide rehabilitation
- Most Frequently Used Include:
  - Set-shifting – Wisconsin Sort Test (WCST)
  - Planning – Trail Making Test, Part B
  - Fluency tasks
- Shown to be related to focal DLPFC lesions

Card sorting

Red plus

Green tree

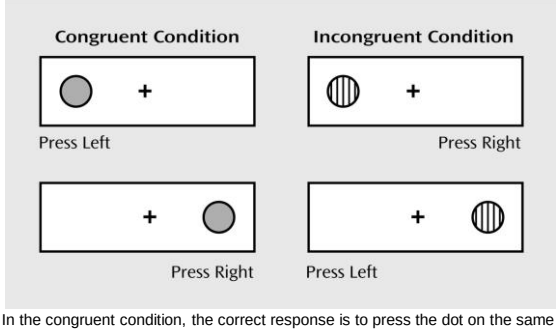
Activation Regulating Functions

- Damage to left or right medial frontal regions results in poor capacity to generate or maintain actions or mental processes
- Fluency tasks
- STROOP Test – problems maintaining a selected target
  - Sensitive to DLPFC and VMPFC lesions

Other Assessments used in research that can be applied for clinical use

- Dots incongruent vs. dots congruent
- Object or picture sorting where the sorting rule is switched

Dots mixed task

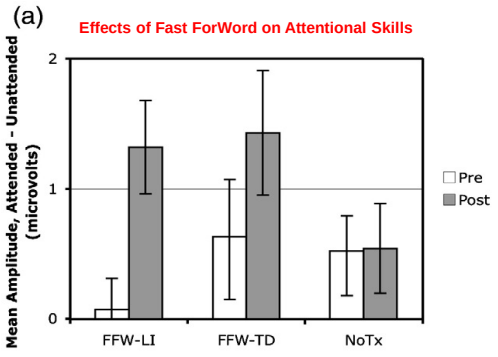


In the congruent condition, the correct response is to press the dot on the same side as the stimulus. In the incongruent condition, the response and stimulus are on opposite sides. In the mixed condition, equal numbers of congruent and incongruent trials are randomly intermixed.

Interventions for Children

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



Courtney Stevens, et al. *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

Other Interventions for School SLP's

Ways to enhance classroom (listening) attention

- Listening activities
  - Audio books (without the written book to follow along) with periodic comprehension questions
- Following oral directions
- During book reports or oral classroom presentations provide a post-activity prize for specific details students recall

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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

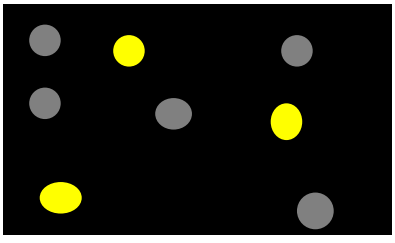
Working memory, attention, receptive language and verbal expression

- Fast ForWord and BrainPro programs – Bottom-up + Top Down
  - Attention, Auditory Working Memory, Language and Processing Speed
- SAT – Bottom up auditory processing skills dependent on needs
- Reading Assistant
  - Oral/Reading fluency and expression – excellent for children with CAS and (C)APD
- Cog-Med – Visual Attention & Visual Working Memory
- Classroom amplification systems – Auditory Processing and Reading
- PROMPT and other motor speech approaches like KSLP - excellent for children with CAS in conjunction with interventions to address other issues,(APD, Language)

Counting span task

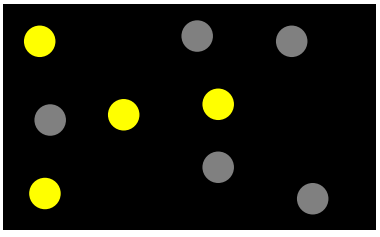
- Selective attention – inhibition of yellow dots
- Holding information in mind while executing another mental option
- Updating the information held in mind on each trial
- Temporal order memory

Please count the number of grey dots aloud?



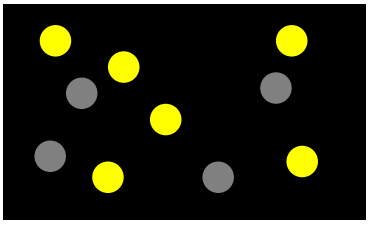
How many grey dots?

Please count the number of grey dots aloud



How many grey dots? How many last time?

Please count the number of grey dots aloud



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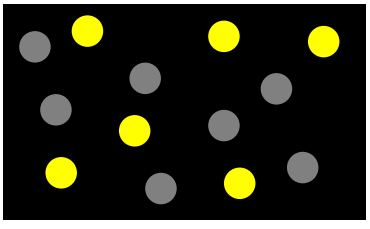

How many grey dots? Last time?

Working memory activities for children

Burns, 2010

- Concentration (matching cards – regular deck or Old Maid)
- N – Back tasks
- I am going to say a letter, tell me when a letter is the same as you heard _____ back
- I am going on a trip(using alphabet or numbers)
- Scavenger hunt with a mental list
  - First find the rock with next to the dandelion
  - Then follow the arrow you find under the rock to a large tree
  - Look behind the large tree and find a clue about the bridge
  - Follow the clue to find a prize
- Following Directions – Strategies (say it to yourself), visualize what I say then follow your visual map, Imagine doing it
- PT – route memory, sequential movement games
- OT - Smart Moves
- A display of toys or a list of words ----remove one or more. What is missing?
- Retelling stories – plan ahead for the kind of information that will need to be retold
  - Character list, chronology, chapter headings etc.

Word Recall Exercises

Word recall requires consideration of the following:

1. frequency of occurrence (the more common/familiar the word the easier to recall) – *common is relative to the speaker*
2. Superordinates are usual easier than subordinates – *chair vs. recliner*
3. Related to fluency in general – and fluency is dependent on practice
    1. Not just practice recalling words but practice with expressive formulation in general
    2. Musical training may help APD as well as fluency
4. Reading fluency builds language fluency – written formulation builds oral fluency

- Play on Words
  - Multiple meanings
- Smart Talk
  - For younger children – mealtime, bath time, dressing time
- *Potter* Puzzles
  - Character names in alphabetical order by category, eg. Wizards
  - Character names in chronological order by book

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Cognitive Control

- **Teaching goal setting works the best with major projects and assignments …**
  - Rather than assigning a due date, try giving incentives for steps achieved or project completion before the due date
    - Due June 21 – but five extra points for full outline of report received before May 15; 5 extra points for first two sections of project received before May 25; 5 extra points for four out of five sections of project received before June 15
  - OR
    - 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

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Some Added Considerations

- **With respect to risk taking – remember:**
  - You see the risk – the student sees the reward
- **For students on the autism spectrum, social skills require executive functions as well**
  - Meta-cognition for taking the perspective of others
  - Flexibility for adjusting to wants and needs of others
  - Emotional control for handling social embarrassments and rejection

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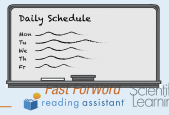
Middle School – Importance of Routines

- You are still the students' frontal lobes but … the goal is emergence and gradual assumption of independence
- When students know what to expect they can focus on learning with fewer EF demands
- Establish routines to aid expectations
  - Develop techniques to welcome students into the classroom:
    - *Try standing at the door and directing each student as they enter to take out warm-ups or materials to be used at the start of that class*



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End of Class Routines

- **Establish routines at the end of the class or day that provide comfort, direction and closure**
  - *"You have ten minutes to finish team work and clean up"*
  - *"Please watch the clock – we will spend the last five minutes closing together"*
  - *"When finished with your assignment spend the last five minutes writing a headline to summarize your thoughts"*

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Activities That Build Selective Attention

- Listening for specific details such as: how many times the word _____ is used in a news cast, audio book, video, etc.
- "Where's Waldo"-type visual search activities
- During book reports or oral classroom presentations provide a post-activity prize for specific details students recall

#SPEDAhead

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Ways to Enhance Classroom Attention (Listening) Outside of the Classroom

- Listening activities
  - Audio books with periodic comprehension questions (without the written book to follow along)
- Following complex oral directions

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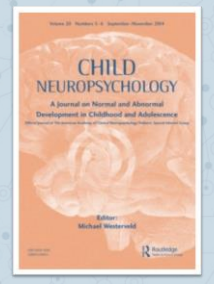
Working Memory Training Improves Reading Processes in Typically Developing Children



- Sandra V. Loosli Martin Buschkuehl Walter J. Perrig Susanne M. Jaeggi
- Volume 18, Issue 1, 2012

Fast ForWord reading assistant Scientific Learning

Supporting Students Who Need More Help

- **Specific Interventions for Specific Targets**
  - Planners
  - Materials
    - Trapper Keeper
    - Locker Organizers with weekly checks
    - Google Docs or email to self to backup
    - TIGERS folder (for younger or students with greater disabilities
  - Reading
    - Warm-ups
    - $10 words

#SPEDAhead

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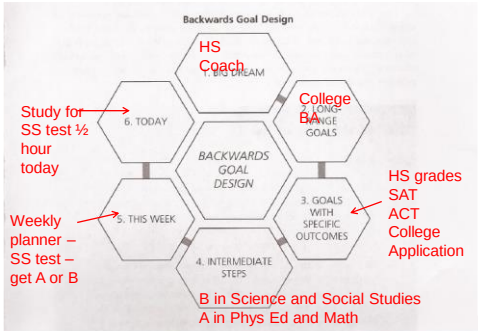
Goal Setting (Jensen & Snider, 2013)



Solutions: Neuroscience – Moving from Why to *What and How*

- Positive experiences after infancy have been shown to compensate to some degree for the negative behavioral consequences
  - Being exposed to an environment rich in opportunities for exploration and social play,
  - Caring and positive relationships with adults
- Computer activities designed to target the skills that are impacted can turn around some effects of poverty
  - *Fast ForWord* exercises, because of their specific emphasis on language, attention and memory are particularly effective and offer a cost effective valuable solution

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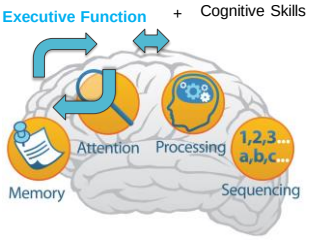
The Role of Neuroscience Technology

- Well designed neuroscience-based technology
- **builds the underlying capacities that are reduced in some children of poverty or with learning issues**



12
8

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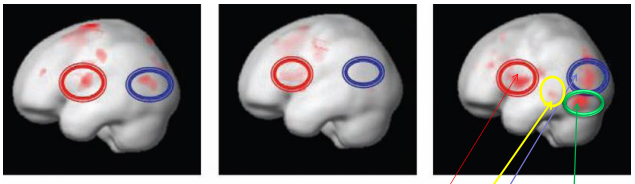
And the Brain Structures affected most by Poverty

LANGUAGE AND READING AREAS ARE ACTIVATED AFTER SIX WEEKS OF FAST FORWORD TRAINING



Typically reading children Impaired Children

Reading Impaired Children

before remediation

Reading

after remediation

Left anterior inferior frontal gyrus IFG

Angular Gyrus AG

Visual Word Form Area

Left Medial Temporal Gyrus

Gabrieli, 2009

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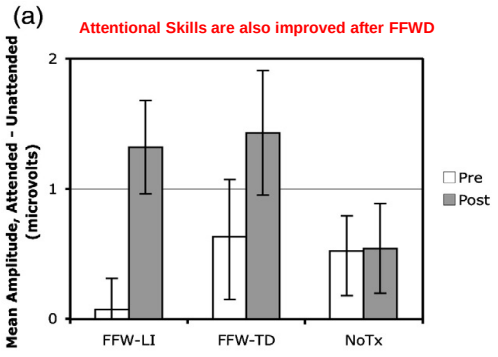

Courtney Stevens, et al. *B R A I N R E S E A R C H* 1 2 0 5 (2 0 0 8) 5 5 – 6 9

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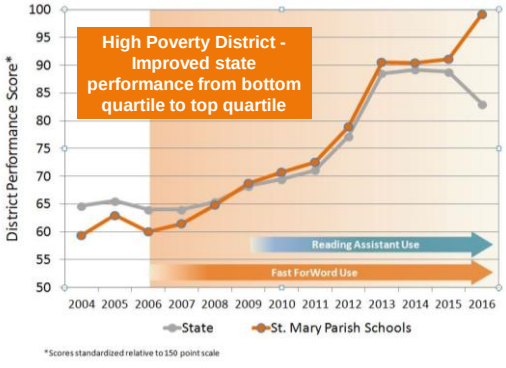
Solution Delivers Fast Change, Lasting Results



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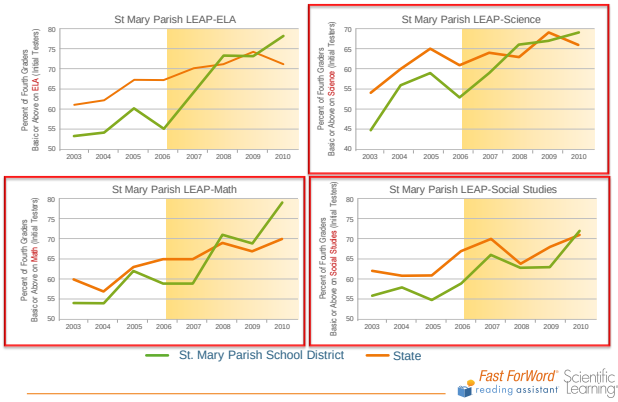
…in Multiple Subjects



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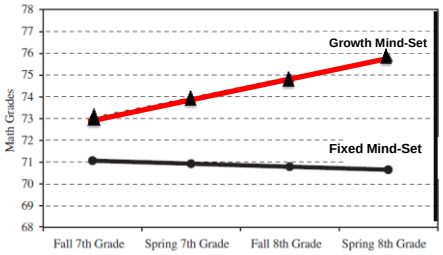
The Secret to Raising Smart Kids

Carol S. Dweck, Scientific American, 2013



Students who believe intelligence is malleable (growth mind-set) earned higher math grades in the fall of 7th grade than those who believe in static intelligence (fixed mind-set) even though the groups had equivalent math achievement test scores in the sixth grade. *From Implicit Theories of Intelligence Predict Achievement. LS Blackwell et al.,* CHILD Devel., Vol. 78, No. 1