Strengthening the Brain in ADHD and Dyslexia

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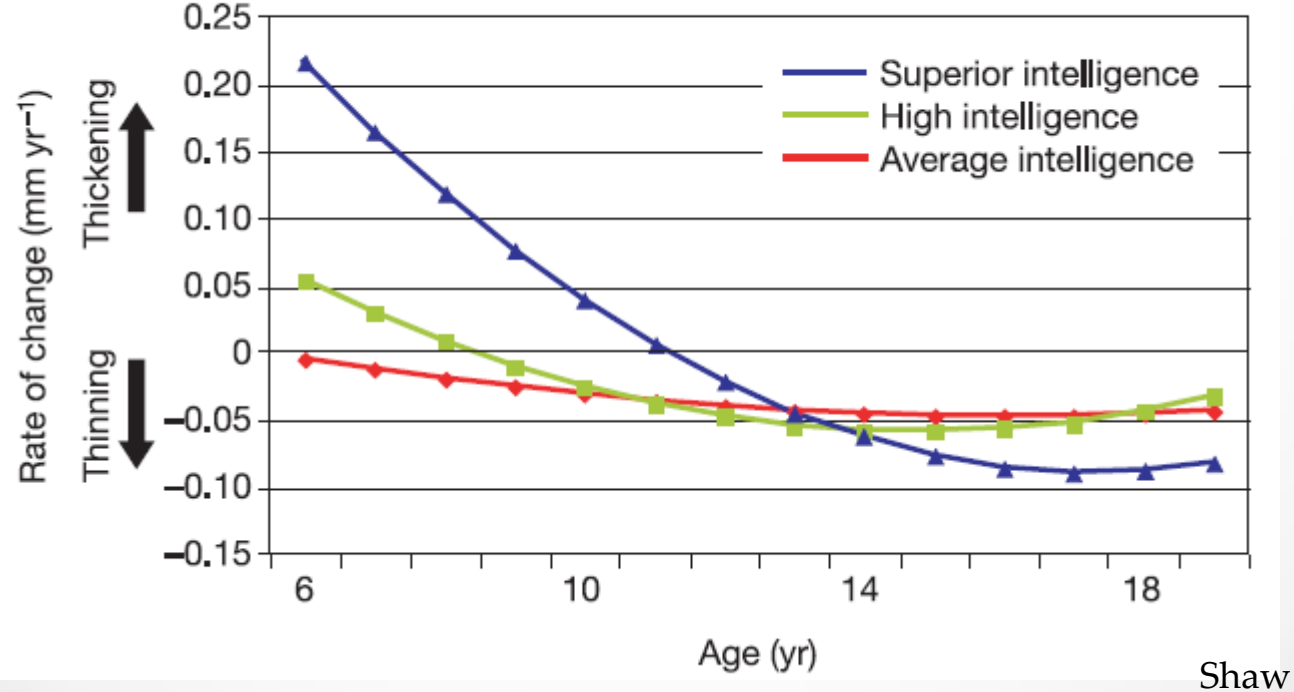
Outline

- Brief overview of ADHD and Dyslexia
- ADHD/Dyslexia Neurobiology
- How to strengthen the brain in ADHD and Dyslexia via neuroplastic change

Neurodevelopmental disorders

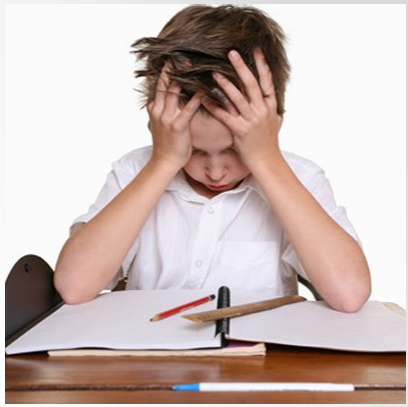
- Disorder of brain function that affects socio-emotional-cognitive functions that unfolds as a person grows

- Life-long implications of brain disorders



Shaw et al 2006

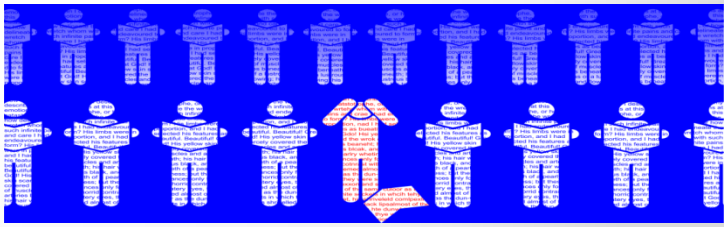
ADHD & Dyslexia (SLD) commonalities



- Both are highly prevalent disorders
  - ADHD: ~5-10% of children 5-18 years of age .
  - SLD: ~6-17% of school age children, comprise 42% of special ed services
- Boys more likely than girls to receive diagnosis
  - ADHD: Boys 2-3x as likely to have a diagnosis compared to girls
  - SLD: Boys comprise 2/3 of those with diagnosis
- Both likely to drop out of high school
  - ADHD: 33% Hs drop out rate
  - SLD: 19% drop out of HS (was 35% in 2002), 12% receive a certificate (GED)
- BUT differing diagnostic trends:
  - ADHD diagnosis increased 16% between 2007 and 2011
  - SLD diagnosis declined 18% between 2002 and 2011

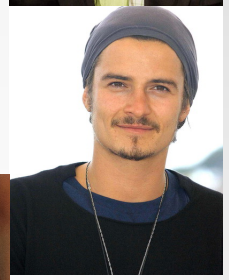
Associated Features

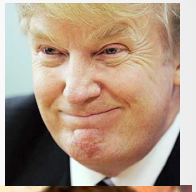
- Highly co-morbid (or co-occurring disorders), ~25% with each other
- Other learning disorders- especially math and writing
- Other emotional/psychiatric co-morbidities: depression, anxiety
- Demoralization, low self-esteem, poor social skills
- Symptoms typically persist into adulthood and cause impairment:
  - Less likely to seek post-secondary education
  - Less likely to be employed and part of the work force
  - High rates of poverty
  - High rates of justice system involvement



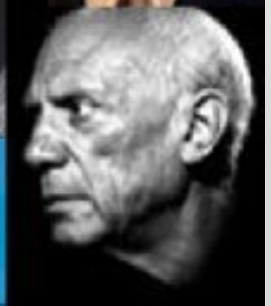
Associated Features

- Bright, very creative, free thinkers
- Perceives patterns that others don't
- Excellent higher order thinking & reasoning
- Thinks visually
- Persistence
- Artistic












Desirable difficulty

- Bjork (1994)-conditions of learning that appear to cause difficulties for the learner but actually improve long-term performance.

- ~35% of people with Dyslexia go on to be extraordinarily successful (Logan 2009)

- Forced compensation for a skill that is lacking, development of skills might otherwise have lain dormant or try things you might never otherwise have considered

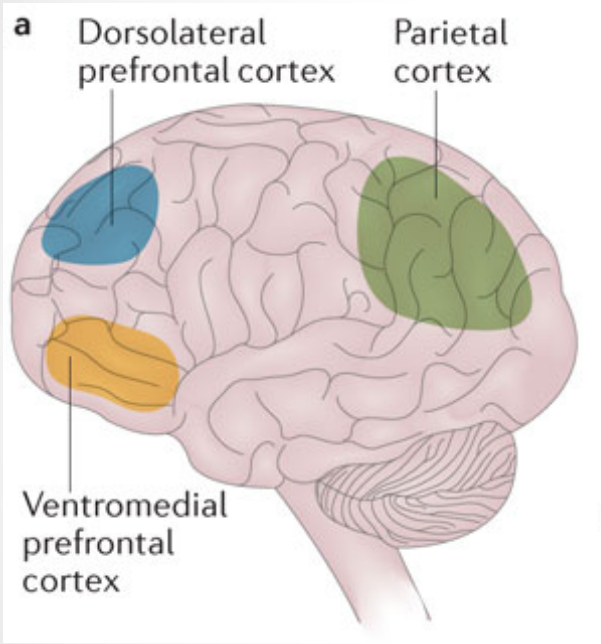
- Highly developed ability to deal with failure

ADHD core deficits

- No one cognitive/brain deficit defines all children with ADHD
- Executive function deficits: skills needed to select and achieve a goal (inhibition, working memory, planning, problem solving)
- Behavioral and emotional dysregulation: delay gratification, tolerate frustration, manage boredom
- Reward processing/motivation deficits

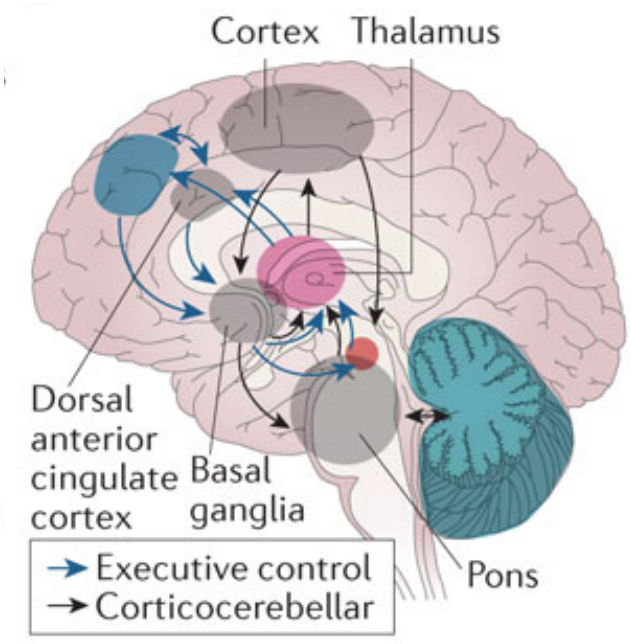
ADHD Neurobiology

Fronto-parietal circuit



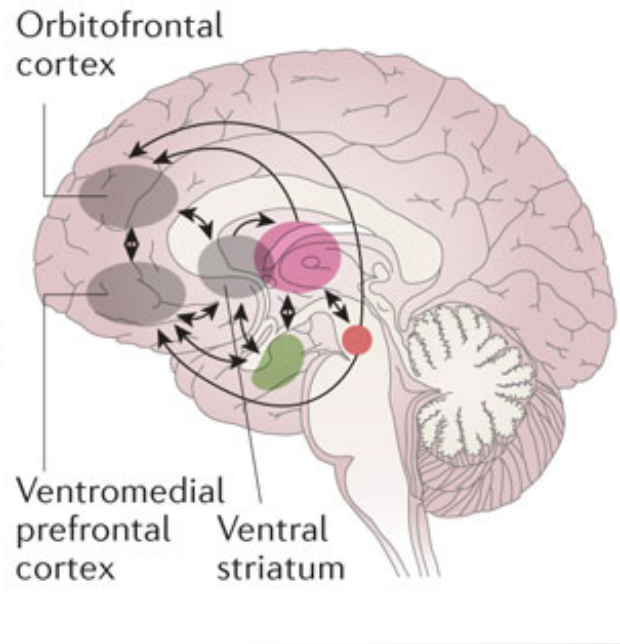
Sustained Attention
Working memory
Problem solving

Cortico-striatal circuit



Inhibition
Decision making
Attention shifting

Cortico-limbic circuit



Reward processing
Motivation
Anxiety/fear
Happiness

Dyslexia core deficit(s)

- Phonemic awareness: identifying and manipulating phonemic units in words or non-words
- Letter-sound knowledge : understanding the alphabetic principle: letters in words map on to phonemes in spoken words. Represents associative learning process
- Rapid naming: visual-word recognition, orthography, linguistic retrieval
- Other RD subtypes: slow fluency and poor reading comprehension (suggests more language based disorders)
- Note: NOT letter/number reversals

Dyslexia Neurobiology

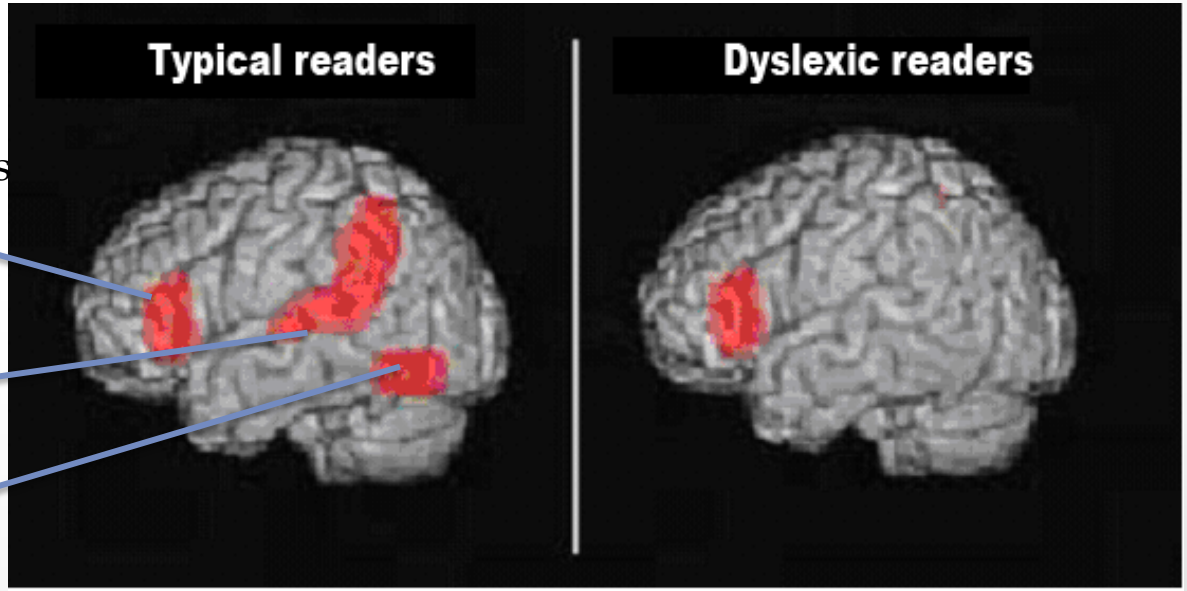
- Brain pathways involved in converting written words into spoken words are not functioning properly.

- Studies support functional and structural abnormalities in left hemisphere regions important for language, phonological processing and word recognition.

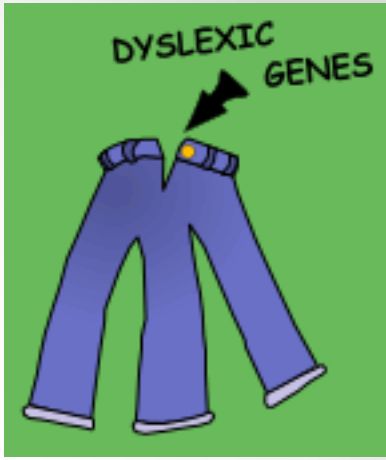
Broca's area
Inferior frontal gyrus
Articulation/word analysis

Parieto-temporal
(word analysis)

Occipito-temporal
(word form)



Causes of disorder



- Genetics:
  - Both disorders are heritable and run in families
  - Specific genes have been identified as conferring risk for disorder, common genes lead to diagnostic overlap
  - Genes involved in neural migration, axonal growth, and brain development have been implicated.
  - But, 'genetic' does not mean fixed.

Neural plasticity

- Long lasting changes in the brain that occur as the result of development, experiences, or injury → synaptogenesis, myelination, neuronal connectivity

- Occurs naturally with development , with peak times in first 3 years of life, teen years, and possibly early 20's. "Use it or lose it" or "Use it and grow it"

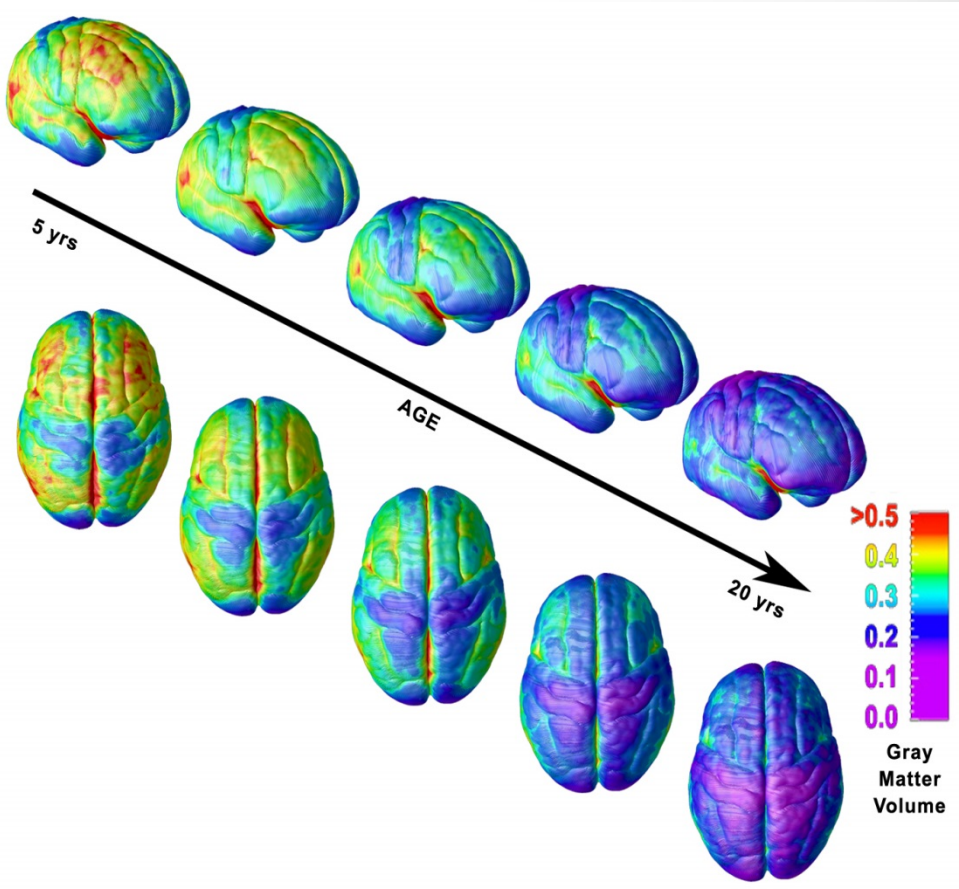
- Adaptive plasticity: Changes in neuronal circuitry that enhances a special skill with practice allowing the brain to adapt or compensate for injuries.
  - E.g., if entire left hemisphere is removed

  in a 4-yr-old child→ may still develop normal language functions

  In an adult→ permanent loss of all language function

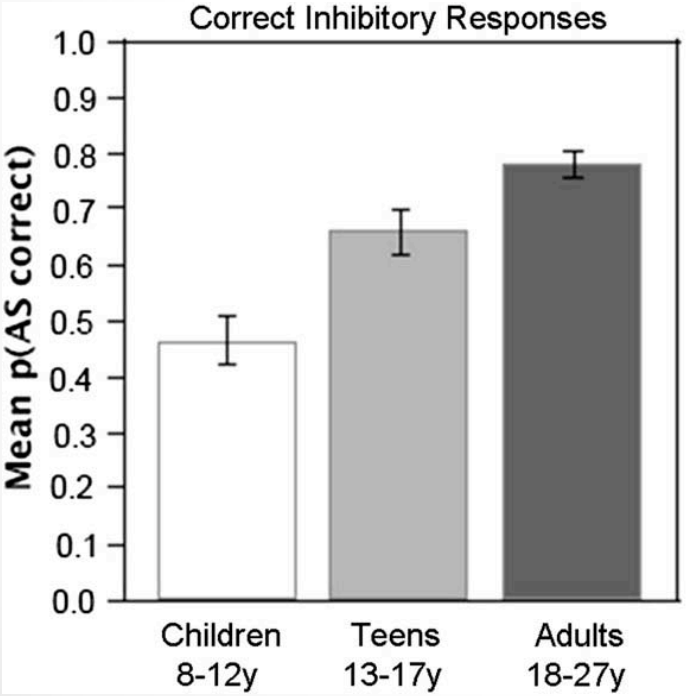
Normal brain development

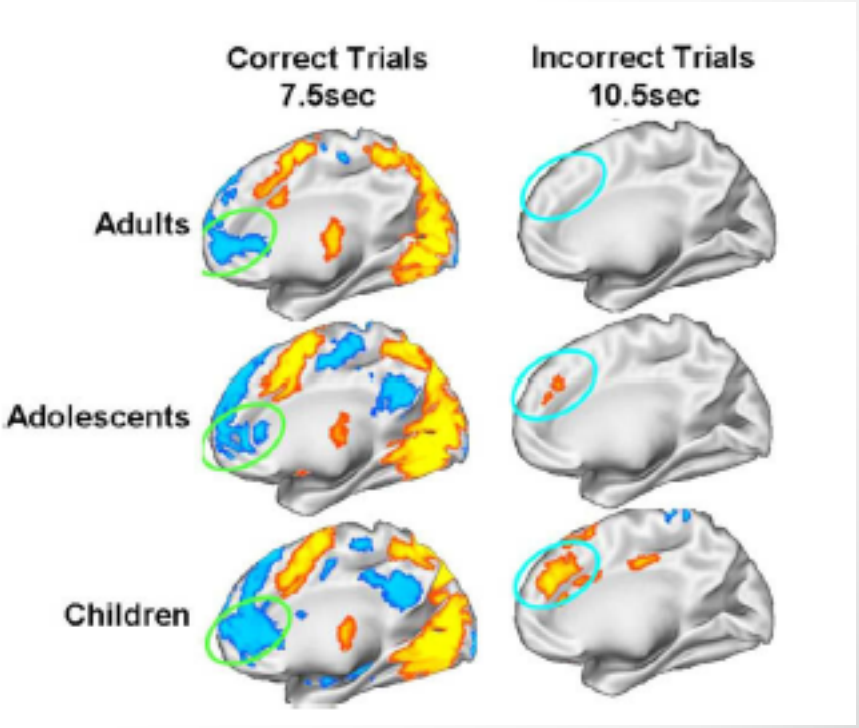
- Brain develops in utero & is ~80% of adult size by 2 yrs. Age 5: brain organization & refinement
- Peak Cortical thickness @ 10-12yrs depending on region
- Pruning and thinning to facilitate efficient neural transmission for functional brain maturation



Brain maturation

- Improved inhibitory functioning
- Increased specialization and efficiency of neural circuits with age

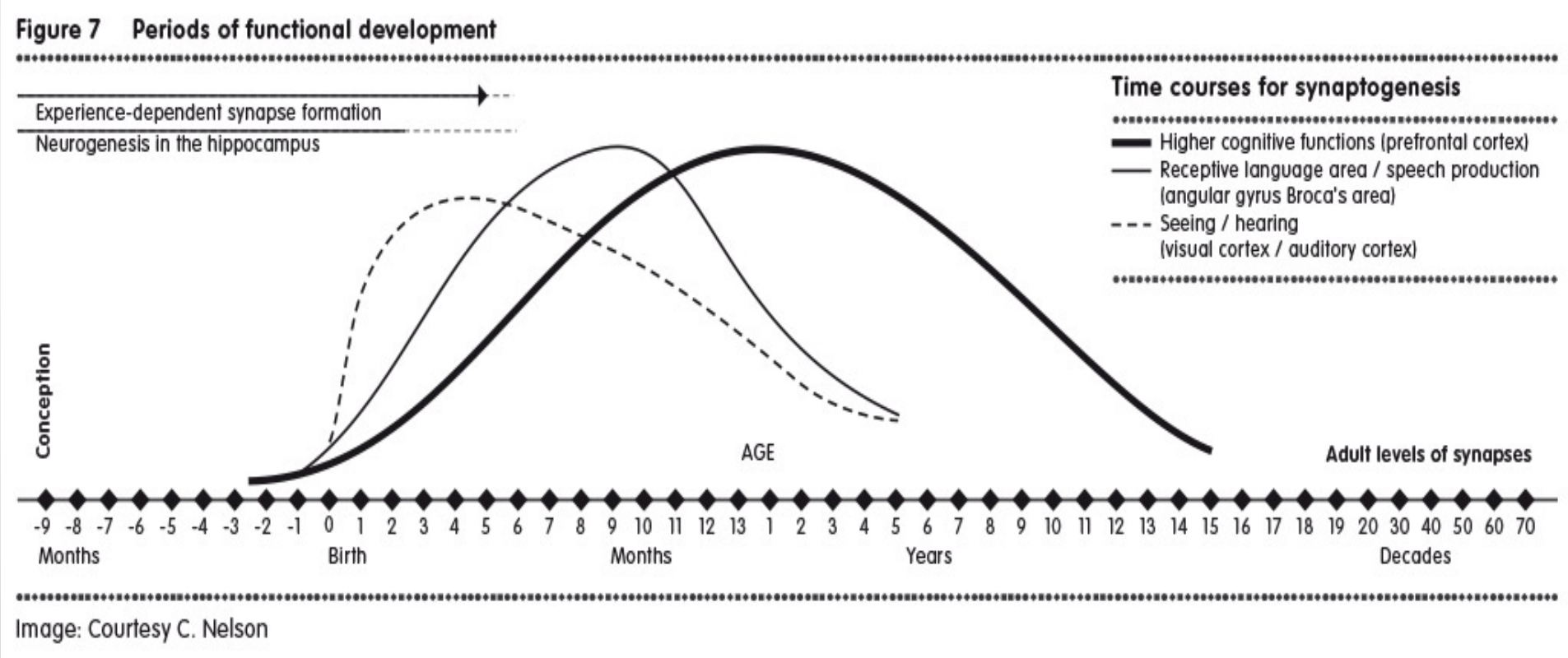




Velanova et al., 2008

Neural plasticity

- Critical periods: crucial experience will have its peak effect on brain development. This figure represents synaptogenesis only



Neural development in ADHD

- Delayed cortical maturation supported but the lack of normalization in cognitive and behavioral domains remains an issue.

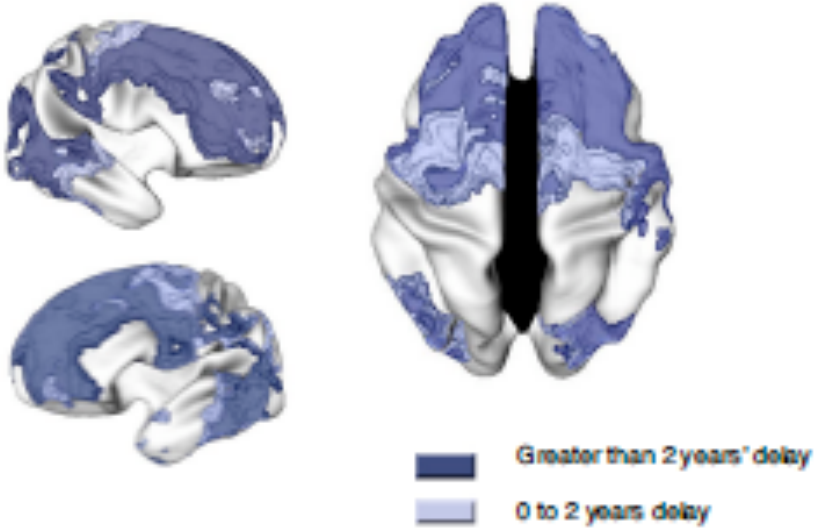


Fig. 2. Regions where the ADHD group had delayed cortical maturation, as indicated by an older age of attaining peak cortical thickness.

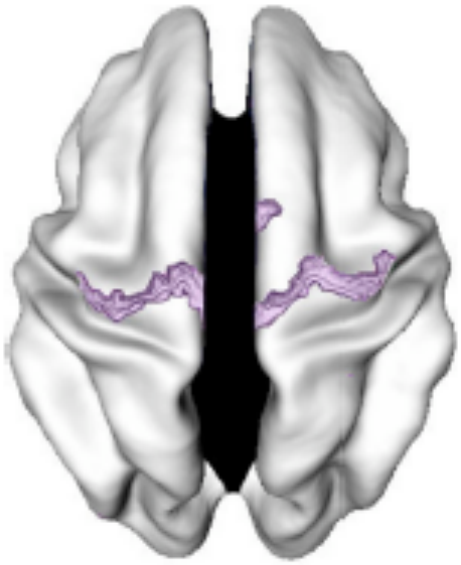
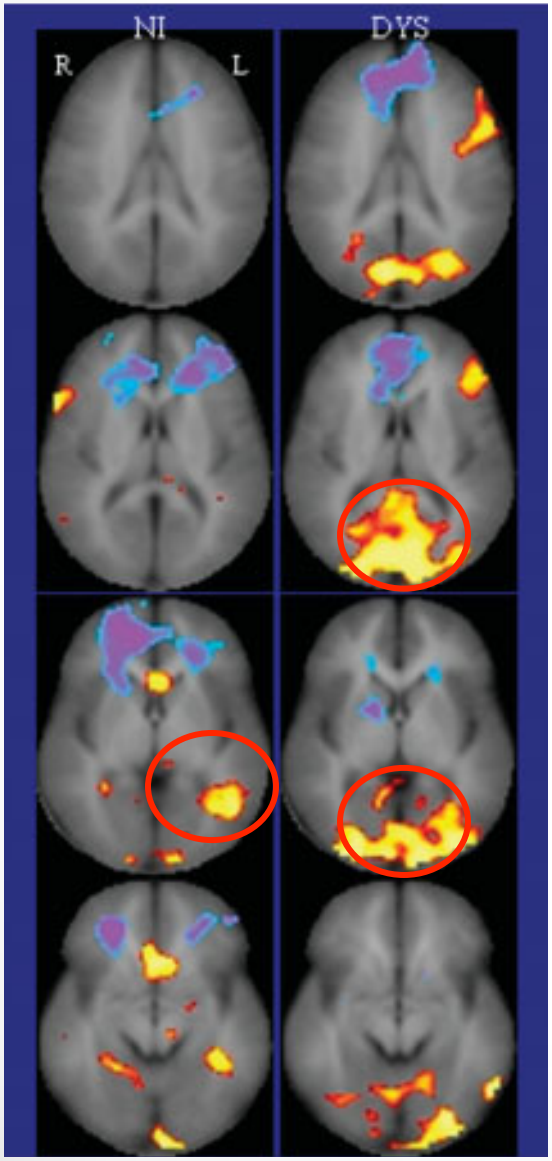


Fig. 4. Regions where the ADHD group had early cortical maturation, as indicated by a younger age of attaining peak cortical thickness.

Shaw et al., 2007

Brain development in Dyslexia

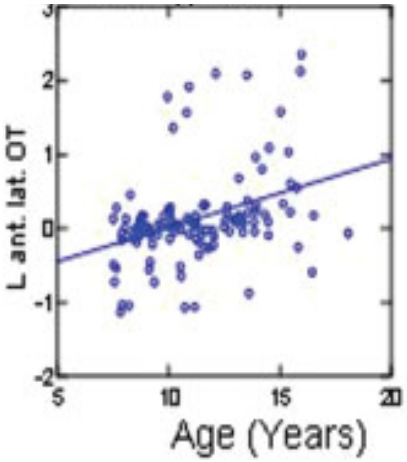
Non-impaired Dyslexic



Non-impaired

r= 0.37, p<0.001

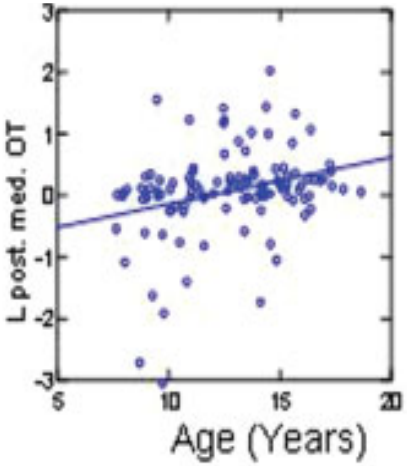
Letter-sound integration



Dyslexic

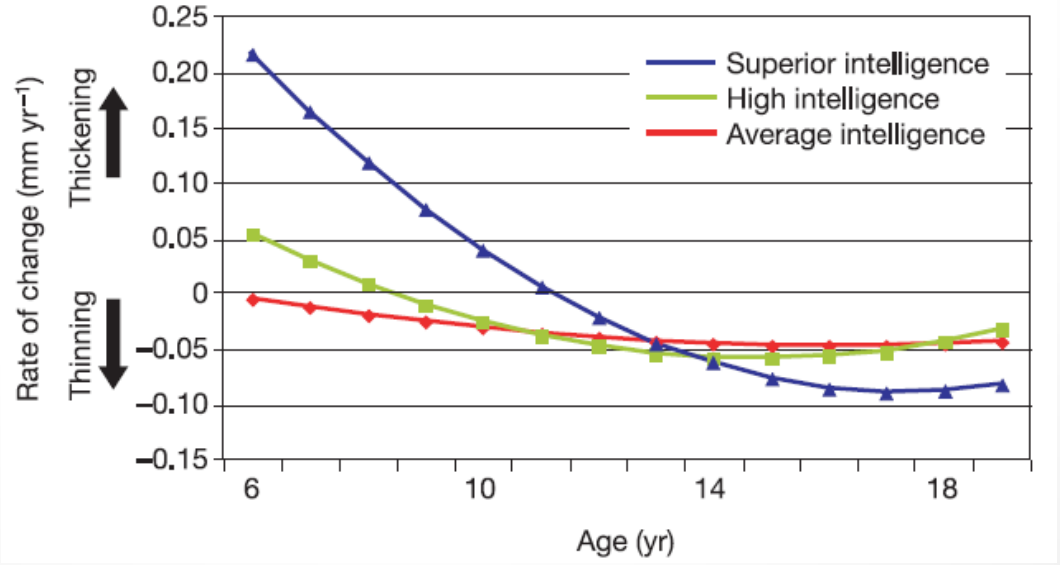
r=0.29, p=0.002

Memory – based system for visual information



Take the long-term view

- Neural plasticity is a continuous normal developmental process
- How the brain is used now will affect how it functions in the future
- Design and evaluate interventions with both short and long-term perspectives



Inducing neural plasticity is…

…like building a new house:

- Need a good foundation
  - Physical health
  - Motivation/Effort
  - Arousal/activation
  - Calmness (reduce stress, anxiety, depression)

AND

- Then learn/build needed skills
  - Behavioral
  - Cognitive
  - Brain
  - Compensatory

Foundation => Brain state

- In order to build new skills, having the right brain state is a critical foundation

- Physical health (sleep, nutrition, exercise) and brain health are intertwined
  - Aerobic exercise for 20 min facilitates information processing and memory formation
  - Sleep plays a critical role in memory consolidation
  - Exercise stimulates growth of new connections and brain growth factors
  - Brain-gut connection is a two way street

Arousal/Activation

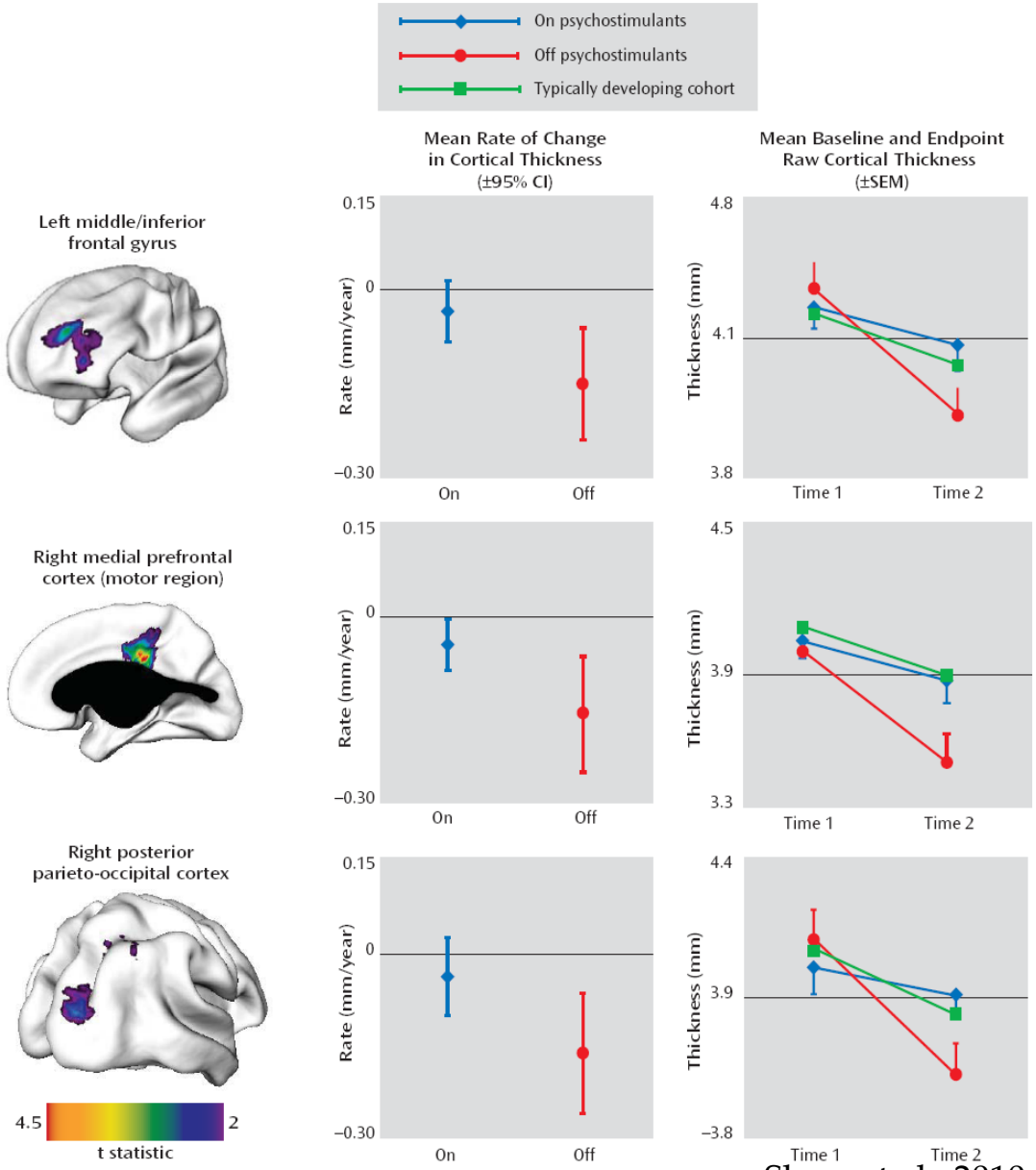
- Need the right balance of arousal/activation in order to engage in new skill building for plasticity

- If arousal/activation are imbalanced, the fundamental ability to purposefully engage is compromised

- Assess whether environmental (e.g., distractions) or internal factors affect arousal/activation

Medications help brain development

- Meds are related to highly focal (rather than global) changes
- Suggests med effects facilitate use of neural circuits
- Consistent with more normalized white matter density with meds (Castellanos et al., 2002)



Shaw et al., 2010

And on brain functions in ADHD

- Brain structure: 6/6 studies found meds associated with attenuation of structural abnormalities.
- Brain function: 19/20 studies found attenuation of control vs ADHD differences in striatum (9/15), anterior cingulate (10/16), and prefrontal cortex (9/15).
- Brain connectivity: 3/3 studies found improved connectivity in ADHD with medications.
- Not one study found an association of medication with worse brain outcomes!

Spencer et al.. 2013

Medications for ADHD + Dyslexia?

- Does Atomoxetine treatment improve reading over and above the effect on ADHD symptoms?

- Two studies suggest Yes, but this is specific to co-morbid ADHD+Dys (Shaywitz et al., 2014; Sumner et al., 2009) and not Dys alone

- More research is needed, however, Atomoxetine affects the norepinephrine neurotransmitter, which has been implicated in neuroplasticity.

Non-pharmacological treatments

- Omega 3 fatty acids: small but significant effects on ADHD symptoms, particularly hyperactive/ impulsive symptoms

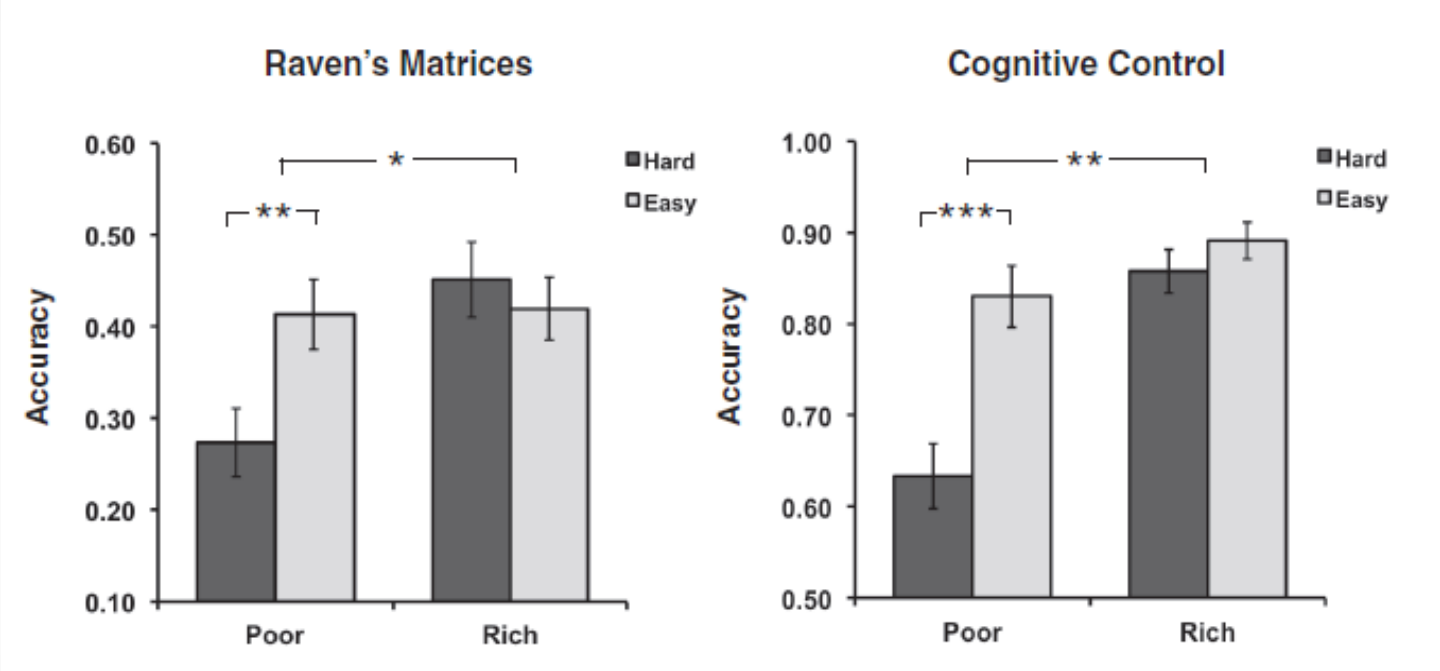
- Artificial food color exclusion produces larger effects but primarily among individuals selected for food sensitivities

- Physical activity/exercise interventions appear promising for ADHD (Rommel et al., 2015) but requires more study

Motivation/effort

- Rewards often normalize cognitive performance in ADHD, but need short-term, immediate reinforcers
- Identifying motivational factors to enhance effort and motivation, particularly in the beginning of learning a new skill is important
- Engage individual in setting goals and why new skill acquisition is beneficial for him/her.

Be Calm: reduce stress…

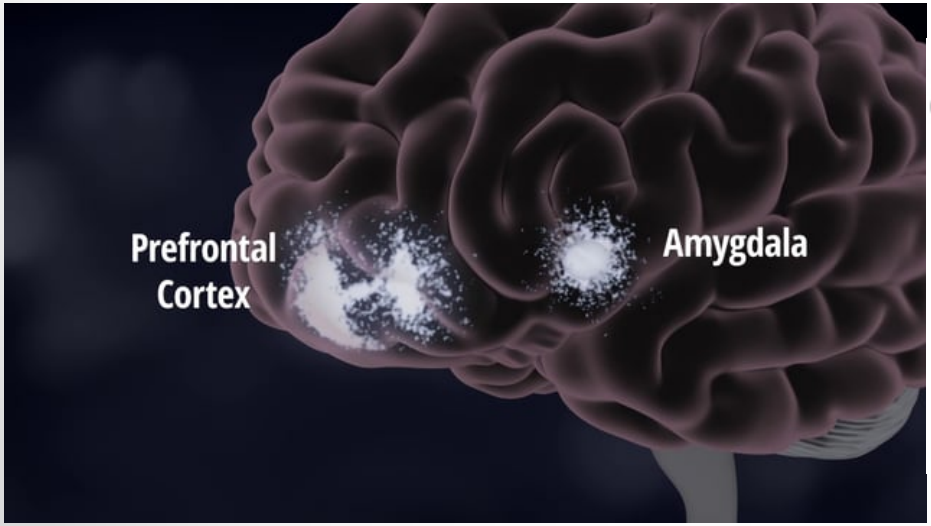


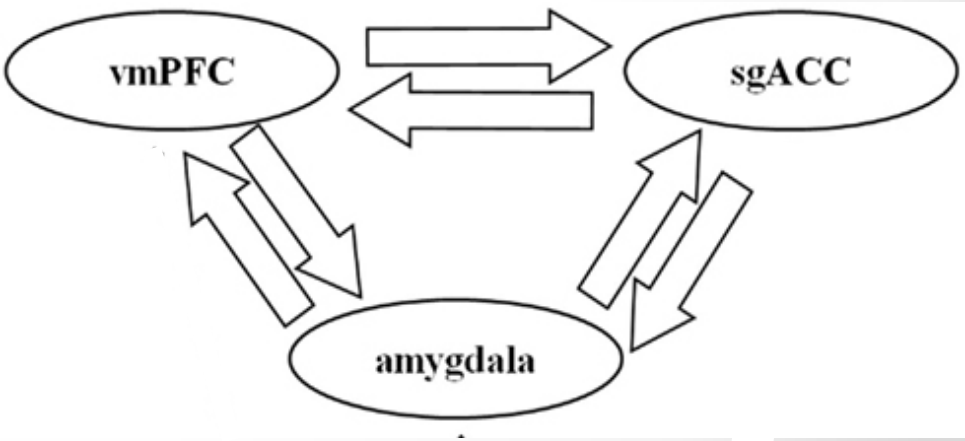
Mani et al., 2013

- The brain is a limited capacity system
- Increased emotional demands affect problem solving & intelligence
- Reducing stress promotes better learning

Be Calm: reduce anxiety & mood problems

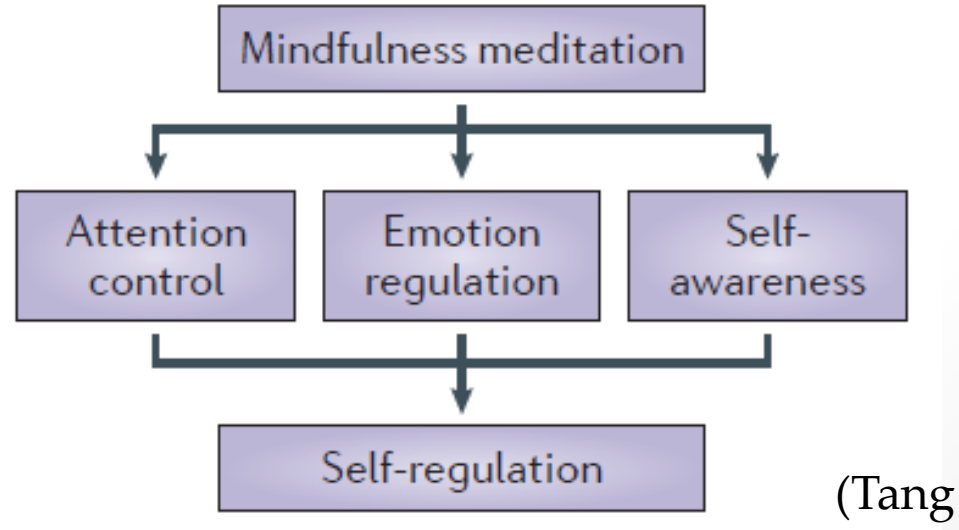
- PFC critically involved in attentional and cognitive control
- Normally, the PFC inhibits the amygdala
- When highly activated, the amygdala inhibits the PFC





Alternative treatments: Meditation & Mindfulness

- Mindfulness and meditation has positive effects on attention, anxiety and depression
- Just 20 min/day for 5 days of meditation (group practice) significantly improved attention and decreased physiological stress indicators compared to relaxation training (Tang et al., 2007)



(Tang et al., 2015)

Why is brain state so important?

- The brain is unable to fully process the experiences it needs for reorganization if these factors are not in place.

- If one (or more) are not possible, this doesn't mean that neural plasticity won't take place, but it may take longer, more practice, or more maintenance for long lasting changes to occur

- BUT brain state alone will not build new skills.



Once the foundation is in place, it's time to build…

- Need a good foundation
  - Physical health
  - Motivation/Effort
  - Arousal/activation
  - Calm (reduce stress, anxiety, depression)

AND

- Then learn/build needed skills
  - Behavioral
  - Cognitive
  - Brain
  - Compensatory

"Exercising our minds should be approached much in the same way we exercise our bodies." *Richie Davidson*

- "brain workouts" help the brain reorganize connections more quickly and stimulate neural change.

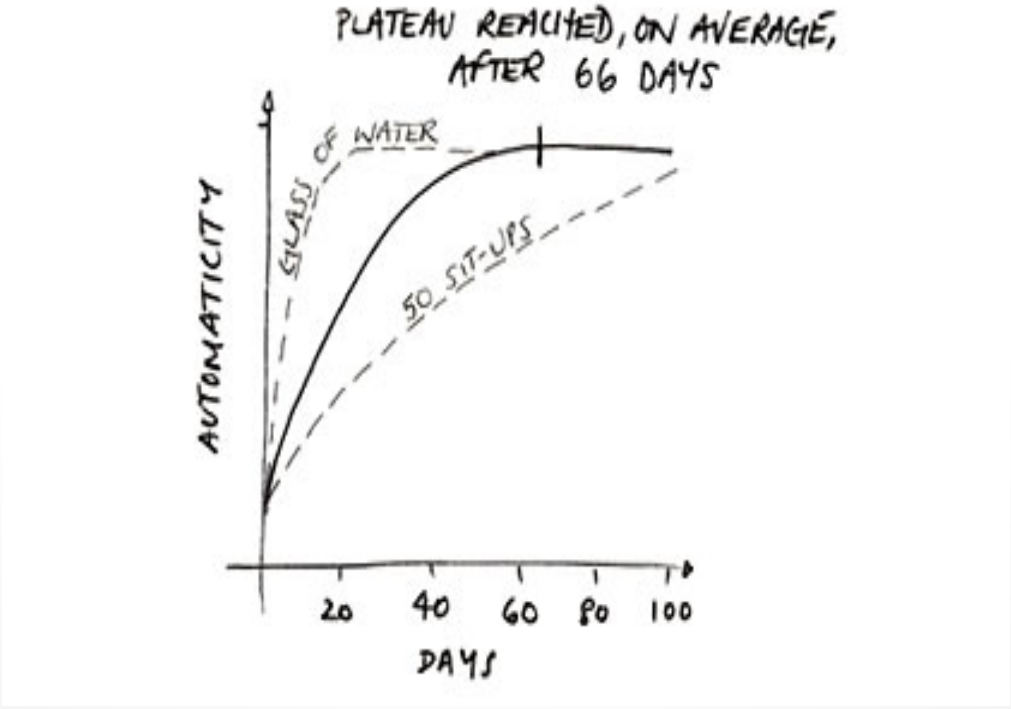
- Generalized stimulation may not be very helpful for rebuilding a specific damaged area of the brain.

- Seeking out challenging intellectual environments, interacting in novel social situations, or getting involved in physical activities will boost the general growth of neural connections.

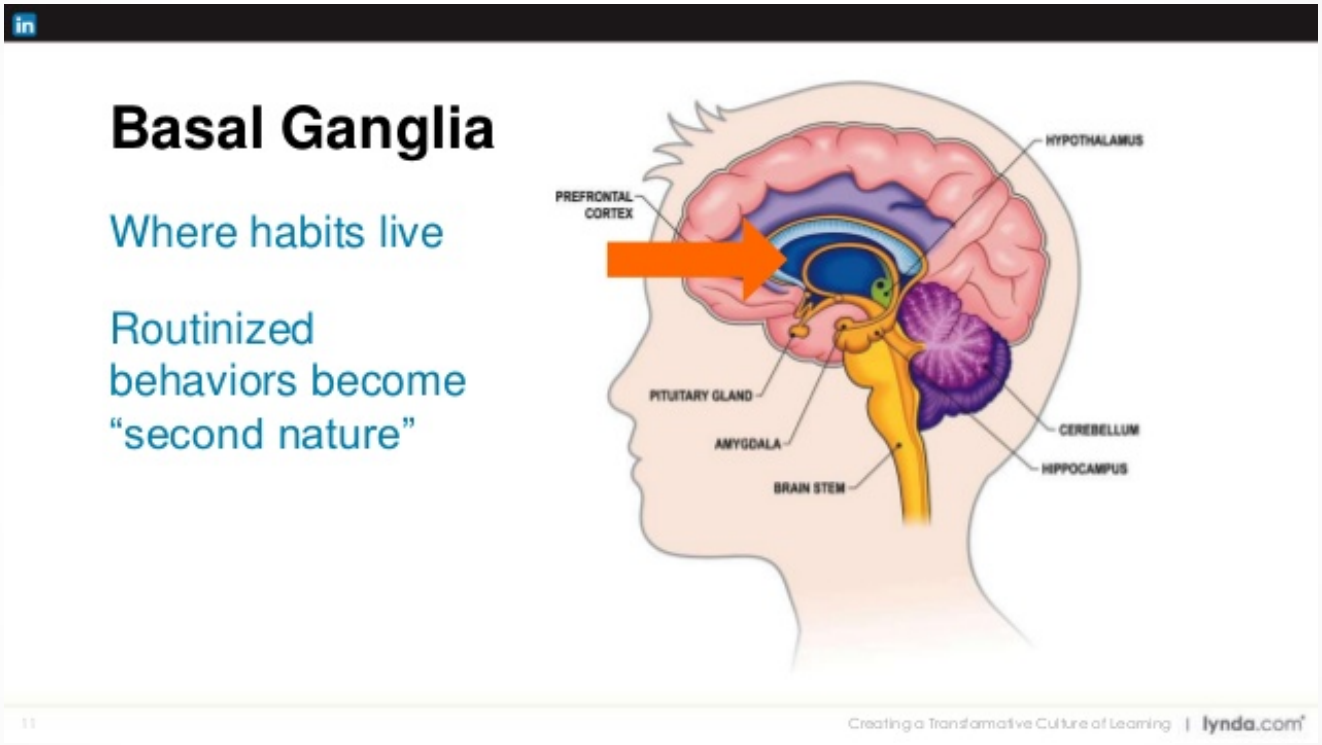
Think of it like forming a habit

- On average, it takes 66 days (~ 2 to 8 months) to form a new habit (21 days is a pseudo-myth!)

- Missing an opportunity did not materially affect the habit formation process



Neural underpinnings of habits



Note: This area is affected in ADHD, so it may take longer and more practice for individuals with ADHD to form new habits.

Behavioral interventions for specific skills

- Most effective for improving parenting quality and decreasing conduct problems in ADHD

- Parent skills training: consistency, positive parenting, break cycle of coercion
  - best for child management (<11 yrs., 65-75% respond)

- Family therapy: Reduce family conflict
  - Family environment strongly linked to comorbidities, particularly disruptive behavior and anxiety disorders.

Combined therapy leads to greatest improvement in overall functioning

- BT combined with meds showed significant improvement over meds alone in aggressive/ oppositional behavior, internalizing symptoms, teacher reported social skills and parent-child relations and reading scores.

- Greater improvements in constructive parenting (e.g., warmth, positive reinforcement, setting the stage and behavior management) than meds alone.

- These changes will drive neural reorganization

Cognitive Behavioral Therapy

- Cognitive-behavioral therapy, Dialectical behavior therapy effective for co-morbid mood and anxiety disorders

- For adults (and potentially adolescents) with ADHD, skills based CBT can be an efficacious treatment (Knouse & Safen, 2014).

- Teach consistent use of: 1. specific compensatory behavioral skills (e.g., organization and planning), and 2. coping skills to deal with thinking patterns that block the use of compensatory skills

CBT: Successful ingredients for students

- Timing: intervention ~8 weeks in duration allows for a start a few weeks into school, before high stress periods begin and person is not "in crisis"

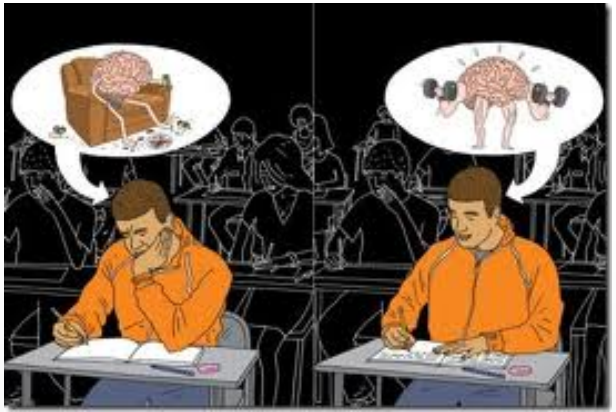
- Measure skill use and functioning, not just symptoms. Several tools are available: Strategies for Success scale, On Time Management, Organization and Planning Scale

- Provide more frequent support: build in reminders or cues for skills use

CBT: Successful ingredients for students

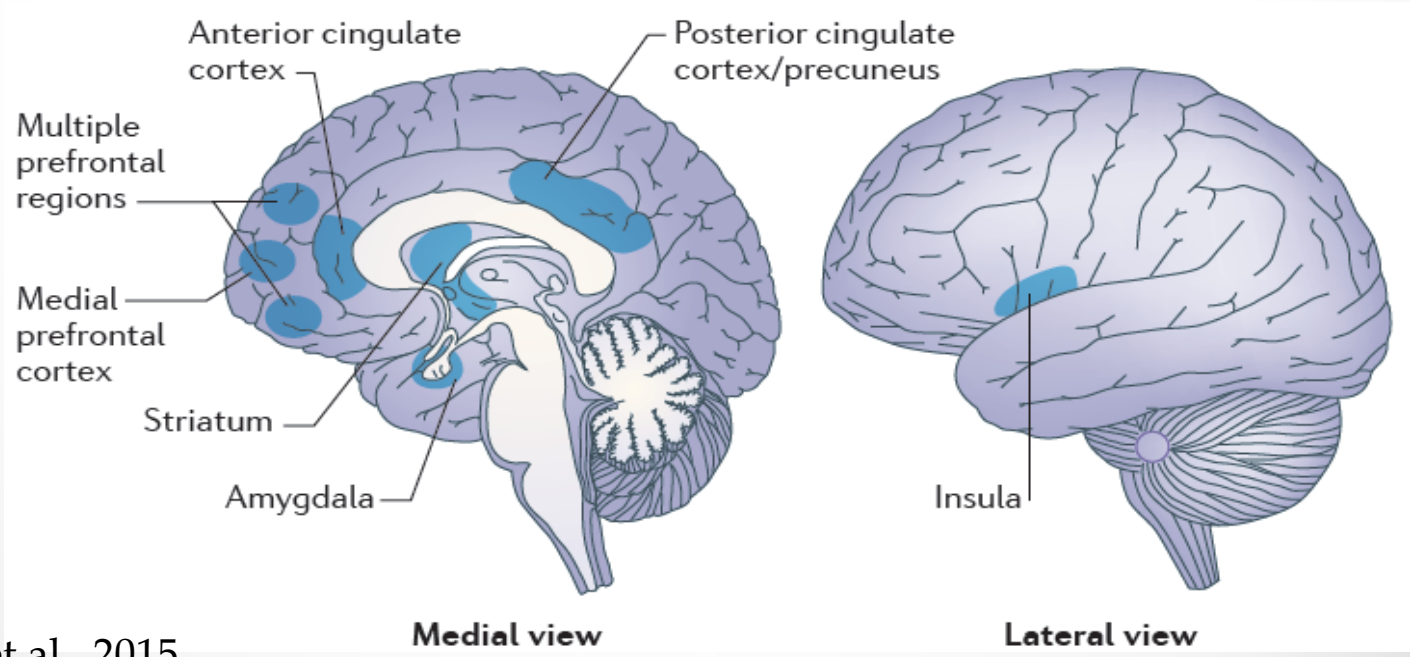
- Treatment should be tailored to individual needs but most include
  - intense targeting of procrastination and avoidance patterns
  - Heavy emphasis on organization, time-management, planning skills
  - Incorporate specific study skills and strategies

Practice of these skills will alter and reorganize neural pathways



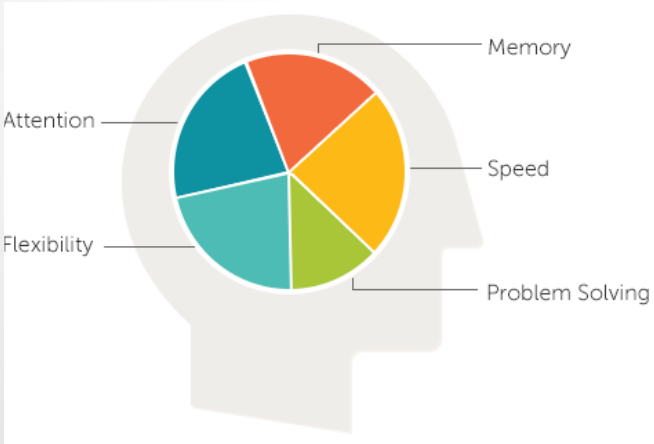
Alternative treatments: Meditation & Mindfulness

- Meditation affects activation of the default mode network and increases connectivity in attention networks.
- These circuits are being exercised through regular practice



Tang et al., 2015

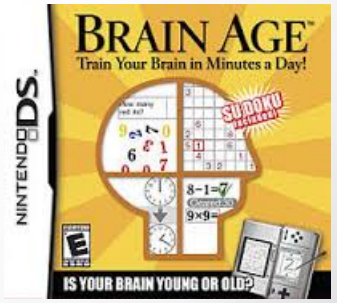
Cognitive training and Educational Therapy to address deficient cognitive functioning



HAPPY neuron

COGMED

Working Memory Training



Cognitive training

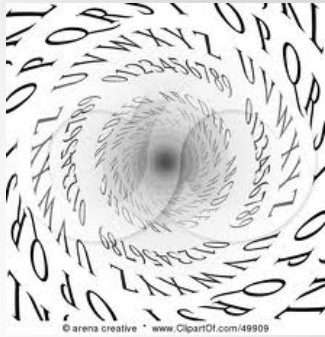
- Cogmed Working Memory Training Program (Klingberg et al, 2002; 2005)-resulted in improvement on visual & verbal WM, nonverbal reasoning, & inhibition.
  - Gains maintained at 3 mo follow up.
  - Increased brain activity in frontal & parietal regions linked to WM (Olesen et al., 2004).
- Recent studies have replicated the positive effects of WM training at school (Holmes et al., 2009) and at home (Beck et al., 2010) in independent samples of children with ADHD (ages 7-17).

- Recent reviews suggest that effects are specific to WM and not effective on improving ADHD symptoms.

Other methods for learning EFs

- Educational therapy: Explicit teaching and practice of EFs
- ALL other cognitive training programs/video brain games have limited to no empirical support for improving ADHD symptoms or Dyslexia core features.
- Given significant neuropsychological heterogeneity, more attention to identifying who would benefit from this treatment is needed (should there be a clearly identified cognitive dysfunction?).

Reading Interventions



- Empirically supported treatments: Linda-mood Bell, Orton-Gillingham approaches

- Intensive daily individualized instruction that explicitly teaches phonemic awareness, application of phonics, word analysis, reading fluency and reading comprehension.

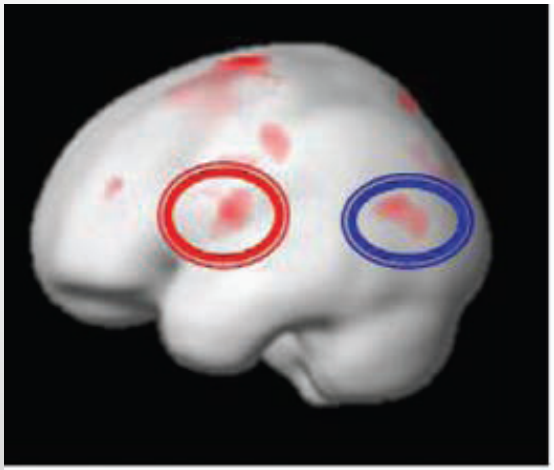
- Intervention is most effective when provided in a one-to one or small group setting

- Early identification and treatment are key. Children 8 years and younger are more likely to show improvement

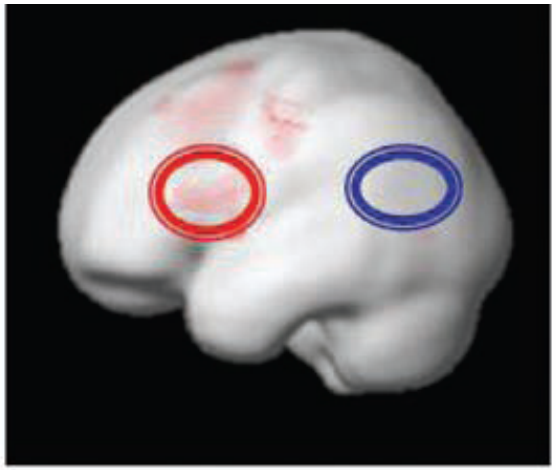
Dyslexia treatment changes

- Compensatory mechanisms include frontal regions and right hemisphere

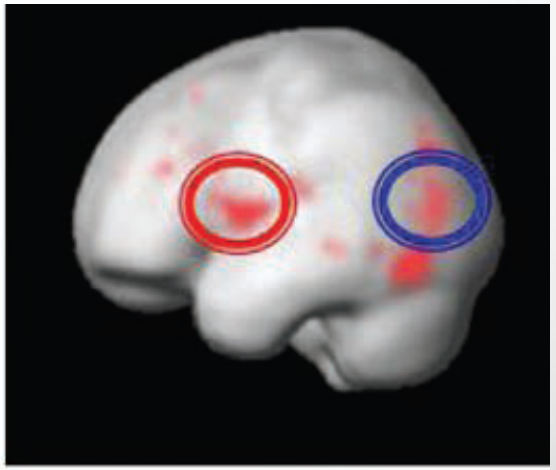
- Successful remediation leads to normalization of left hemisphere activation



TD children



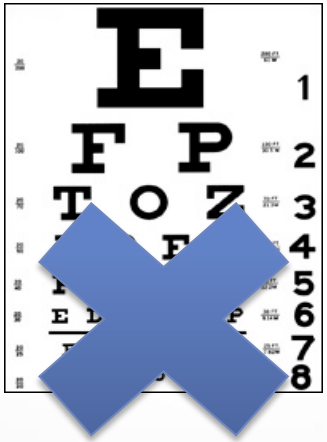
Children w/ dyslexia

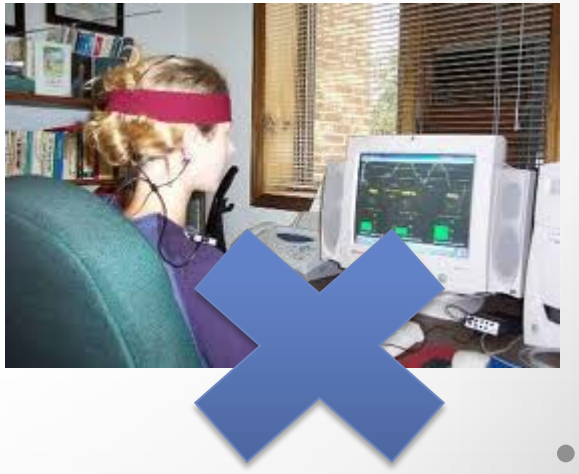


After remediation

Alternative Interventions for Dyslexia

- **Evidence does not support the following interventions:**
- rapid auditory processing (Fast ForWord),
- various visual treatments (e.g., muscle exercises, ocular pursuit-and-tracking exercises, colored lenses and filters)
- exercise or movement-based treatment (e.g., vestibular training)

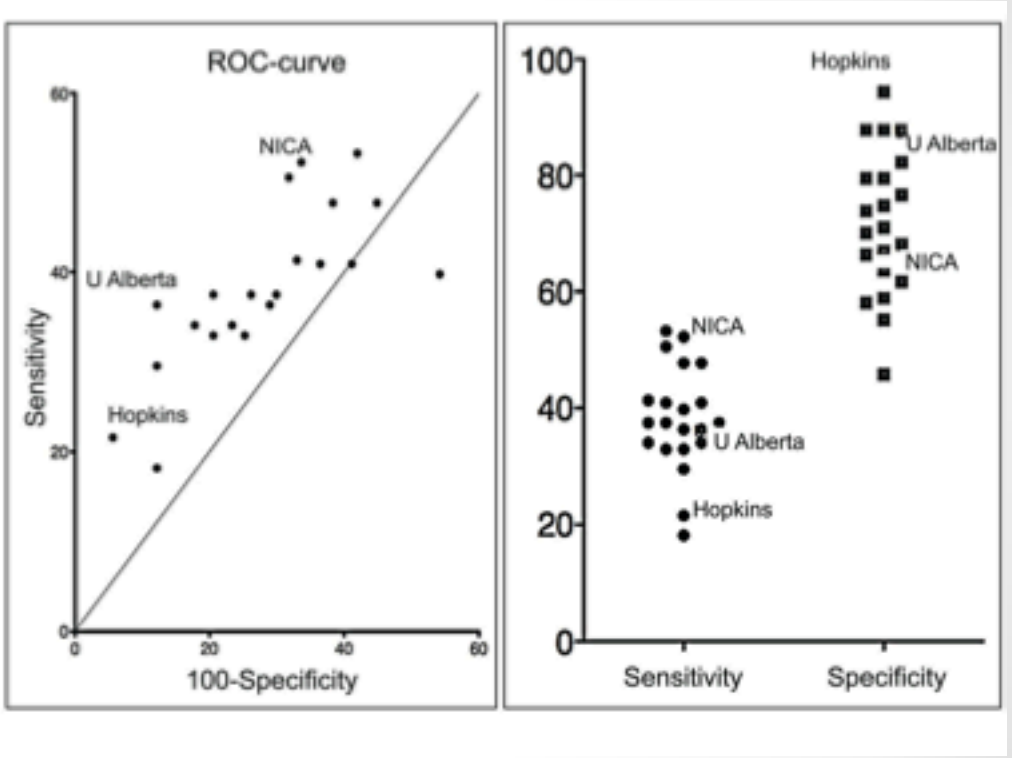




Direct brain intervention?

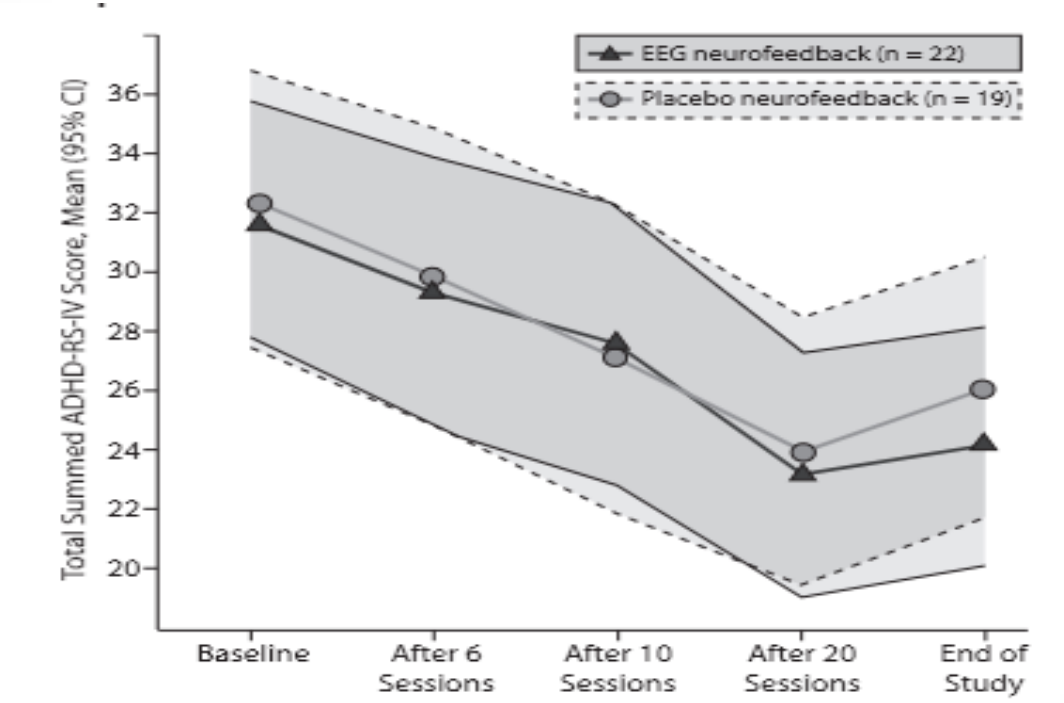
ADHD 200 competition

- f/sMRI: 491 TD, 285 ADHD children (ADHD-PI/CT)
- Winning team: 94% TD but only 21% ADHD correctly classified.
- Ave prediction accuracy ~50% (range 37-61%)
- Highest prediction accuracy, 63% (age, sex, handedness, IQ, no imaging (!))



The ADHD Consortium, 2012

What about neurofeedback for brain regulation? …



Abbreviations: ADHD = attention-deficit/hyperactivity disorder, EEG = electroencephalographic.

As it is currently practiced, neurofeedback is a very expensive placebo effect

Van Dongen-Boomsma et al., 2013

Neuromodulation

- Neuromodulation techniques include: Transcranial Magnetic Stimulation (TMS), external Trigeminal Nerve Stimulation (eTNS), transcranial direct current stimulation (tDCS).

- Non-invasive treatments that use electrical current to modify the process of brain reorganization and enhance the benefits of "rewiring".

- These specific and targeted brain interventions have preliminary support, but are still considered experimental.

Until new skills are established, use strengths to compensate for weaknesses

- Everyone has strengths! Identify and intentionally use while practicing the new skill.
- Most do this unconsciously but to the exclusion of practicing the weaker skill
- Neuropsychological assessments are helpful in identifying cognitive strengths

And use educational accommodations: ADHD

- Preferential seating
- Test taking in quiet environment
- Provision of lecture notes
- Reduce work load-quality not quantity
- Multi-modal learning
- Flexible format expression of knowledge
- Extra breaks off the clock (note: not extended time)
- Assistive technology (if warranted)

And use educational accommodations: Dyslexia

- Extra time (50-100%) on assignments and exams with heavy reading requirements.
- Use of calculator for rote math
- Books on tape
- Waive 2nd language requirement
- Assistive technology
- External reader

Tips and pointers

- Know/expect that It will be hard - patience and persistence are key
- Focus on one to two things at a time (Pick across domains: behavior, cognitive, social, emotional)
- Use observable, quantifiable metrics to measure progress
- Notice and celebrate baby steps
- Try to work with and allow for natural abilities and talents as well as developmental level.

Summary and Conclusions

- To overcome negative outcomes associated with ADHD and RD, strengthen the brain via neural plasticity.

- Both a good foundation AND building/practicing of skills are needed for lasting changes to occur (indicating neuroplastic alterations and rewiring)

- When choosing interventions, evaluate the potential for short-term and long-term impact on brain function.

UCLA Research Study For Children and Adolescents With ADHD

This 8-week study examines the effects of a non-medication treatment for ADHD

Children are eligible to participate if they:

- Are ages 8-12 years
- Have symptoms of inattention, impulsivity, and hyperactivity
- Are not taking any ADHD medications

Participants will receive

- An evaluation for ADHD
- 4 weeks of treatment with stimulation of nerves in the forehead during sleep followed by 4 weeks of careful follow-up

For more information call
UCLA at 310-825-6170

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