I EXECUTIVE FUNCTIONING: THE MIND-BODY CONNECTION

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INTRODUCTION: **WHAT IS** EF **AND HOW DOES** IT **RELATE TO AOHD ANO LO?**

1. Executi"e functioning defined (All roads **lead** to goal-directed behavior)
   1. Bruce Pennington: 'lhe ability to maintain an appropriate problem solving set for anainment •a future \_g lndudes processes sudl as planning, organizational skill, maintaining mental 5et, selectiveatt.entu and inhibitory control - for which the prefrontal regions of the brain are specialized.
   2. Martha Denckla: Emphasizes interference control, effortful and flexible organization, and\_ strategic planning - or anticipatory, goal-directed preparedness to act. The construct also includes **working memory,** as rt includes maintaining intemal representations to guide actions.

1S15 as the "infrastructure" of executive dysfunction **(Initiate, Sustain,** lnhibrt, **Shift}.**

* 1. Deborah Yurqelin-Todd: Describes frontal lobe functions as follows:
     1. filtering sensory information
     2. organizing information and behavior. putting in sequential \_order
     3. sustaining and focusing attention
     4. starting motor responses
     5. coordinating motor programs into purposeful behavior
  2. Goldberg: Desaibes the functions of the frontal lobe with the metaphor of the orchestra director
  3. Several conditions that manifest, at least in part, with executive dysfunction

1. ADHD
2. Tourette's Syndrome
3. Obsessive-Compulsive Disorder
4. Traumatic Brain Injury
5. Depression
6. Leaming Disabilities
7. **Executive functioning and ADHD**
   1. Almost everyone agrees: ADD and ADHD reOect developmental impairment or multiple executive func

8. Martha Denckla: ADHD can be considered as a disorder of inhibition. intention, and working memc

1. Russell Barkley's theory of ADHD: ADHD comprises a primary deficit in behavioral inhibition.

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* 1. Inhibition makes a crucial contribution to four other executive functions: (a) Verbal working m•

(b) nonverbal working memory, (c) self-regulation of affect, motivation and arousal, and reconstitution.

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* 1. These four occur in delays in responding and are protected by behavioral inhibition. They provide a sense or time, timing, and timeliness to behavior.

1. Thomas Brown's opposing view: Poor behavioral inhibition is not the primary executive deficit in ADHD, as facilitating (activating) and inhibitory deficits are both important. Brown's *Attention Activation Disorder* is characterized by deficits in (a) organizing and activating to work, (b) sustaining attention and concentration. (c) sustaining energy and effort, (d) managing affective interference, and (e) utilizing working memory and accessing recall.

Ill. Executive functioning and learning disabilities

1. Historical view: In 1970's, leaming disabled students were described as "passive\_ leame s· who had wea metacognilive skills (similar to executive functions). Since the 19B0's they have increasingly been descnbed as

•actively inefficient learners· (Torgesen).

1. Executive functions and reading disorders
   1. Sustained attention and frustration tolerance are necessary for most readers to acquire a sufficient level of ·automalicity· with the mechanics of reading to become fluent. comfortable readers.
   2. Working memory is linked to comprehension in both poor and good readers.
   3. Poor readers have trouble suppressing activation of irrelevant infonmation.
   4. Students with strong executive functioning skills are able to compensate effectively for language-based difficulties (Denckla).
2. Executive functions and written language
   1. Verbal retrieval, sentence formulation, and written expression place strong demands on sequencing, organizational and self-monitoring skills, and on holding ideas in working memory
   2. Paragraph and essay-length writing clearly stress planning, sequencing, prioritizing, and integrating infonmation.
   3. Children with executive functioning deficits commonly struggle with spelling and the automatic maste·ry of writing mechanics.
   4. There is strong overlap between dysgraphia and ADHD (stimulants often improve handwriting significantly).
3. Executive functioning and math learning
   1. Students with ADHD common,-y have trouble automatizing math facts, even if they otherwise havea good mind for math. They also are prone to misreading operation signs and to having trouble with multiple-step and/or multiple-column procedures (see studies by David Geary and others).
   2. Rebecca Bull and colleagues have found that the primary difficulties of poor math students are

(a) trouble inhibiting preponent responses and learned strategies and (b) poor working memory.

* 1. Jack Nagliari has identified specific planning deficits in students with math disabilities.

1. Content area learning: Executive dysfunction is related to deficits in deliberate memorization and retrieval as these rocesses are dependent upon the skilled use of mental strategy. Deficits in these areas complicat prepanng ro, and taking tests and often first become problematic in middle school.

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**NEUROLOGICAL UNDERPINNINGS**

1. **Neurological foundations of executive functions and executive dysfunction**
   1. Complex brain systems are involved .
      1. Although executive functions do not ·reside" in the frontal lobes, frontal brain systems are extremely important in executive functioning.
      2. The frontal lobes are densely connected with other cortical and subcortical brain regions.
      3. A very recent study in JAMA (Castellanos, et al). found 3-4 percent sr:naller t\_otal brain volume i\_n ADHD children. including unmedicated children. Brain size correlated negatively with symptom seventy.. Largest difference was in cerebellum; the caudate nucleus (part of the basal ganglia) was smaller in younger children but normal by age 15. Unmedicated children shewed significantly\_ smaller vol n\_i of white matter (myelinated axons or connective fibers), reflecting immaturity and raising the poss1b1llty that stimulant medication may actually enhance brain maturation.
   2. Relationship between what Martha Denckla calls motor control and mental control
      1. ADHD research: The three parts of brain that are most heavily involved in ADHD are motor regions: prefrontal cortex, medial frontal area of basal ganglia, and cerebellum (J. Giedd).
      2. The cerebellum coordinates movement but is also important for mental processing. It keeps developing well into adolescence and is not as genetically programmed as many other structures (e.g., is less similar in twins). It thus seems to be influenced strongly by experience (J. Giedd).
   3. · Working memory. There are cells in the frontal lobe that only fire between the stimulus and the subsequent response. These seem to be working memory or "intentional" neurons that allow the brain to "bring to mind" events in the absence of direct stimulation and to provide the temporal and spatial continuity between past experience and present (or future) actions.
   4. EEG studies: ADD children have 9/1 theta/beta ratio (average= **4/1),** reflects mental idling.
   5. Imaging studies - SPECT scans.
      1. Lou's (1984) SPECT study: Found hypoperfusion of frontal lobes but increased blood flow on Ritalin.
      2. Daniel Amen's SPECT scans: "The harder they try, the worse it gets." Helps to explain Brown's idea of trouble with activation.
   6. Extremely high heritability of ADHD.
2. **Brain development and executive functions**
   1. Earlyevelopm\_ent of t e frontal l?be\_: Between \_3 a 6 years, the most rapid brain growth is in the frontal lobe

areas involved m planning, orgamzat1on, and mamtammg attention and vigilance (corresponds with the •s-7

shift" and readiness for formal schooling.).

8. Frontal development and developmental stages: There is a close correlation between maturational spurts in frontal lobes and transitions into neo-Piagetian stages.

1. Adole ce ce and beyond: Protracted development of the frontal lobe in adolescence and adulthood (myleinahon not complete until fourth or fifth decade of life).
   1. Dramatic spurt in frontal lobe maturation between 17-20 (corresponds to Priscilla Vail's 16-19 shift) Helps explain late bloomers. ·

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Deborah Yurgelun-Todd (Mclean Hospital): Teens have more trouble than adults identifying expressions of fear. On MRI. adults activated in limbic region and prefrontal cortex. in teens. mainly limbic activation. Teens activated amygdala bilaterally, adults left amygdala. On a verbal fluency task. children activated left temporal, teens increasingly activated left frontal.

1. Kurt Fischer has identified cognitive changes through age 25 with corresponding changes in EEG through early 20's.
2. There is also evidence for a significant spurt in the myelination of fibers connecting the frontal lob s and limbic regions between 40 and 50, allows for a ·second chance· at the development of reflective

thinking.

1. Many middle age women report ADHD symptoms for the first time - or a worsening of existin symptoms. May be related to estrogen depletion, as estrogen facilitates the release of dopamine.

Ill. **Factors that affect executive functioning**

1. Stress:
   1. Stress disorganizes the brain (try to organize and set priorities when your stressed!)
   2. Anxiety can mimic ADHD/EF. High amygdala activation produces high volume of dopamine. Too much dopamine flooding the brain can be just as bad as not enough, as it can "disconnecr frontal lobe's central executive from other brain functions (Oenckla).
   3. Stress (particularly the adrenal steroid **cortisol)** significantly interferes with the functioning of the brain's major memory center **(hippocampus).** Over time, cortisol can kill hippocampus cells and retard growth of new cells.- Prolonged stress can lead to significant hippocampal shrinkage and increased risk for Alzheimer's Disease.

* B. Resting the nervous system: The importance of sleep
  1. Sleep is highly associated with mental and physical health in children, adolescents. and adults. Sleep is also extremely important for learning and memory consolidation througho.ut the life span.
  2. A recent study by Dr. Eve Van Cauter found that one week of sleep deprivation (4 hours per night} in· adults slowed glucose metabolism in the brain by 30-40 percent (similar to the functioning of the elderly). Also, cortisol levels were higher during sleep in sleep-deprived group (linked to development of m rnory impairments and age-related insulin resistance).
  3. A single night of partial sleep deprivation (5 hours) affects executive functions in children.
  4. Almost all teenagers as they reach puberty become "walking zombies· (James Maas).
  5. Core symptoms of ADHD and sleep disruption/deprivation are strikingly similar, as are

.ne ro ychological profiles. Children withDHD\_have high incidence of sleep disturbance, particularly vanab1hty in sleep latency. Treatment studies using (a) chronotherapy for insomnia and (b) dopamine stimulaling drugs to treat movements in sleep lead to significant improvement in sleep, attention, and behavior.

C. Depression (talk about an executive buster!): Depression and disordered stress response

**ASSESSMENT ANO INTERVENTION**

1. **Assessment of executive functions**
   1. Measures of verbal and nonverbal fluency (e.g., *Controlled Oral* Word *Association Test; D-KEFS Design*

*Fluency Tes()*

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* 1. Measures of word list learning (e.g., *Selective Reminding Test: California Verbal Leaming Test for Children)*
  2. Measures of motor sequencing/motor control (e.g., *Grooved Pegboard;* Go/ No)

0. Tasks involving planning (e.g.. *Tower of London; Rey Osterrieth Complex Figure: GAS Planning subtests)*

1. Tasks requiring interference control (e.g., *Stroop;* tasks from the *GAS)*
2. Tests of working memory (e.g., digit span; following directions: *Paced Auditory Serial Attention Test)*
3. Tests of vigilance and impulse control (e.g., *TOVA; /VA; GAS Atttention subtests)*
4. Tests of mental flexibility (e.g., *Wisconsin Card Sorting Tes()*
5. Tests of problem-solving, hypothesis testing *(D-KEFS 20 Questions Tes()*
6. New battery: *De/is-Kaplan Executive Function* System *(D-KEFS)*

## Common educational interventions

* 1. Arranging environments (e.g., preferential seating, study carrels, small group instruction).
  2. Behavioral management . Interventions to improve on-task behavior have\_included:

1 . Classroom-based contingency systems

* 1. Response cost programs (e, g, start out with 100 points, lose points for infractions)
  2. Home-school contingencies
  3. Peer-mediated contingencies
  4. Technical supports
     1. Fm systems using headphones and a microphone (auditory trainers)
     2. Beepers (e.g., pageminders.com)
     3. Timers
  5. Study skills/ learning to learn strategies
     1. Planning/goal setting/lime management
     2. Segmenting and sequencing tasks
     3. Monitoring and tracking assignments
     4. Learning-to-learn strategies for organizing time and materials, organizing and remembering information, sequencing ideas (in writing).
  6. Executive coachlrig

Ill. Promoting self-regulation and optimal functioning: What's good for the heart is good for the brain

1. Promoting sleep: the importance of resting the nervous system
   1. Make sleep a high priority.
   2. Follow good sleep hygiene (see books by Mark Durnnd nnd/or William Dement). For teen.lgers. minimize brighl lights ofter 9:00 pm nnd o><pose to bright lights first thing In the morning.

3, Consult with n physician regarding posslble sleep disorder and effects of medication on sleep.

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1. Practice stress management: Deep rest heals the nervous system of stress. in part by lowering cortisol level.
   1. *Transcendental Meditation* (www.tm.org) is best documented, with over 600 published studies. Lower cortisol levels. Increases coherence between lett and right hemispheres. *front* and back of brain. Increases cerebral blood flow. Improves emotional regulation and sleep. Reduces blood pressure as effectively as medication in adolescents and adults {with only positive side effects). Increases ability t focus attention.
   2. "Do Turtle" (students "go into their shell); use techniques from Brain Gym.
   3. The Relaxation Manual by June Groden and Joseph Cautela: Combines progressive muscle relaxatio and visual imagery; is used·extensively even with autistic and low functioning students.
2. Facilitate relaxed alertness in the classroom: This is the optimal mode for learning (high challenge, low threat)
   1. Reduce threat to minimize "downshifting·, explore with children what interferes with their feeling safe i school.
   2. Minimize fear-based motivation. Teach students to set goals, stay in touch with the emotions that motivate the goals. Teach adaptive motivation {preference for difficulty and increased effort with difficulty).
   3. Practice empathy (see Robert Brooks' The Self-esteem Teacher).
   4. Encourage physical activity (due to the overlap between motor and mental control)

1, Encourage aerobic exercise, strengthening, and stretching. Movement stimulates the executive brain primes the ·executive pump".

2. Patterned programmed movements *may* be particularly beneficial, e.g., martial arts, yoga, dance, swimming, drumming).

-3. Use strategies from *Brain Gym* (e.g., "cross crawl"); use techniques for kinesthetic learners (who need movement to get and keep their brains activated).

* 1. Diel: Food affects the nervous system (as is obvious in children's limited emotional regulation when hungry).
     1. In Healing ADD, Dr. Daniel Amen recommends a relatively high protein, low carbohydrate diet (e.g.. Barry Sears' *Zone Diel)* for all types of ADD except the overfocused/inattentive type.
     2. See Jean Carter's Your Miracle Brain for broad nutritional suggestions,

3, Drink water: Brain ls more vulnerable to stress (more cortisol production) when dehydrated.

1. **Provide** lncrea$8d structure of time and **space** (Be frontal lobes for students who lack them).
   1. Organize space (duct tape as metaphor)
2. **Organize** time:
   1. Practice o:»timnting, predicting expected time (people with ADHD nrc r>oor ostimntors of time).
   2. Use schedules, clocks, llmers
   3. Find **ways** of building In down lime, Including tlmo with **eyes**closed.
3. **Teach stnrtegluJor self.rqgulatlon, self-moo!tortng, S@tr-relof<ncemeot,**
   1. f!ehaviorcil r&gulntloo

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* + 1. Philip Kendall's Stop and Think
    2. Bonnie Camp's Think Aloud
    3. ALERT program ("How Does Your Engine Run"): Developed and implemented by occupational therapists. Very useful in the classroom.
    4. Strate,gies for emotional control (e.g., from *Rational Emotive Therapy)*
    5. Myrna Shure's preschool program
  1. Cognitive-behavioral strategies for academic learning
     1. Steve Graham and Karen Harris' Self-Regulated Strategy Development
     2. University of Kansas strategies
     3. Mnemonic techniques
  2. Use modeling, attributions, and teaching of others
     1. Model self-talk re: planning strategizing, organizing, problem-solving
     2. Model self-talk for 20 Questions, verbal fluency, memory strategies .
     3. Attributions help to shape executive system (point out "I've noticed that you can really organize when

you put your mind to it").

* + 1. Encourage children and adults to teacher others.

Play games that demand **executive skills**

A. Emphasize games that require classification (integrating global and local), planning ahead, wai ing u\_nti th.e right time. organizing materials, prioritizing, use of strategy, anticipating a other's moves, working within a time frame..

8. These could include the following: *Blurt, Outburst, Taboo, Tribond, Scattegories, Set, Scrabble, Hangman, Risk, Chess, Monopoly, Battleship, Checkers, Chess, Clue, The Logical Journey of the Zambinis.*

1. Intervention in specific executive **areas**
   1. Initiate

Facilitate neurological readiness to act. Include "rag doll", *Brain Gym* strategies such as "brain buttons· and ·cross crawl", and "anchoring" strategy from NLD (see Thom Hartmann's book, Healing ADD).

Could also inc!ude push ups, trampoline, headstands.

Teach children to "size up· new tasks, determine the relevant component parts. Teach left hemisphere strategies using self-talk ("What am I being asked to do?"). Teach right hemisphere strategies using visualization ("See yourself doing it").

Teach prioritizing and sequencing of steps In time. Use predict and compare strategy (which can greatly reduce procrastination) and various means of marking the passage of time. Always map time left to right.

Use ex1ernal prompts such as beepers to provide reminders, e.g., "Get your butt in gear:

{www. PageMinderslnc.com)

Teach strategies to combat procrastination (e.g., break tasks into small chunks, work in short periods, set lime limits to avoid hyper-focusing).

Model the breathing, posture, and self-talk of students who know how to get started (see the *Neuro­ Ungulstic Programming (NLP}* strategies In Thom Hartman's book, including strategies for planning the future).

Encourage students to sel their own goals, track their own progress (e.g.. ReadNaturally.com).

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# 8. Use humor: Jokes can help kids get started.

* 1. Sustain
     1. Use external means to monitor time. give feedback.
     2. Use of mirrors. videotape, beepers. . .
     3. Have child use ear plugs or head phones during work time to reduce d1stract1on.
  2. Inhibit: Behavioral regulation drives metacognition (Barkley).
     1. Medication: Stimulants improve inhibitory control and other executive skills (including working memory)
     2. Self-talk ("stop and think"; "go slow")
     3. Relaxation work
     4. Practice *Stroop* task (see web site)
  3. Shift
     1. Minimize transitions; move from unstructured to structured to formal
     2. Use a transition clock {from The Difficult Child)
     3. Practice transitions (visualize and/or role play) . . .
     4. Use of paradox (e.g., have child pretend to freak out, fall apart when role playinga trans1t1on.
     5. Play *Set*
  4. Working Memory

1: Use computer programs such as *Earobics* to develop verbal working memory

2. Use guided imagery to develop nonverbal working memory

1. **Direct training of attention and related processes** (the process-specific intervention of Mateer; Keams; Selmud­ Clikeman).
   1. Assumptions: Attentional abilities can be improved by providing structured opportunities for exercising particular aspects of attention. Hypothesis: Repeated activation and stimulation of attentional systems leads to changes

in cognitive capacity that presumably reflect changes in neuronal activity.

1. Attention Process Training (Sahlberg and Mateer). Training focuses on a.group of hierarchically organized remediation tasks that tap five dimensions of attention: focused, sustained, selective, alternating. and divided.
2. Other promising interventions
   1. Neurofeedback training (using feedback to regulate brain waves)
   2. Interactive metronome {www.interactivemetronome.com)

SUGGESTED **READING**

Brain **Development**

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