

# CAN YOU TEACH EXECUTIVE FUNCTIONS?: Understanding the Neurodevelopmental Trajectory of Executive Functions

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## Why do most 16-year-olds drive like they're *missing a part of their brain?*



BECAUSE THEY ARE.



**EVEN BRIGHT, MATURE TEENAGERS SOMETIMES DO THINGS THAT ARE "STUPID."**

But when that happens, it's not really their fault. It's because their brain hasn't finished developing. The underdeveloped area is called the dorsal lateral prefrontal cortex. It plays a critical role in decision making, problem solving and understanding future consequences of today's actions. Problem is, it won't be fully mature until they're into their 20s.

It's one reason 16-year-old drivers have crash rates three times higher than 17-year-olds and five times higher

crashes. These laws restrict the more dangerous kinds of driving teens do, such as nighttime driving and driving with teen passengers. Since North Carolina implemented one of the most comprehensive GDL laws in the country, it has seen a 25% decline in crashes involving 16-year-olds.

To find out what the GDL laws are in your state, visit [Allstate.com/teen](http://Allstate.com/teen). Help enforce them—and if they aren't strong enough, ask your legislator to strengthen them.

Let's help our teenagers not miss out on tomorrow just

# Brain development in adolescence

- ▶ “Neurological development is an important aspect of overall adolescent development and our efforts to understand, guide and help teens should be based in part on a deeper appreciation of adolescent neurobiology”.

(Drs. Jay Giedd, Daniel Weinberger, Brita Elvevag)

Encourage executive skill development with awareness of time sensitive nature of neurodevelopment.

# Teen Brain: A Work in Progress

- ▶ The gray matter growth spurt prior to puberty dominates the frontal lobe, the seat of “executive functions”.
- ▶ MRI scans of young adults, 23 -30 compared to teens, 12 -16 showed large differences in the myelination of the frontal lobes. Parietal and temporal areas (mediating sensory, spatial, auditory and language functions) were matured in the teen brain.

# The critical and late to develop FRONTAL LOBE

- ▶ EF are the major province of the **prefrontal cortex** with connections to other parts of cortical and subcortical structures.
- ▶ The frontal lobe makes up **almost half** of the cerebral cortex.
- ▶ The frontal lobe has the **longest, most continuous developmental trajectory** with growth spurts occurring between 5-7 yrs., 9-12 yrs., adolescence, with stability into the 20's.

# Brain Changes

- ▶ 6 yrs. brain is 90% -95% of its adult size
- ▶ 6 - 20 yrs. Different regions undergo dynamic changes with increased synaptogenesis.
- ▶ 6 -8; 10 -12; 14 -16 yrs. spurts of brain growth **in frontal cortex.**
- ▶ 11 yrs. (girls); 12 yrs. (boys) Spurt of growth in frontal cortex- second wave of overproduction.
- ▶ 4 -13 yrs. Myelinating of frontal lobes proceeds rapidly.
- ▶ 20+ yrs. Myelinating of dorsolateral prefrontal cortex (DSPC)

# Defining Executive Function

- ▶ EF is an umbrella term that includes a collection of interrelated functions that are responsible for purposeful, goal directed, problem solving behavior.
- ▶ EF are processes that guide, direct, and manage cognitive, emotional and behavioral functions especially for novel problem solving.
- ▶ EF are dynamic, interactive and evolving skills that result in goal directed behavior.
- ▶ EF support the ability to reflect, alter performance and respond to unexpected situations.

# Executive Functions

- ▶ A diverse group of cognitive processes that act in a coordinated way to direct: **perception, emotion, thought and action**
- ▶ Executive Functions are not a unitary trait i.e., not the CEO of the brain
- ▶ Executive Functions are : THE ENTIRE MANAGEMENT TEAM OF A MULTINATIONAL CORPORATION



# Executive Functions versus Executive Skills

- ▶ EF are used to become aware of the **NEED** to use executive skills.
- ▶ Executive Skills are responsible for cueing the area of the brain needed to perform a task such as attending, inhibiting, planning, organizing and associating.

# EF: The Commander

- ▶ EF give the commands to the rest of the brain. They do NOT carry out the commands!
- ▶ EF are managers that tell the system what to do
- ▶ Executive Skills tell the brain HOW to do it

▶ Executive Function = WHEN

▶ Executive Skill = HOW

# The Practice Effect

- ▶ As a task becomes more routine it requires LESS self regulation of EF to be successful.
- ▶ The more novel the task the greater the demand on EF. (*The hard job of thinking*)

CAN YOU GIVE EXAMPLES???? Writing

Language

Driving a car

# Brain is the *Worker*. EF is the *Supervisory System*

- ▶ Can't really "build" more workers but you can develop strategies to use what you have efficiently, i.e. there is more than one way to get the job done!
- ▶ Brains like automaticity. It is harder to engage the frontal cortex. *The brain is good at practiced learning NOT the "hard job of thinking"*. (eg. what is  $5 \times 3 =$  practice; what is the problem asking = thinking)
- ▶ The more you practice the less frontal activation you need. If you have to think about what you are doing the brain is slower, more effortful, has to work harder.

# Meta-cognition = Executive Functions

- ▶ A human trait, critical to attention, memory and learning

# Observable implications of children with delayed development of the prefrontal cortex

- ▶ Inattentive
- ▶ Disorganized
- ▶ Difficulty starting and completing a task in sequential order
- ▶ Difficulty generating a realistic plan
- ▶ Difficulty completing work within a given time frame
- ▶ Difficulty developing alternative strategies
- ▶ Limited working memory can impair retention of directions

# Behavioral consequences of delayed frontal/prefrontal neural systems

- ▶ Inattention to relevant information
- ▶ Poor mediation of emotions
- ▶ Difficulty controlling impulsive behavior (poor filtering)
- ▶ Deficits in problem solving or alternative strategies
- ▶ Difficulty with transitions and learning from past experiences
- ▶ Socially inappropriate behavior

# Executive Functions

- ▶ TO THINK ABSTRACTLY
- ▶ TO ORGANIZE, PLAN, SEQUENCE TOWARD A GOAL
- ▶ DECISION MAKING
- ▶ FLEXIBILITY GIVEN NOVEL SITUATION
- ▶ INITIATE
- ▶ CONCENTRATE
- ▶ FORESIGHT, HINDSIGHT, INSIGHT
- ▶ SELF MONITOR
- ▶ SELF AWARENESS
- ▶ SELF REGULATION



# Mature Executive Functions

- ▶ Have many learning strategies (repetition, organization, verbal elaboration, summarization, etc.)
- ▶ Understands when, where and why these strategies are important
- ▶ Recognizes the value of carefully deployed effort (as opposed to “luck”)
- ▶ Is instinctively motivated, task/goal oriented. Sets short and long term goals.
- ▶ **Learning difficulties are often the result of insufficient maturity in the EF system.**

# EF are biologically “time” sensitive

- ▶ 10-12 yrs. is when many executive functions mature to “adult” levels
- ▶ **Aspects of EF occur at different times:**
  - ability to inhibit and transition matures around 12 yrs.
  - planning, organization and problem solving develop around 15 yrs and beyond
  - working memory continues to develop into adulthood

ALL INDIVIDUALS WITH ADHD HAVE  
EXECUTIVE FUNCTIONS DEFICITS BUT  
NOT ALL PEOPLE WITH EXECUTIVE  
FUNCTION DEFICITS HAVE ADHD

# The intersection of ADHD and EF

- ▶ Attention is a complex skill that includes establishing, sustaining dividing and switching focus.
- ▶ Planning, organizing, self monitoring are executive function skills.
- ▶ Both ATTENTION and EXECUTIVE SKILLS are critical for effective learning. Without ATTENTION it is difficult to be in a state of readiness.
- ▶ EF are important in controlling impulses, managing emotions and responses, anticipating consequences and learning from past experiences.

# Executive Functions versus ADHD

- ▶ ADHD involves EF deficits in:  
focus/select, sustain, modulate, inhibit
- ▶ Pharmacological treatment for ADHD often addresses the problems associated with the EF specific to ADHD but ***do not*** impact the self regulation difficulties that commonly cooccur in ADHD

# Other coexisting disorders with compromised executive functions

- ▶ Autism (aspergers)
- ▶ Language disorders (CAPD)
- ▶ Fragile X, Williams Syndrome, Fetal Alcohol Syndrome

# TEACH THE OBVIOUS

- ▶ READ TO UNDERSTAND: preview; identify topic, main idea and details
- ▶ DON'T JUST DO HOMEWORK: learn from it, rehearse it; do the most difficult work first
- ▶ LISTEN IN CLASS: rehearse or reauditorize, take notes, participate, relate new information to known information, look at the speaker
- ▶ STUDY WITH AN ADULT
- ▶ To LEARN SOMETHING: study; review in 24 hrs., 1 week, 1 month. This will result in 95% retention
- ▶ PROVIDE FEEDBACK frequently about the effectiveness of the performance

# FEEDBACK

Immediate and frequent feedback about the effectiveness of performance and the accuracy of the responses is one of the most effective means of increasing engagement of self regulation capacities and internal control verses external control.

(George McCloskey)



# Strategies for EFD

- ▶ Working memory
- ▶ Planning and organization
- ▶ Cognitive filtering
- ▶ Pre-teaching; over-learning; previewing.
- ▶ Discreet task assignments will be easier than tasks that require simultaneous processing. Provide information to reference.
- ▶ Assistance with getting started on complex tasks; assign interim dates for long term projects/papers. Require assignment/appointment book, list making and check off sheets.
- ▶ Assist with identifying *essential* information; orient student to “novel” tasks; help separate “the forest from the trees” by encouraging student to discriminate details from broad concepts.

# Strategies for EFD

## ▶ Time management

- ▶ Adult oversight including regular “check in” times with *designated* staff
- ▶ Direct monitoring of homework and projects
- ▶ Keep homework log of assignments completed and length of time
- ▶ Break more complex tasks into smaller manageable and *concrete* tasks
- ▶ Have master calendar of semester assignments and *weekly assignments*. Revise the schedule routinely and check off completed assignments.
- ▶ ***Give yourself a reward when work is successfully completed.***

# Strategies for EFD

- ▶ Self monitoring
  - ▶ Develop meta-cognitive thinking skills by building increased awareness of problem solving thought processes.
  - ▶ Teach student to ask oneself questions like: “What is the best way to approach this problem; How will I know if I need to change my problem solving strategy; What other approaches are possible.”
  - ▶ Have adults “model” and describe how they approach novel tasks.

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