NATIONAL SCIENTIFIC COUNCIL ON THE DEVELOPING CHILD

Adult Executive Function Skill Development

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Outline

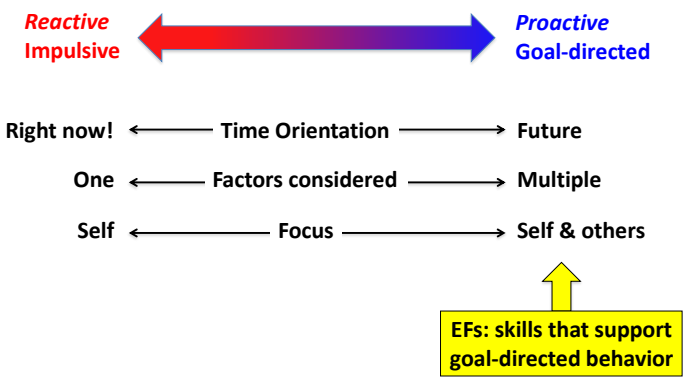
- **What are EFs, and why do they matter?**
- When & how do EFs develop?
- Which factors influence EFs?

Self-Reported Executive Functioning

Items from the Dysexecutive Questionnaire (DEX):

- I have trouble making decisions, or deciding what I want to do
- I have difficulty thinking ahead and planning for the future
- I find it difficult to keep my mind on something, and am easily distracted
- I act without thinking, doing the first thing that comes to mind
- I lose my temper at the slightest thing
- I am unaware of/unconcerned about how others feel about my behavior
- I have difficulty realizing the extent of my problems

Our behavior lies along a continuum



Factors that influence behavior

Financial instability
Chronic stress

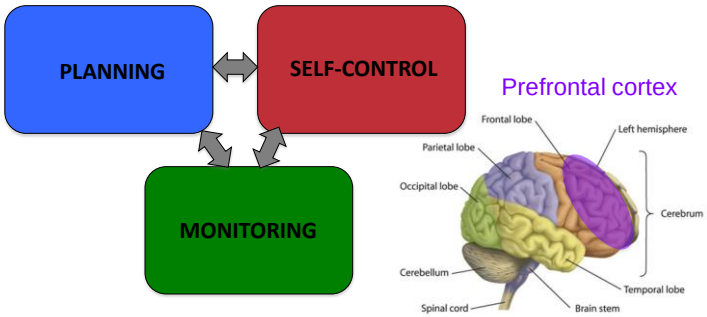
Behaviors & programs that combat life challenges, reduce stress levels, and build EF skills

Reactive, impulsive behavior

Proactive, goal-directed behavior

Adult EF skills

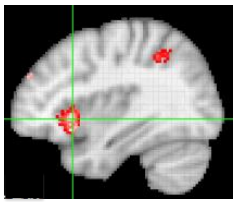
- Skills needed to get & keep a job, pay rent, care for children, etc.
- Informed by cognitive neuroscience research



SELF-CONTROL

Controlling one's

- Thoughts
- Feelings
- Behavior



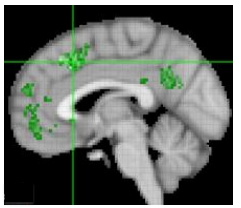
Meta-analysis conducted with Neurosynth

Examples:
- Not getting distracted from a goal
- Not making an impulse purchase
- Not getting angry

MONITORING

Moment-by-moment awareness of…

- Thoughts, feelings, behavior
- Performance, progress
- Surroundings, context
- Others' behavior

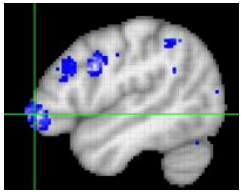


Meta-analysis conducted with Neurosynth

Examples:
- How well am I doing?
- Is my behavior appropriate in this setting?
- What is she thinking?

PLANNING

- Identifying long-term goals
- Identifying obstacles and possible solutions
- Specifying steps needed to achieve goals
- Setting appropriate deadlines & reminders

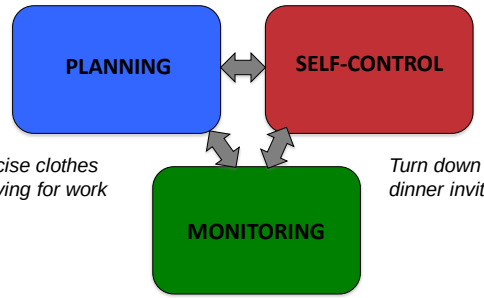


Meta-analysis conducted with Neurosynth

Examples:
- Drafting a household budget
- Identifying steps needed to prepare a job application
- Making arrangements for child-care

Adult EF skills are inter-related

Long-term goal: Get healthier
Specific goal: Exercise after work



Pack exercise clothes before leaving for work

Turn down dinner invitation

Make sure that behavior is consistent with the goal

Self-Reported Executive Functioning (DEX)

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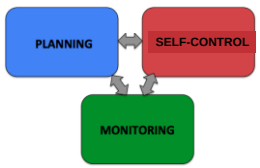

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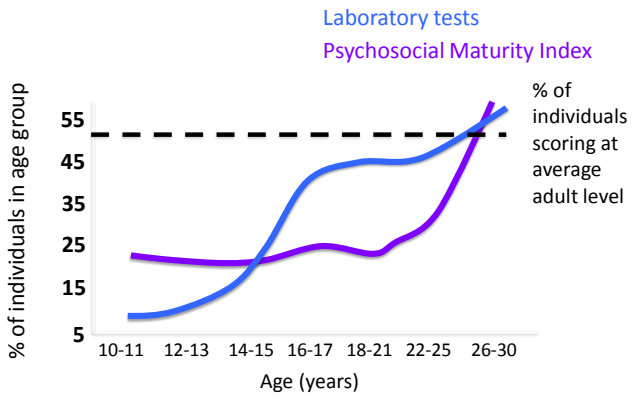
- Which factors influence EFs?

Development of EF-dependent behaviors

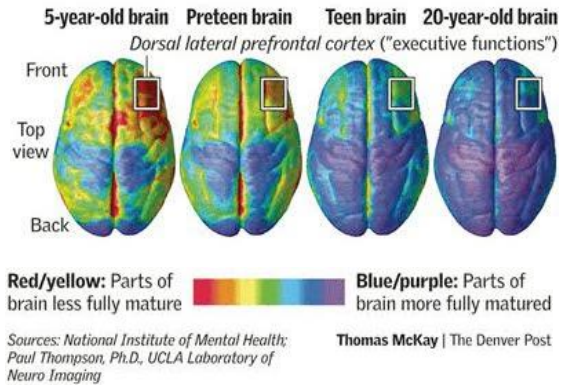


Steinberg et al., 2007

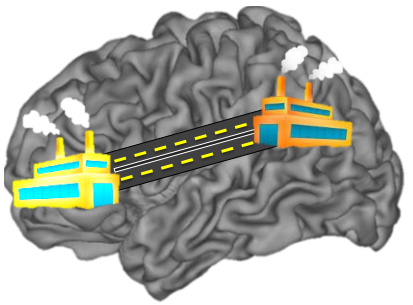
Psychosocial Maturity Index Steinberg et al., 2007

Impulsivity	"I do things without thinking."
Sensation Seeking	"I sometimes like to do things that are a little frightening."
Risk Perception	"If you did this activity (e.g., had unprotected sex), how much are you at risk for something bad happening?"
Resistance to Peer Influence	"Some people think it's better to be an individual even if people will be angry at you for going against the crowd. BUT Other people think it's better to go along with the crowd than to make people angry at you."
Future Orientation	"Some people take life one day at a time without worrying about the future BUT Other people are always thinking about what tomorrow will bring."

Why do EFs develop so late? Because prefrontal cortex is still maturing until our mid-twenties



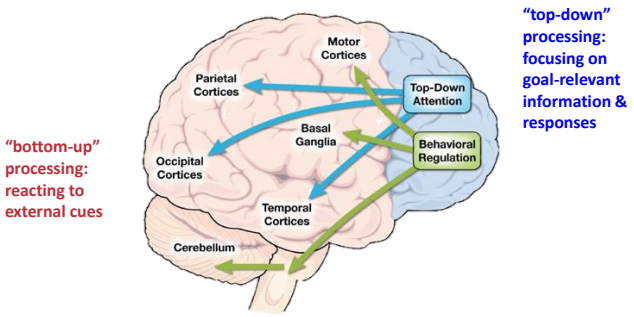
Development of brain networks



Across childhood & adolescence:

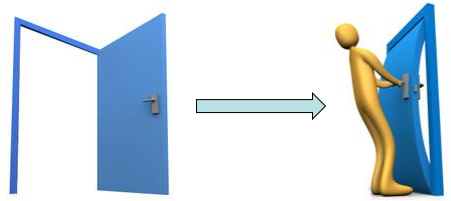
- increased efficiency of function within regions
- increased communication between regions

EF skills require communication between prefrontal cortex and other brain regions



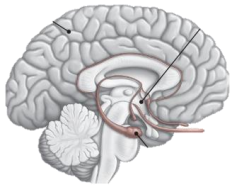
Arnsten, Berridge, & McCracken, 2009

Windows of vulnerability & opportunity for the developing brain

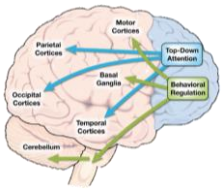


- The brain is most sensitive to environmental factors (for better or for worse) *while it is still developing*
- Each brain network has its own developmental timecourse
- Therefore, the window of greatest opportunity & vulnerability depends on the brain network

Windows of vulnerability & opportunity for specific brain networks



- Basic emotional circuitry matures early
- Neglect/abuse in first few years of life can have long-lasting effects on social and emotional functioning (Nelson & Fox)



- EF circuitry matures late
- Early environmental influences are less likely to permanently affect it (Fox & Nelson)
- Strengthening EF skills could help to cope with deficits in other areas

Outline

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Factors that influence EFs *on a daily basis*

The importance of getting good sleep

Prof. Matthew Walker, UC Berkeley
https://www.youtube.com/watch?v=51e2NEmuI7I

Prof. Allison Harvey, UC Berkeley
https://www.youtube.com/watch?v=EMdaQMlXF-Q

The importance of exercise

Short-term benefits (same-day)

- Increased blood flow to the brain, bringing vital nutrients to cells
- Effects on mood, stress, and EFs that last for several hours

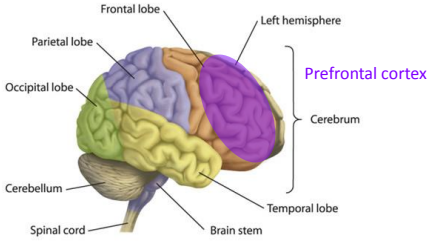
Long-term benefits (after several months)

- Leads to formation of new neurons & connections in the brain
- Improves resilience to stress, lowering hormonal response to stressors

Factors that influence EFs over the longer term

- Factors that influence *brain development* have long-lasting effects
- Prefrontal cortex is particularly sensitive to the environment

  For review see Mackey, Raizada, & Bunge (2012), http://bungelab.berkeley.edu



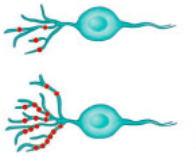
Influences on prefrontal cortex development

Negative influences
- Malnutrition
- Exposure to drugs, toxins
- Neglect, abuse
- Brain injury
- Chronic stress

Positive influences
- Higher socioeconomic status (many factors)
- Exercise?
- Cognitive training?
- Mindfulness?

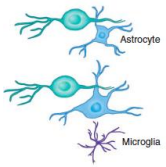
Ways in which the environment shapes the brain

connections between neurons

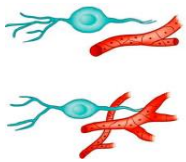


Speed of communication

support cells



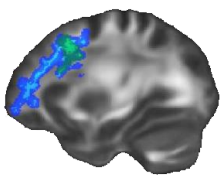
Blood vessels



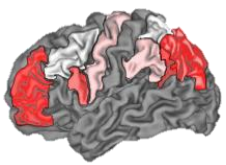
Zatorre et al, *Nat Rev Neuro*, 2012

Prefrontal cortex is sensitive to experience even in adulthood: Effects of 3 months of reasoning training

Structural changes
Changes in prefrontal white matter tracts



Functional changes
Increased communication between prefrontal cortex and other regions



Mackey, Whitaker, & Bunge, *Frontiers in Human Neuroanatomy*, 2012
Mackey, Miller Singley, & Bunge, *Journal of Neuroscience*, 2013
http://bungelab.berkeley.edu

Promising approaches to EF skill development in adults?

2 types of programs that target adult EF skills

Field-based interventions

- Not necessarily *called* EF interventions, but may tap into one or more EF skills
- Designed with needs of constituents in mind, targeting the real-world challenges they face
- Often involve face-to-face interactions
- Effectiveness may or may not have been evaluated rigorously

Crittenton Women's Union — live work thrive

http://www.tedxbeaconstreet.com/beth-babcock-science-reshaping-poverty/

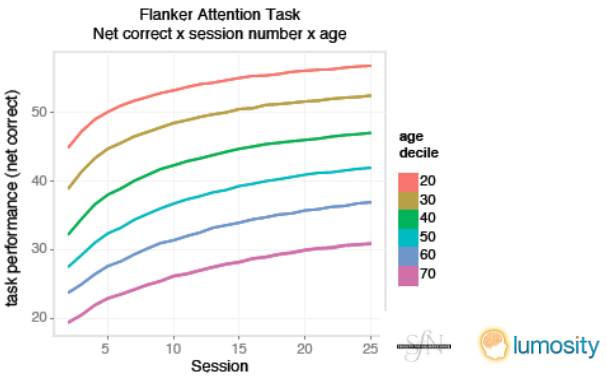
2 types of programs targeting adult EF skills

Laboratory-based cognitive training

- Derived based on years of research
- Well-controlled studies
- Precise data collection
- Focus on strengthening specific EF skills
- Often computerized
- Training is not directly linked to real-life challenges, but rather focuses on general EF skills that – in theory – should transfer to improved functioning in daily life

Training-related improvements in cognitive performance persist over time but depend on age; an online study including > 140,000 participants

Kacey Ballard*[1], Daniel A. Sternberg[1], Joseph L. Hardy[1], and Michael Scanlon[1]; [1]Lumos Labs, Inc., San Francisco, CA



lumosity

October 16, 2012 | 693.10 | ZZ3

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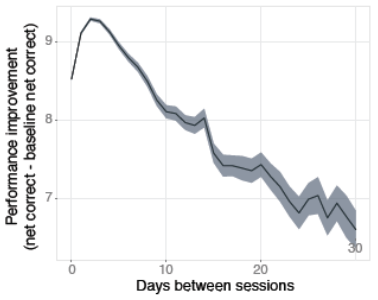
- Benefits are greatest when training every other day or so (distributed practice)



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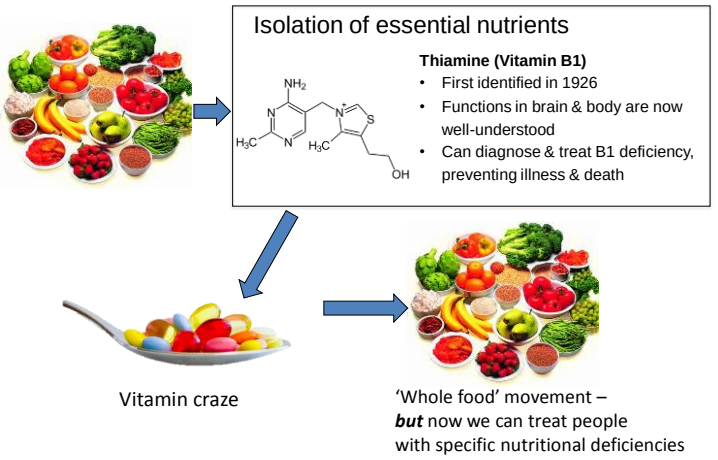
Laboratory-based cognitive training

- Powerful approach for developing & rigorously assessing science-based interventions
- Important limitations:
  - Repetition of the same task many times ("drill and kill") doesn't account for the pivotal role of **motivation** in learning
  - A focus on **isolated** cognitive skills ignores research showing **limited transfer** of skills from one setting/context to another
  - To solve real-world problems, we need to **work backwards** from what we want to achieve

Analogy to nutrition science



Promising approach to EF skill development

Combine the strengths of field-based and laboratory-based interventions

- Form partnerships between scientists, practitioners, and industry to identify, develop, & test interventions that build on existing science to address real-world problems

Example:

- Science shows that EF skills are essential ingredients for life, and that they can be strengthened with practice
- Two-generational approaches to EF skill development in parents & their children may produce sustainable change

Frontiers OF INNOVATION

Center on the Developing Child HARVARD UNIVERSITY