Boosting Brains: Evidence-Based Interventions for Children's Executive Functioning

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TREATMENT

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- There is minimal risk to attending this CE talk, but participants are encouraged to seek appropriate consultation and supervision when utilizing new interventions.

- Participants are also responsible for practicing in the bounds of their own clinical competency and following the ethical and legal guidelines in their state of practice. We will discuss the limitations of the statements provided from the research.

Program Notices

- Conflicts of Interest: None
- Commercial Support: None

Agenda

- Introduction
- Definitions
- Strategies with Limited to No Evidence Base
- Strategies with Mixed Findings
- Evidence Based Interventions
  - Mindfulness-Based Interventions
  - Physical Activity

Introductions

- Laura Rowley, Ph.D.
  - Licensed Clinical Psychologist
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  - Expertise in ADHD testing and intervention for children and adults

- Jessie Johnston, Ph.D.
  - Postdoctoral Psychology Resident
  - Expertise in ADHD testing and intervention for children

Executive Function

Executive Function (EF)

"Executive functions are **higher order cognitive functions** that are responsible for initiating, adapting, regulating, monitoring, and controlling information processes and behavior"

- Literature generally agrees that the **three core** executive function abilities are:
  - Working memory
  - Inhibition
  - Shifting or cognitive flexibility

Best, 2010; Greeff et al., 2018, p. 501, Diamond, 2013;

Inhibition

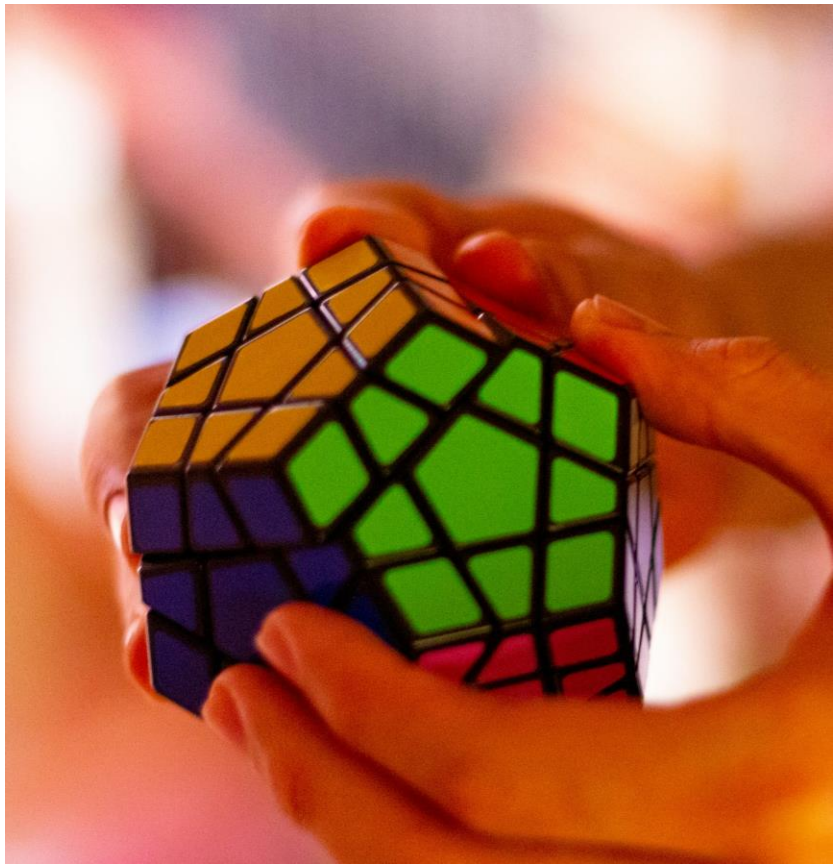
- “Inhibition is defined as the ability to **withhold dominant automatic behaviors** that are irrelevant for the task at hand” (De Brujin et al., 2018). Inhibition includes behavioral inhibition, selective attention, and cognitive inhibition (Diamond, 2013).
- Examples:
  - Staying focused in class
  - Controlling a habit (e.g., nail biting)
  - Filtering thoughts

Working Memory

- Working memory involves "**holding information** in mind and **mentally working with it** (e.g., relating one thing to another, using information to solve a problem)" (Diamond, 2013).
- Examples:
  - Mental math
  - Taking notes
  - Cooking a recipe

Cognitive Flexibility

- Cognitive flexibility “refers to the ability to **shift attention** forward and backward among multiple tasks in order to easily adapt to changing situations” (De Brujin et al., 2018).
  - Examples:
    - Adapting to changing plans
    - Switching between languages or topics in conversation
    - Problem-solving in the moment



Attention-Deficit/ Hyperactivity Disorder (ADHD)

ADHD associated with deficits in core EF domains

Inattentive	Hyperactive
Misses details; makes careless mistakes	Often fidgets
Difficulty sustaining attention on activities	Leaves seat
Seems not to listen when spoken to directly	Moves excessively; internal restlessness
Does not follow through or finish tasks	Difficulty engaging in activities quietly
Difficulty organizing tasks, time, possessions	Often "on the go"
Avoids, procrastinates tasks requiring mental effort	Often talks excessively
Often loses things	Blurts answers
Easily Distracted	Difficulty awaiting turn
Forgetful	Interrupts

Strategies with Limited Evidence Base

Assumptions

- Performance on EF tasks are correlated with outcomes like reduced ADHD symptoms or higher academic achievement
- Therefore directly training EF skills should lead to improved outcomes

...not necessarily

What Defines Evidence-Based EF Intervention?

- Proof across studies (meta-analyses) that the direct targets of the intervention CAUSE improvements in core EF skills
- Also helpful to demonstrate improvement in functioning with kids with ADHD

- Problems with research on EF
  - EF skills may have improved but the cause is unclear
  - EF skills may have improved but it doesn't also lead to real world changes or improvements in ADHD symptoms
  - Common third variables
    - Time, regression to the mean, motivation, practice effects, cultural context

Niebaum & Munakata, 2024

Why Doesn't Executive Function Training Improve Academic Achievement?

"...training executive functions improves performance on the tasks used for training but rarely leads to domain-general improvements in executive function capacities and rarely benefits academic achievement or outcomes in the real world"

Niebaum & Munakata, 2024

Strategies with Limited Evidence Base

Executive Function Coaching

School/Classroom-Based Interventions

Functional Medicine Approaches

Executive Function Coaching

- Cons
  - Lack of standardization
  - No defined credentials or qualifications required- May not understand psychological underpinnings of executive dysfunction
  - May not lead to long term change or translatable skills
  - Limited to no evidence base
- Pros
  - Can focus on relevant day-to-day problems (e.g., organization, planning, study skills)
  - May be helpful in some contexts
  - Individualized
  - accessible

School and Classroom-Based Interventions

- 504 Plan or Individualized Education Plan (IEP)
- Some improvement in academic performance
- No significant change in EF abilities
- More about accommodation

Functional Medicine Approaches

- Acupuncture, homeopathy, and hypnotherapy did not show clinically significant changes in ADHD symptoms or EF abilities

EF Strategies: Mixed Results

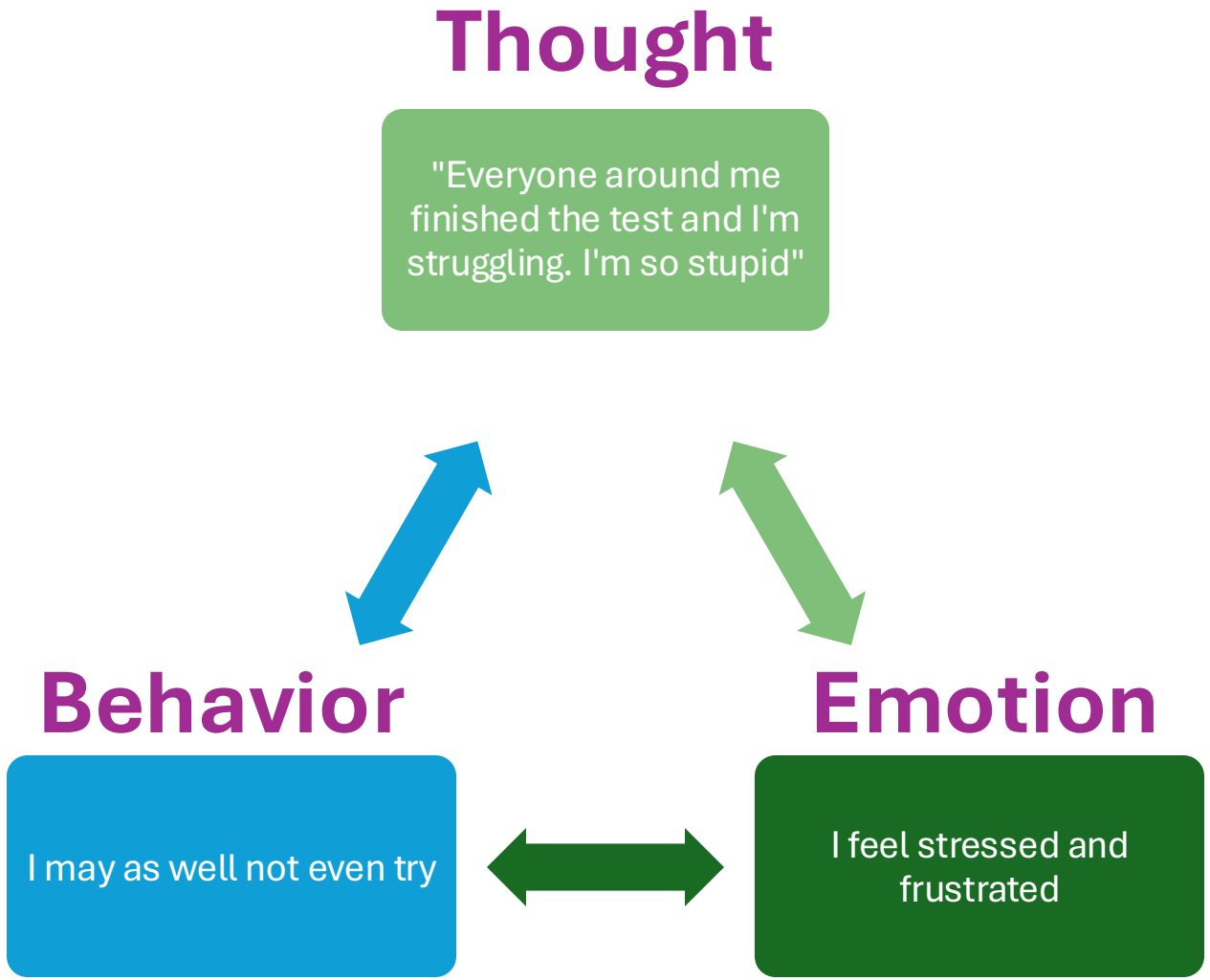
Nutrition

- Variability across studies
  - Mixed results on omega-3 and vitamin D
  - Some evidence base for supplements
  - No relationship between ADHD symptoms and artificial food coloring

Common Therapy Modalities: CBT

- **Cognitive Behavioral Therapy (CBT):**
  - CBT has been described as “a form of psychological treatment that is based on the principles that psychological problems are based, in part, on faulty or unhelpful ways of thinking, and learned patterns of unhelpful behavior, and can help them learn better ways of coping with them, thereby relieving their symptoms and becoming more effective in their lives”

Cognitive Triangle



Common Therapy Modalities: Behavior Management/Parent Training

- **Behavior Management:**
  - Relies on behavioral changing contingencies

- **Parent Training:**
  - Aims to increase relationship between parent and child
  - Recognize undesirable behaviors and discourage them through using behavioral techniques

Common Therapy Modalities

Behavior Management/ Parent Training

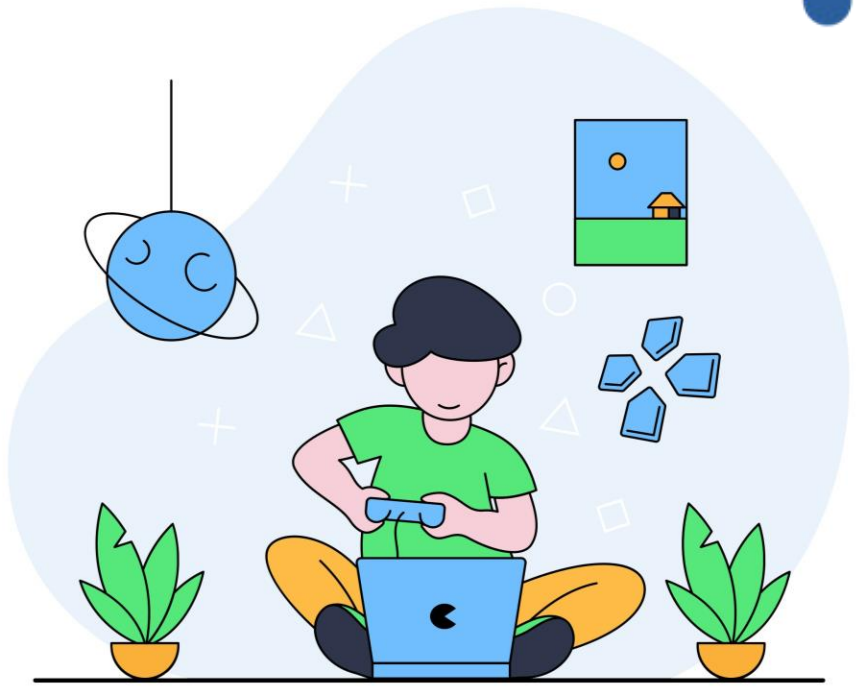
Studies show improved behavior on outcome measures, although there were no significant effects on overall ADHD symptoms

Cognitive Behavioral Therapy (CBT)

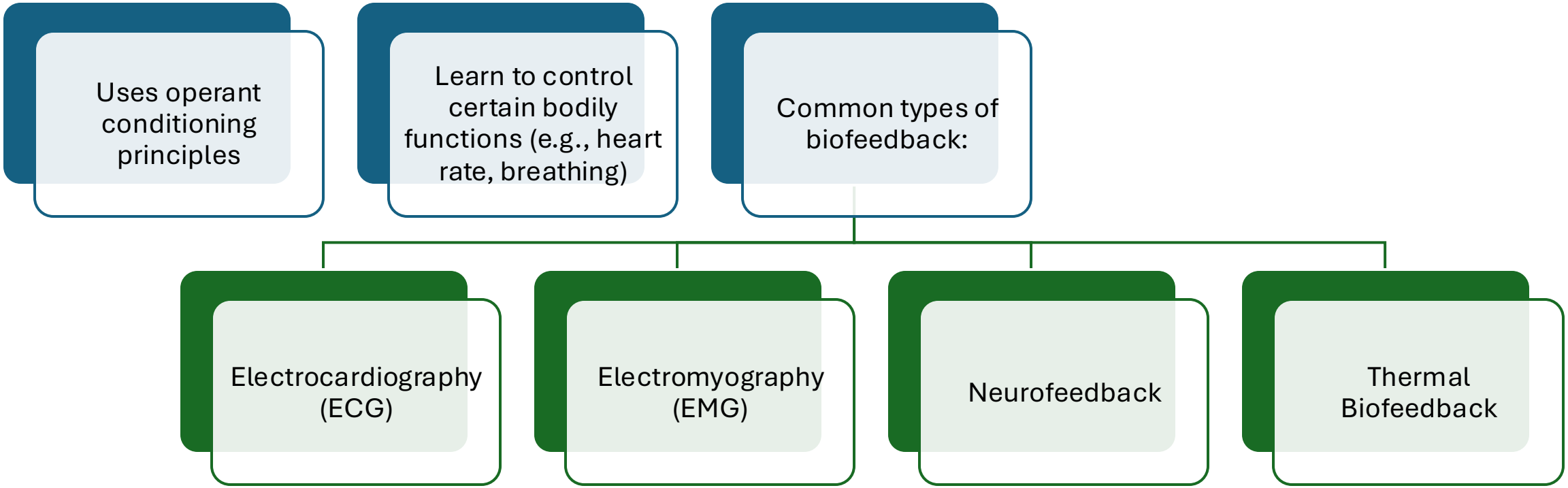
Parents had improved ratings of ADHD symptoms but found little evidence for functional impairment

Cognitive Training

- Mixed Results
- Meta-analyses have shown it tends to improve ADHD symptoms on formal measures of working memory
  - Is not effective in improving functional impairments or disruptive behaviors
- Results tend to be more significant when paired with neurofeedback and/or biofeedback

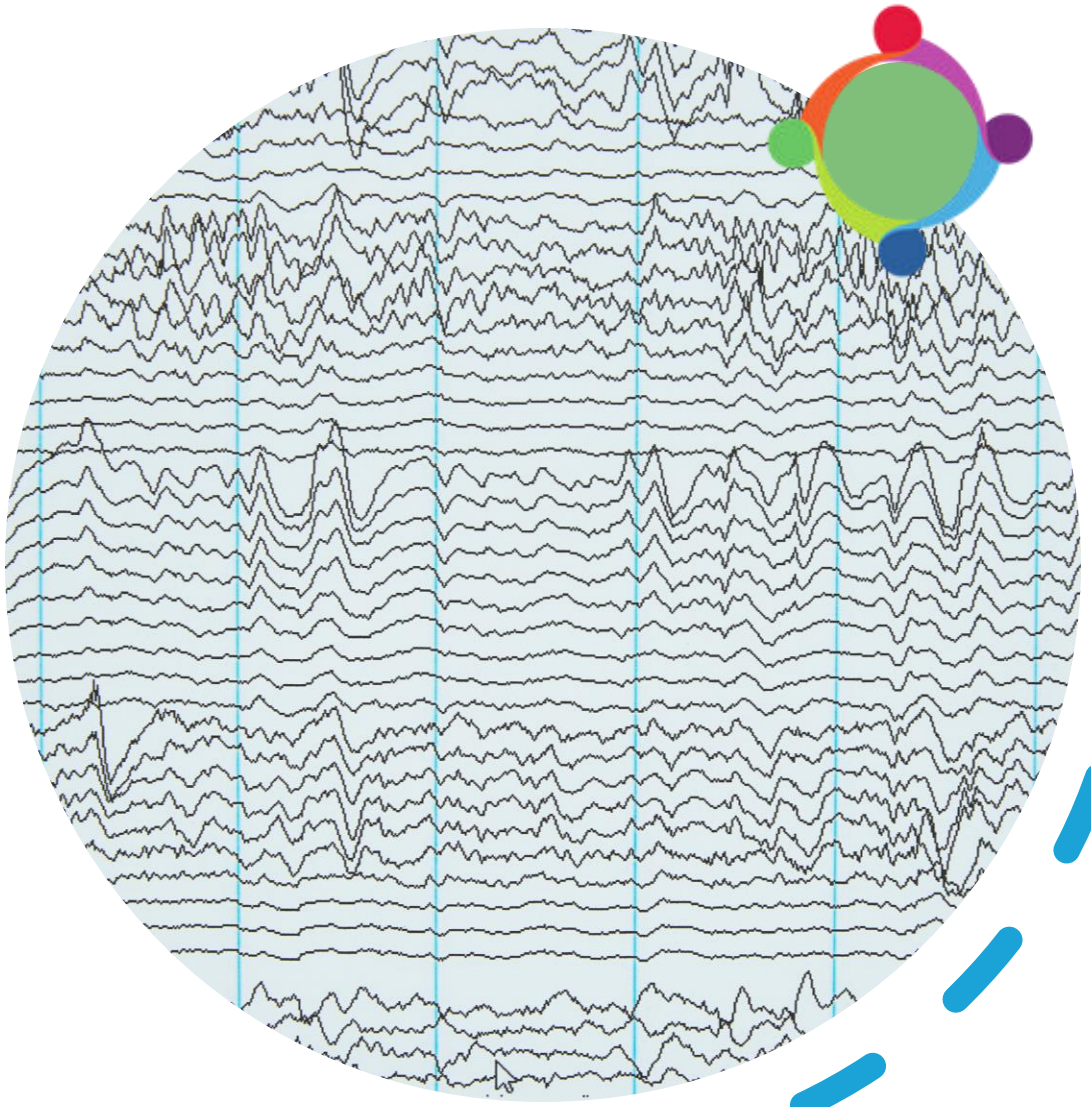


Biofeedback



Neurofeedback

- Subset of biofeedback that utilizes EEG or fMRI
- Aims to modulate brain activity
- EEG activity is converted into visual or acoustic signals which are then processed and presented to the patient in real time



Neurofeedback & Biofeedback

- Significantly improved ADHD symptoms on measures of working memory and inhibition
  - Did not improve disruptive behaviors or functional impairment
  - No effect on cognitive flexibility

Effective Components of Neurofeedback

- Standard protocols for neurofeedback in ADHD:
  - Theta/Beta Ratio (TBR)
  - Sensorimotor Rhythm (SMR)
  - Slow Cortical Potential (SCP)

- Organizations working towards standardization of practice:
  - Society of Applied Neuroscience (SAN)
  - International Society for Neurofeedback and Research (ISNR)

Interventions That Work!

Mindfulness-Based Interventions

- "Mindfulness involves **focusing on the present moment without judgement** or reaction."
- Can include movement (e.g., yoga) or meditation
- Shared goals of mindfulness practice are strengthened awareness and a "more integrated sense of self-accomplishment through the attention regulation process."

(Lee et al., 2022)

Mindfulness-Based Interventions

- Mindfulness-based interventions have shown increased core EF abilities in children with ADHD
  - Parent rating forms have also shown decreases in hyperactivity and impulsivity
  - Increased management of ADHD behaviors within the home environment

Common Mindfulness-Based Interventions

Limitations include:

- Lack of consistency across intervention types and outcome measurements
- Lack of diversity across samples

Common protocols currently being utilized:

- Mindfulness Based Stress Reduction protocol (MBSR)
- Mindfulness-Based Cognitive Therapy (MBCT)
- Mindfulness-Oriented Meditation (MOM)

Mindfulness-Based Interventions

- Components shown enhance effectiveness across interventions:
  - Parental involvement
  - Intensive interventions

How Can Kids Participate in Mindfulness Meditation?

- Very short sessions to start (5-10 minute exercises)
- Reinforcements for effort and participation
- Incorporate more movement or sensory-focused activities
- Example activities
  - Mindful eating
  - "I notice" game
  - Coloring
  - Statue game

Outcomes of Mindfulness Based Intervention

- Improved core EF skills
- Reduced hyperactivity and impulsivity
- Reduced distractibility
- Improved emotion regulation

- Not necessarily academic achievement directly

Physical Activity

"Any bodily movement produced by the contraction of skeletal muscles that raises energy expenditure above the resting metabolic rate and is characterized by its modality, frequency, intensity, duration, and context of practice" (Wyszyńska et al., 2020, p. 2).

Physical Activity

Pathways of PA on EF:

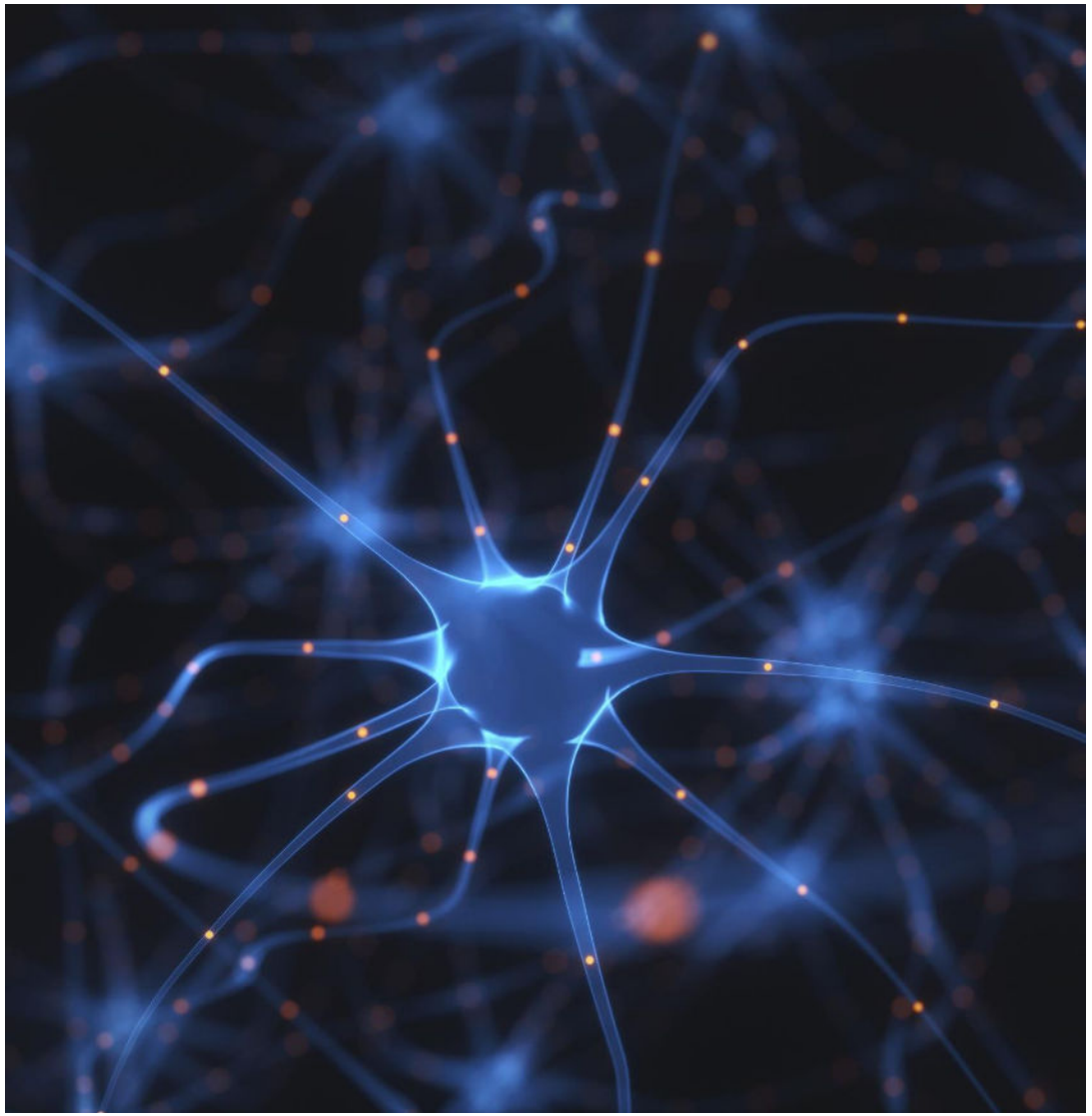
PHYSIOLOGICAL CHANGES

COGNITIVE DEMAND

COMPLEX MOTOR TASKS

Physiological Changes

- Neurotransmitters
- Cerebral blood flow and angiogenesis
- Neurogenesis
- Brain-derived neurotropic factors (BDNF)



Cognitive Demand

- Includes activities that are both exciting and cognitively challenging (e.g., decision-making and problem solving)
- Emotional and social development opportunities incorporated
  - Example: group games

Complex Motor Tasks

- Coordination, strength, and endurance
- Neural connectivity increases in parts of the brain implicated in EF

Physical Activity Interventions

Frequency

Intensity

Duration

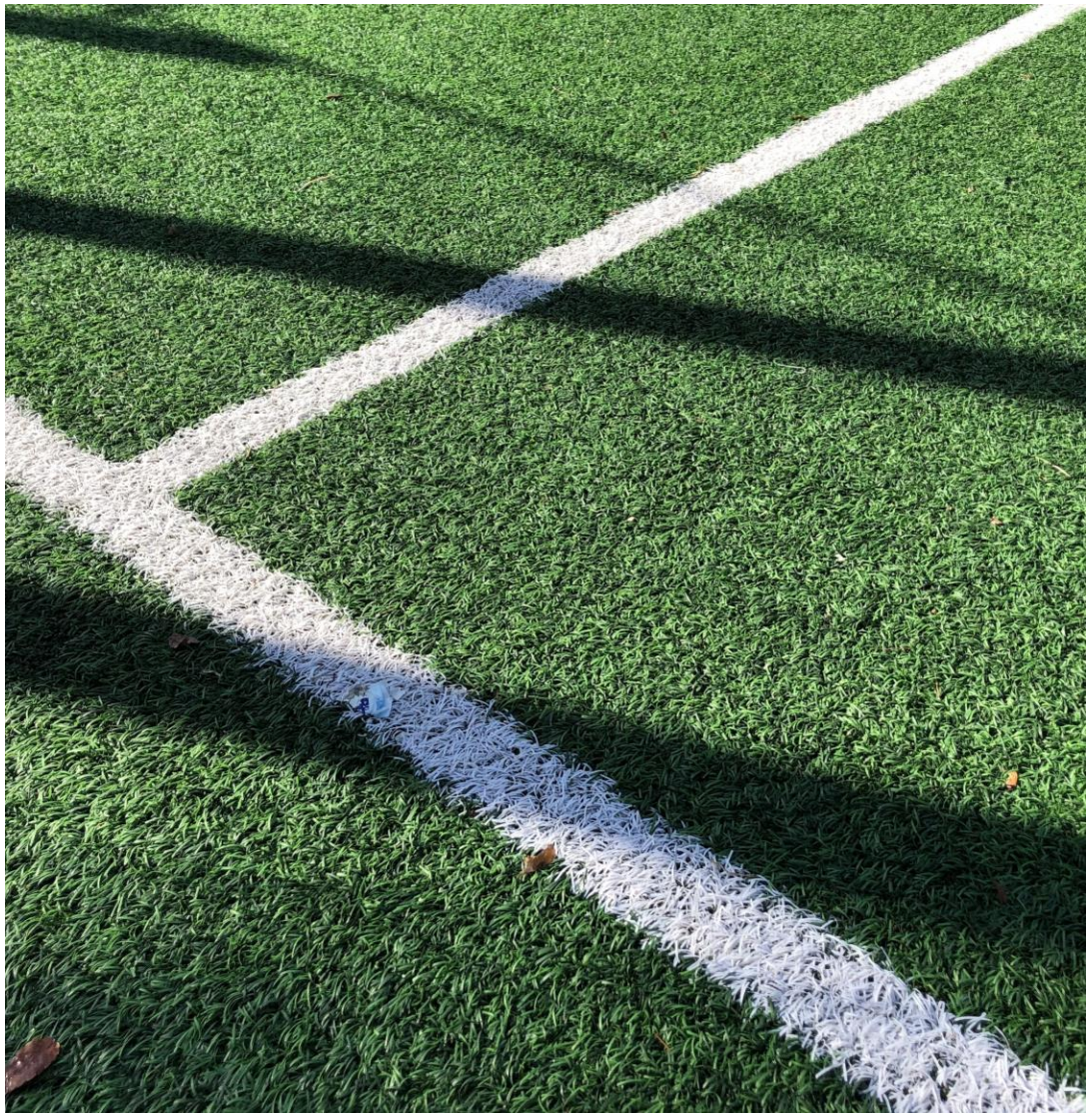
Outcomes of Physical Activity Intervention

- Improved core EF skills
  - Working memory
  - Cognitive Flexibility
  - Inhibition
- Reduced hyperactivity and impulsivity
- Improved emotion regulation
- Improved social outcomes- friendships, social skills, etc.

- Not necessarily associated with academic achievement

EF in Practice

- Noodle hockey
  - Physiological: moderate intensity
  - Cognitive component: coordinating with teammates, decision-making
  - Complex motor skills: using noodles to hit the ball (e.g., passing, shooting), playing in the goal



Evidence-Based Principles

- EF skills are improved when trained in real-world contexts
  - Personal, social, historical, emotional factors
- Child motivation moderates any effects
  - Engagement strategies
  - Reward systems for effort
- Interventions with mixed research may still be helpful for EF
  - Depends on the training strategies used (how contextually relevant)

Limitations

- Included studies primarily focused on children and adolescents with ADHD
  - Boys made up more of the samples across studies than girls
  - Lack of diversity
    - Samples largely included White individuals from North America and Western Europe
- Specific attention was also provided to including interventions of children from diverse backgrounds and genders, although the evidence-base is limited, and results may not be consistent

Summary

- Interventions that improve EF abilities in children:
  - Physical Activity
  - Mindfulness
- Interventions that need more research/are best used in conjunction with other treatment:
  - Therapy modalities (behavior management, CBT, parent training)
  - Cognitive training, neurofeedback, and biofeedback
  - Nutrition
- Interventions that improve Executive Functions ARE NOT PROVEN to improve academic achievement

Thank you!

What questions
do you have?

Related UCEBT Trainings

Back to School Playbook: Evidence-Based Strategies for Helping Neurodivergent Kids and Teens Succeed

ACT Mindfully: Acceptance and Commitment Therapy (ACT) with Children & Adolescents

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References

Ahmed Aboalola N. (2024). The effectiveness of a mindfulness-based intervention on improving executive functions and reducing the symptoms of attention deficit hyperactivity disorder in young children. *Applied neuropsychology. Child*, *13*(4), 366–374. https://doi.org/10.1080/21622965.2023.2203321

Best, J. R. (2010). Effects of physical activity on children's executive function: Contributions of experimental research on aerobic exercise. *Developmental Review, 30*(4), 331-351. https://doi-org.unco.idm.oclc.org/10.1016/j.dr.2010.08.001

Diamond, A. (2013). Executive functions. *Annual Review of Psychology, 64*, 135–168. https://doi.org/10.1146/annurevpsych-113011-143750

Enriquez-Geppert, S., Smit, D., Pimenta, M. G., & Arns, M. (2019). Neurofeedback as a Treatment Intervention in ADHD: Current Evidence and Practice. *Current psychiatry reports*, *21*(6), 46. https://doi.org/10.1007/s11920-019-1021-4

Lee, Y. C., Chen, C. R., & Lin, K. C. (2022). Effects of Mindfulness-Based Interventions in Children and Adolescents with ADHD: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. *International journal of environmental research and public health*, *19*(22), 15198. https://doi.org/10.3390/ijerph192215198

Louthrenoo, O., Boonchooduang, N., Likhitweerawong, N., Charoenkwan, K., & Srisurapanont, M. (2022). The Effects of Neurofeedback on Executive Functioning in Children With ADHD: A Meta-Analysis. *Journal of attention disorders*, *26*(7), 976–984. https://doi.org/10.1177/10870547211045738

Peterson, B. S., Trampush, J., Maglione, M., Bolshakova, M., Rozelle, M., Miles, J., Pakdaman, S., Brown, M., Yagyu, S., Motala, A., & Hempel, S. (2024). Treatments for ADHD in Children and Adolescents: A Systematic Review. *Pediatrics, 153*(4), e2024065787. https://doi.org/10.1542/peds.2024-065787

Qiu, H., Liang, X., Wang, P., Zhang, H., & Shum, D. H. K. (2023). Efficacy of non-pharmacological interventions on executive functions in children and adolescents with ADHD: A systematic review and meta-analysis. *Asian journal of psychiatry, 87*, 103692. https://doi.org/10.1016/j.ajp.2023.103692

References

Riise, E. N., Wergeland, G. J. H., Njardvik, U., & Öst, L. G. (2021). Cognitive behavior therapy for externalizing disorders in children and adolescents in routine clinical care: A systematic review and meta-analysis. *Clinical psychology review*, *83*, 101954. https://doi.org/10.1016/j.cpr.2020.101954

Santonastaso, O., Zaccari, V., Crescentini, C., Fabbro, F., Capurso, V., Vicari, S., & Menghini, D. (2020). Clinical Application of Mindfulness-Oriented Meditation: A Preliminary Study in Children with ADHD. *International journal of environmental research and public health*, *17*(18), 6916. https://doi.org/10.3390/ijerph17186916

Schmidt, M., Egger, F., Benzing, V., Jäger, K., Conzelmann, A., Roebers, C. M., & Pesce, C. (2017). Disentangling the relationship between children's motor ability, executive function and academic achievement. *PLOS ONE, 12*(8): e0182845. https://doi.org/10.1371/journal.pone.0182845

Shrestha, M., Lautenschleger, J., & Soares, N. (2020). Non-pharmacologic management of attention- deficit/hyperactivity disorder in children and adolescents: a review. *Translational pediatrics, 9*(Suppl 1), S114–S124. https://doi.org/10.21037/tp.2019.10.01

Sultan, M. A., Nawaz, F. A., Alattar, B., Khalaf, E., Shadan, S., El-Abiary, N., Tegginmani, S., Qasba, R. K., & Jogia, J. (2025). Assessing the impact of mindfulness programs on attention-deficit/ hyperactivity disorder in children and adolescents: a systematic review. *BMC pediatrics*, *25*(1), 32. https://doi.org/10.1186/s12887-024-05310-z

What is Cognitive Behavioral Therapy. American Psychological Association. (cited 03/03/2025). Available online: https://www.apa.org/ptsd-guideline/patients-and- families/cognitive-behavioral

Wyszyńska, J., Ring-Dimitriou, S., Thivel, D., Weghuber, D., Hadjipanayis, A., Grossman, Z., Ross-Russell, R., Dereń, K., & Mazur, A. (2020). Physical activity in the prevention of childhood obesity: The position of the European childhood obesity group and the European Academy of Pediatrics. *Frontiers in Pediatrics*, *8*, 535705. https://doi.org/10.3389/fped.2020.535705