Novel Interventions for ADHD: Cognitive, Attention, Executive Function Training

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What is ADHD?

Attention-Deficit/Hyperactivity Disorder

- Persistent pattern of developmentally inappropriate levels of inattention, hyperactivity, and/or impulsivity

Inattention

- Attending
- Seatwork/Homework completion
- Distractibility

Impulsivity

- Interrupting
- Reactive Aggression
- Violating Class Rules

Hyperactivity

- Fidgeting
- Running/Climbing

American Psychiatric Association, 2014

Why focus on children with ADHD?

- Prevalence
  - 3-7% of children
- Associated impairment
  - Academic Problems
  - Peer Problems
- Long-term risks
  - School drop-out/delinquency
  - Substance abuse
  - Vocational underachievement
  - Relationship problems
  - Peer rejection

Current Evidence-Based Treatment for ADHD

- Pharmacological Treatment
- Behavioral Treatment
- Multimodal Treatment

Why need another treatment for ADHD?

- Pharmacotherapy
  - 30% don't respond
  - No long term effects
  - Parents don't like meds
- Behavioral therapy
  - Difficult, time-consuming
  - Not as efficacious as meds
  - Limited efficacy for some subgroups (predominantly inattentive type)
- Long term effects of these interventions not great, and few normalize behavior
- Neither of these interventions is particularly efficacious for executive function or cognitive deficits in ADHD

Cognitive/Executive Functioning Deficits in ADHD

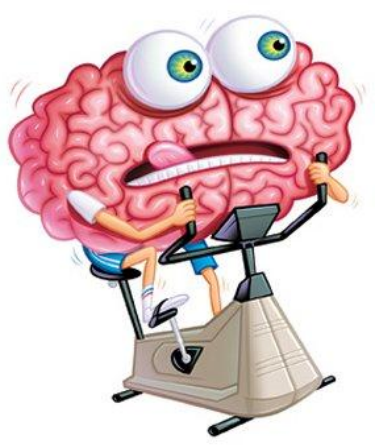
- Inhibition
  - putting the brakes on behavior
- Self-Regulation
  - ability to tolerate frustration, thinking before acting or speaking
- Attention Shifting
  - Ignoring distractors, paying attention to what's important
- Memory
  - holding facts in mind while manipulating information; accessing facts stored in long-term memory
- Planning
  - think ahead, organize work
- Activation, arousal, effort
  - getting started, paying attention, finishing work
- Self-regulation
  - control self within parameters of a situation
- Metacognition
  - awareness of self, monitor/control one's own actions

Cognitive Training

- Technique involving children practicing different types of attention
- Based on the concept that attention is a "muscle" that subserves executive functioning and can be exercised and trained
- Assumes that processes of neural plasticity allow for improved efficiency with focused and extended practice

Cognitive Training

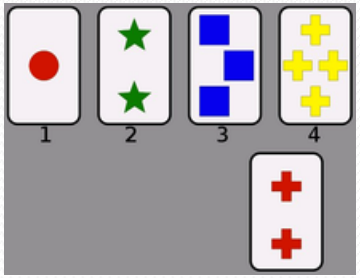
- Process-specific repeated skill practice
  - Standard
  - Repeated practice on a variety of tasks to target a specific ability
  - Tasks begin simple and get harder
  - Vary
  - Paper & pencil OR computerized
  - Individual OR group administered
  - Therapist present OR absent

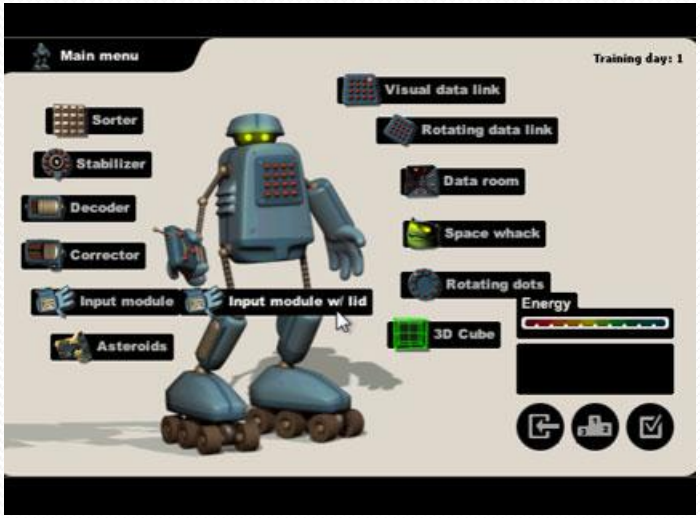


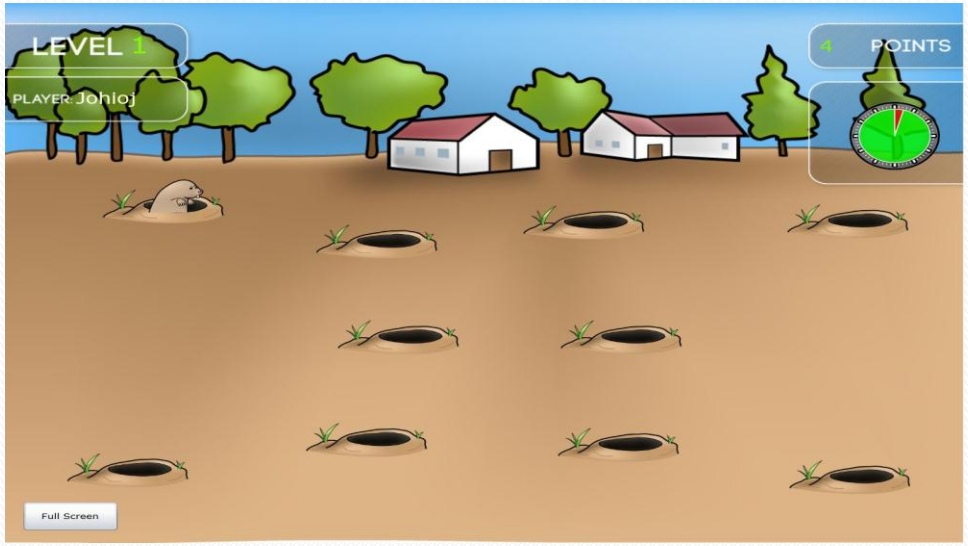
Cognitive training is not:

- Verbal self-instruction; self-reinforcement; self-monitoring; problem-solving strategies. These have limited efficacy and impact on ADHD symptoms.
- Neurofeedback/EEG biofeedback which attempts to normalize abnormal neural frequencies by increasing awareness of a normalized EEG pattern. The data for neurofeedback is promising, but research needs to address expectancy effects, active control group, medication status, etc.

Sample cognitive training programs for ADHD

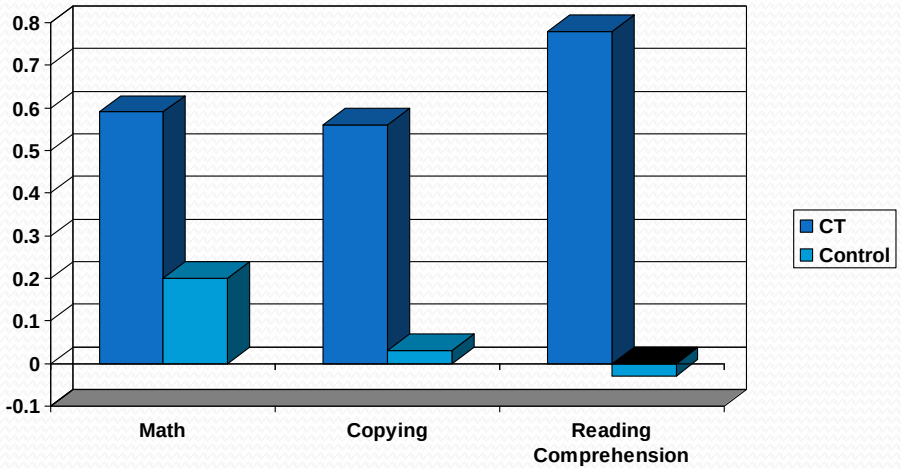


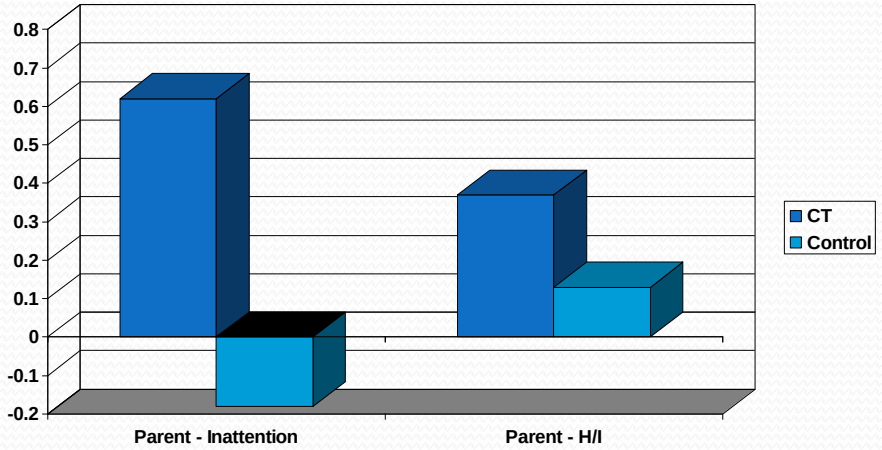




Shalev et al. (2003)

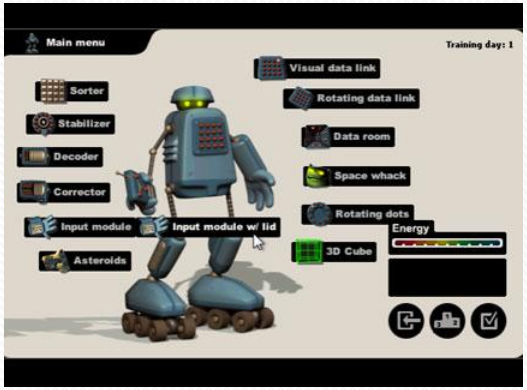
- 24 Intervention / 17 sham control
- Computerized Progressive Attentional Training
  - Executive attention (global-local task)
  - Selective attention (visual search task)
  - Sustained attention (CPT)
  - Orienting of attention (conjunctive search)
- 2x per week / 1 hour for 8 weeks

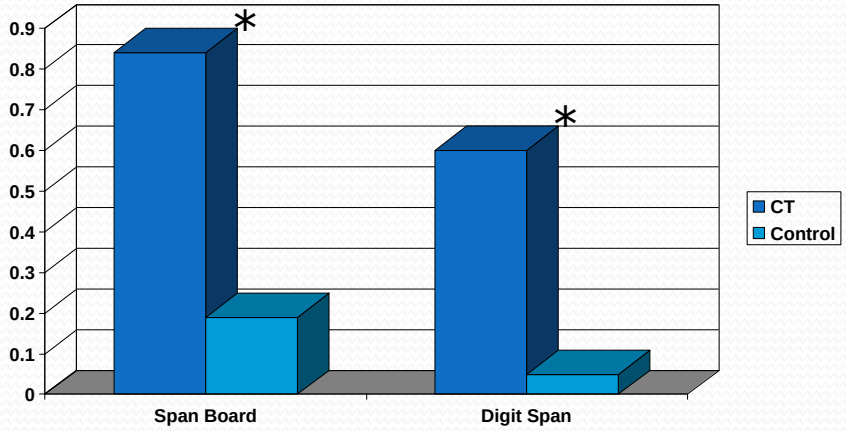


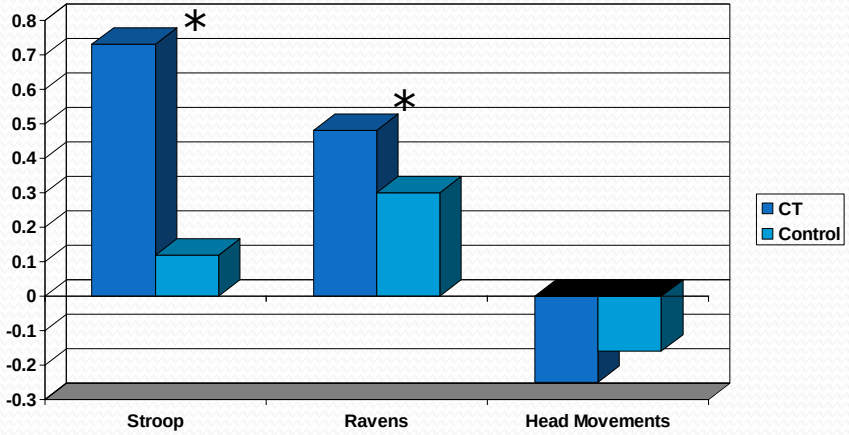


Klingberg et al. (2005)

- 27 Intervention / 26 Sham control
- Working Memory Training
  - Visual-spatial memory task
  - Backwards digit span
  - Backwards letter span
  - Go/No-go
- Every day / 30 min for 25 days

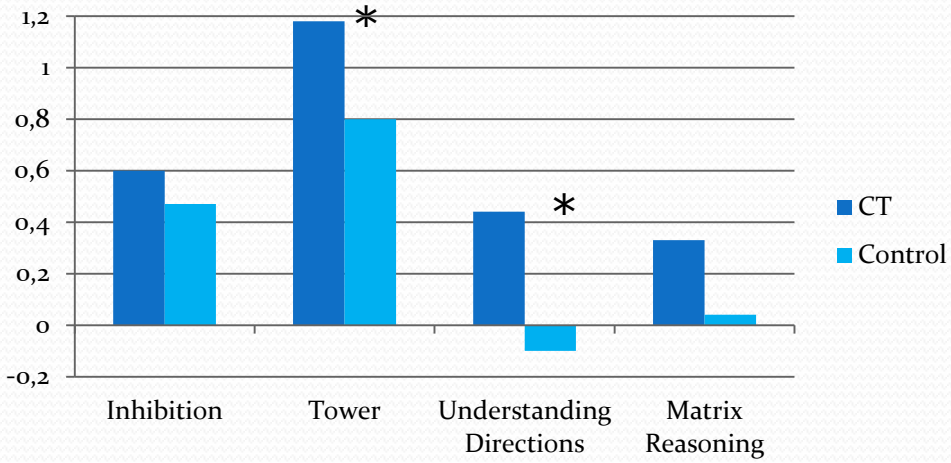


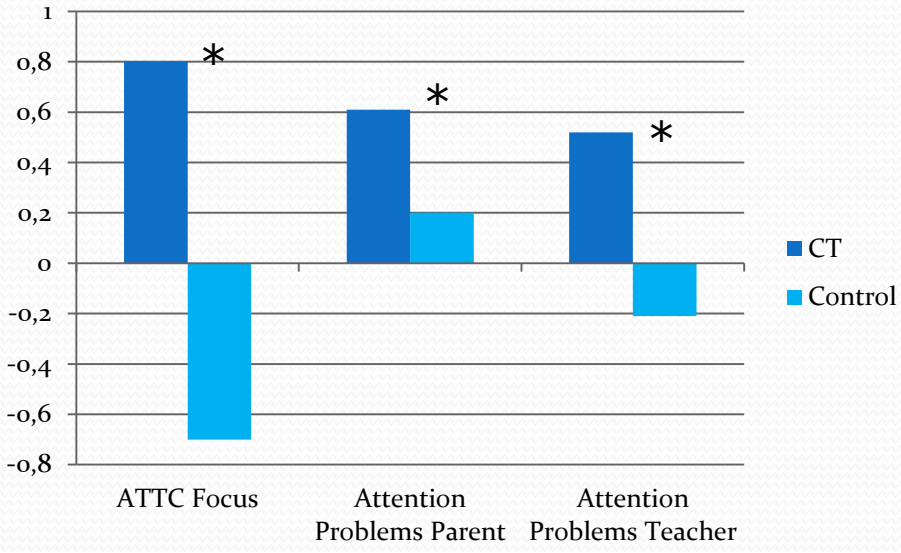




Tamm et al. (2012)

- 49 Intervention / 48 Sham control
- Pay Attention! 2x/week 45 min for 8 weeks
  - Visual and Spatial
    - Sustained Attention Tasks
    - Selective Attention Tasks
    - Alternating Attention Tasks
    - Divided Attention Tasks





Summary of ADHD CT Studies

- 25 studies to date
- Much variability across studies
  - Constructs trained
    - Working memory
    - Attention
    - Set Shifting
    - Mixed Executive Functioning
  - # of sessions
    - Range = 4-36 sessions
    - Median ~ 20 sessions
  - Length of sessions
    - Range = 15-60 mins
    - Median ~ 30 mins
- Variability in control groups
  - None (open label trial)
  - Waitlist
  - Non-adaptive
  - Adaptive

Rapport et al., 2013

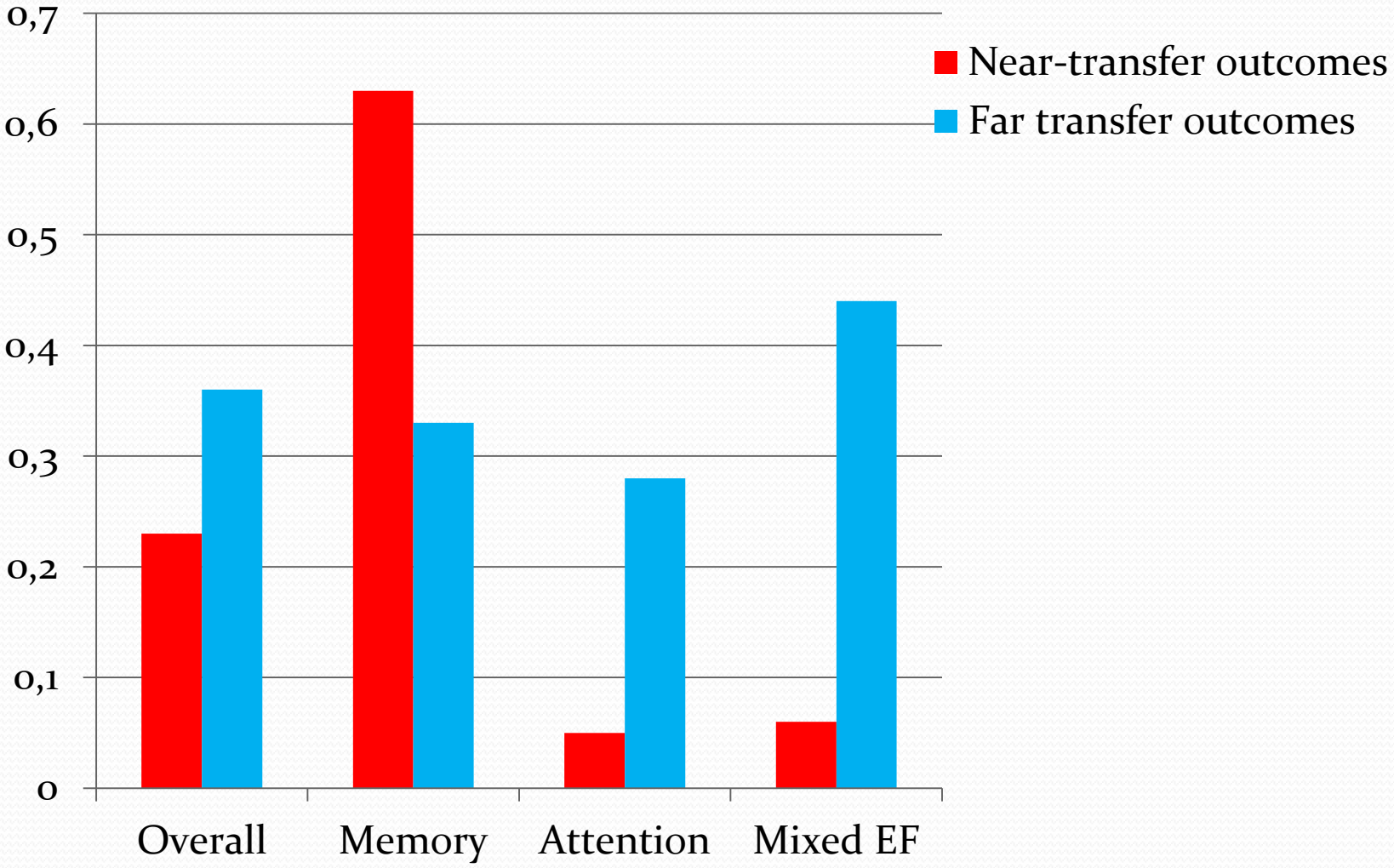
Cognitive Training Outcomes

<u>3 levels</u>

1. Trained skill neuropsychological performance (near transfer)
   - Digit span after working memory intervention
2. Non-trained neuropsychological performance (mid transfer)
   - Ravens after working memory intervention
3. Everyday functioning (far transfer)
   - ADHD symptomatology, impairment

Epstein et al. 2010

Efficacy of Cognitive Training for ADHD



Rapport et al., 2013

Summary of CT efficacy in ADHD

- Moderate to large effects of cognitive training on trained tasks
  - Magnitude of effects increase as cognitive training tasks are more similar to neuropsychological tasks
- Small to large effects of cognitive training on untrained tasks
  - Suggests generalization to overall cognitive functioning, but not for working memory training
- Distal measures
  - Moderate to large effect of cognitive training on academic performance
  - Large effect on objective measurement of hyperactivity
  - Mixed effects on parent ADHD ratings (mostly inattention)
  - No effect on teacher ADHD ratings
- Maintenance of gains
  - Few studies assess. Visuospatial memory gains maintained but not verbal working memory

Epstein et al. 2010, Melby-Lervag & Hulme, 2013, Rapport et al. 2013

Challenges

Cognitive training approaches for mental and addictive disorders:

1. must take into account possible inherent limitations in the underlying brain 'learning machinery' due to pathophysiology
2. must grapple with the presence of complex overlearned maladaptive patterns of neural functioning
3. must find a way to ally with developmental and psychosocial factors that influence response to illness and to treatment.

Vinogradov et al 2012

Outstanding Challenges/Questions

- Need more rigorously designed studies that employ random assignment with at least 30 children in each group
  - Rule out expectancy effects, effects of attention, etc.
- Need to investigate skill transfer, generalizability, maintenance of effects, and clinical efficacy
- Need to work from a model of attention
- Need to apply in real world with “messy” patients – effects of comorbidity?
- Need to investigate potential moderators and mediators
  - Executive function/Attention deficits?
  - Include only children with specific deficits in targeted areas and match deficits with training approach?

Future Directions

- Well articulated theoretical rationale
- Understood mechanisms of action grounded in the neuroscience of learning and cognition
- Induce specific, robust, enduring change in well-defined cognitive/socio-affective functions and neurological outcomes
- Generalize beyond trained task to meaningful behavioral improvements that affect real world functioning

Vinogradov et al 2012