Executive Functioning Training in Children with Fetal Alcohol Spectrum Disorder
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Executive Functioning (EF)

- Refers to the higher-order cognitive processes under conscious control, necessary for thought and action in complex goal-directed behaviour and adaptation to environmental changes and demands.

(Loring, 1999; Welsh, Pennington, & Grossier, 1991; Zelazo & Muller, 2002)

EF includes:

- Flexible thinking, e.g. the ability to monitor and change behaviour when necessary.

- Strategy employment, e.g. Planning future behaviour when faced with new situations and tasks

- Initiating and stopping actions, inhibition, fluency, and planning.
EF and FASD

Children and adolescents with FASD and (PAE) are impaired on many aspects of EF including:

- Measures of cognitive flexibility
- Inhibition
- Fluency
- Abstract thinking
- Deductive reasoning
- Working Memory
- Problem solving
- Planning
- Concept formation
- Sustained attention

(Mattson et al., 1999; Rasmussen & Bisanz, 2009; Schonfeld et al., 2001)
Primary deficits in aspects of attention and working memory for individuals with FASD are pervasive.

These deficits impact:
- Memory and learning
- Executive functioning
- School performance
  - e.g. difficulty with learning from mistakes, difficulty with completing tasks, inconsistent skill performance
- Behavioural regulation

Despite these significant deficits there has been little research conducted around how to improve these underlying abilities in children with FASD.
Reviewing the research

- Problems in attention, working memory and EF are seen in many childhood conditions:
  - **Brain injury** caused by TBI, stroke, anoxia, cancer treatments affecting the CNS etc.
  - **Developmental disorders** such as ADHD, FASD, learning disabilities, Autism Spectrum Disorders.
  - **Other conditions** such as low birth weight, prematurity, seizure disorder, Spina Bifida etc.
The impacts of these difficulties commonly include:

- Problems with learning, life skills, and adaptive functioning at school and at home.
- Difficulty with coping skills, especially when demands, stress, and frustration increase.
- Negative impacts on self-esteem.
- Avoidance of or decrease in motivation to try cognitive tasks – “learned helplessness.”
• In the school setting, attention and memory difficulties result in:
  – Inconsistent learning profiles
  – Knowledge gaps

• Executive difficulties result in:
  – Limited self-regulation of learning
  – Impaired ability to plan and organized behaviour to complete tasks
  – Inconsistent self-regulation of mood and emotion

• Repeated failures result in:
  – Frustration, anger, and acting out
  – Withdrawal, avoidance, and low self-esteem
Research in remediation/rehab of cognitive functioning

- Research has shown that it is possible to improve aspects of cognitive functioning.

- Improvements have been made in sustained attention/concentration and working memory in children with ADHD and brain injuries.
Experience Dependent Neural Plasticity
(Kleim & Jones, 2008)

- Evidence suggests the brain continuously remolds its neural circuitry.

- This is also the mechanism by which the damaged brain re-learns lost behavior or supports new behavior in response to rehabilitation.

- Principles considered critical for experience dependent neural include:
  - Repetition
  - Time Matters
  - Intensity
  - Salience
    - engaging/rewarding
Can we capitalize on this plasticity for cognitive interventions?

**Process Specific Cognitive Training**

- Interventions designed to improve the underlying impaired processes directly through “practice.”

- Research supports that certain types of cognitive training can actually change underlying brain functioning.

- Interventions designed specifically to improve an underlying impaired process directly.

- Any change in underlying capacity is assumed to be due to neural plasticity and/or reorganization of neural system
Cognitive Remediation in Context

Skill Teaching Strategies
(Direct Instruction, Errorless Learning, Prompting, Task Analysis, Shaping, Chaining)

Assessment
Psychometrics, Interview, Observation

Strategies for Reducing Maladaptive Behaviour
(Functional Behavioural Assessment or Functional Analysis, Schedules of Reinforcement, Redirecting, Ignoring, Extinction)

Specific Training Programs/Curricula
(Attention Training, Self-Regulation, Anger Management, Social Skills, etc.)

Arranging the Environment for Success
(Adaptation/Accommodation & Modification, including Physical Space, Teaching/Training Materials, Persons in the Environment)
Process Specific Cognitive Training:

• NOT A CURE or FIXALL – While these techniques may not restore (or remediate) cognitive function to full capacity, they may improve function enough to allow children to engage more in learning or other compensatory strategies.

• Process specific training should be delivered within the context of an overall remediation plan.

• Participants have increased sense of self-esteem which can lead to increased benefit for other interventions & therapies.
Principles of Attention Process Training 
(Sohlberg & Mateer, 1989)

1. Adopt a treatment model grounded in attention theory

2. Use therapy activities that are hierarchically organized

3. Provide sufficient repetition to re-establish skills

4. Base treatment decisions on performance – adapt the level of difficulty based on success

5. Actively facilitate generalization to functional activities from the start
All published reports of “Process Specific” Interventions for Improving Attention in Children with Brain Injury as of 2004

Penkman, 2004

Since this time there have been many other published positive results
“Pay Attention” Training in Children with FASD

As stated earlier, children with FASD have widespread neuropsychological impairments:

- visual-spatial processing
- attention
- executive functioning
- intelligence (however wide variation and most not <70)
- academic achievement
- language

- ADHD is a core feature of FAS – 63% in some samples

- Frequent co-morbid developmental and psychiatric conditions
Application of “Pay Attention”
Attention Process Training in children with FASD

■ 20 Labrador Inuit children (ages 7-12, 11 girls, 9 boys)
■ 2 groups matched for age and non-verbal IQ
■ Randomly assigned to sustained attention training or contact control group condition
■ 12 daily 30 min individual training or support sessions (approx 3 weeks)

Vernescu (2008)
Pay Attention Training Materials

- Pay Attention! sustained attention modules

Contact Control Materials

- Worksheets, games, and art activities tailored for academic concepts and typically available within the regular academic environment

Vernescu (2008)
Visual Sustained Attention

**Variability of Response Time**

- Pre-test
- Post...

**Number Correct Responses**

- Pre...
- Post...

**Number of Omissions**

- Pre-test
- Post...
Auditory Sustained Attention

**Score**

<table>
<thead>
<tr>
<th>Standard Score</th>
<th>Pre-test</th>
<th>Post-test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control</td>
<td>PA</td>
</tr>
</tbody>
</table>

**Code Transmission**

<table>
<thead>
<tr>
<th>Standard Score</th>
<th>Pre-test</th>
<th>Post-test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control</td>
<td>APT</td>
</tr>
</tbody>
</table>

Graphs showing the comparison of performance scores and code transmission between control and enhanced groups pre-test and post-test.
Selective Attention

Errors of Comission

- Pre-test
- Post-test

Control
PA
Alternating Attention

**Correct Targets**

**Errors of Commission**

- Pre-test
- Post-test

[Graphs showing data for Correct Targets and Errors of Commission with bars for Pre-test and Post-test for Control and PA conditions.]
Post-test Findings for Children with FASD

- Significant treatment effects were found on several untrained tasks.

- Significant treatment effects were also seen on a measure of non-verbal reasoning (CTONI) – probably due to better attention to the test.

- Teachers rated all children as having post-test improvements in attention and executive functioning regardless of treatment group – “halo effect”

Vernesu (2008)
Using ‘Computer-Based’ Interventions

- In the past, computer based interventions have suffered a number of negative stereotypes … Some deserved!

- At current there is a ‘resurgence’ of interest in the use of computer programs claiming to enhance brain function

- Good intervention efforts which utilize computer based materials do so in conjunction with ‘meta-cognitive’ & behavioral interventions and are showing positive outcomes!

- However, given the number of materials being produced and becoming available online and in other formats – due diligence is required!
Attention Training in Traumatic Brain Injury (Galbiati, 2009)

- All 6-18 year olds with severe brain injury
- 40 children in treatment group (75% male)
  25 children in control group (64% male)
- Age at Injury – 13.4 years (SD = 3.83)
- Days unconsciousness – 21.33 (SD = 15.67)
- Surgical Intervention (Tx=52%, Con=48%)
- Tested pre/post treatment & 1 year followup
Attention Training Intervention

- 6 months, 4x weekly, 45 minutes per session
- Computerized attention training (REHACOM)
  - Reaction time, divided attention, selective attention, working memory, attention shifting
- Table-top tasks:
  - Targeting ‘meta-attention’ and focusing on selective, sustained, dividing attention and inhibition
### RESULTS

#### Overall Pre/Post Outcomes

Table 3

*Comparison Between Clinical and Control Groups, With Mean IQ, CPT II, and VABS Scores (and Standard Deviations) at Baseline and Follow-Up*

<table>
<thead>
<tr>
<th></th>
<th>Clinical group</th>
<th>Control group</th>
<th>ANOVA group × assessment F</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline</td>
<td>Follow-up</td>
<td>Baseline</td>
</tr>
<tr>
<td><strong>IQ</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VIQ</td>
<td>72.97 (16.90)</td>
<td>82.68 (16.26)</td>
<td>67.16 (15.41)</td>
</tr>
<tr>
<td>PIQ</td>
<td>69.45 (18.99)</td>
<td>79.97 (16.58)</td>
<td>60.52 (16.67)</td>
</tr>
<tr>
<td>F IQ</td>
<td>68.61 (18.11)</td>
<td>80.06 (16.29)</td>
<td>61.21 (16.27)</td>
</tr>
<tr>
<td><strong>CPT II</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Omission</td>
<td>91.86 (11.90)</td>
<td>76.01 (24.19)</td>
<td>93.87 (6.02)</td>
</tr>
<tr>
<td>Commission</td>
<td>63.66 (30.21)</td>
<td>46.46 (30.97)</td>
<td>71.84 (30.01)</td>
</tr>
<tr>
<td>Hit RT</td>
<td>33.33 (34.91)</td>
<td>36.56 (28.68)</td>
<td>42.66 (30.09)</td>
</tr>
<tr>
<td>Standard Error</td>
<td>88.66 (19.50)</td>
<td>66.14 (26.17)</td>
<td>93.63 (10.78)</td>
</tr>
<tr>
<td>Risk Taking</td>
<td>92.27 (15.82)</td>
<td>75.21 (26.44)</td>
<td>94.31 (13.88)</td>
</tr>
<tr>
<td>Hit Block</td>
<td>65.34 (33.12)</td>
<td>51.35 (23.09)</td>
<td>69.08 (35.23)</td>
</tr>
<tr>
<td>Hit RT ISI</td>
<td>83.87 (23.43)</td>
<td>64.00 (26.99)</td>
<td>78.21 (31.33)</td>
</tr>
<tr>
<td><strong>Overall Index</strong></td>
<td>15.31 (4.11)</td>
<td>5.40 (4.68)</td>
<td>16.75 (4.29)</td>
</tr>
<tr>
<td><strong>VABS domain</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication</td>
<td>65 (21)</td>
<td>94 (9)</td>
<td>63 (26)</td>
</tr>
<tr>
<td>Daily living skills</td>
<td>70 (19)</td>
<td>94 (9)</td>
<td>68 (23)</td>
</tr>
<tr>
<td>Social skills</td>
<td>69 (13)</td>
<td>95 (9)</td>
<td>63 (22)</td>
</tr>
</tbody>
</table>

*Note. The comparison was performed with repeated measures analysis, with group as the between-subjects factor and assessment time as the within-subjects factor. ANOVA = analysis of variance; VIQ = Verbal IQ test; PIQ = Performance IQ test; F IQ = Full IQ test; CPT II = Continuous Performance Test II; RT = reaction time; ISI = interstimulus interval; VABS = Vineland Adaptive Behavior Scales.  
*p < .05.  **p < .01.  ***p < .001.*
Baseline, post-tX & follow-up performance clinical group on Conners CPT

*: p<0.05; **: p<0.01; ***: p<0.001
Percentile Scores on Vineland Adaptive Behavior Scale
CPAT: A Computerized Attention Training Program in Children (Shalev, Tsal & Mevorach, 2006)

- CPAT tasks train 1 of 4 proposed attention networks based on Posner’s model:
  - sustained attention, selective attention, orienting of attention, executive attention (Posner & Peterson, 1990)

- Participants advanced in difficulty based on the speed and accuracy of their performance – program automatically adjusts to level

- Tasks completed with research assistant monitoring/encouraging during the training

- Original study demonstrated efficacy in a group of children with ADHD
CPAT in Children With FASD:
(Kerns, MacSween, VanderWeeken & Grupposo, 2010)

- Sample included 10 children (6 male, 4 female) who were identified as having FASD.
  - Age ranged from 8-15 years (M = 12.3, SD = 2.67) and mean IQ was 91 (range 60-107)

- Intervention provided 4 x 30 minute sessions each week at school as part of the school day

- On average, participants completed 30.5 sessions over a period of 9.5 weeks to reach the required total of 16 training hours.
- Children were administered the CPAT individually by a research assistant who provided behavioral support and metacognitive strategies to enhance performance.

- External motivators were provided based on improvement and performance as tracked in the CPAT.

- Pre & post testing conducted within 2 weeks of ending the intervention, by research assistants who did not work with the children.
Results to date

Table 1. Pairwise comparisons of attention, working memory and academic measures pre- and post-intervention.

<table>
<thead>
<tr>
<th></th>
<th>t</th>
<th>sig. (p)</th>
<th>Cohen’s d</th>
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</thead>
<tbody>
<tr>
<td><strong>Attention</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distractibility</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commissions</td>
<td>3.16</td>
<td>0.012*</td>
<td>1.00</td>
</tr>
<tr>
<td>Reaction time</td>
<td>2.63</td>
<td>0.027*</td>
<td>0.83</td>
</tr>
<tr>
<td><strong>Sustained</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commissions—Visual Task</td>
<td>0.94</td>
<td>0.373</td>
<td>0.30</td>
</tr>
<tr>
<td>Total—Auditory Task</td>
<td>2.82</td>
<td>0.047**</td>
<td>1.26</td>
</tr>
<tr>
<td>Reaction time</td>
<td>0.47</td>
<td>0.651</td>
<td>0.17</td>
</tr>
<tr>
<td><strong>Divided</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commissions</td>
<td>1.82</td>
<td>0.102</td>
<td>0.58</td>
</tr>
<tr>
<td>Reaction time (Audio/Visual)</td>
<td>0.70</td>
<td>0.499</td>
<td>0.22</td>
</tr>
<tr>
<td><strong>ANT-C Reaction Times</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neutral Targets</td>
<td>3.466</td>
<td>0.007**</td>
<td>1.10</td>
</tr>
<tr>
<td>Congruent Targets</td>
<td>2.182</td>
<td>0.057</td>
<td>0.690</td>
</tr>
<tr>
<td>Incongruent Targets</td>
<td>3.400</td>
<td>0.008**</td>
<td>1.07</td>
</tr>
<tr>
<td><strong>Working Memory</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spatial span forward</td>
<td>1.63</td>
<td>0.138</td>
<td>0.51</td>
</tr>
<tr>
<td>Spatial span backward</td>
<td>1.99</td>
<td>0.078</td>
<td>0.63</td>
</tr>
<tr>
<td>CSOT</td>
<td>1.18</td>
<td>0.269</td>
<td>0.37</td>
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<tr>
<td><strong>Academic</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Math fluency</td>
<td>2.29</td>
<td>0.048*</td>
<td>0.72</td>
</tr>
<tr>
<td>Reading fluency</td>
<td>4.42</td>
<td>0.002**</td>
<td>1.40</td>
</tr>
</tbody>
</table>

* p < 0.05; ** p < 0.01.

- ERP analyses are still being completed on ANT-C
More Research:

Cogmed’s ROBOMEMO

In addition to attention training, currently there is a growing research base for improvement in working memory (WM) using computerized interventions.
Computerized Working Memory Training in Children with ADHD
(Klingberg, Forssberg & Westerberg, 2002; Klingberg et al., 2005)

- Randomized, double-blind studies
- Each working memory task presented daily for 5-6 weeks
- 2002: 14 children ages 7-15
- 2005: 53 children ages 7-12
- Conducted at home or school

<table>
<thead>
<tr>
<th>Treatment Condition</th>
<th>Placebo Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tasks started simple and became more difficult according to individual progress</td>
<td>Tasks started simple and did not change in difficulty</td>
</tr>
</tbody>
</table>
## Results

<table>
<thead>
<tr>
<th></th>
<th>2002 Post-test</th>
<th>2005 Post-test</th>
<th>2005 3-month f-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual Spatial Working Memory (trained task)</td>
<td>***</td>
<td>Not given</td>
<td>Not given</td>
</tr>
<tr>
<td>Digit span</td>
<td>Not given</td>
<td>**</td>
<td>*</td>
</tr>
<tr>
<td>Span Board</td>
<td>***</td>
<td>***</td>
<td>**</td>
</tr>
<tr>
<td>Raven’s Matrices</td>
<td>***</td>
<td>**</td>
<td></td>
</tr>
<tr>
<td>Stroop <em>(accuracy)</em></td>
<td>*(accuracy)</td>
<td>** <em>(accuracy)</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>(timing)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Head Movements</td>
<td>***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Choice reaction time</td>
<td></td>
<td>Not given</td>
<td>Not given</td>
</tr>
<tr>
<td>Conners &amp; 18 DSM-IV items</td>
<td>Not given</td>
<td>**Parent – att</td>
<td>*Parent - att</td>
</tr>
<tr>
<td></td>
<td></td>
<td>**Parent - hyp</td>
<td>*Parent - hyp</td>
</tr>
<tr>
<td></td>
<td>*(p&lt;.05)</td>
<td>***(p&lt;.001)</td>
<td></td>
</tr>
<tr>
<td>Researcher</td>
<td>Population</td>
<td>RCT Trial</td>
<td>N</td>
</tr>
<tr>
<td>---------------------</td>
<td>---------------------</td>
<td>-----------</td>
<td>-----</td>
</tr>
<tr>
<td>Holmes (09)</td>
<td>Low WM on testing</td>
<td>by School</td>
<td>22/20</td>
</tr>
<tr>
<td>Holmes (09)</td>
<td>ADHD</td>
<td>No</td>
<td>25</td>
</tr>
<tr>
<td>Thorell (09)</td>
<td>Preschool</td>
<td>by School</td>
<td>65</td>
</tr>
<tr>
<td>Mezzacappa (10)</td>
<td>Low SES</td>
<td>No</td>
<td>9</td>
</tr>
<tr>
<td>Dahlin (10)</td>
<td>LD</td>
<td>Yes</td>
<td>42/15</td>
</tr>
<tr>
<td>Beck (10)</td>
<td>ADHD</td>
<td>Wait list</td>
<td>52</td>
</tr>
<tr>
<td>Løhaugen (10)</td>
<td>ELBW</td>
<td>Yes</td>
<td>19/11</td>
</tr>
<tr>
<td>Kronenberger (10)</td>
<td>Cochlear Implants</td>
<td>No</td>
<td>9</td>
</tr>
</tbody>
</table>
Combining Attention, Working Memory and Inhibitory Control Training

*Should we try?*

- Many of the children we see exhibit deficits or inconsistency in all 3 of these domains.

- These abilities are rarely used in isolation in the real world.

- Within a school environment it is necessary for children to be able to maintain abilities across longer durations of time and with ongoing distractions.
Cognitive Carnival

- *Our current work-in-progress: computerized intervention training program*
- Combines working memory, inhibitory control and attention training
Cognitive Carnival

- Designed with key aspects in mind:
  - Consists of 3 games: Liftoff, Wheel and Platform
  - Played as a “game” with an X-box controller
  - Levels are hierarchically organized by difficulty
  - Internal and external rewards provided throughout game play
  - Each level requires ≥90% accuracy to advance
  - Levels can be re-tried as many times as necessary
  - Noises indicate omission and commission errors
Liftoff

QuickTime™ and a decompressor are needed to see this picture.
Liftoff

- Measure of auditory and visual spatial working memory
- Total of 18 levels
  - 9 trials per level that also increase in difficulty - three levels with 3 items, three levels with 4 items, three levels with 5 items
- Variables:
  - Location of items on screen
  - Visual or auditory presentation of items
  - Visual and auditory distracters
  - Speed of presentation
  - Rule complexity: repeat sequence or put in numerical/alphabetical order and ignore shape
  - Number of items: standard is 3, 4, 5 – can be increased or decreased depending on child’s age and abilities
Wheel

If you see: 2 pictures after it

Followed by: 2 pictures after it
Wheel

- Measure of sustained attention
- Total of 19 levels

Variables:
- Length of time (increases from 3 to 7 minutes over trials)
- Target present (20-30%)
- Speed of presentation (slow, medium, fast)
- Number and location of distracters
- Rule complexity:
  - Press “A” when you see blue star
  - Press “A” when you see red square followed by green circle
Platform
Platform

• Measure of auditory and visual working memory
• Total of 20 levels
• Variables:
  ▪ Number of items to find (increase from 3 to 7 over levels)
  ▪ Type of item (fruit, balls, flags)
  ▪ Distracters (spikes and “bad guys”)
  ▪ Visual or auditory presentation
  ▪ Rule complexity: forward or backward
Metaphorically speaking...

- The participants are taught that the brain is like a muscle that becomes stronger with repeated exercise.
- Key to brain growth: PRACTICE!
Metacognition

• Consists of:
  – Monitoring cognition: self-reflection of own thought and thought processes
  – Controlling cognition: using metaknowledge to regulate information processing and behaviour

• Necessary for **self-regulation** – the volitional process of being aware of goals and monitoring and controlling cognitions, emotions, behaviours, and environment for the achievement of self-goals
  ■ Deliberately controlling one’s thoughts and actions
Metacognitive skills

(Veenman & Elschout, 1999)

- Deliberate use of goals and strategies to control cognition
- Procedural knowledge
- Such skills comprised of:
  - Orientation strategies
  - Planning strategies
  - Strategies for regulation of cognitive processing
  - Strategies for monitoring the execution of planned action
  - Strategies for evaluating the outcome
Scaffolding

- Scaffolding is combined with metacognitive strategies provided by a trained interventionist.

“Scaffold are tools, strategies, and guides used during learning to enable the development of understanding that is beyond the individual’s immediate grasp.”

(Azevedo & Hadwin, 2005)
Scaffolding

- Used to facilitate learning

- Scaffolding:
  - Is individualized - support is tailored to child and context
  - Is calibrated - support is dynamic and provided at specific level
  - Fades - scaffold provided as necessary and reduced over time as competence increases

- Diagnosis needs to be ongoing
Cognitive Carnival

- Application of metacognitive skills, self-regulation and scaffolding
- Children are explicitly encouraged to make errors and learn from them
- Children are encouraged to employ additional strategies when performance is weak
  - Child may help brainstorm different strategies with interventionist
Metacognitive/Self-Regulatory Scripts

Format of script used with children:
1) Identify the issue
   • Child repeatedly forgets sequence

2) State the reason
   • Explain that the sequence
   • has become longer as the
   • difficulty of the game has
   • increased
Metacognitive/Self-Regulatory Scripts

3) Strategy planning
   • Rehearsal or visualization strategies, reduce speed

4) Review
   • Offer encouragement and evaluate outcome
   • Continue, change, modify or terminate strategy
   • Celebrate success!!
Strategies:

- Rehearsal strategies:
  
  “Try repeating the numbers as you hear them.”

- Visualization strategies:
  
  “Picture the shapes in your mind.”

- Reducing speed:
  
  “Take some time to memorize the items before starting the level.”
Metacognitive/Self-Regulatory Scripts

- Modify the language: use metaphors or visual techniques to make the strategy motivating
- Use scripts frequently
- Pull back supports as child acquires and internalizes the script
- Weave scripts together – can increase complexity of scripts
- Reward the use of self-regulation!!
Executive Functioning Training in Children with FASD: A Pilot Study

- March to June 2010 we completed the pilot study using Cognitive Carnival with children diagnosed with FASD

- Randomized clinical control trial with 18 students in Edmonton Public Schools

- Children ages 6-12 (mean 9.5 years)

- Randomly assigned to control or intervention condition, all had FASD

- Control condition: equal amount of time with interventionist using computer education materials (animals/geography/strategy games)

- Each child received 24 half-hour sessions over a 12-week span.
Cognitive Carnival Pilot Study Cont.

- Process of partnering with schools
  1. Working with preexisting networks of collaboration and contacting the school board
     - Fostering and maintaining relationships is extremely important
  1. Contacting interested schools:
     - Principals are busy – persistence!
     - “Pitching” the intervention – keep it simple!
  2. Determining who has FASD
     - There is inconsistency in how diagnoses are kept on files and communicated to teachers and principals
Cognitive Carnival Pilot Study Cont.

4. Handing out and collecting caregiver consents and rating scales through the schools

5. Finding a way to work quietly and easily within the school:
   - Knowing your way around
   - Not being an inconvenience

6. Showing appreciation:
   - Book donations
   - Thank you cards
## Cognitive Carnival Pilot Study: Test Battery

<table>
<thead>
<tr>
<th>Pre and Post Measures</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEPSY and NEPSY-II</td>
<td>neuropsych: memory, visuomotor, visuospatial, attention &amp; inhibition</td>
</tr>
<tr>
<td>Spatial Span (WISC IV Integrated)</td>
<td>working memory</td>
</tr>
<tr>
<td>Digit Recall (WMTB-C)</td>
<td>working memory</td>
</tr>
<tr>
<td>WJ-III Reading Fluency</td>
<td>reading</td>
</tr>
<tr>
<td>WJ-III Quantitative Concepts</td>
<td>math</td>
</tr>
<tr>
<td>CPT</td>
<td>attention</td>
</tr>
<tr>
<td>Day/Night Task</td>
<td>inhibition</td>
</tr>
<tr>
<td>Go/No-Go</td>
<td>inhibition</td>
</tr>
<tr>
<td>BRIEF Parent and Teacher</td>
<td>behaviour</td>
</tr>
<tr>
<td>Conners Parent and Teacher</td>
<td>behaviour</td>
</tr>
</tbody>
</table>
Cognitive Carnival Pilot Study Cont.

- Testing completed by research assistants blind to group assignment
- Several of participants also received pre/post DTI scans (co-enrolled in longitudinal DTI study)
- For analysis we looked at differences in raw scores between pre- and post- intervention
## Cognitive Carnival Pilot Study Results

### Subtests that improved pre- to post-test

<table>
<thead>
<tr>
<th>Control Group</th>
<th>Experimental Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEPSY-II Memory for Names</td>
<td>NEPSY-II Memory for Names</td>
</tr>
<tr>
<td>NEPSY-II Memory for Names Delayed</td>
<td>NEPSY-II Memory for Names Delayed</td>
</tr>
<tr>
<td>WJ-III Quantitative Concepts</td>
<td>WJ-III Quantitative Concepts*</td>
</tr>
<tr>
<td>NEPSY Visuomotor Precision: completion time</td>
<td>NEPSY Arrows</td>
</tr>
<tr>
<td>NEPSY Auditory Attention: total correct</td>
<td>NEPSY Auditory Attention: total errors*</td>
</tr>
<tr>
<td>NEPSY Auditory Attention: omission error</td>
<td>WMRT-R Word ID</td>
</tr>
</tbody>
</table>

*Approached significance*
Cognitive Carnival Pilot Study: *Noteworthy Results*

- WJ-III Quantitative Concepts includes identifying terminology, formulas, sequences and number patterns related to math.

*Approached significance*
Cognitive Carnival Pilot Study: 
Noteworthy Results

- NEPSY-II: Memory for Names
- NEPSY-II: Memory for Names Delayed

Both statistically significant.
Cognitive Carnival Pilot Study: Noteworthy Results

- NEPSY Arrows: Visuospatial processing

*Not statistically significant
Cognitive Carnival Pilot Results

- NEPSY II: Visuomotor Precision

Completion Time (seconds)

Total Errors

*Control Completion Time was the only one found to be statistically significant at 0.05
Cognitive Carnival Pilot Results

NEPSYII: Auditory Attention inhibitory errors

Results not statistically significant
Cognitive Carnival Pilot Results

NEPSYII: Auditory Attention total errors

Neither group statistically significant, however experimental group approached significance.
+ Issues we encountered:

- Low power due to small groups (9 ctrl, 9 exp)
- Pre- and post-measures not sensitive enough.
- Time-lapse between intervention and post-testing.
- Variability within groups
- Differences between groups
Important to note...

- The control group in 2010 still received an educational computer intervention.

- While Cognitive Carnival is designed to target executive functioning, the personal component (coaching, scaffolding, one-on-one time) is essential.

- The control group still received the personal component of the intervention.

- Our results may be due to the positive effect that one-on-one time and coaching have on students with FASD.
Diffusion Tensor Magnetic Resonance Imaging (DTI)

- DTI permits the virtual dissection of white matter (i.e. the wiring) in the brain as well as a measure of their structural integrity (e.g. degree of myelination).

- DTI may provide a more sensitive measure of tissue microstructure than conventional MRI.

- DTI is not presently performed in routine clinical MRI scans although it is one of the most active research topics in MRI.
**DTI Parameters**

- **Fractional anisotropy (FA):** measure of white matter integrity

- **Mean diffusivity (MD):** measure of average water diffusion
7/10 tracts showed significant diffusion abnormalities, bilaterally (SLF, ILF, splenium, IFO & genu) or unilaterally (cingulum, ILF, CST).

8 participants had both pre and post scans--3 intervention and 5 controls.

Almost everyone has a substantial increase in FA (tissue integrity) in the genu of the corpus callosum.

This is a surprising finding because although FA increases with age, we wouldn't expect significant changes in this short of a period.
Looking forward: 2011 Intervention

We used the 2010 pilot study to modify our approach…

- *Increased age range*: currently working with 24 students ages 6 to 16 (mean 11.8 years).

- Using a delayed-treatment control approach:
  - 2 groups \((n_1=11, n_2=13)\)
  - All students are tested at 3 time-points:
    - 0 weeks
    - 12 weeks
    - 24 weeks
## Delayed-treatment Control Method

<table>
<thead>
<tr>
<th>Time</th>
<th>Group A: Intervention</th>
<th>Group A: nothing</th>
<th>Group B: nothing</th>
<th>Group B Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 weeks</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 weeks</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24 weeks</td>
<td></td>
<td>Group A: nothing</td>
<td>Group B Intervention</td>
<td></td>
</tr>
</tbody>
</table>

- Using this delayed-treatment approach:
  - Group B will be a control (12 weeks with no intervention)
  - Group A will measure retention (12 weeks after intervention)
2011 Intervention

- Benefits of this approach:
  - Larger power because twice as many participants
  - Still have a control group without using a “sham” intervention (no educational games etc.)
  - Eliminates group differences (age, functioning etc.)
  - Determine if there is sustained learning
  - Easier to administer intervention to half the number of students at one time
2011 Intervention

Additional Changes

- New measures:
  - Tasks of Executive Control (TEC)
  - KITAP: Flexibility, Distractibility, Divided Attention

- Measures that we kept:
  - Reading fluency and Quantitative concepts (WJ-III)
  - Digit Recall (WMTB)
  - Spatial Span (WISC IV Integrated)
  - Parent and teacher rating scales (changed)
2011 Intervention
Additional Changes

- Pre-, mid-, and post-testing is being done in the schools rather than the university, to eliminate caregiver burden and time-lapse.

- Better communication with teachers: allow input about when students are taken out of class for intervention.

- Gift cards for older children: $1 per session
2011 Intervention

*Our hopes for this year…*

- We hope to find measurable differences using our new, more sensitive measures, new procedures and design.

- With two larger groups and a total *n* of 24, we hope to find significant results.
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Material available online at:
http://web.uvic.ca/~kkerns/EFIntervention.pdf

Thank you!