Cognitive Interventions for Individuals with Fetal Alcohol Spectrum Disorder (FASD)

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Overview

- FASD
- Cognitive interventions
- Math intervention
- Language intervention
- Memory intervention
- Executive functioning intervention
- Attention process training intervention

FASD

- FASD Diagnosis
- FASD Prevalence and Cost
Fetal Alcohol Spectrum Disorder (FASD)

- Prenatal alcohol exposure (PAE) produces a range of effects including:
  - Fetal Alcohol Syndrome (FAS)
  - Fetal Alcohol Effect (FAE)
  - Fall under the umbrella term FASD
- FASD refers to individuals who may have physical, mental, behavioral, and/or learning disabilities as a result of maternal alcohol consumption (Chudley et al., 2005).

FASD Diagnosis

- Growth Deficiency
- Facial Features
- CNS damage
- Alcohol Exposure
- 92% of children with FASD had no growth deficiency and 66% had no facial features (Rasmussen et al., 2006).

FASD Prevalence and Cost

- FASD is one of the most common known causes of mental retardation, yet in theory it is preventable.
- ~1/100 children is affected with FASD
- The annual cost of FASD in Canada (aged 0 to 53) is ~$5.3 billion, with an annual cost per individual of nearly $22,000 (Stade et al., 2009).
- In Alberta, estimated lifetime cost for one person with FASD is $1.1 million (Thanh & Jonsson, 2009).
- U.S. estimates place the lifetime cost of a child with FASD at $2 million.
Cognitive Intervention

- Cognitive Intervention: Traditional
- Cognitive Intervention: Context Sensitive

Cognitive Intervention: Traditional

- The focus is on the underlying impairment
- Goal of restoring cognitive functions (e.g., attention, organization, memory, reasoning, problem solving)
- Increasingly the focus has expanded to include the use of compensatory strategies to support interventions across areas of functioning for the individual
- Cognitive remediation is often done outside of the functional contexts or environments of the individual (e.g., in a hospital or clinical setting)

Cognitive Intervention: Context Sensitive

- The focus is on understanding how the underlying impairments impact functional activities in everyday life, and/or the individual’s participation in chosen life activities (e.g., school).
- Flexible combination of cognitive exercises, task-specific training of relevant everyday skills, and intervention for strategic thinking and compensatory behavior in functional contexts.
- Important to this approach is environmental modifications, including changes in the support behaviors of relevant people in the individual’s natural environments (e.g., in home or school).
Cognitive Intervention: Context Sensitive

- In contrast to traditional cognitive remediation approaches, this intervention is typically embedded within the person's natural environments (e.g., in the home or classroom setting).

Math Intervention

- Math Interactive Learning Experience (MILE)
- Results of Math Intervention

Math Intervention

- Kable et al. (2007) assigned children (3-10 years) with FASD to two groups
  1. Math Intervention Group
  2. Standard Psychoeducational (contrast group)
     - Neurodev evaluation, Individual Education Plan
- All parents received parental instruction on FASD: the math intervention group was focused on math and contrast group on standard education.
- Children were assessed on behavior and math before and after the 6 week intervention
Math Interactive Learning Experience (MILE)

- 6 weeks of tutoring in math, focusing on the cognitive deficits that contribute to math difficulties
  - Slower pace of instruction to compensate for lower processing speed
  - Used physical objects and tools (number lines) to assist with visual spatial deficits and poor working memory
  - Repetition: verbal and visual spatial
  - Adapted the ‘Handwriting without Tears’ program to assist with poor graphomotor skills

Results of Math Intervention

- Children in math group showed more improvements in math than the contrast group
  - More likely to have clinical significant gains in math (>1SD increase)
- Parents of children in both groups reported improvements in behaviors
- Follow-up 6 months later: Math group still had higher math scores than contrast group, and both groups still showed improvements in behaviour (Coles et al., 2009)

Language Intervention
Language Intervention (Adams et al. 2007)

- Language and literacy training (LLT) program for children with FASD in South Africa.
  - 40 children with FASD (aged 9 years) randomly assigned to intervention or control group
  - 25 non-exposed children
- LLT: children worked with a Speech Language Therapist twice a week for 9 months.
  - Emphasized phonological awareness and other literacy skills involved in reading and spelling

Children completed scholastic, language, and literacy tests and parents and teaching completed ratings before and after the intervention.

Compared to the FASD control group, the LLT group showed significantly more improvements on measures of language and literacy:
  - Syllable manipulation, letter sound knowledge, written letters, word reading, non-word reading, and spelling.

The LLT, FASD control, and non-exposed control groups showed similar changes on general scholastic achievement.

The intervention was effective!

Memory Intervention

- Memory Training in FASD
Loomes, Rasmussen, Pei et al. (2008) examined whether teaching children with FASD a verbal rehearsal strategy increases their memory span.

**Participants**: 33 children (19 males and 14 females) with FASD. Age range: 4 to 11 years.

Children were assigned to two groups:
1. **Experimental group (n=17)**: who received rehearsal training (children were told to whisper items repeatedly in their head).
2. **Control group (n=16)**: who received no training.

### Memory Training in FASD

<table>
<thead>
<tr>
<th></th>
<th>Experimental</th>
<th>Control</th>
</tr>
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<tbody>
<tr>
<td>Day 1 Pretest</td>
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<tr>
<td>Day 1 Posttest</td>
<td></td>
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<tr>
<td>Day 2 Posttest</td>
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<tr>
<td>1 week later</td>
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</tbody>
</table>

**Pretest**: Both groups completed a digit span task (1-4, 2-4-7)

**Posttest 1**: Exp. group received rehearsal training, then completed the digit span task. Control group had a break with training, then completed the digit span task.

**Posttest 2**: Exp. group was given a reminder on how to rehearse, then both groups completed digit span task.

- Behavioral evidence of rehearsal (e.g., whispering, moving lips, or saying the stimuli repeatedly) was also recorded.

### Results: Rehearsal Training

- Age was not correlated with whether children showed and increase in memory span.
Results: Behavioral Evidence

<table>
<thead>
<tr>
<th>Session</th>
<th>Percentage of Children Showing Behavioral Evidence of Rehearsal</th>
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</thead>
<tbody>
<tr>
<td>Pretest</td>
<td>10% Control, 30% Experimental</td>
</tr>
<tr>
<td>Posttest 1</td>
<td>40% Control, 60% Experimental</td>
</tr>
<tr>
<td>Posttest 2</td>
<td>50% Control, 70% Experimental</td>
</tr>
</tbody>
</table>

Conclusions

- Rehearsal training is effective in improving memory for numbers among young children with FASD
  - Age was not related to increases in memory span indicating that rehearsal training may be beneficial for children of all ages (even preschool)
  - More children in the experimental group showed behavioral evidence of using rehearsal after the intervention
    - Age was not related to behavioral evidence
    - Older children were more able to articulate that they were using rehearsal

Executive Functioning Intervention

- Executive Functioning in FASD
  - Executive Functioning Interventions
Executive Functioning (EF) in FASD

- EF: higher order cognitive process
  - Inhibition, set-shifting, working memory, planning, organization, decision making, fluency
- Children and adults with FASD and PAE are impaired on a variety of EF tasks. EF is mediated by frontal lobe, PAE negatively effects the prefrontal cortex (see Rasmussen, 2005)

Importance of EF (Diamond et al., 2007)
- EF is important for academic achievement
- Poor EF linked to problems with social functioning and mental health
- Poor EF linked to poverty

EF Interventions

- Diamond et al. (2007) evaluated EF intervention program “Tools of the Mind”
  - 147 preschoolers in low-income urban preschools
  - 85 randomly assignment to Tools and 62 to contrast group (supports academics but not EF)
- Children were in program for 1-2 years
- Completed EF tests after the program
  - Measuring inhibition, rules, switching attention

Vygotsky: (Bodrova and Leong, 2007)

- Based on Vygosky’s theory of cognitive and EF development.

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**Zone of Proximal Development**

- Assisted Performance
- Independent Performance

**Scaffolding**
Tools of the Mind Program (Diamond, 2007)

1. Concrete, External Aids

**Buddy Reading**: Children in pairs with picture book, take turns telling each other story
- Visual aids (picture of ear when time to listen)
- After a few months pictures not needed
- Listener asks a question about the book at end
‘Clean up song’ used when cleaning up after activities

Tools of the Mind Program (Diamond, 2007)

2. Regulate Others’ Behavior

- Counting done in pairs: One child counts and one watches, and then checks counting after
  - Self-reflection and inhibition

3. Self-Regulatory Private Speech

- Self-directed speech out loud
- Teachers model and encourage private speech
- Pretend play

Tools of the Mind Program (Diamond, 2007)

4. Private Speech During Rule Switching

- Private speech important when tasks become more difficult and involve rule switching

  **Pattern movement game**
  ▲ ▲ ▲ ▲ ▲
  - Different shapes assignment to different movements, then switch rule
  - Encourages use to private speech to remember new rules
5. Mature Dramatic Play

- Children think and plan play scenario ahead of time, then act out scenario
- Repeat with different scenario
- Think ahead (and talk) and plan
- Remember the role and the scenario
- Inhibit other behaviors

6. Teacher Training

Tools of the Mind Program (Diamond, 2007)

Results (Diamond, 2007)

- After the program, children in Tools performed much better than contrast group on measures of EF (inhibition, rules, and switching attention).
- More demanding EF tasks showed largest effects and correlated most with academic measures.
- EF CAN be improved in young children attending regular classrooms.
- Long-term effects?

Using Computer-Based Interventions

- There is interest in the use of computer programs claiming to enhance brain function (e.g. Wii, Nintendo DS)
- Intervention efforts which utilize computer based materials do so in conjunction with meta-cognitive and behavioral interventions and positive outcomes have been identified
- However, given the number of materials being produced and becoming available online and in other formats due diligence is required
Using Computer-Based Interventions

- 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.

Cognitive Carnival
Our current work-in-progress:

- Combines working memory, inhibition control and attention training.
- 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

- 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
Liftoff

- 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

- 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
**Wheel**

**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
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

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

Scaffolding

- Back to Vygotsky
- Used to facilitate learning in combination with the metacognitive strategies
- 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
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."

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
- Each child received 24 half-hour sessions over a 12-week span

Children ages 7-13 (mean 9.5 years)

- Randomly assigned to control or intervention condition, all had an FASD
- Control condition: equal amount of time with interventionist using computer education materials; for example: animals/geography/strategy games
Cognitive Carnival Pilot Study Cont.

<table>
<thead>
<tr>
<th>Pre and Post Measures</th>
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<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>executive functioning</td>
</tr>
<tr>
<td>Conners Parent and Teacher</td>
<td>attention</td>
</tr>
</tbody>
</table>

Cognitive Carnival Pilot Study Cont.

- Testing completed by research assistants blind to group assignment
- Majority 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>
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<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.

  ![Graph showing WJ-III Quantitative Concepts](image)

  *Approached significance

Cognitive Carnival Pilot Study: Noteworthy Results

- NEPSY II: Memory for Names

  ![Graph showing NEPSY II: Memory for Names](image)

  Both statistically significant.

Cognitive Carnival Pilot Study: Noteworthy Results

- NEPSY Arrows: Visuospatial processing

  ![Graph showing NEPSY Arrows: Visuospatial processing](image)

  *Not statistically significant
Cognitive Carnival Pilot Study: Noteworthy Results

- NEPSY II: Visuomotor Precision

*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:

- Small groups (9 control, 9 experimental).
- Pre- and post-measures not sensitive enough.
- Time-lapse between intervention and post-testing.

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.

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 (n₁=11, n₂=13)
  - All students are tested 3 times:
    - Before Group A receives intervention (0 weeks)
    - After Group A receives intervention but before Group B starts (12 weeks)
    - After Group B completes intervention (24 weeks)
Delayed-treatment Control Method

<table>
<thead>
<tr>
<th></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>
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<tr>
<td>12 weeks</td>
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<tr>
<td>24 weeks</td>
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- 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

- Using this delayed-treatment approach:
  - Group B will be a control for itself and Group A.
  - Group A will look at whether changes are retained for 12 weeks after intervention.
- Benefits of this approach:
  - Allows us to still have a control group without using a “sham” intervention (educational games etc.)
  - Eliminates group differences
  - 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 and math fluency (WJII)
  - 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.

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.

Cognitive Interventions: Overall Conclusions

› Show promise for individuals with FASD

› Need to be studied to ensure effectiveness, and then implemented within a larger context of support - no quick fixes but rather part of a larger system of support
Contact Information

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For information on upcoming sessions
in the FASD Learning Series:
www.fasd-cmc.alberta.ca

Please take the time to fill out the
on-line evaluation

Thank You!