Cognitive Interventions to Improve Math Skills

Jacqueline Pei, R. Psych., PhD
Department of Educational Psychology
University of Alberta

Carmen Rasmussen, PhD
Department of Pediatrics, University of Alberta
Glenrose Rehabilitation Hospital

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The FASD Learning Series is part of the Alberta government’s commitment to programs and services for people affected by FASD and those who support them.
Co-Investigators

- Katrina Kully-Martens (Masters Student)
- Gail Andrew, Glenrose Rehabilitation Hospital
- Clair Coles, Emory University, Atlanta
- Julie Kable, Emory University, Atlanta
Session Goals

• Review math impairments in FASD
• Review the MILE program
• Review the Edmonton Mile Project
• Consider ways to apply what we know to practice
Math in FASD
Math Deficits in FASD

• Mathematics is specific difficulty for individuals with prenatal alcohol exposure (PAE) and FASD (see Rasmussen & Bisanz, 2009 for a review).

• Deficits in math are more pronounced than in other academic and cognitive areas and math is most strongly correlated with prenatal alcohol exposure.
Math Deficits in FASD

• Mathematics difficulties occur in children and adults with FASD even when IQ is controlled for (Rasmussen & Bisanz, 2009).

• Streissguth’s longitudinal research found math difficulties in children with PAE as young as age 4 which persisted through adolescence and adulthood (Streissguth et al., 1994).

• One study found that arithmetic among adults with FASD was at the 2nd grade level (Streissguth et al., 1991).
Why Do Children with FASD Have Such Difficulty with Math?

• May be related to processing speed and efficiency (Burden et al. 2005)

• Underlying brain function: white matter tracts in left parietal area (Lebel et al. 2011)

• Executive functions (Kopera-Frye et al., 1996)
Why Do Children with FASD Have Such Difficulty with Math?

- **Working memory** is highly correlated with math performance in non-exposed children (Rasmussen & Bisanz, 2005).

- Math disabilities in children are linked to impairments in working memory (McLean & Hitch, 1999).
Math Interactive Learning Experience (MILE)
Math Intervention for FASD

- Kable et al. (2007) tested children (3-10 years) with FASD in two groups:
  1. Math Interactive Learning Experience (MILE) (intervention group)
  2. Standard Psychoeducational (contrast group)
- Neurodevelopmental evaluation, Individual Education Plan
MILE Intervention (Kable et al., 2007)

- 6 weeks of individual tutoring in math and cognitive deficits that relate to math difficulties
- Slower pace of instruction to compensate for processing speed
- Used physical objects and tools (number lines) to assist with visual spatial deficits and poor working memory
- Repetition: verbal and visual spatial
- Assisted with poor graphomotor skills
MILE Intervention (Kable et al., 2007)

- All parents received parental instruction on FASD: the math intervention groups was focused on math and contrast group on standard education.

- Children were assessed on behaviour and math before and after the 6 week intervention
MILE Results

• Kable et al. (2007) found that children in math group showed more improvements in math than the contrast group

• More likely to have clinically significant gains in math (>1SD increase)
MILE Results

• 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)
The Math Interactive Learning Experience (MILE) Program

Claire D. Coles, PhD
Emory University School of Medicine
Is it just a problem for math skills?

- Not really just math skills
- Math is a marker of underlying “core deficits” that interfere with learning in this area.
- Core deficits impact motor skills, arousal regulation, visual/spatial skills and learning.
- Teaching methods can address these problems
Goals of the Mile Program

• To support, educate and empower caregivers

• To achieve learning readiness (Behavior/arousal regulation)

• To Improve mathematical achievement in a known area of deficit often noted in children affected by prenatal alcohol exposure
Target Population: Validated by Research Evidence

- Children between the ages of 3–10 years of age
- Have been with one caregiver for 6–months and projected to remain with that caregiver for the next 6–months
- Evidence of alcohol-related dysmorphia (Dx of FAS/pFAS)
- No evidence of other major diagnoses (i.e., PDD)
Math Intervention

- Kable et al. (2007) assigned children (3-10 years) with FASD to two groups:
  - Math Intervention Group
  - Standard Psychoeducational (contrast group)
- 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 behaviour and math before and after the 6 week intervention
Parent Education

Empowering caregivers with knowledge and creating “Partners” in Treatment of Children
Goals of the Mile program: Parents

1. To support, educate and empower caregivers

2. To achieve learning readiness (Behavior/arousal regulation)
Workshop I: Understanding FASD & Advocating for Children

Parent training program completed by all caregivers (and others) as part of our “readiness to learn” program.
Workshop II: Behavioral regulation training

Incorporates recognized behavioral management principles into the context of the neurodevelopmental damage associated with prenatal alcohol exposure to treat deficits that interfere with learning and self-regulation.
Parents reported significantly fewer problem behaviors at post testing 1 and 2:

Post 1: Internalizing Problem Behavior (F(1,50)=8.1, p < .006); Externalizing Problem Behavior (F(1,50)=21.9, p < .000); Total Problem Behavior (F(1,50)=15.4, p < .000)

Post 2: Internalizing Problem Behavior (F(1,45)=11.4, p < .002); Externalizing Problem Behavior (F(1,45)=35.9, p < .000); Total Problem Behavior (F(1,45)=28.9, p < .000)

(Kable, Coles, & Taddeo, 2007; Coles, Kable, & Taddeo, 2009)
Conclusions: parent education

- The workshops were well received and the majority of participants reported them to be useful.
- Caregivers reported increased knowledge of FAS, Advocacy, and Behavioral Regulation Methods.
- Parents and Teachers reported improvements in children’s behavior.
Goals of the mile program: intervention with children

- To improve mathematics achievement known to be specifically affected in FASD.

- To improve effortful control of behavior (executive functioning) in alcohol-affected children, 3 to 10 years.
Components of the math intervention

- Caregiver training
  - Manual regarding math development and FAS
  - Individual discussion regarding implementation of home math stimulation activities

- Child tutoring
  - 6 week IEP developed using curriculum
  - 6 week 1 on 1 tutoring sessions

- Teacher training
  - Manual regarding FAS
  - Discussion regarding child’s neurodevelopmental profile
  - Discussion regarding our 6-week IEP
Elements of the mile program

- Parent Education
- MILE Instruction for Children
- Training for Instructors
- Train the Trainer curriculum
Parents as partners

- Taught parents about math development
- Gave FunWork to maintain exposure to the weekly lesson
- Encouraged parents to observe
- Encouraged parents to provide math enrichment activities
Math intervention

- Children in the Math Intervention Group received:
  - 6 weeks of 1:1 individualized tutoring
  - Parent training and weekly coordinated activities to do at home to support learning
  - Presentations to children’s teachers on FASD
  - Special educator consultations
Appropriate lesson plan selected from electronic database.
The MILE Program: Key Facets

- Remediate underlying cognitive factors
  - **General learning ability**
    - Slower pace of instruction
    - Active learning
    - Touch, talk, experiment
  - **Working memory**
    - Small pieces of info
    - Rhymes/songs
    - Cues
    - Repetition/practice
    - Time for recall
  - **Visual-spatial skills**
    - Tactile objects/manipulatives
    - Guide visual attention
    - Add structure to paper
    - Vertical number line
The MILE Program: Key Facets

Pre-test: Age 6 yrs

After 6 Weeks of Tutoring

- **Visuomotor/Graphomotor Skills**
  - E.g., Handwriting Without Tears
- **Metacognition**
  - “Great answer, how did you do that?”
  - “What strategy did you use?”
  - “What do you think you need to do here?”
FAR

FAR is a metacognitive strategy that supports increased self-regulation and reflection. It is incorporated into all of the MILE learning activities.
After controlling for age of the child, there was a significant treatment effect at both immediately (F(1,52)=4.0, p < .05) and at 6-month follow-up (F(1,52)=4.8, p < .03) on number of gains. (Kable, Coles, & Taddeo, 2007; Coles, Kable, & Taddeo, 20009)
conclusions

Children with FASD can improve in learning readiness, behavior, and math with interventions that include:

PARENT EDUCATION:
• On the neurodevelopmental deficits associated with FASD—particularly, impact on arousal regulation, behavior, and learning.
• On Behavior Management and social learning principals.

INDIVIDUALIZED INTERVENTION PLANS:
• Scaffolded according to the children’s learning needs.
• Integration of strategies with school and family.

INSTRUCTION:
• Supporting growth in areas associated with the effects from prenatal alcohol exposure
• That incorporates metacognitive strategies, ways to integrate information, and frequent review and repetition
Edmonton MILE Project
Edmonton MILE Project

- We received a grant from ACCFCR to study the MILE program (replication and extension).
- In collaboration with Claire Coles and Julie Kable (Atlanta, GA), who developed the MILE program.
- Conducted with Glenrose Hospital FASD clinic and local school boards.
Remaining Questions

• Can MILE be successfully conducted in a school or home setting?
• Is MILE effective \textit{without significant parental involvement}?
• Does MILE improve other cognitive areas beyond math?
Edmonton MILE Project

Some key changes:

• Comparison group will receive social skills intervention
• Different pre and post measures: wide variety of math skills and other cognitive areas
• Intervention conducted in the school or home
• No parent component
• Sample aged 5-10, different demographics
Research Questions

• Do children with FASD or PAE in the MILE intervention program improve in mathematics compared to children with FASD or PAE in a social skills intervention?

• Does the MILE intervention also improve other cognitive skills like working memory and visual-spatial abilities?

• Are improvements (in both mathematics and behavior) maintained 6 months after the intervention?
<table>
<thead>
<tr>
<th></th>
<th>Kable et al. (2007)</th>
<th>Edmonton Study</th>
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</thead>
<tbody>
<tr>
<td><strong>Length of intervention</strong></td>
<td>6 one hour sessions over 6 weeks</td>
<td>10 half hour sessions over 6-8 weeks (~2 per week)</td>
</tr>
<tr>
<td><strong>Location</strong></td>
<td>Laboratory</td>
<td>School/Home</td>
</tr>
<tr>
<td><strong>Parental Involvement</strong></td>
<td>Extensive</td>
<td>None</td>
</tr>
<tr>
<td><strong>Control Group</strong></td>
<td>Sham intervention</td>
<td>Social skills intervention</td>
</tr>
<tr>
<td><strong>Outcome Measures</strong></td>
<td>Math achievement, behavior</td>
<td>Math achievement, behavior, social skills, working memory, visual-spatial processing, executive function</td>
</tr>
<tr>
<td><strong>Sample</strong></td>
<td>American Ages 3-10 FASD Clinically-referred</td>
<td>Canadian Ages 4-10 FASD and PAE Clinically and community referred</td>
</tr>
</tbody>
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## Participants

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Math (n = 11)</th>
<th>SS (n = 6)</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age (range)</td>
<td>7.6 (4 – 10)</td>
<td>7.5 (6 – 9)</td>
<td>0.90</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>(n.s.)</td>
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<tr>
<td>Diagnosis (% FASD)</td>
<td>45.5%</td>
<td>33.3%</td>
<td>0.63</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(n.s.)</td>
</tr>
<tr>
<td>Mean IQ (range)</td>
<td>87.8 (69 – 109)</td>
<td>101.2 (66 – 122)</td>
<td>0.16</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(n.s.)</td>
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<tr>
<td>Gender (% male)</td>
<td>45.5%</td>
<td>50.0%</td>
<td>0.86</td>
</tr>
<tr>
<td></td>
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<td>(n.s.)</td>
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Method

• 3 interventionists trained on MILE by Dr. Julie Kable and Dr. Elles Taddeo in Atlanta, GA (January, 2011).

• Assigned to MILE or Social skills group
• 10 sessions
  • 30 minutes each, ~ 2x per week
  • 5-7 weeks for total intervention
  • School (during school hours) or at home (day-time)
Difference in Total Raw Score Points (KeyMath 3) From Pre- to Post-Test

![Bar chart showing difference scores for Math and Social Skills intervention groups. Math intervention group has a much higher difference score compared to the Social Skills group.]
Difference in Total Raw Score Points (KeyMath3 Subtests) From Pre- to Post-Test
Conclusions

• Math difficulties in children with FASD/PAE can be improved with a targeted intervention
  • Individualized
  • Little parental involvement
  • Short-term
  • Conducted in school or home
Further Questions

• Are these improvements in math maintain at 6month follow up?
• Do these improvements transfer to other domains like visual-spatial abilities, working memory etc?
• What about the social skills intervention?
Questions?
Presenter Contact Information

jacqueline.pei@ualberta.ca

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

Please take the time to fill out the online evaluation

Thank you!
References


