Thinking about future intervention for low math achievers

Ideas, discussion, and feedback
At what level should interventions be targeted?

**Number Sense**
- What specific skill should be targeted – non-symbolic skills, number-line estimation?
- Opportunities for cheap and engaging enrichment opportunities?
- May help to develop arithmetic fluency

**Math Fluency**
- Early arithmetic fluency important for continued development of math skills
- Better arithmetic fluency may limit requirements for Working Memory.

**Working Memory**
- Specifically numerical?
- Transfer from abstract to real-word context?
- What math and general learning outcomes should be measured?
• Adaptive WM training led to significant gains in math achievement as assessed at 6 month post intervention.

• There are many studies in which these results have not been replicated (including our study of low working memory LSM children in Singapore!)

*Figure 1 Impact of training on working memory.*

*Holmes et al (2009)*
Thoughts about future WM intervention

• Timing of the intervention when relationship between math and WM at peak.
• Dosage?
• Domain-specific versus domain-general training
• Outcome measures assessed:
  – Math: Accuracy, fluency, strategy use, reasoning?
  – General: Learning related behaviours, other academic abilities?
• Will benefits only be observed further down the line?
• Transfer of skills from abstract WM task to classroom context
  – Training the transfer
Child gets multiple representations of number: non-symbolic, Arabic digit, auditory number word
2

5 - 1
The Number Race

- **Enhance number sense**
  - intensive number comparison (e.g. largest of 3, 9?)
  - speed deadline
  - link between number and space

- **Cement non-symbolic symbolic links**
  - repeated association of non-symbolic & symbolic numbers
  - encourage increasing reliance on symbols

- **Conceptualise and automatise arithmetic**
  - concrete representations of operations
  - speed deadline

- **Maximize motivation**
  - positive reinforcement
  - difficulty adaptation
  - entertaining format (game!)
**The Great Number-Line Race!**

Date: ____________  Start Time: __ : ____  End Time: __ : ____

Directions: Mark the winner for each game with an 'X' in the table below.

<table>
<thead>
<tr>
<th>Players</th>
<th>Game 1</th>
<th>Game 2</th>
<th>Game 3</th>
<th>Game 4</th>
<th>Game 5</th>
<th>Game 6</th>
<th>Game 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Siegler, R. S. (2009). Improving the numerical understanding of children from low-income families. *Child Development Perspectives, 3*(2), 1
Number-line interventions

- Children with more linear representations of number show better memory for numbers, better arithmetic proficiency, mathematics achievement-test scores, and mathematics course grades.

Figure 2  Mean percent variance in individual children’s pretest and posttest estimates accounted for by the linear function.

Lots of relevant papers can be downloaded from Robert Siegler’s website.
Number-line interventions (adaptive). Kucian et al (2011)

Train at home 15 mins a day, 5 days a week for 5 weeks. A timer controls the daily training time, which is always visible during the game.
Number-line training (Kucian et al, 2011)

Both groups showed a reduction in recruitment of relevant brain regions after the training, including frontal areas, bilateral intraparietal sulci, and left fusiform gyrus. Previous neuroimaging studies which examined learning processes in arithmetic have reported a similar decrease in the fronto-parietal activation pattern after training.

Reduction of brain activation in these regions argued to reflect automatization of cognitive processes necessary for mathematical reasoning. Therefore, it seems that after completion of the training, the task puts less demand on quantity processing, executive functions, working memory, and requires less attentional effort.

Stronger decrease in recruitment of these regions in children with dyscalculia, which is consistent with the more pronounced improvement of behavioral outcome in these children.
Creating opportunities for incidental exposure to number

• Creating opportunities to learn that are cheap – engagement of parents to encourage child’s incidental learning through everyday activities.

  – No Child Left Behind (US) – activity booklets for parents: Mathematics in the Home, Mathematics at the Grocery Store, Mathematics on the Go and Mathematics for the Fun of It.

  – Maju Minda Matematika (Tiga M): to assist parents develop the knowledge and skills to help their children develop competency towards the learning of Mathematics (Malay-Muslim low income families).

  – Objectives: Increase parents’ knowledge and understanding of the development of basic numeracy concepts; Boost the confidence level of the parents and improve their skills in engaging children in home-based activities; Empower parents in creating a home environment that is conducive to the development of children’s mathematical skills.
Your thoughts and feedback??