Executive Functions and Number Sense as Predictors of Math Learning Disabilities

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Executive Functions (EF)

• Definition

• Novel situations

• Structure:
  (1) shifting
  (2) inhibition
  (3) working memory
EF: Shifting

Animal Shifting
Yellow: name the fruit
Purple: name the animal
EF and Math

Executive Functions

Shifting
- Switch between sets, tasks, or strategies.
EF: inhibition

Simon Task

If you see a mouse: tap with your left hand

If you see a dragon: tap with your right hand
EF and Math

Executive Functions

Shifting
- Switch between sets, tasks, or strategies.

Inhibition
- suppress dominant responses in favor of more goal-appropriate ones.

In math
Alternation between steps, sub-solutions and strategies
Inhibit old, predominant strategies and task-irrelevant information
EF: Working Memory

Digit Span Backwards

9 2 6 1 4
EF and Math

Executive Functions

Shifting
- Switch between sets, tasks, or strategies.

Inhibition
- suppress dominant responses in favor of more goal-appropriate ones.

Working Memory
- store information and revise this in the light of new information.
Previous studies

• Relationship EF and Math:
  
  Shifting (e.g., Bull, Espy, & Wiebe, 2008)
  
  Inhibition (e.g., St. Clair-Thompson & Gathercole, 2006)
  
  Working Memory (e.g., the review of Raghubar, Barnes & Hecht, 2010)

• EF and Math are developing; longitudinal studies are scarce.

• Number sense is strong predictor of math difficulties.
  (e.g., Jordan, Glutting, & Ramineni, 2010)
Number Sense: an example

“Take a look at these pictures. Point all the pictures that are not the same as five.”
"Here you see a vase with eight flowers. Point all the vases which also contain eight flowers."
Aims

1. EF can **identify** children with later persistent mathematical difficulties.

2. The predictive value of EF **adds** to the predictive value of number sense.
Method (I)

N = 209  (108 boys and 101 girls)
Method (II)

Classification:
- **Persistent Very Low (PVL)**
- **Persistent Below Average (PBA)**
- **Typically Achieving group (TA)**

Criteria:
- $4x < 25\%$
- $4x < 50\%$
- Remaining

**difficulties**
- **PVL:** 10\%
- **PBA:** 22\%
- **TA:** 68\%

**at risk**

**special attention**
Statistics

1. Repeated measures ANOVAs
2. Discriminant analyses
Repeated measures ANOVAs: shifting

Animal Shifting

- PVL
- PBA
- TA

Mean difference score (sec)

B1, M1, B2
Repeated measures ANOVAs: inhibition

![Graph showing mean difference score (sec) for Simon Task across B1, M1, and B2 for PVL, PBA, and TA conditions.]

- PVL
- PBA
- TA

Mean difference score (sec)

B1 | M1 | B2

PVL

PBA

TA
Repeated measures ANOVAs: working memory

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- PVL
- PBA
- TA

Mean total

B1 M1 B2
Repeated measures ANOVAs: conclusion

- Significant development in one shifting task and all WM tasks.
- Shifting and Inhibition: no group differences
- Working Memory: group differences between three groups on all tasks.

The three groups only differ in their performance on working memory tasks.
## Discriminant Analyses: WM

<table>
<thead>
<tr>
<th></th>
<th>WM</th>
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<tbody>
<tr>
<td><strong>PVL</strong></td>
<td>57.1</td>
</tr>
<tr>
<td>PVL as PBA</td>
<td>28.6</td>
</tr>
<tr>
<td><strong>PBA</strong></td>
<td>28.9</td>
</tr>
<tr>
<td><strong>TA</strong></td>
<td>50.3</td>
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## Discriminant Analyses: NS

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## Discriminant Analyses: WM and NS

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<td><strong>PBA</strong></td>
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<td>26.7</td>
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# Discriminant Analyses: WM and NS

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Discriminant Analyses: conclusion

**PVL as PVL**
- WM and NS comparable
- WM and NS together the best

**PVL as PVL or as PBA**
- NS best predictor
- WM adds value to this prediction
Discussion

- Using NS and WM ability in screening children at risk for math learning difficulties
- Stimulating both NS and WM ability → further research
Questions?

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