## Training of basic arithmetic competencies (MARKO-T) for 5- to 8-year-old children

Katleen Sahr, Dominique Arndt, Maria Opfermann, Annemarie Fritz, Detlev Leutner

University of Duisburg-Essen, Germany

### Design

<table>
<thead>
<tr>
<th>Year</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>T1 Screening</td>
<td>T2 Pre-test</td>
<td>T3 Post-test</td>
</tr>
<tr>
<td>Time</td>
<td>October/November</td>
<td>December</td>
<td>January</td>
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- **T1**: Screening
- **T2**: Sample of training & longitudinal groups
- **T3**: Training process
- **T4**: Follow-up
- **T5**: Follow-up2
Screening

2008
October/November

T1 Screening

2009
December

T2 Pre-test

January

T3 Post-test

February/March

T4 Follow-up

April

T5 Follow-up2

October

2010

June

- Screening-test
- Coloured Progressive Matrices (version A & B)¹

Random sample:
N=1298 children from kindergarten, grade 1 & 2
Ø age 80.3 months (SD = 14.0)


Sample of training groups

2008
October/November

T1 Screening

2009
December

T2 Pre-test

January

T3 Post-test

February/March

T4 Follow-up

April

T5 Follow-up2

October

2010

June

N=204 children
Ø age 81.8 months (SD = 16.3)

<table>
<thead>
<tr>
<th>Age-based development</th>
<th>Intelligence (percentile rank)</th>
<th>Mathematical ability (percentile rank)</th>
<th>Age in months M (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>normal (N=57)</td>
<td>20 &lt; I &lt; 80</td>
<td>20 &lt; MA &lt; 80</td>
<td>65.18 (11.9)</td>
</tr>
<tr>
<td>math problem (N=77)</td>
<td>20 &lt; I &lt; 80</td>
<td>MA &lt; 20</td>
<td>85.84 (12.1)</td>
</tr>
<tr>
<td>learning problem (N=70)</td>
<td>I &lt; 20</td>
<td>MA &lt; 20</td>
<td>90.77 (13.1)</td>
</tr>
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### Screening

- **Math-Problem Type**
  - Math or IQ high
  - Normal
  - Math Problem
  - Learning Problem
  - Line for Total

- **Levels**
  - Level V
  - Level IV
  - Level III
  - Level II
  - Level I

- **R Sq Linear** = 0.411

### Pre-test

<table>
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<tr>
<th>Year</th>
<th>Month/Season</th>
<th>T1</th>
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<th>T3</th>
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- **Tests**
  - Mathematical Test MARKO-D
  - Culture Fair Test

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1. Math-training (MARKO-T) in individual settings
2. Working memory-training in group settings, computer-based
3. Social-training in group settings
4. Control group without any training

- up to 20 sessions
- each session lasted about 45 min
**Training (MARKO-T)**

**interactive role-play:**
- dung beetle named Karl

**constant structure:**
- instruction, problem solving, strategies, reflection…

**learning environment:**
- daily life problem context
- different materials
- rituals

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**Training (MARKO-T)**

**adaptivity:**
- short testing of knowledge acquired in prior session
- diagnostic windows

→ intensive-repetitive / normal /shortened performance
Training (MARKO-T)

Tasks Level 1

Trainer counts aloud and says the number words by pointing at each bowl

Karl counts slowly by simultaneously pointing at each bowl, but he makes a mistake

The child evaluates Karl’s counting procedure and counts him/herself

Instruction:
How many bowls do you have?

Instruction:
How many bowls do you have?
Training (MARKO-T)

**Tasks Level 1**

Instruction:
What do you think; where are more bowls?
Check it!

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**Design**

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- Mathematical Test MARKO-D
- Culture Fair Test¹

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Results Post-Test

Figure 1: Changes in mathematical ability from pre- to posttest: Differences between training groups

\[ F(3,176) = 17.63; \ p < .001; \ \text{part. } \eta^2 = .23 \]

Results Follow-Up

Figure 3: Changes in mathematical ability from pre- to follow-up-test: Differences between training groups

\[ F(3,139) = 2.85; \ p = .04; \ \text{part. } \eta^2 = .058 \]
Results TEDI-MATH

TEDI-MATH: Test of mathematical abilities oriented at the content of the German curriculum from kindergarten to grade 3 → near transfer

Figure 5: Changes in mathematical ability (TEDI-MATH) from pre- to follow-up-test: Differences between training groups

Thank you for your attention!