Visuo-spatial abilities are key for children’s verbal number skills

Véronique CORNU1, Romain MARTIN2 & Caroline HORNUNG1
1Luxembourg Centre for Educational Testing (LUCET), University of Luxembourg, Esch-Belval (Luxembourg)
2University of Luxembourg, Esch-Belval (Luxembourg)
Contact: veronique.cornu@uni.lu

Theoretical background
- The acquisition of number words and their meaningful use (verbal number skills) represents a milestone in early mathematical development taking place in the preschool years (1)
- Different research studies highlight the importance of verbal abilities (VA; e.g. 2,3,4) and/or visuo-spatial abilities (VSA; 5,6,7) for mathematical development
- Understanding the role of verbal and/or visuo-spatial abilities for the development of verbal number skills is important with regard to effective practices in early childhood education and intervention

Method
Sample: N = 151 kindergarten children (80 boys), Age ‚Äì mean = 5.9 years (age range: 4 to 6 years)

Different measures of VA, VSA and verbal number skills were administered (all tasks yielded acceptable to good internal consistencies). Verbal abilities and VSA are both broad concepts including a variety of different tasks and facets. In the present study, we focused on different aspects that have been related to mathematics in prior research and considered them concurrently.

Internal structure of the variable “verbal number skills” is confirmed by exploratory factor analysis yielding a 1-factor solution

Results
Model 1 – VA only
Expressive vocabulary
Phonological awareness
Phonological loop
Verbal number skills

Model 2 – VSA only
Spatial perception
Design copy
Figure copy
Spatial reasoning
Spatial attention
Visuo-spatial sketchpad
Verbal number skills

Model 3 – VA and VSA*
Spatial perception
Design copy
Figure copy
Spatial reasoning
Spatial attention
Visuo-spatial sketchpad
Expressive vocabulary
Phonological awareness
Phonological loop
Verbal number skills

Prediction of verbal number skills

<table>
<thead>
<tr>
<th>Model</th>
<th>Expressive vocabulary</th>
<th>Phonological awareness</th>
<th>Phonological loop</th>
<th>Verbal number skills</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.31 (.07)</td>
<td>0.22 (.08)</td>
<td>0.13 (.07)</td>
<td>0.15 (.09)</td>
</tr>
<tr>
<td>2</td>
<td>0.24 (.09)</td>
<td></td>
<td>0.26 (.07)</td>
<td>0.09 (.08)</td>
</tr>
<tr>
<td>3</td>
<td>0.19 (.09)</td>
<td>0.19 (.09)</td>
<td>0.09 (.08)</td>
<td>0.09 (.09)</td>
</tr>
</tbody>
</table>

R² = .22 ** (.06)

R² = .37 ** (.08)

R² = .40 ** (.07)

Discussion
- The concurrent consideration of different measures, within the broad concepts of VA and VSA allowed us to gain information about the relative importance of these different measures
- Importance of VSA for early math tasks that appear, at first sight, to be primarily verbal in nature
- VSA important for novel math tasks (e.g. 7,8) → VSA especially important in the preschool years
- VSA as potential target of interventions to provide children with a good foundation for math learning
- Longitudinal study required to investigate the predictive role of the different measures for mathematical achievement in 1st grade

Conclusion
Importance of VSA also for number skills with a strong verbal component in young children

Research question
What is the nature of verbal number skills? Are they primarily verbal, or do they call upon other math-related processes, such as visuo-spatial abilities?

Visuo-spatial abilities
- Spatial perception (orientation discrimination)
- Design copy
- Figure copy
- Spatial sketchpad
- Spatial reasoning
- Spatial attention

Verbal number skills
- Expressive vocabulary
- Phonological awareness
- Phonological loop

Note: Regressions computed with Mplus using FIML and MLR
* Similar pattern of results when controlling for age and socioeconomic status

References: