Cognitive and Educational Foundations of Preschool Maths: (Not) as easy as 1, 2, 3

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The Nuffield Foundation Maths Showcase
How do young children learn about maths?

Busy classrooms, different attentional states, educator’s guidance
‘Cognitive and Educational Foundations of Preschool Maths: (Not) as easy as 1, 2, 3’

- Non-Verbal IQ (BAS-3)
- Receptive Language (BPVS-2)
- Number Knowledge (Domain Specific)
- Cardinality
- Symbolic Number System
- Counting
- Executive Function (Domain General)
- Inhibition
- Shifting
- Attention

Home Environment
Language Questionnaire
Parent Questionnaire
Funder “recommended” collaboration!

Maths Language
Educational Environment
Practitioner Viewpoint
ECERS-E

Key Worker report of School Readiness (BESSI)
Key Worker report of EF (BRIEF-P)
Participants

Cross-sectional sample (N = 231 children, their preschool practitioners and parents) to study age-related differences.

Children with EAL included (N = 55)

Longitudinal sample:

170 preschool children (3-4 years old; range: 39 – 55 months) from 13 (12) preschool settings, tested twice, 5 months apart, both times in preschool settings.

22 children with EAL included

Mean SES deprivation decile = 7.62 (range: 2 -10; 10 being the least deprived).
Part I – Early number skills:
Child-level differences

How can we measure early number skills?

1. Cardinal knowledge: Give a Number (Give-N) task

2. Counting: Counting amounts
Part I – Early number skills:
Child-level differences

3. Counting High (up to 100)

4. Naming Numbers

Symbolic number identification

e.g. | 2 | 7 | 1 | 8 | 3 | etc.

5. Magnitude Comparison

Approximate Number Sense

“Who has more?”
Part I – Early number skills: Child-level differences

Early maths skills not unitary!

Best fitting models involve separate:
- Symbolic maths
- Non-symbolic maths
  (separate EFA analysis for clarifications)

Coolen, Merkley et al. (in prep)
Co-developed observations and mixed methods:

1. Advisory Panel – Make best links with educators

2. Teacher talk – Observations of Maths Language Breadth (Braham & Libertus, 2016)

3. ‘Lunch and Learn’ – With educators and researchers – semi-structured interviews

4. Structured observation – Adapted ECERS-E (Sylva, Siraj-Blatchford, & Taggart, 2010)

Overall, performance on cardinality (Give N), Counting High and Number Naming tasks were all higher for children from settings with higher Observed Maths Language Breadth scores.

Von Spreckelsen, Dove, Mills, Coolen et al. (under review)
Part III: Beyond maths skills alone...
Interplay with Executive Skills

How do we measure them in preschool?

1. Go/No-go Task
Inhibition

2. Mr. Ant.
Visuo-Spatial short-term Memory
Part III: Beyond maths skills alone...
Interplay with Executive Skills

3. Animal Stroop
Shifting Attention to Relevant Dimension

4. Cancellation
Selective Attention

Baseline verbal IQ (BPVS) and non-verbal IQ (BAS – Picture simil)
Part III: Beyond maths skills alone…
Interplay with Executive Skills

Domain-specific measures split:
Symbolic maths
Non-symbolic maths

Coolen, Merkley et al. (in prep)
Part III: Beyond maths skills alone...
Interplay with Executive Skills

1. Executive skills predict symbolic maths.
   
   Executive Functions T1 → Symbolic maths T2
   \[ \text{coef} = .697^{***} \]

2. Executive skills predict growth in symbolic maths.
   
   Executive Functions T1 → Symbolic maths T2
   \[ \text{coef} = .233^* \]
   Symbolic maths T1 → Executive Functions T2
   \[ \text{coef} = .513^{***} \]

3. Symbolic maths predict executive skills.
   
   Symbolic maths T1 → Executive Functions T2
   \[ \text{coef} = .537^{***} \]

4. Symbolic maths does not predict growth in executive skills.
   
   Symbolic maths T1 → Executive Functions T2
   \[ \text{coef} = .090 \]
   Executive Functions T1 → Executive Functions T2
   \[ \text{coef} = .641^{***} \]

*Coolen, Merkley et al. (in prep)*
In conclusion thus far: Not as easy as 1, 2, 3...

1. Non-symbolic and symbolic skills separate even in preschool and preschool practitioners flagged need for / interest in training in broader early maths activities.

2. Domain-general skills are strong predictors of symbolic maths and of growth in maths in preschool (converging with many: e.g., Bull et al., 2008)

3. The relation between domain-general and domain-specific skills is bidirectional, not unidirectional! (see also Fuhs et al., 2014 in the US)

Immediate future steps:

1. Work with practitioners (see Megan von Spreckelsen)

2. Further longitudinal follow-up (see Annelot Mills!)

Recommendations

1. Both general and maths-specific skills need to be considered together in preschool children (→ Policy discussion?).

2. Training for early year practitioners could be adjusted to provide the means to identify strengths / weaknesses in domain-general skills as well as maths-specific skills for their key children (→ Practitioners’ input?).

3. New ways of incorporating domain-general skills in maths learning activities, not training the executive or maths in isolation (see Vicky Simms!)

...injecting executive challenge in everyday maths activities...
Future of Early Maths Research Funding?

What should future early maths research look like?

• Collaborative! Leverage data sharing!

• Work in partnership with practitioners and policy makers

• Capture diversity (SES, parental influences, EAL)

• Understand good practice: What are the cognitive ingredients of success for excellent teaching practices?

• Interventions co-developed by cognitive scientists and practitioners, with a view to scaling up (with parents / practitioners?)
Thank you and...

Thanks to all participating nurseries, schools, practitioners, parents and children!

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