

Perceptual and cognitive contributions to early mathematical learning

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- Complex skills depend on various building blocks
- o present from birth
- o gained from experience and interaction with world

Can I benefit from teaching? How will I benefit from teaching?

Prior knowledge – using it optimally while teaching?

Spelke, 2000; Butterworth, 1999; Dehaene & Spelke, 2004; Xu, Spelke & Goddard, 2005; Aunola, Leskinen, Lerkkanen & Numi, 2004

A framework for understanding the building blocks

- o Biological level
 - Brain areas Neurological pathways Plasticity
- o Cognitive level
 - Numerosity Approximate number system Conceptual development Working memory Fluid intelligence
- Operational level

Mathematical and arithmetic procedures and operations



Rubinstein & Hennik, 2009

Cognitive level

Numerosity Approximate number system Conceptual development Working memory Fluid intelligence

Numerosity & dyscalculia

- o causes of dyscalculia
- o 3 to 7% of children
- Some studies indicate up to 10%

Benefits of knowing whether a child is dyscalculic or has difficulties with number skills or difficulties with mathematics?



Butterworth, 2005; Dehaene, 2007; Gillum, 2012; Fritz, Ehlert & Balzer, 2013; Arsic, Eminovic & Stankovic, 2011

Fluid intelligence

Think logically and solve problems in novel situations

- Patterns and relationships
- Correlate with quantitative reasoning
- Has a genetic base, but cognitive exercise can result in improvements

Does this relate to teaching in the early grades?



Cattell, 1971; Qiu, Wei, Qinqin, Liying & Lin, 2009





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Still not convinced?

Testing almost 1000 grade 1 learners at end of grade 1 year

- between 1 and 5% reverse/rotate numerals
- o between 1 and 5 reverse digits in two-digit numbers
- o almost 10% confuses before and after
- o 5% of learners confuses less and more

The % reversals and rotations pretty much the same for grade 2 and 3 learners



Working memory

Multi-component storage and processing unit

- phonological loop verbal and auditory information, allow understanding of verbal instructions
- visuospatial sketchpad visual and spatial information, shape and location, visual imagery
- central executive attentional control system, allow focus of and swifting of attention, evaluation of pieces of information

Most important domain-general predictor of mathematical achievement

Baddeley & Hitch, 1974; Baddeley, 2007; Friso-van den Bos, Kroesenbergen & Van Luit; 2014

What about perceptual building blocks?

Research not clear

Correlation between visual perceptual, motor and visual-motor integration and achievement in mathematics

What is certain?



Policy implications

Looking at finer categories of learners struggling

Going back to the real basic building blocks

Making the perceptual and conceptual blocking blocks explicit

Teacher training – remedial teachers and educational psychologists or all teachers?



