Future Schools in 2030

The Developmental Dynamics of Cognition, Mathematics, Motivation and Well-being

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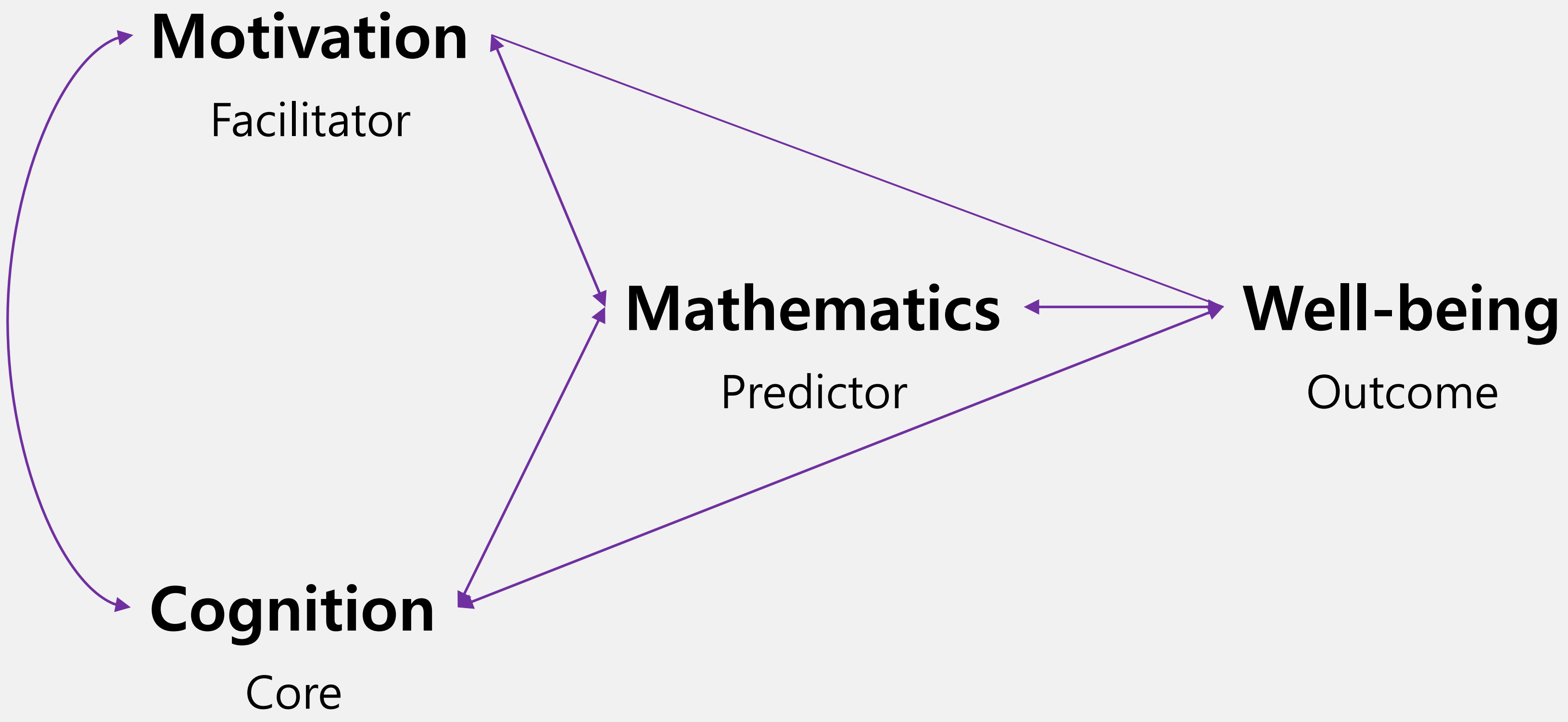
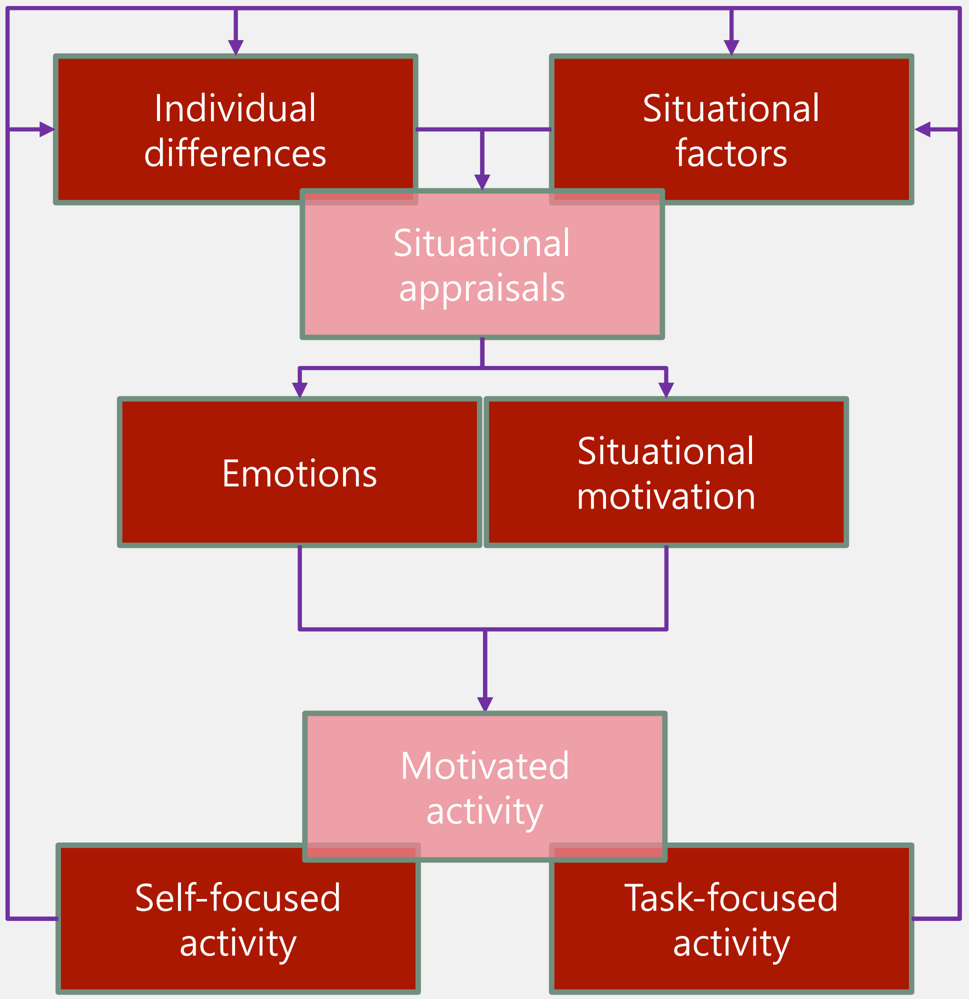
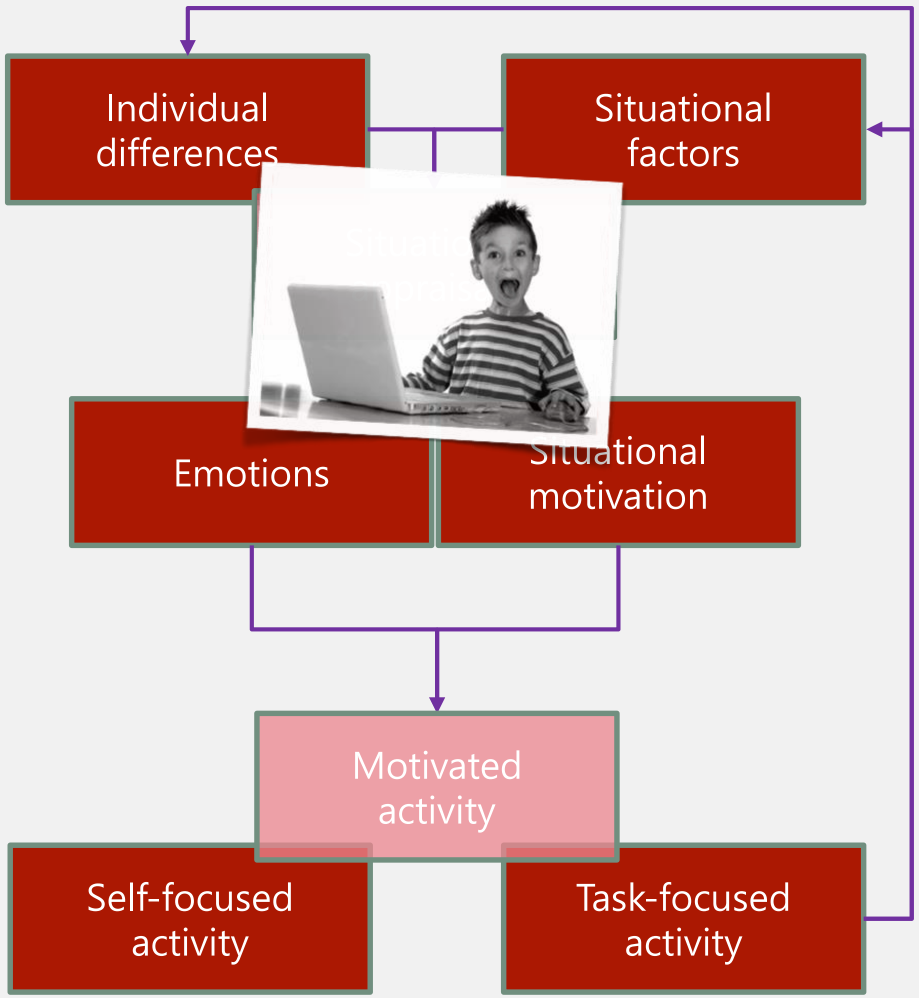
Beijing Advanced Innovation Center for Future Education

The aim of this research project

The Developmental Dynamics in Cognition, Mathematics, Motivation and Well-being




Individual differences
Situational factors
Situational appraisals
Emotions
Situational motivation
Motivated activity
Self-focused activity
Task-focused activity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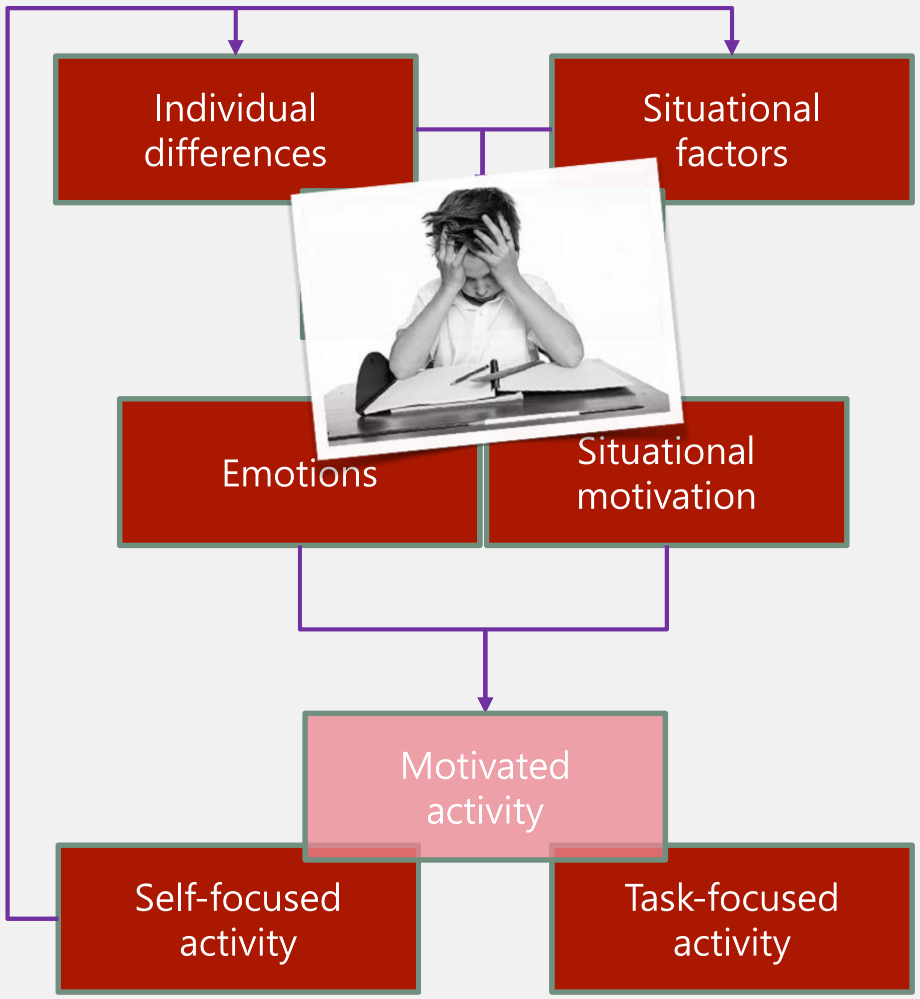
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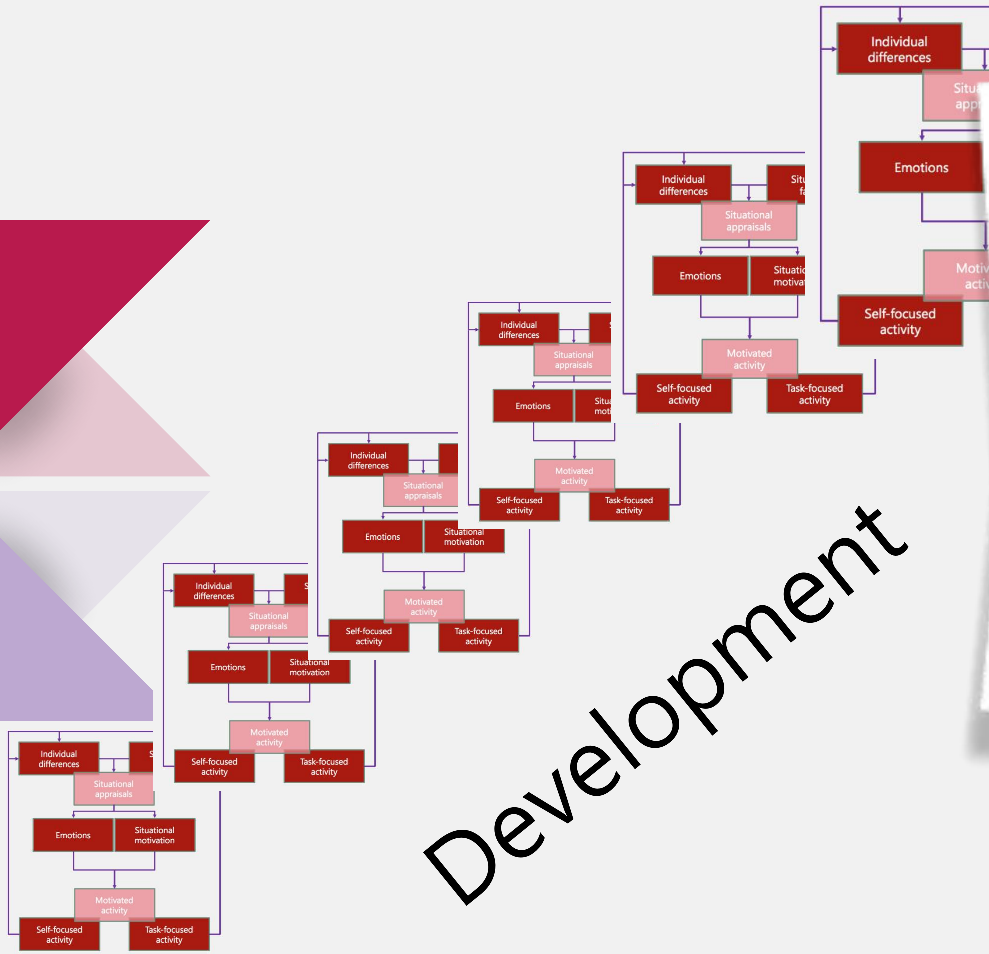
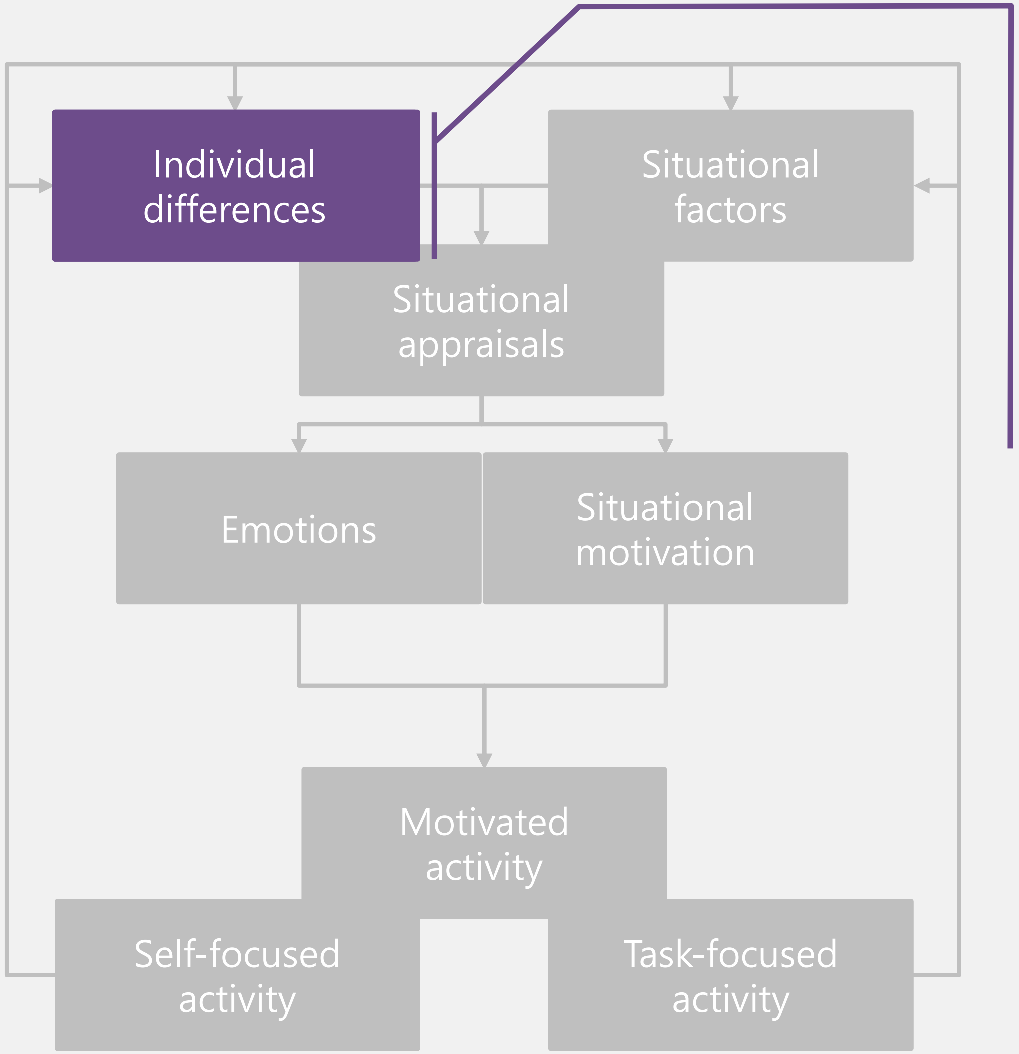


Development



Development

Educational setting

Cultural context

Goal of the project

To examine the developmental dynamics in cognition, mathematical skills, motivational tendencies, and well-being within two different educational settings

Points of interest

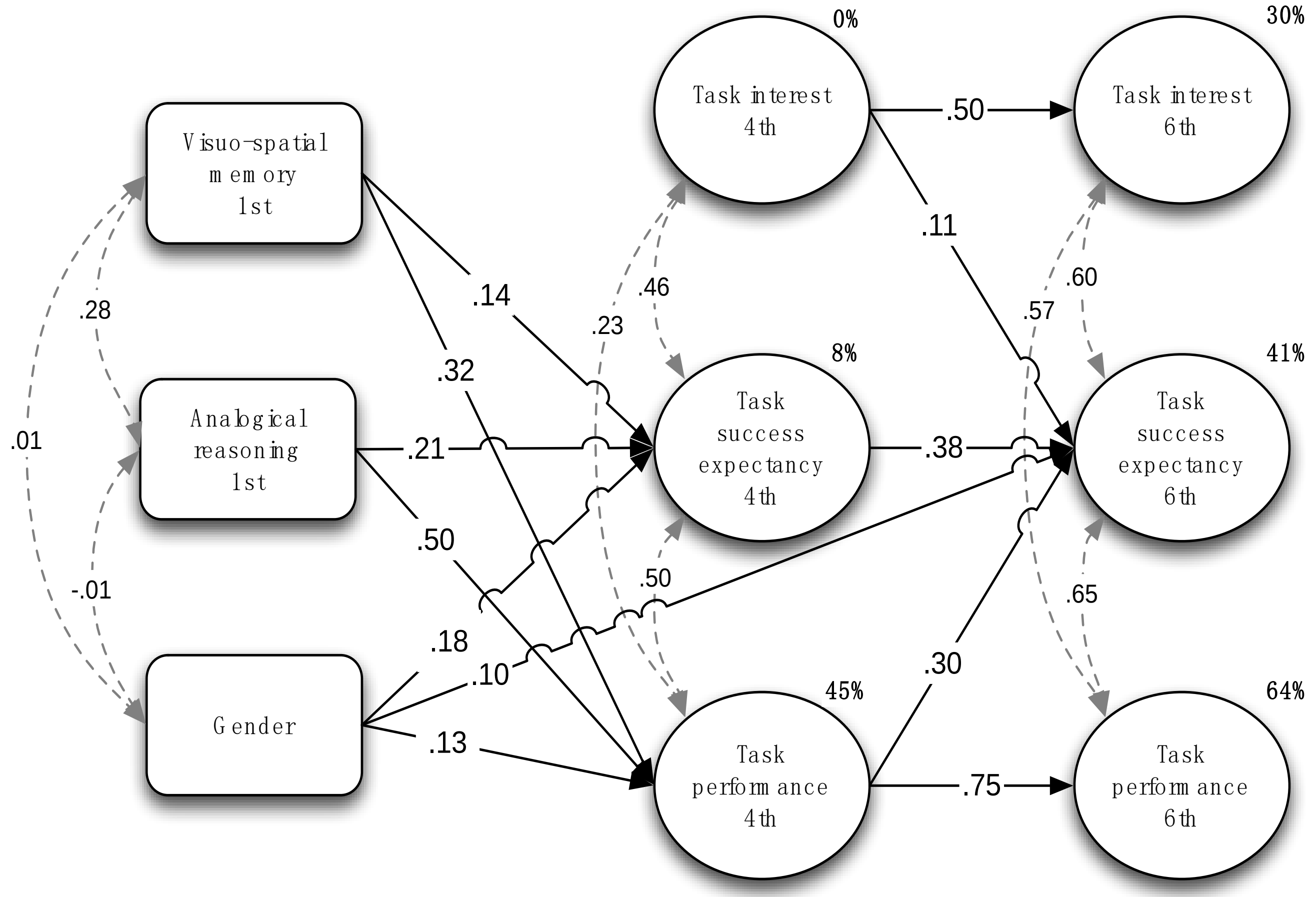
1. Longitudinal design
2. Cross-cultural comparison
3. Broad view on learning and achievement

Previous research

- Skill development in mathematics
- Development of motivation
- Developmental interplay between math learning and motivation

Early predictors of math-related motivation

Nuutila, Tuominen-Soini, Niemivirta (in prep.). Developmental predictors of interest, success expectancy and task performance in mathematics.



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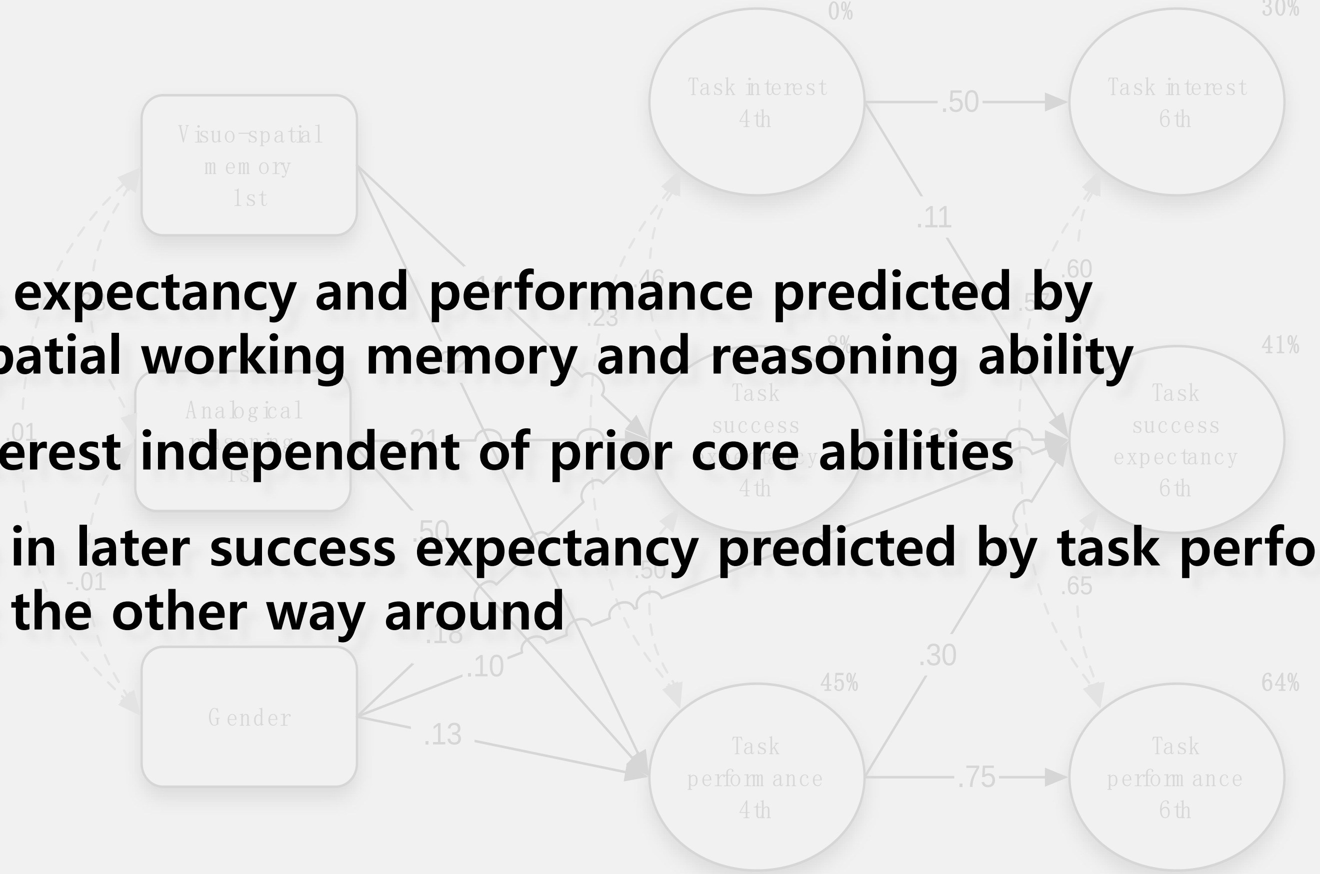
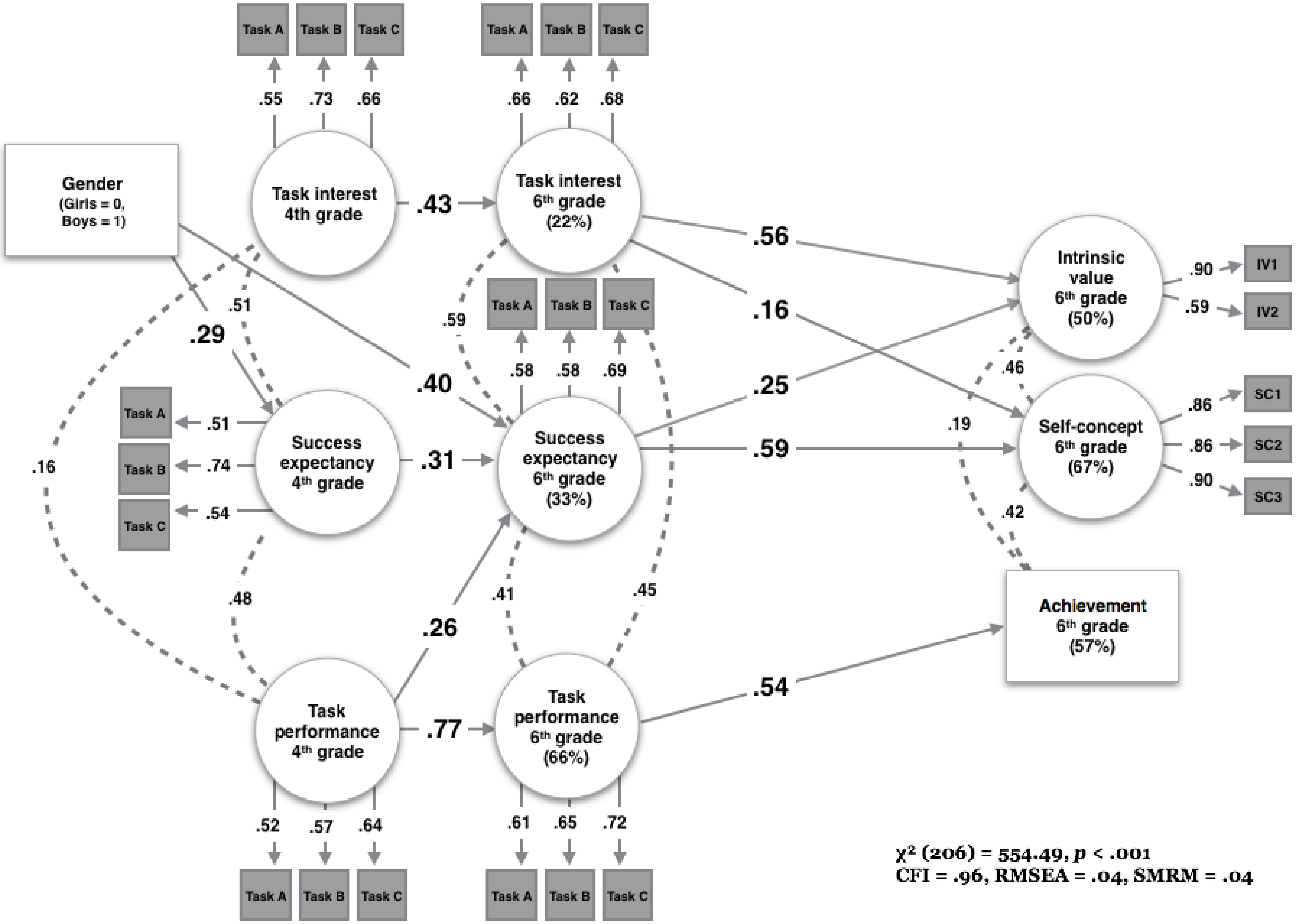


- Success expectancy and performance predicted by visuo-spatial working memory and reasoning ability
- Task interest independent of prior core abilities
- Change in later success expectancy predicted by task performance, but not the other way around

Long-term predictions of math-related motivation

Nuutila, Tuominen-Soini, Vainikainen & Niemivirta (2016). The Consistency and Longitudinal Predictions of Elementary School Students' Task Motivation in Mathematics. *Submitted*



χ^2 (206) = 554.49, p < .001
CFI = .96, RMSEA = .04, SMRM = .04

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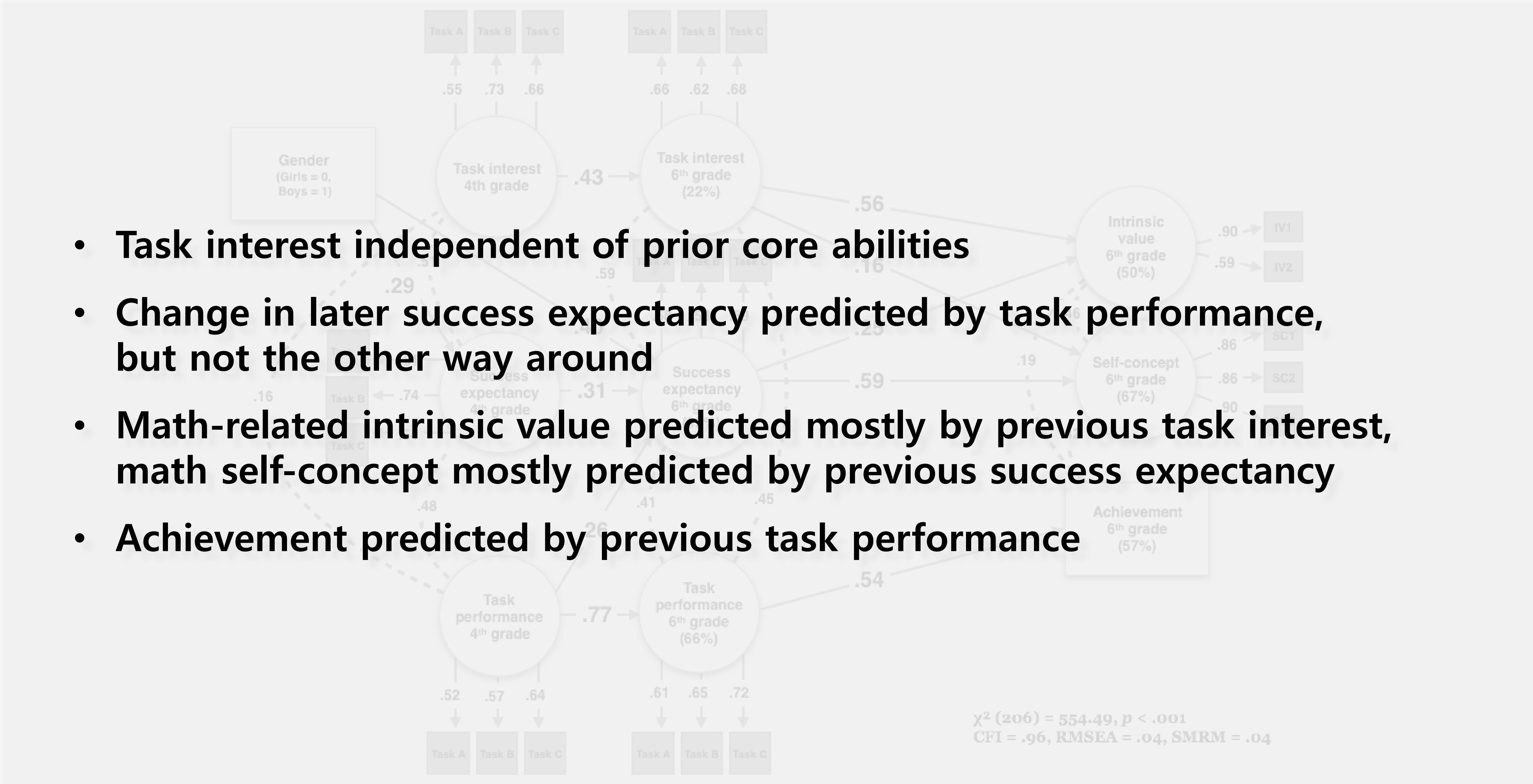
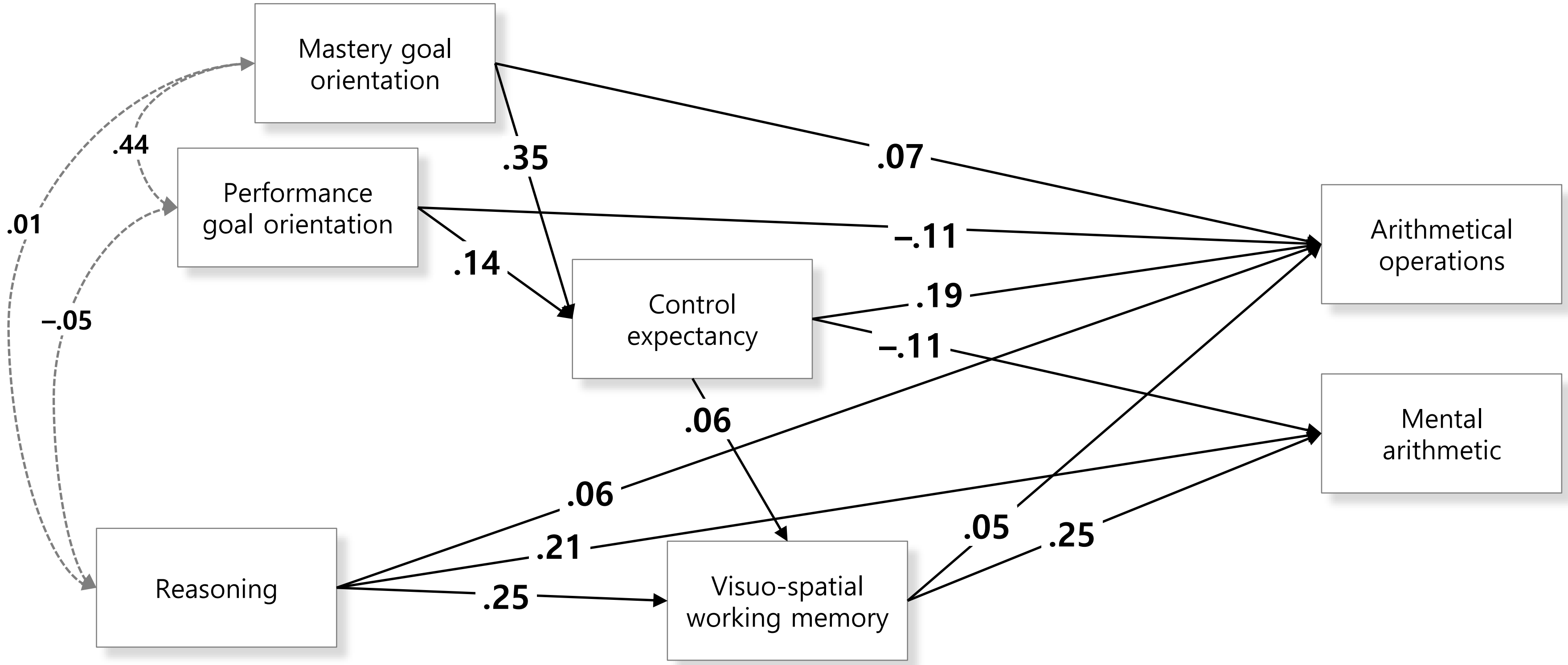


- Task interest independent of prior core abilities
- Change in later success expectancy predicted by task performance, but not the other way around
- Math-related intrinsic value predicted mostly by previous task interest, math self-concept mostly predicted by previous success expectancy
- Achievement predicted by previous task performance

Motivational and cognitive predictors of math performance

Husberg, Aunio, Vainikainen & Niemivirta (in prep). The Role of Working Memory and Motivation in Children's Arithmetical Performance.

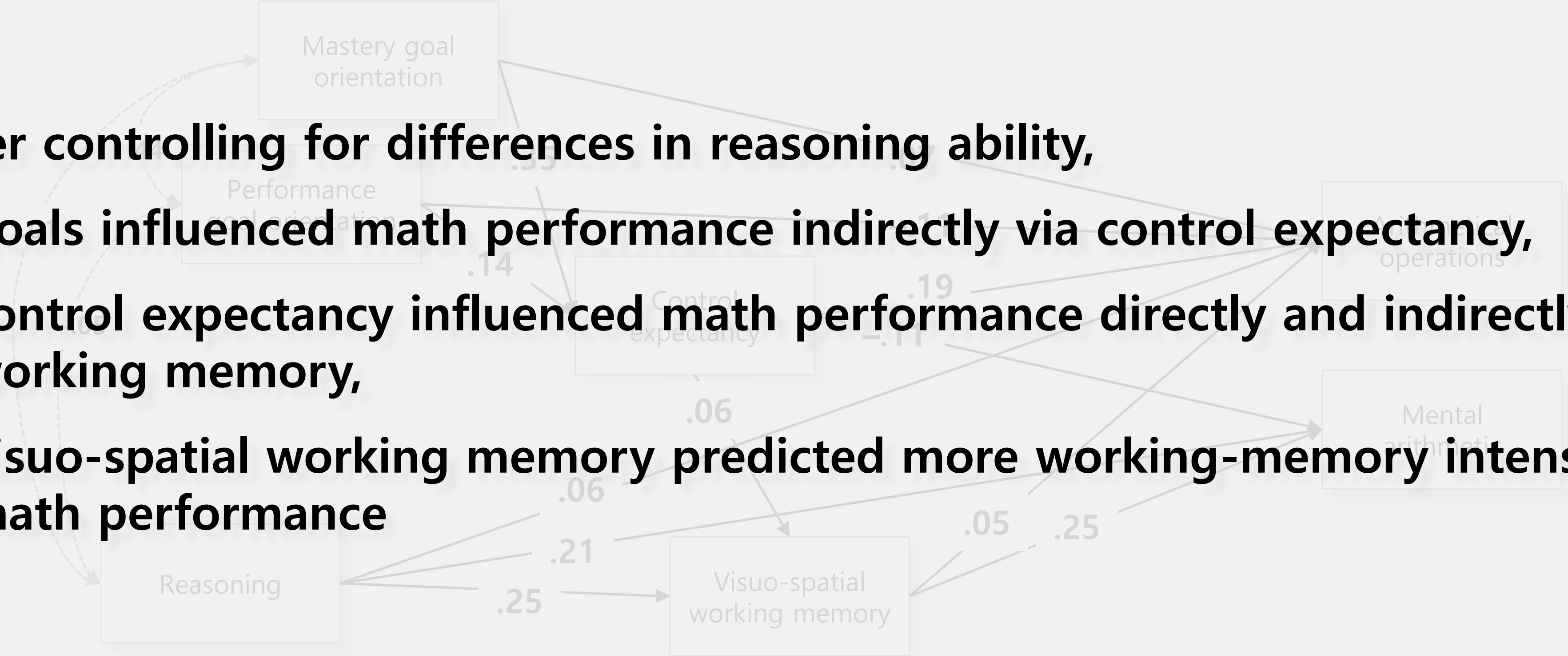


Motivational and cognitive predictors of math performance

Husberg, Aunio, Vainikainen & Niemivirta (in prep). The Role of Working Memory and Motivation in Children’s Arithmetical Performance.

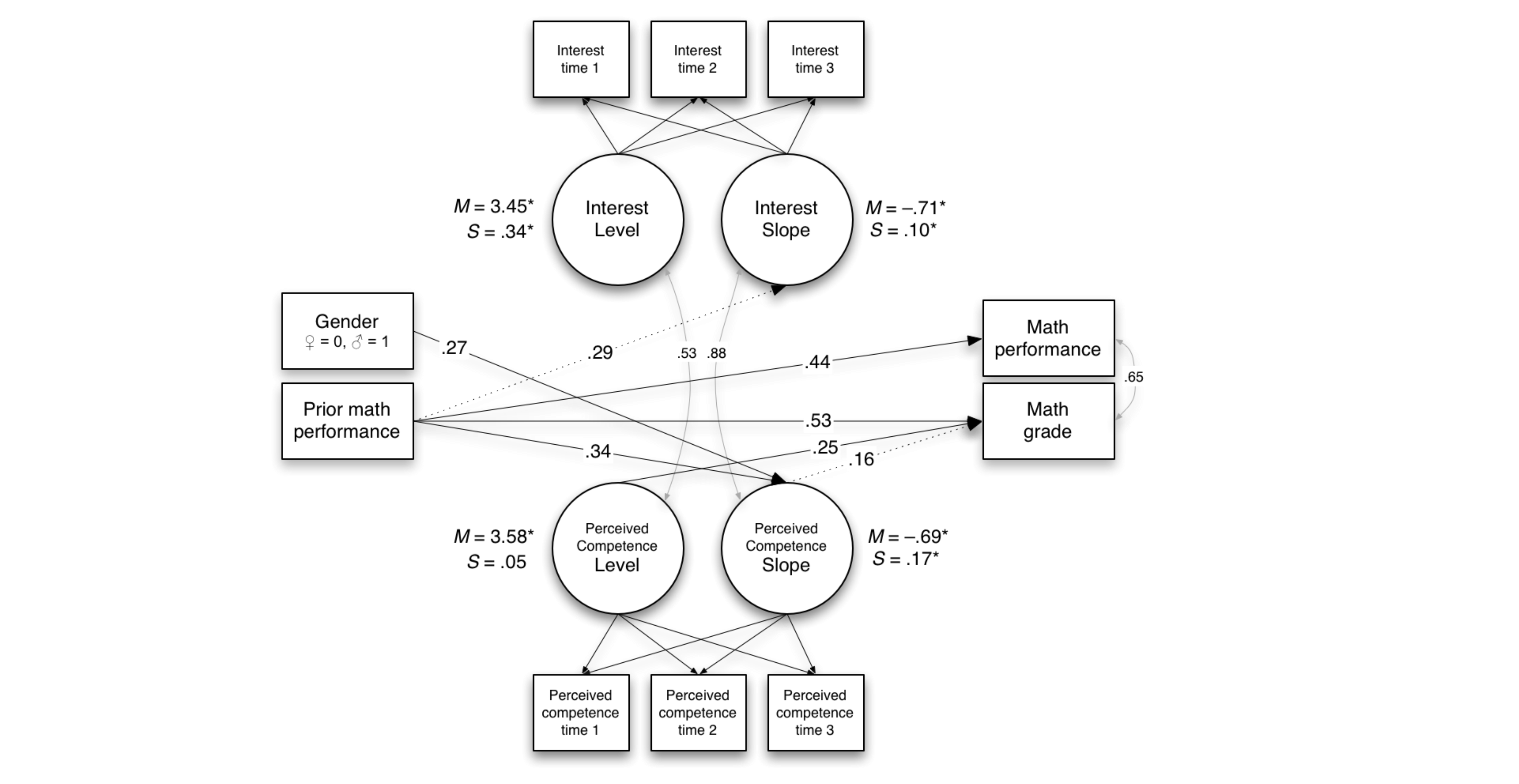
After controlling for differences in reasoning ability,

- **goals influenced math performance indirectly via control expectancy,**
- **control expectancy influenced math performance directly and indirectly via working memory,**
- **visuo-spatial working memory predicted more working-memory intensive math performance**



Development of math-related interest, self-concept and achievement

Tapola & Niemivirta (in prep). Developmental trajectories of school beginner's perceived competence, interest and performance in mathematics.



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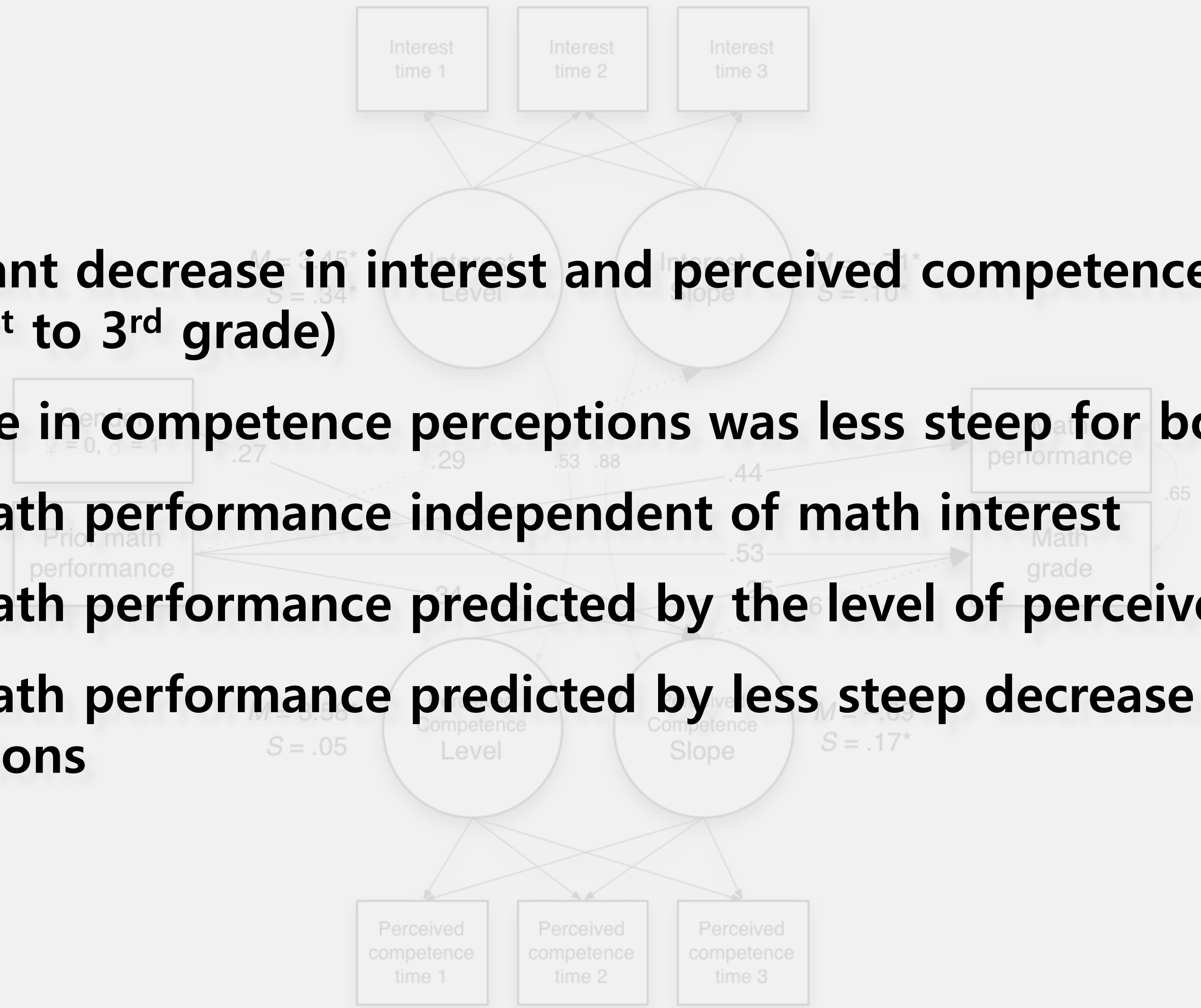
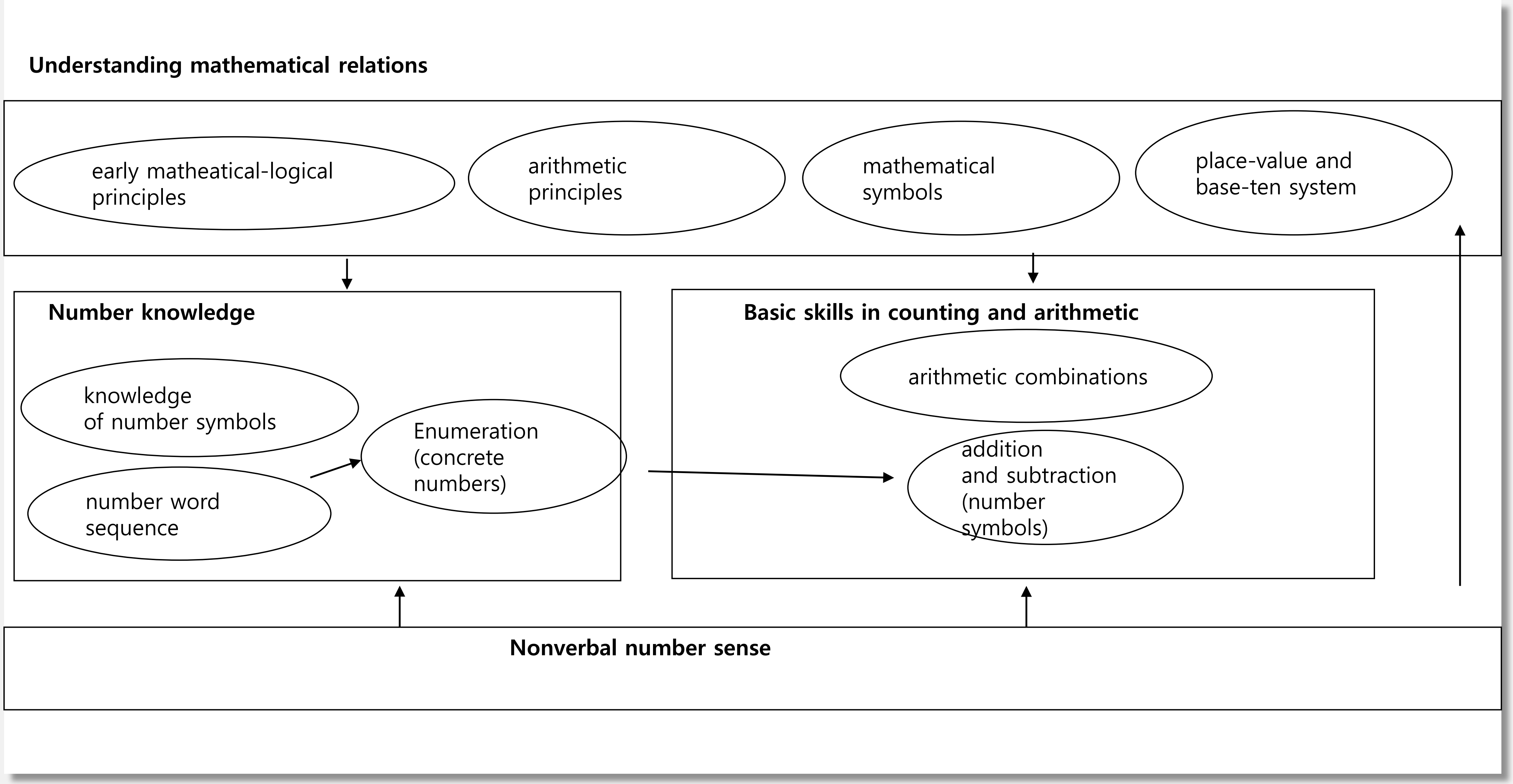


- **Significant decrease in interest and perceived competence over time (from 1st to 3rd grade)**
- **Decrease in competence perceptions was less steep for boys**
- **Later math performance independent of math interest**
- **Later math performance predicted by the level of perceived competence**
- **Later math performance predicted by less steep decrease in competence perceptions**

A model of the development of basic mathematical skills

Aunio & Räsänen (2015). Core mathematical skills at ages 5 to 8 years. European Early Childhood Education Research Journal.



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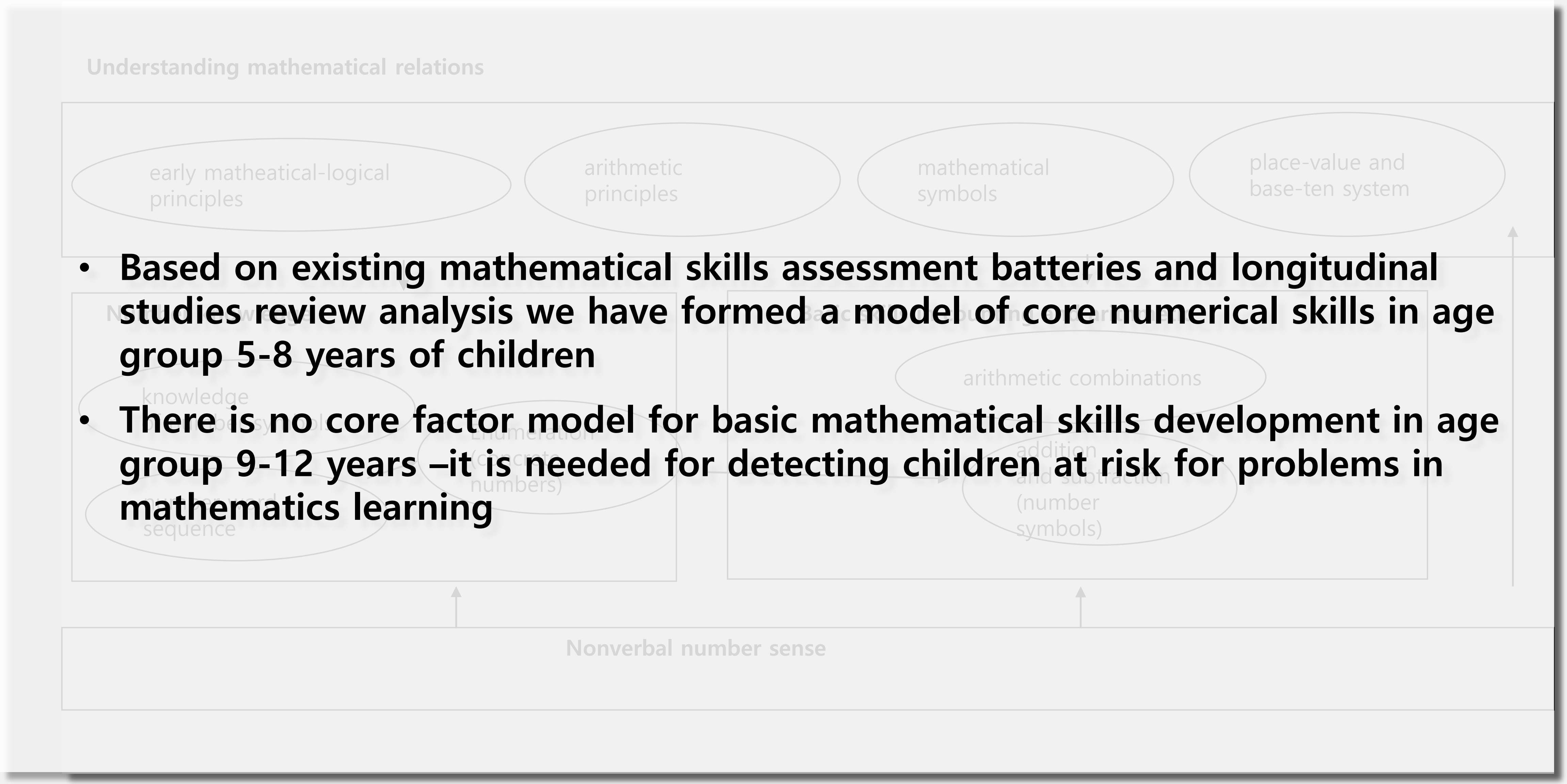
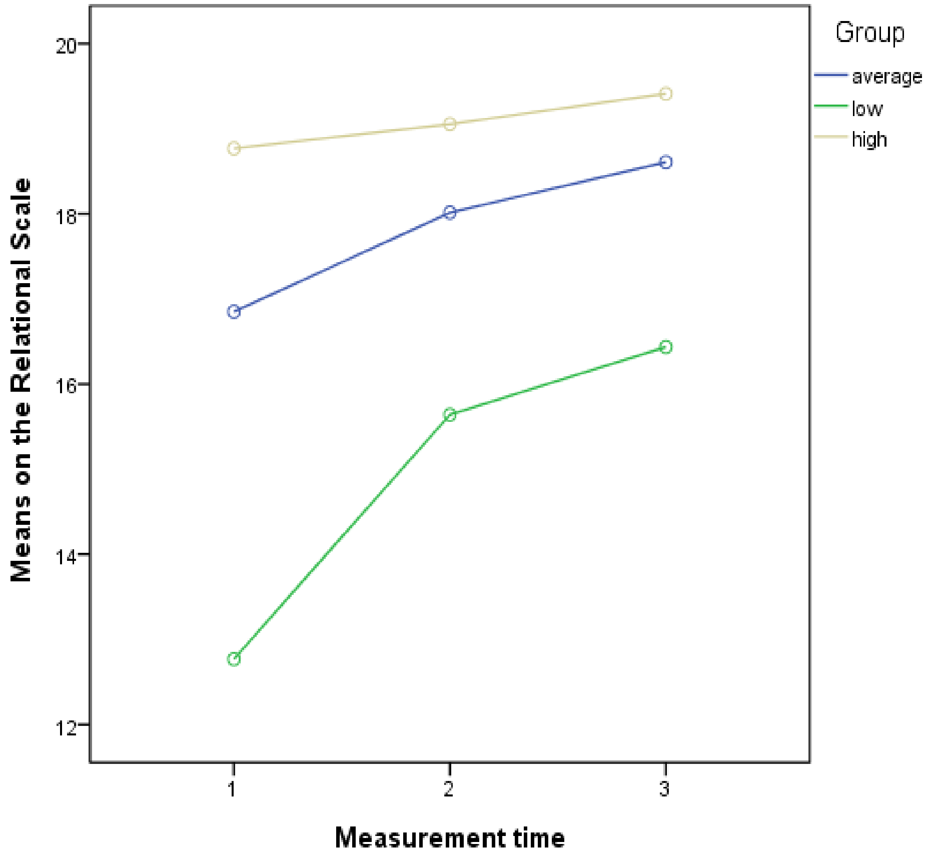
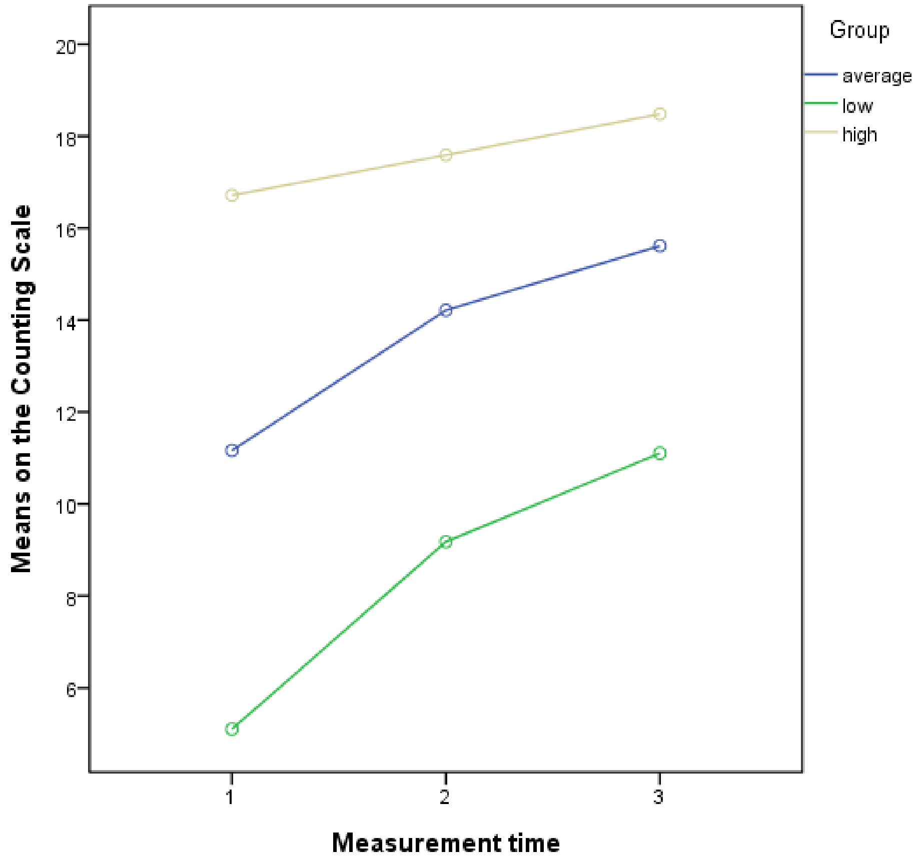


- **Based on existing mathematical skills assessment batteries and longitudinal studies review analysis we have formed a model of core numerical skills in age group 5-8 years of children**
- **There is no core factor model for basic mathematical skills development in age group 9-12 years –it is needed for detecting children at risk for problems in mathematics learning**

Longitudinal studies into mathematical development

Aunio, P., Heiskari, P., Van Luit, J.E.H & Vuorio, J-M. (2015) The development of early numeracy skills in preschool and kindergarten. *Journal of Early Childhood Research, 13,* 13-16.





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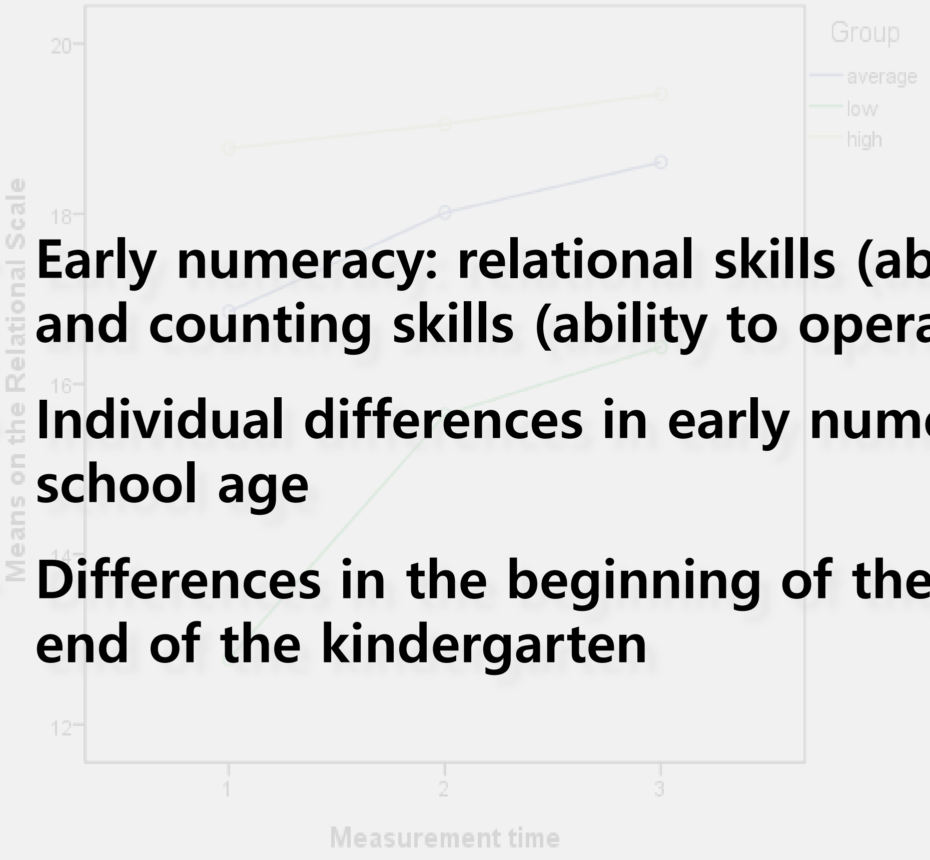
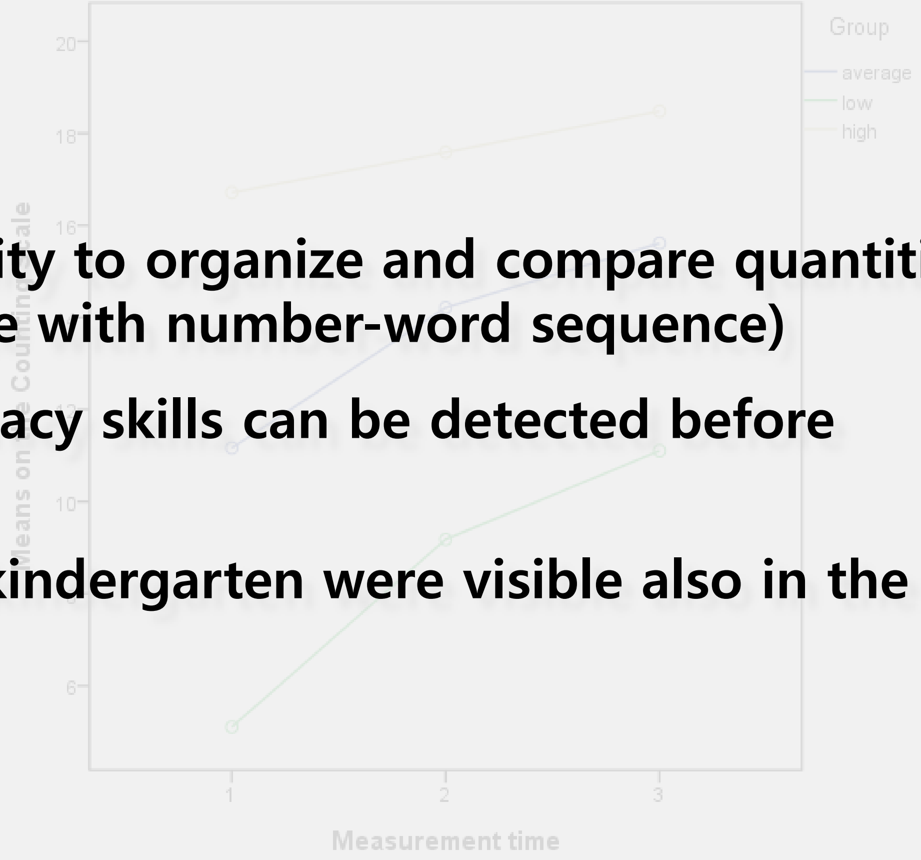
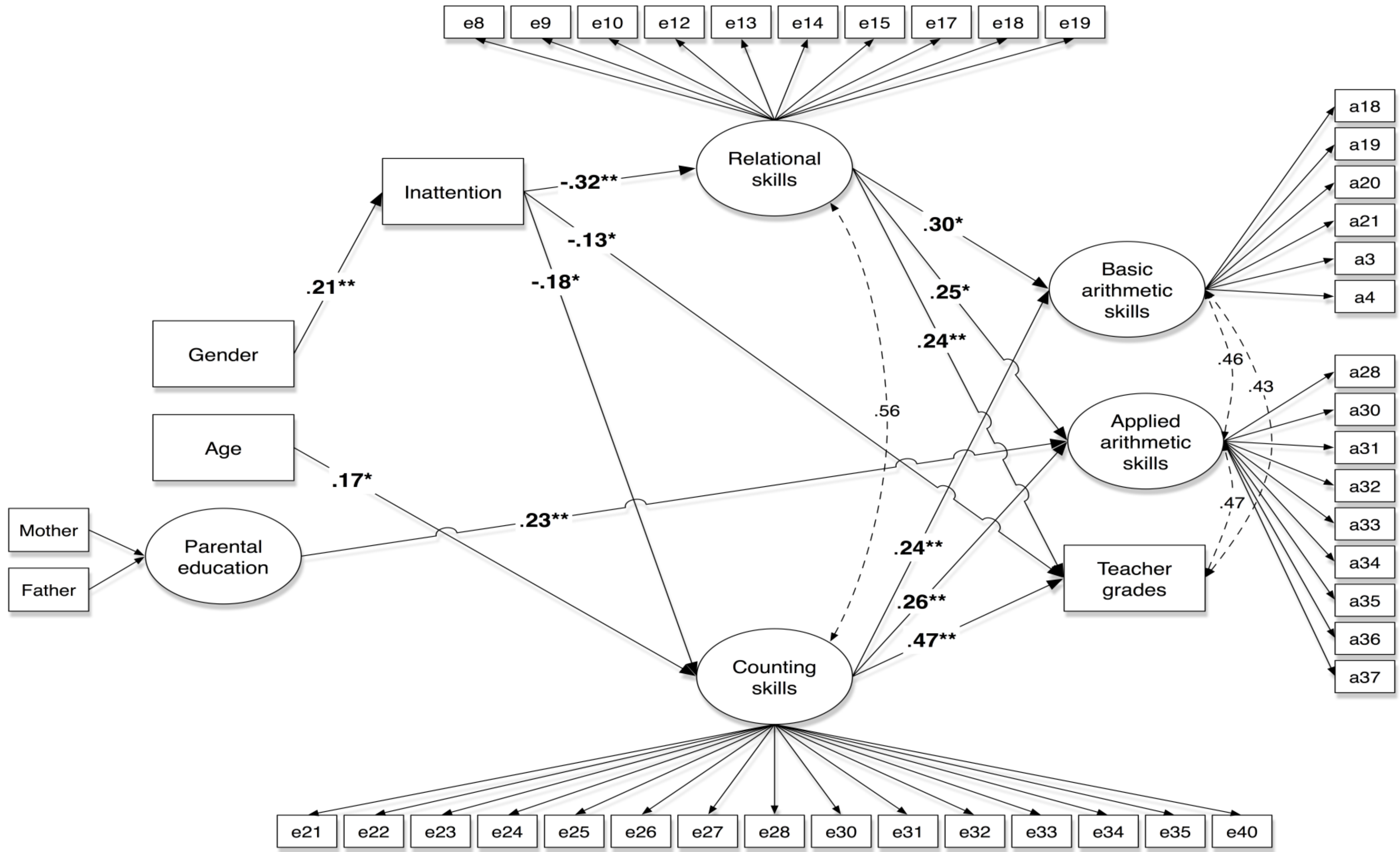




- Early numeracy: relational skills (ability to organize and compare quantities) and counting skills (ability to operate with number-word sequence)
- Individual differences in early numeracy skills can be detected before school age
- Differences in the beginning of the kindergarten were visible also in the end of the kindergarten

Longitudinal studies into mathematical development

Aunio, P. & Niemivirta, M. (2010) Predicting children's mathematical performance in grade one by early numeracy skills. *Learning and Individual Differences, 20,* 427-435.



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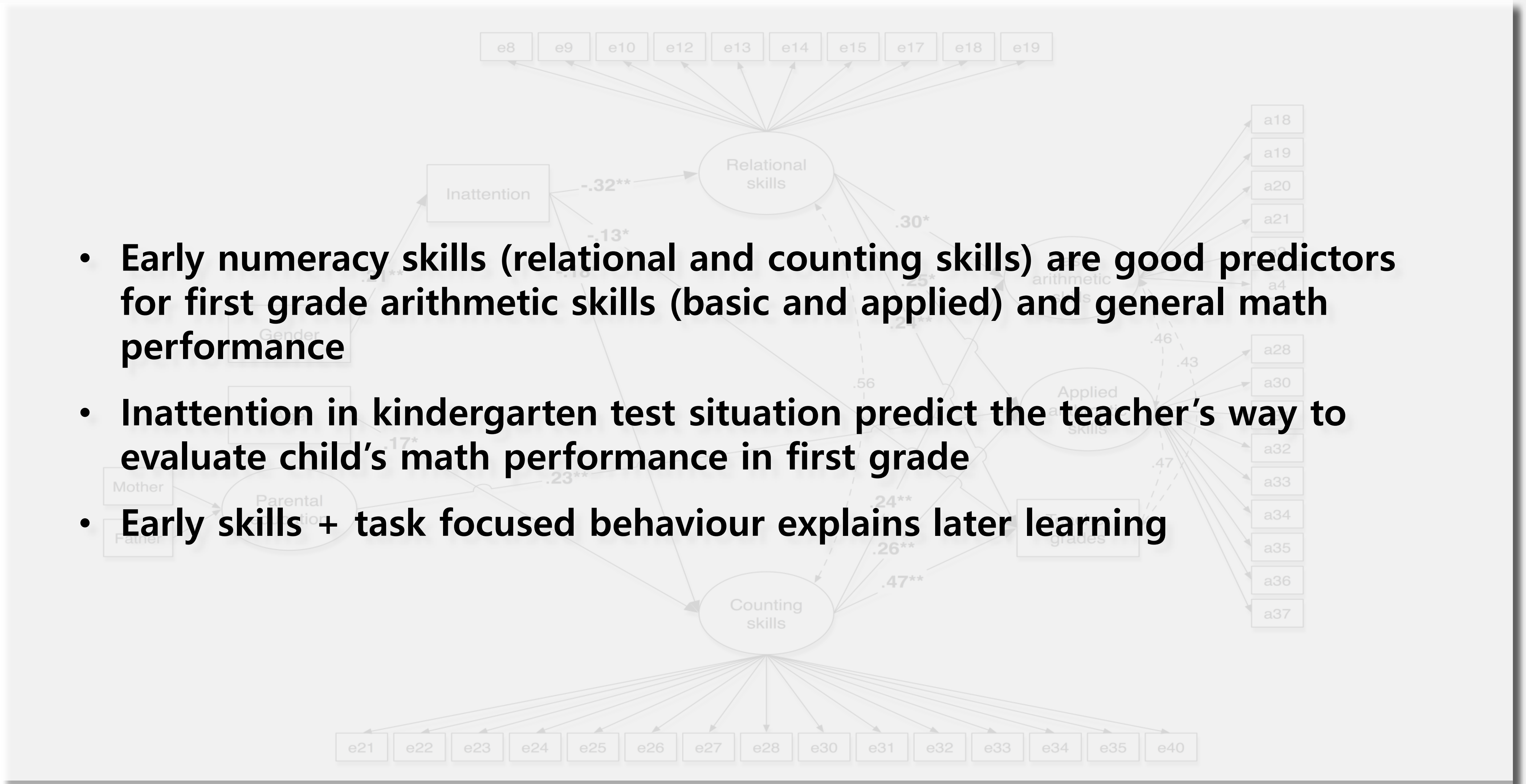
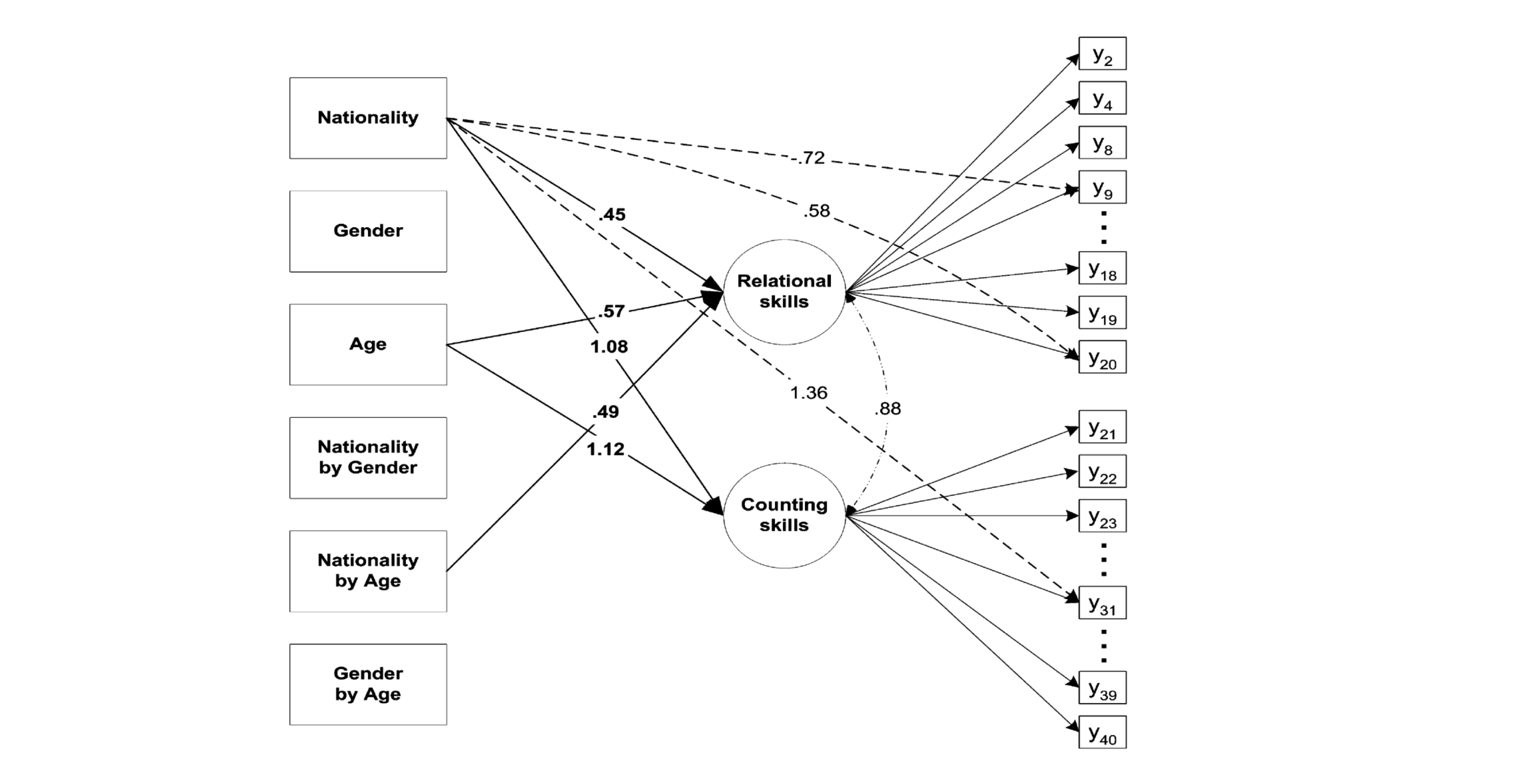


- Early numeracy skills (relational and counting skills) are good predictors for first grade arithmetic skills (basic and applied) and general math performance
- Inattention in kindergarten test situation predict the teacher's way to evaluate child's math performance in first grade
- Early skills + task focused behaviour explains later learning

Cross-cultural studies into mathematical development

Aunio, P., Niemivirta, M., Hautamäki, J., Van Luit, J.E.H., Shi, J. & Zhang, M. (2006) Young Children's Number Sense in China and Finland. *Scandinavian Journal of Educational Research*, 50 (5) 483-502.



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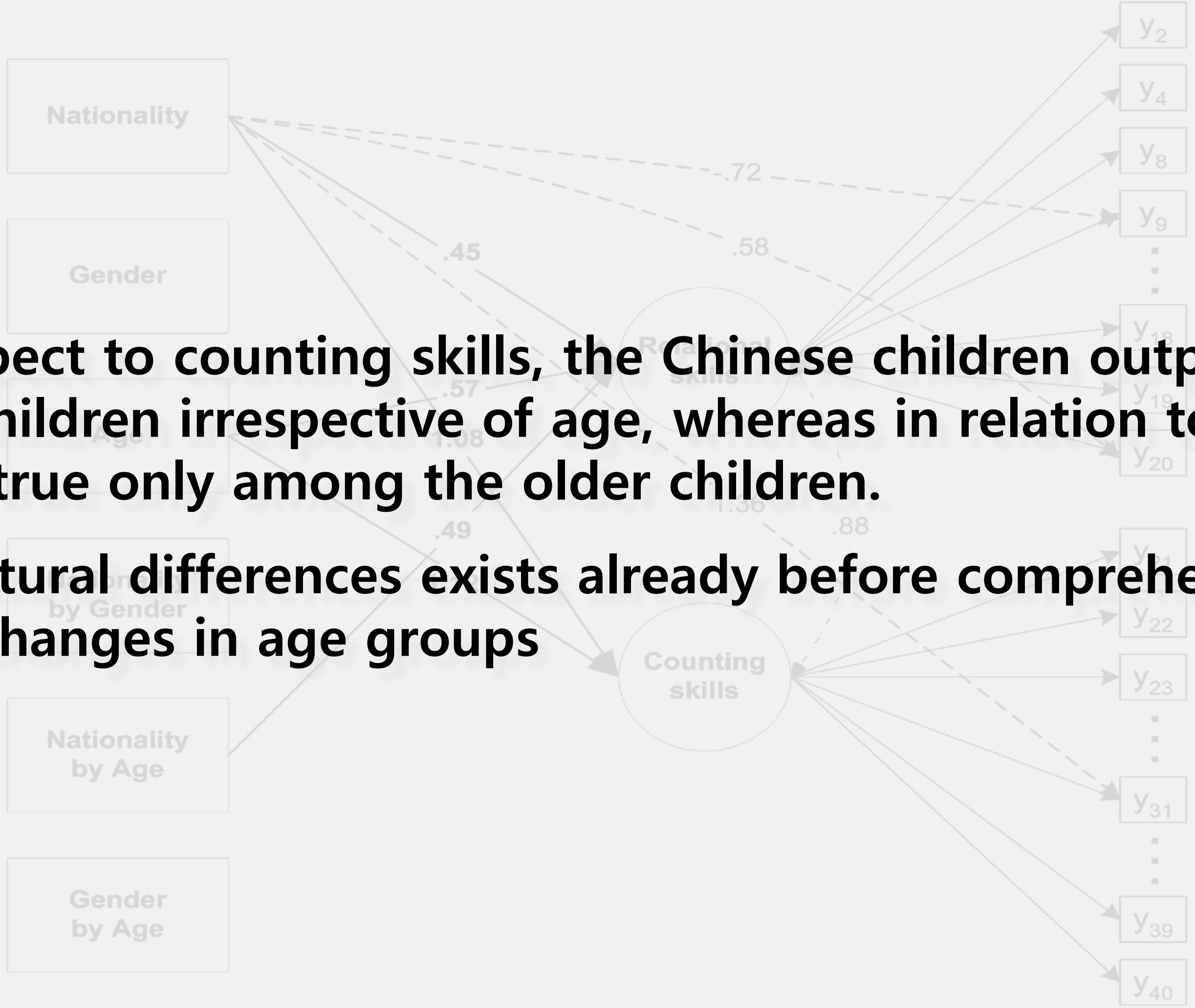

- **With respect to counting skills, the Chinese children outperformed the Finnish children irrespective of age, whereas in relation to relational skills, this was true only among the older children.**
- **Cross-cultural differences exists already before comprehensive school and there is changes in age groups**

Mathematical development and other learning related factors

Korhonen, J., Linnanmäki, K. & Aunio, P. (2014). Learning difficulties, academic well-being and educational dropout: A person-centred approach. *Learning and Individual Differences*, 31, 1-10.

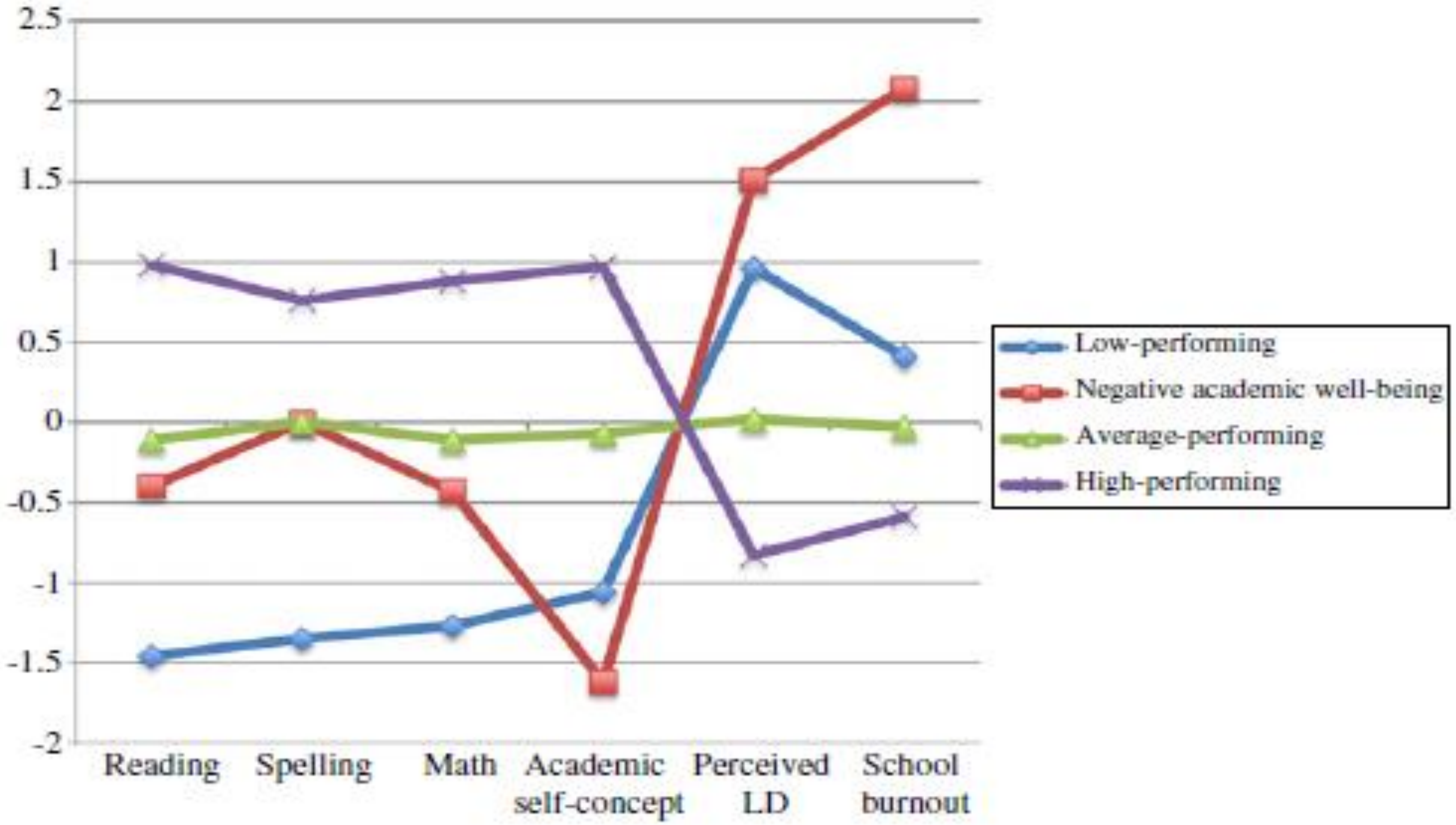

Fig. 2. Students' latent mean scores on performance and well-being scales as a function of group membership.

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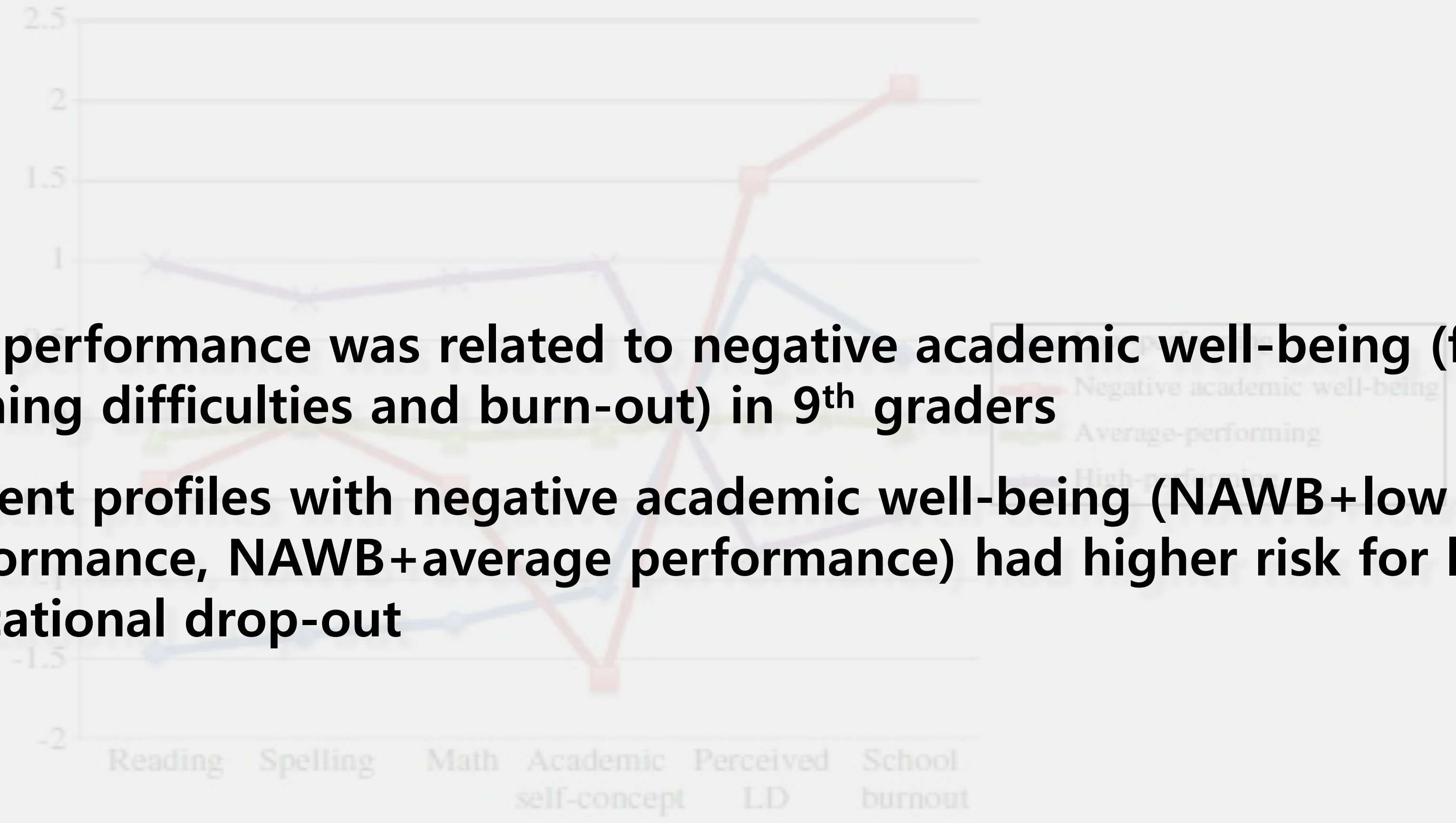

- **Low performance was related to negative academic well-being (feeling of learning difficulties and burn-out) in 9th graders**
- **Student profiles with negative academic well-being (NAWB+low performance, NAWB+average performance) had higher risk for later educational drop-out**

Fig. 2. Students' latent mean scores on performance and well-being scales as a function of group membership.

Key measures

- Mathematical skills (Math Achievement Test, Stage I, Grades 1 to 3)
  - Basic arithmetic skills
  - Measurements
  - Applied arithmetic
  - Reasoning
- Cognitive components (Children and Adolescent Cognition Manual, National Children’s Study of China (NCSC), National Key Laboratory of Cognitive Neuroscience and Learning, Beijing Normal University)
  - Short-term memory (STM I Visual Number Immediate Recognition; STM II Paired Association Immediate Recognition)
  - Attention
  - Visuo-Spatial Ability (VSA I Hidden Figures, VSA II Mental Rotation)
  - Long-term memory (LTM I Visual Number Delayed Recognition, LTM II Paired Association Delayed Recognition)
  - Reasoning (Reasoning I Digit Analogy, Reasoning II Graph Analogy, Reasoning III Graph Sequence)

Key measures

- Motivational tendencies
  - Value and expectancy beliefs
    - Utility, importance, interest
    - Competence, effort, anxiety
  - Achievement goal orientations
    - Mastery-intrinsic, mastery-extrinsic, performance-approach, performance-avoidance, work avoidance
  - Control beliefs
    - Agency beliefs
    - Means-ends beliefs
- Well-being
  - Fear of failure
  - Academic withdrawal
  - Self-esteem
  - School value
  - Emotional exhaustion
  - Perfectionistic tendencies
    - Standards, discrepancy, expectations
- Temperament
  - Behavioral inhibition, behavioral approach, reward seeking

Procedure and updated timetable

Schedule	Procedure
November 2016	Piloting of the measures
November & December 2016	Research permits from communities, schools and parents
January & February 2017	Data collection – first phase
March 2017	Data coding
April – June 2017	Results from the first phase
December 2017 & January 2018	Data collection – second phase
December 2018 & January 2019	Data collection – third phase
December 2019 & January 2020	Data collection – fourth phase

Take home message

- The joint effects of skill and will on learning are complex and challenging to detect, yet a necessary task for understanding the big picture
- Developmental analyses within a design that includes various types of key constructs are imperative
- Close collaboration with schools and parents is a necessity

Take home message

- **Expected key outcomes and implications:**
  - Increases our – and thus teachers' – understanding of various factors contributing to students' math learning
  - Produces knowledge that will help teachers to provide the students with more personalized support for successful learning