LMU KLINIKUM DER UNIVERSITÄT MÜNCHEN
CAMPUS INNENSTADT
KLINIK UND POLIKLINIK FÜR KINDER- UND JUGENDPSYCHIATRIE, PSYCHOSOMATIK UND PSYCHOTHERAPIE

Predictors of Arithmetic Skills in Children at Family-Risk of Dyslexia

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Background

- RD and MD frequently co-occur (Badian, 1999; Barbaresi et al., 2005; Dirks et al., 2008 Lewis et al., 1994; Landerl & Moll, 2010)

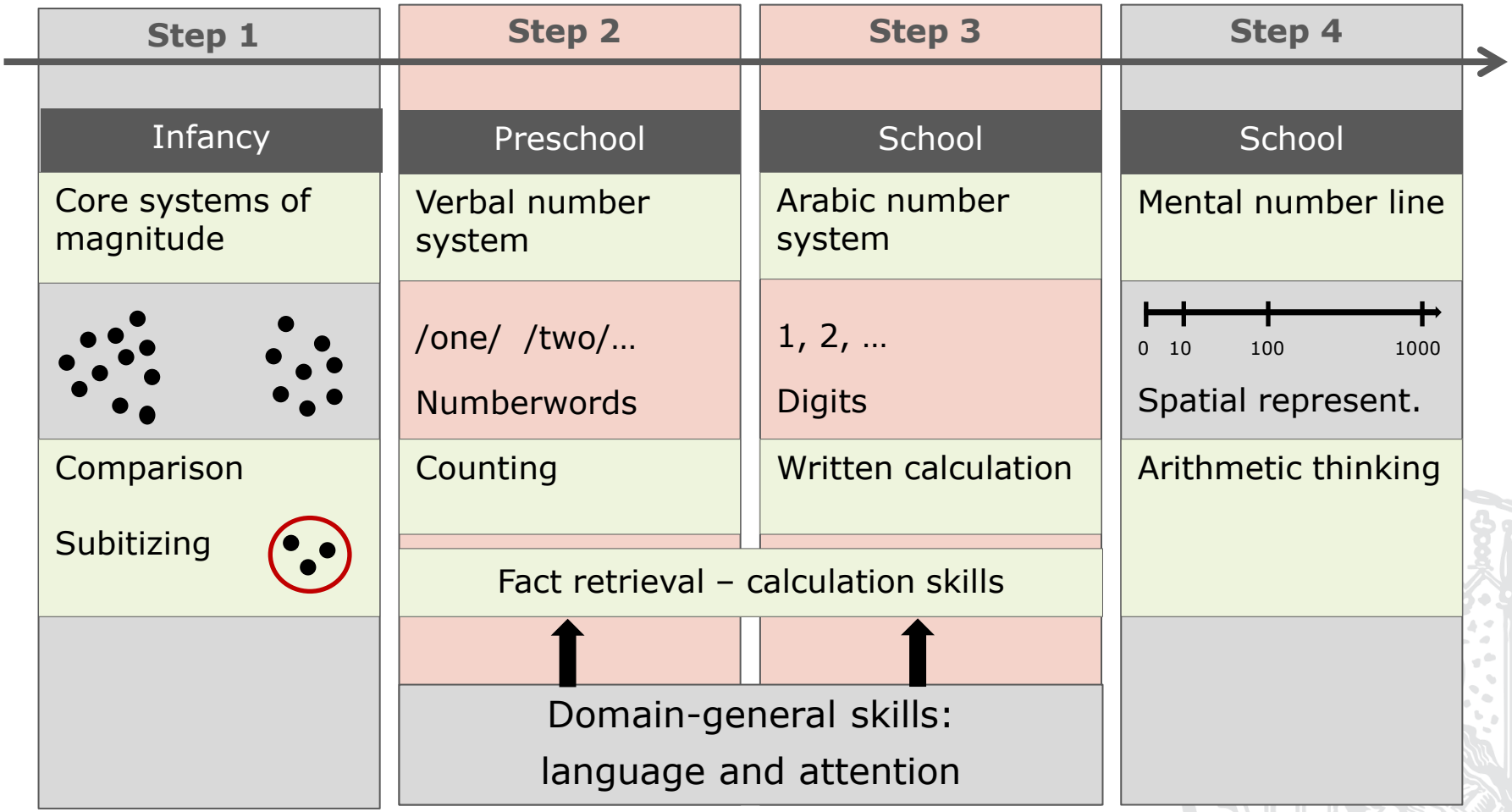
- Distinct core deficits (Ashkenazi et al., 2013; Landerl et al., 2009)

- Influence of domain-general risk factors on arithmetic development in children at family-risk of dyslexia

→ Comorbidity between RD and MD

→ Theories of arithmetic development

Development of Number Skills (von Aster & Shalev, 2007)



Background

- Children with language or reading problems are at risk of developing arithmetic difficulties

- Evidence: individuals with RD perform poorly on arithmetic

  (De Smedt & Boets, 2010; Göbel & Snowling, 2010; Simmons & Singleton, 2006)

- But are unaffected in non-verbal number processing

  (Landerl et al., 2004, 2009; Moll et al., in press)

Cognitive precursors of arithmetic skills in children at risk of dyslexia

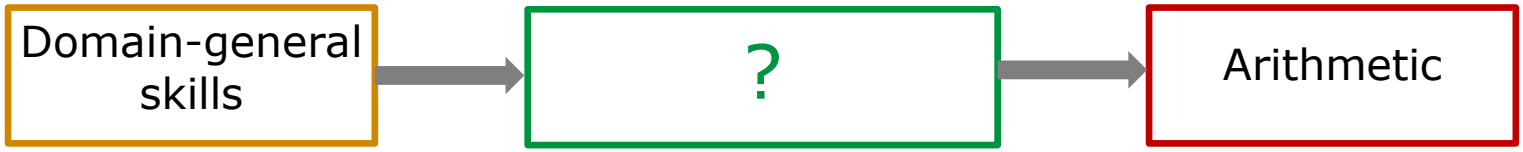
→ identify causes of arithmetic difficulties in this population

Domain-General Skills → Arithmetic

- Language: londitudinal predictor of arithmetic (LeFevre et al., 2010)
- Executive Functions: inhibition (Bull & Scerif, 2001; Espy et al., 2004)
- IQ: inconsistent
  - more important later in development (Geary, 2011)
  - more important for non-verbal number tasks (Krajewski & Schneider, 2009)

→ Language and executive skills: development of arithmetic skills

Mediating Mechanisms?



(1) Exact verbal number skills

- Counting (Aunio & Niemivirta, 2010; Koponen et al., 2013; Stock et al., 2009)
- Number knowledge (Geary, 2011; Jordan et al., 2009; Östergren & Träff, 2013)

(2) Phonological awareness

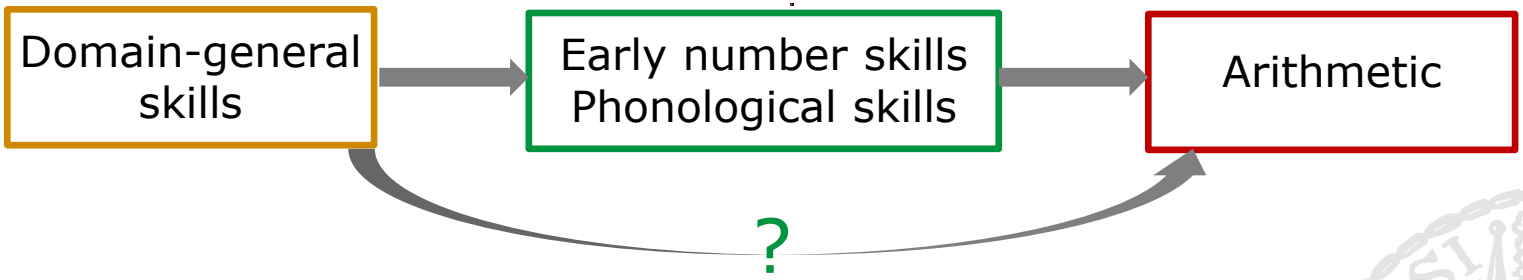
PA → Arithmetic (e.g., De Smedt et al., 2010; Fuchs et al., 2005, 2006; Hecht et al., 2001)

BUT: De Jong & van der Leij, 1999; Durand et al., 2004; Passolunghi et al., 2008

Aims

(1) Compare the predictive pattern between TD and children at family-risk of dyslexia

(2) Trace possible causal pathways



(3) Identify mediating mechanisms

Method

Sample: N = 169 76 TD and 93 FR

Time 1	Time 2	Time 3	Time 4	Time 5
3 yrs 9 mths				
Domain-general skills: • IQ • Executive Functioning • Language	4 yrs 8 mths	5 yrs 8 mths	6 yrs 7 mths	8 yrs 1 mth
	Precursors: • Counting • Number knowledge • Phonological awareness		**Outcome:** Calculation efficiency	

Measures Time 1

Nonverbal IQ

WPPSI-III: Wechsler Preschool and Primary Scale of Intelligence

- Block Design

- Object assembly Puzzle

Language

CELF - preschool: Clinical Evaluation of Language Fundamentals

- Expressive Language: Vocabulary
- Receptive Language: Sentence structure

Executive functions

Inhibition:

- GoNogo (Kochanska et al., 1996) :

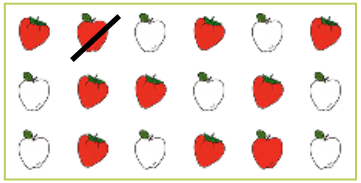
thumbs up

- HTKS: (Burrage et al., 2008)

touch your head

Selective attention:

- Visual search (Breckenridge, 2010)

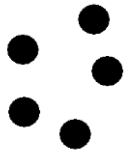


target: red apple

Measures Time 2

Counting

- Counting dots



- Counting maximum

Number knowledge

- Number recognition

  what number is this? 14

- Number writing

Phonological Awareness

- Syllable matching

  fireworks: doctor or **fire**man

- Alliteration matching

  pot: duck or **p**each

- Phoneme Isolation

  nonwords: first sound /**g**uf/

Outcome Measures Time 3

Calculation: One-minute addition and one-minute subtraction test

Descriptives

Construct	TD	FR	*T*-value	*Cohen's d*
IQ	0.00 (0.83)	-0.45 (0.96)	3.12 **	-0.50
Executive Functions	-0.01 (0.79)	-0.34 (0.78)	2.31 *	-0.36
Language	-0.00 (0.80)	-0.34 (0.78)	2.69 **	-0.43
Counting	0.07 (0.79)	-0.23 (0.93)	2.18 *	-0.35
Number Knowledge	0.00 (0.87)	-0.16 (0.96)	1.10	-0.17
Phonological Awareness	0.03 (0.82)	-0.38 (0.94)	2.50 *	-0.40
Arithmetic	-0.00 (0.90)	-0.46 (0.93)	3.14 **	-0.50

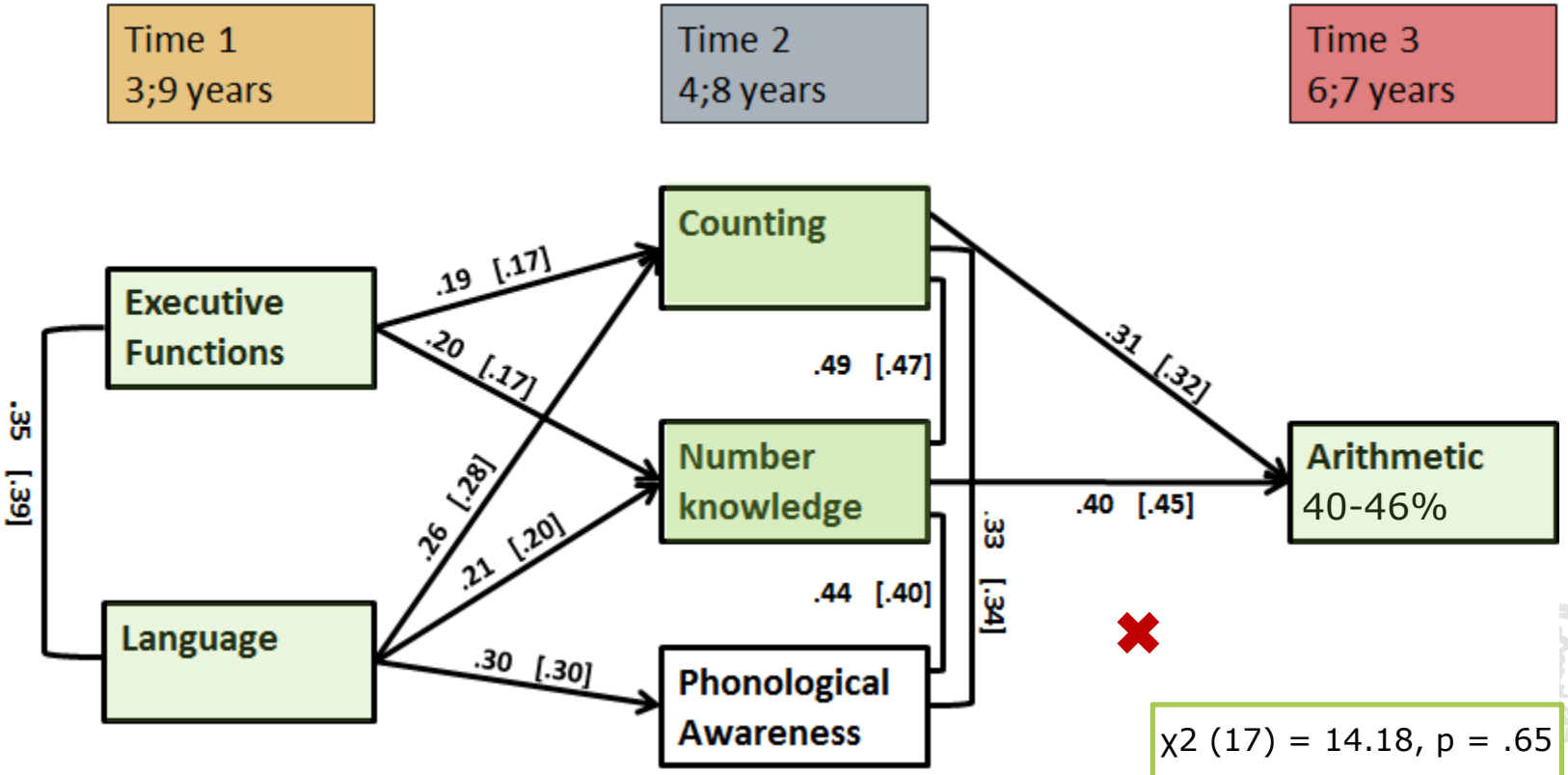
→ FR < TD

→ Predictive pattern: FR = TD

Correlations

	Language	EF	Counting	Number knowledge	PA	Arithmetic
IQ	.43 ***	.39 ***	.31 ***	.23 **	.29 ***	.22 **
Language		.39 ***	.33 ***	.25 **	.31 ***	.32 ***
EF			.30 ***	.27 **	.17 *	.31 ***
Counting				.54 ***	.42 ***	.56 ***
Number knowledge					.47 ***	.59 ***
PA						.38 ***

Results



χ2 (17) = 14.18, p = .65

RMSEA = .000
90% CI = .000-.082

CFI = 1.0

SRMR = .068

Summary and Discussion

(1) Aim: Different pattern for FR?

- Performance: FR < TD

- BUT
  Regression slopes: FR = TD
  → same cognitive processes accounted for variability in the two groups

Summary and Discussion

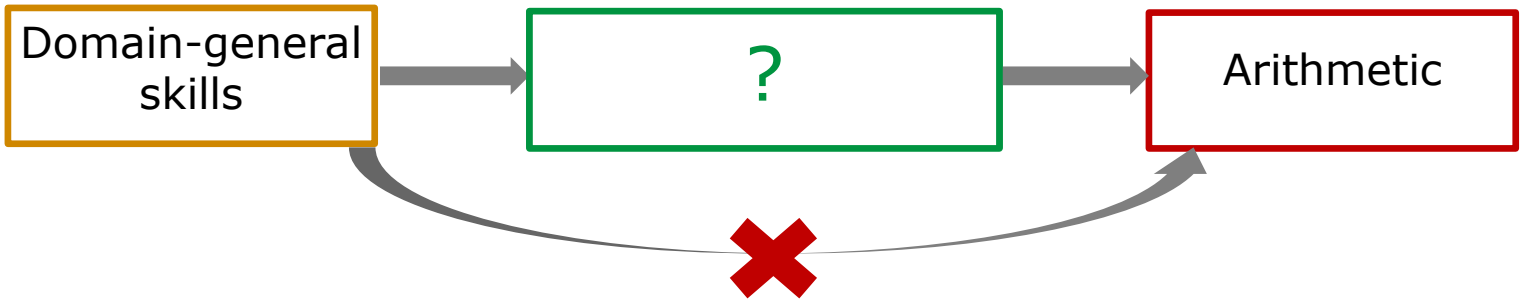
(2) Aim: Trace causal pathways

- Arithmetic:
  verbal number skills (40-46%)
- Verbal number skills:
  EF and language skills
  NOT IQ
- PA = No direct predictor

Language skills underpin both, PA and verbal number skills

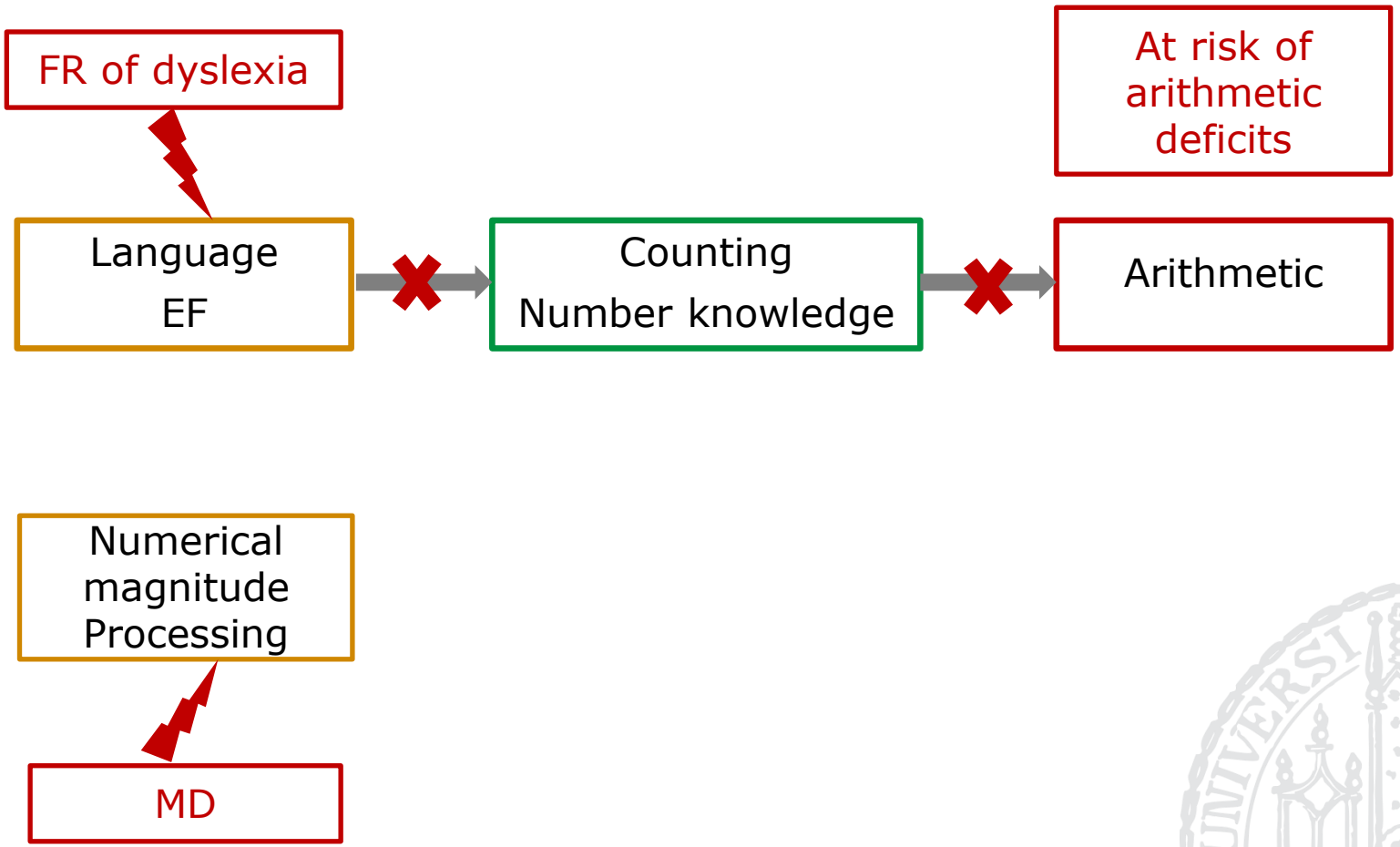
Summary and Discussion

(3) Aim: Mediating mechanisms



Full mediation!

Conclusions



Funding

wellcome trust

Thank you for your attention!

CONTACT:

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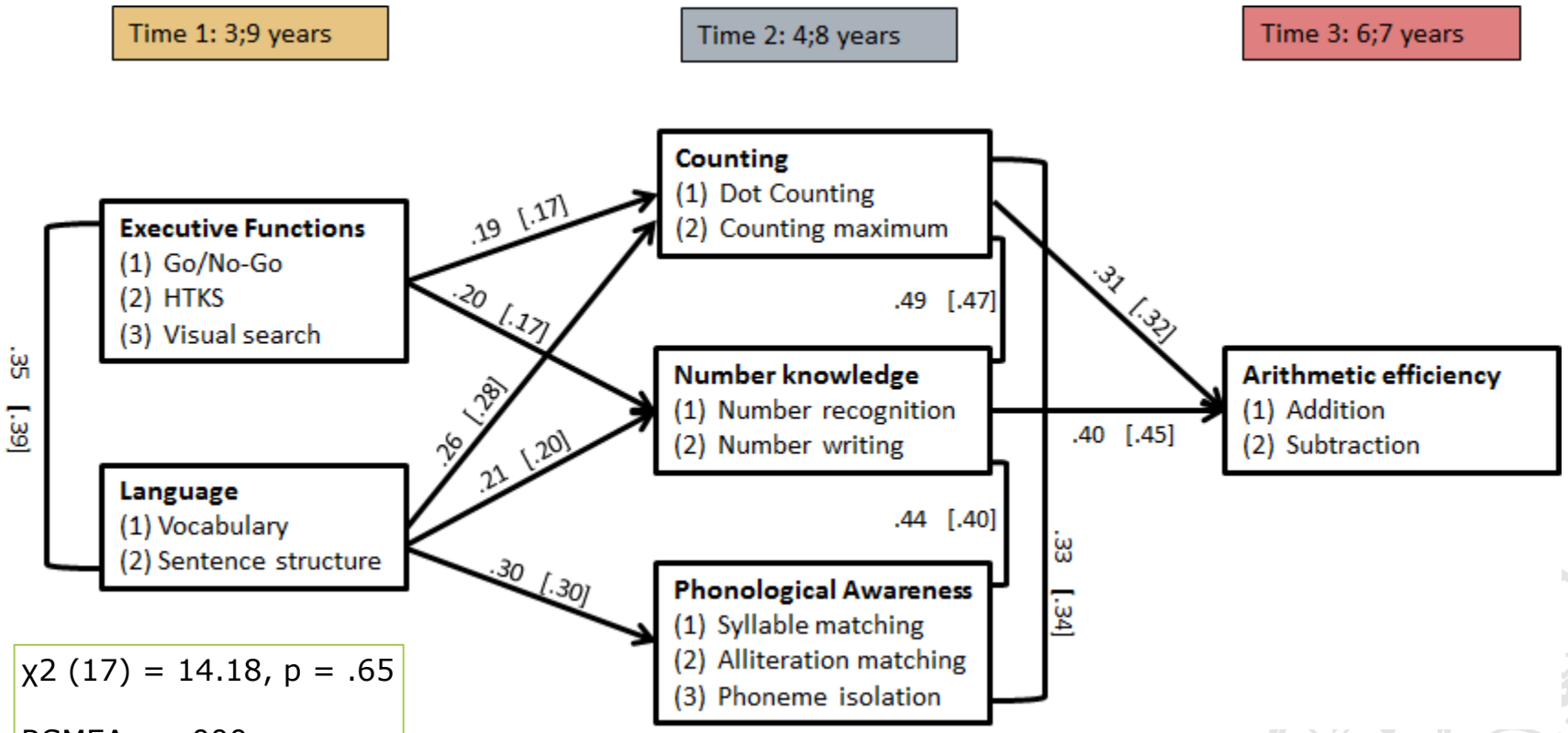
DESCRIPTIVES

Variable	TD	FR	*t*-value	*Cohen's d*
IQ: Blockdesign	20.63 (2.94)	19.12 (3.38)	2.97 **	0.48
IQ: Object assembly	21.68 (7.24)	18.82 (7.50)	2.41 *	0.39
EF: GoNogo (hits/total responses)	0.81 (0.22)	0.75 (0.23)	1.36	0.27
EF: HTKS [40]	13.39 (12.61)	8.46 (10.18)	2.45 *	0.43
EF: Visual Search efficiency	0.13 (0.06)	0.11 (0.06)	1.41	0.33
LANGUAGE: EV	20.69 (5.24)	18.53 (5.32)	2.55 **	0.41
LANGUAGE: SS	14.39 (3.27)	13.52 (2.77)	1.81	0.29
Counting: Dots [8]	5.22 (1.35)	4.75 (1.68)	1.94	0.31
Counting: maximum	28.86 (14.89)	24.77 (13.60)	1.82	0.29
Numberknowledge: recognition [%]	65.28 (23.79)	58.12 (24.08)	1.91	0.30
Numberknowledge: writing [%]	54.28 (28.14)	55.24 (29.15)	0.21	-0.03
PA: Syllable matching [%]	83.45 (11.66)	80.34 (16.73)	1.39	0.22
PA: Alliteration matching [%]	83.42 (19.38)	74.77 (20.57)	2.73 **	0.43
PA: Phoneme isolation [%]	58.27 (31.99)	52.42 (32.44)	1.09	0.18
ARITH: addition [corr/min: max 30]	10.26 (5.07)	7.99 (4.65)	2.95 **	0.47
ARITH: subtraction [corr/min: max 30]	7.32 (3.49)	5.71 (3.69)	2.83 **	0.45

Results



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