

Mathematical Profile & Dyscalculia Test



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Varese

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Sketching out the mathematical cognitive profile of students with mathematical learning difficulties through the:
MathPro & Dyscalculia Test

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- ❖ Children who subsequently complete high school with relatively low mathematics achievement are **more likely to be unemployed or paid lower wages** (Rivera-Batiz, 1992).
 - ❖ Mathematics ability in general is **crucial for success** in Western societies (Ancker & Kaufman, 2007).
 - ❖ Poor mathematics skills have **a bigger impact** on life chances than poor literacy (Parsons & Bynner, 2005).
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Mathematical Profile & Dyscalculia Test

overview

- ☐ Theoretical framework
- ☐ The MathPro Test
- ☐ MLD profiles

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overview

- ☐ Theoretical framework
- ☐ The CleverMath test
- ☐ MLD profiles

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Mathematical Profile & Dyscalculia Test

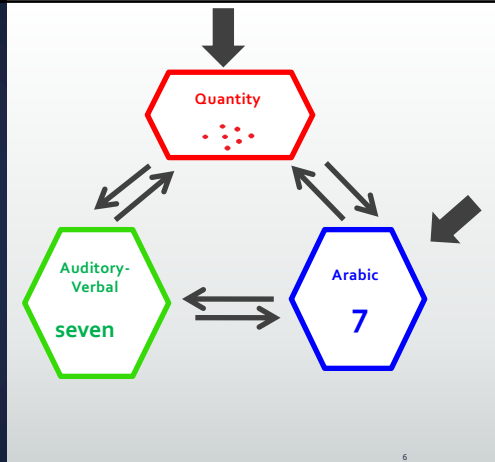
- ❑ Although approximately **5–8%** of students have **dyscalculia** researchers have not yet developed **consensus operational criteria** (Lewis & Fisher, 2016).
- ❑ There aren't district borderlines between **low achievement in mathematics** and **Dyscalculia** *due to* the lack of studies that attempt to differentiate the **cognitive** from **non-cognitive** sources of mathematics difficulties.
- ❑ The above explain partly the **heterogeneity** and the **comorbidity** often-mentioned at MLD studies.

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A. in the magnitude system
(Landerl, Bevan, & Butterworth, 2004;
Wilson & Dehaene, 2007)

Domain
specific
cognitive
deficit

**B. in the accessing a magnitude
representation from symbolic
numbers** (De Smedt, Noel, Gilmore,
& Ansari, 2013; Rousselle & Noel, 2007)



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Domain general cognitive deficit

(Andersson, 2008; Geary, 2004; Geary & Hoard, 2005; Fuchs et al., 2005; Huber et al., 2015; Swanson et al., 2009; Szucs, 2016; Visscher, 2015)

- **long term memory (semantic memory)** in learning and storing knowledge mathematical concepts and procedures
- **short term memory** for maintaining information in unchanged format for a short while.
- **working memory** (phonological & visual-spatial) in storing and processing simultaneously information
- **executive functions:** processing speed, *inhibition* of irrelevant associations from entering WM, *shifting* from one operation-strategy to another, *attention*, *updating* and *strategic planning*

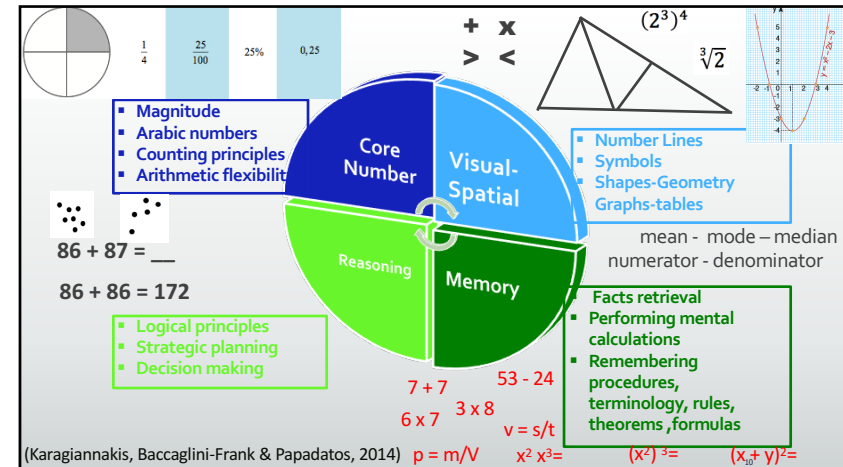
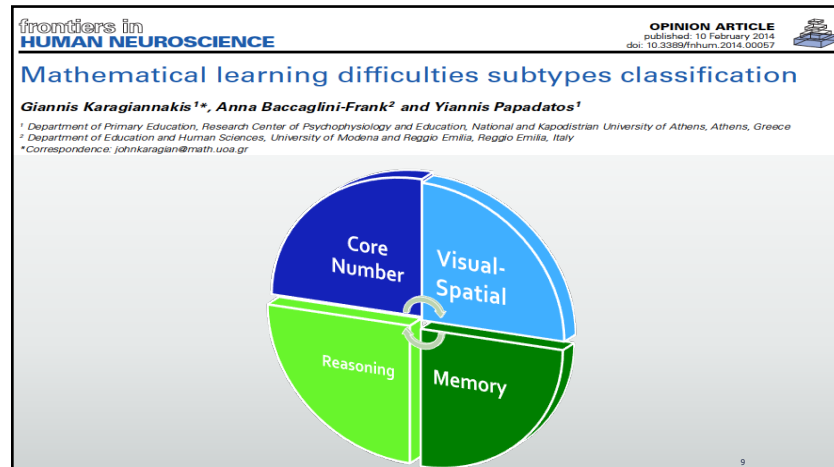
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Mathematical Learning Difficulties

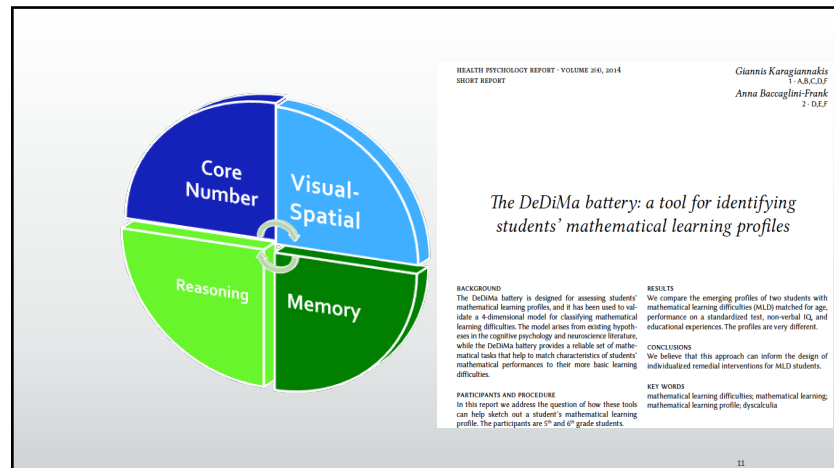
- ❖ Dyscalculia (pure)
- ❖ Dyslexia
- ❖ SLI
- ❖ Dyspraxia (DCD)
- ❖ NLD
- ❖ ADHD
- ❖ Autistic Spectrum Disorder
- ❖ Low average Intelligence

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Mathematical Profile & Dyscalculia Test



Mathematical Profile & Dyscalculia Test



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Routledge
Taylor & Francis Group

Detecting strengths and weaknesses in learning mathematics through a model classifying mathematical skills

Giannis N. Karagiannakis^a, Anna E. Baccaglini-Frank^b and Petros Roussos^c

Table 5. Principle component analysis (varimax) of the tasks of the experimental battery.

	Components			
	Reasoning	Facts retrieval	Core number	Number lines
Mental calculations	.77			
Equations	.74			
Word problems	.70			
Number lines 0-1000	.70			
Maths terms	.59			
Calculations principles	.59			.47
Multiplication facts retrieval		.88		
Addition facts retrieval		.86		
Dots magnitude comparison			.80	
Subitizing-Enumeration			.79	
Number magnitude comparison			.66	
Ordinality				.84
Number lines 0-100				.64
Eigenvalues	4.57	2.14	1.09	1.03
% of variance	35.12	16.47	8.41	7.93

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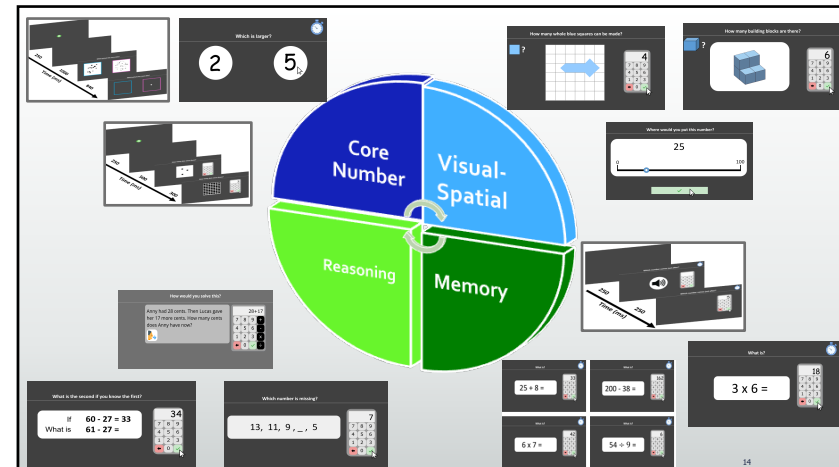
Mathematical Profile & Dyscalculia Test

overview

□ Theoretical framework

□ The MathPro Test

□ MLD profiles



Mathematical Profile & Dyscalculia Test

Population

Typical sample

Grade	Sex		Sum
	Boys	Girls	
1	50	57	107
2	55	43	98
3	52	50	102
4	55	56	111
5	52	40	92
6	56	57	113
Sum	303	320	623

$\chi^2 (5, N = 623) = 3.09, p = .69.$

Clinical sample

19 6th grade MLD from Eureka Leuven school

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Cronbach's a coefficient and repeated-measures analysis of gender, grade, difficulty and grade x difficulty

	Cronbach's a	Gender	sig.	Grade	Difficulty	Grade x Difficulty
Dots comparison (AC)	.53	$F_{1,601} = 1.69$	.194	$F_{1,597} = 27.76$	$F_{4,2160} = 466.46$	$F_{20,2160} = 0.89$
Single digit numbers comparison (RT)	.95	$F_{1,590} = 2.46$	.117	$F_{5,580} = 217.34^{**}$	$F_{1,616} = 252.96^{**}$	$F_{5,616} = 7.12^{**}$
Multi-digit numbers comparison (RT)	.87	$F_{1,505} = 4.50$	.026	$F_{4,502} = 79.56^{**}$	$F_{3,717} = 161.61^{**}$	$F_{6,717} = 2.68$
Single digits numbers typing (RT)	.93	$F_{1,620} = 0.01$	.928	$F_{5,616} = 133.41^{**}$		
Numbers dictation (CRT)	.91	$F_{1,595} = 9.62^{**}$	.002	$F_{5,591} = 26.77^{**}$	$F_{4,2460} = 654.96^{**}$	$F_{20,2460} = 108.17^{**}$
Next number (CRT)	.91	$F_{1,581} = 0.431$	.51	$F_{5,577} = 14.40^{**}$	$F_{2,1020} = 135.84^{**}$	$F_{8,1020} = 34.01^{**}$
Previous number (CRT)	.87	$F_{1,589} = 0.02$	.893	$F_{5,585} = 14.76^{**}$	$F_{2,1020} = 135.61^{**}$	$F_{8,1020} = 39.99^{**}$
Subitizing (AC)	.78	$F_{1,603} = 5.99$	.015	$F_{5,589} = 27.72^{**}$		
Enumeration (CRT)	.91	$F_{1,599} = 0.051$	.821	$F_{5,595} = 58.04^{**}$		
Addition facts retrieval (CRT)	.86	$F_{1,583} = 4.802$	.029	$F_{5,579} = 102.81^{**}$		
Multiplication facts retrieval (CRT)	.79	$F_{1,582} = 0.368$	.545	$F_{4,580} = 76.17^{**}$		
Mental calculations (AC)	.87	$F_{1,483} = 0.34$	.558	$F_{4,480} = 82.96^{**}$		
Number Lines 0-100 (AC)	.93	$F_{1,590} = 9.40^{**}$	.002	$F_{5,586} = 188.97^{**}$		
Number Lines 0-1000 (AC)	.88	$F_{1,583} = 9.37^{**}$	.002	$F_{4,581} = 53.31^{**}$		
Squares (AC)	.67	$F_{1,569} = 0.22$	.639	$F_{3,564} = 16.11^{**}$		
Building blocks (AC)	.80	$F_{1,594} = 0.01$	.953	$F_{5,590} = 63.99^{**}$		
Word problems (AC)	.93	$F_{1,494} = 3.05$	.081	$F_{4,491} = 53.80^{**}$		
Calculation principles (AC)	.92	$F_{1,500} = 0.586$	.444	$F_{4,497} = 23.08^{**}$		
Numerical patterns (AC)	.89	$F_{1,587} = 0.26$	.872	$F_{5,574} = 96.02^{**}$		

^{*}p<.05. ^{**}p<.001

(Karagiannakis & Noël, under publication)

Mathematical Profile & Dyscalculia Test

Principle Component Analysis (varimax) of the tasks of the CleverMath test

	Components			
	1	2	3	4
Numerical patterns (AC)	.763			
Building blocks (AC)	.683			
Word problems (AC)	.671			
Mental calculations (AC)	.655			
Squares (AC)	.631			
Calculation principles (AC)	.563			
Previous number (CRT)		.752		
Multiplication facts retrieval (CRT)		.716		
Next number (CRT)		.707		
Addition facts retrieval (CRT)		.696		
Enumeration (CRT)		.615		
Numbers dictation (CRT)		.573		
Single digit numbers comparison (RT)			.902	
Multi-digit numbers comparison (RT)			.867	
Number Lines 0-100 (AC)				.807
Number Lines 0-1000 (AC)				.602
Subitizing (AC)				.471
Dots comparison (AC)				.453
Eigenvalues	4.41	2.31	1.65	1.17
% of variance	24.49	12.85	9.15	6.51

(Karagiannakis & Noël, under publication)

MANOVA for differences in means of accuracy between 4th – 6th grade control (n=244) and MD (n=43)

	M (SD) control	M (SD) MD	F _{1,282}	Sig
Dots comparison	66.46 (8.95)	64.26 (8.83)	2.205	.139
Single digit numbers comparison	98.16 (2.62)	98.16 (2.62)	0.125	.724
Multi-digit numbers comparison	86.69 (12.03)	80.43 (14.65)	9.224	.003
Numbers dictation	93.58 (12.49)	85.27 (19.12)	13.458	<.001
Next number	93.57 (11.59)	88.76 (15.55)	5.607	.019
Previous number	96.24 (9.87)	93.80 (6.77)	2.431	.120
Subitizing	87.72 (9.89)	81.74 (14.47)	11.372	.001
Enumeration	92.51 (11.48)	84.72 (18.15)	13.712	<.001
Addition facts retrieval	97.99 (7.42)	93.22 (13.76)	11.105	.001
Multiplication facts retrieval	95.47 (8.29)	81.06 (24.88)	50.183	<.001
Number Lines 0-100	4.66 (1.49)	5.72 (2.05)	16.113	<.001
Number Lines 0-1000	59.92 (33.04)	89.12 (46.63)	24.831	<.001
Squares	75.02 (15.52)	61.86 (19.67)	24.039	<.001
Building blocks	92.12 (12.08)	79.36 (24.23)	28.058	<.001
Word problems	72.22 (25.89)	43.02 (20.02)	44.692	<.001
Calculation principles	42.39 (24.19)	24.99 (22.73)	19.197	<.001
Numerical patterns	59.09 (19.45)	41.61 (21.12)	28.757	<.001

MANOVA for differences in means of reaction time between 4th – 6th grade control (n=244) and MD (n=43)

	M (SD) control	M (SD) MD	F _{1,280}	Sig
Single digit numbers comparison	2230.18 (246.63)	2234.33 (264.69)	.011	.918
Multi-digit numbers comparison	2953.32 (370.47)	2981.67 (403.58)	.217	.642
Numbers dictation	1790.36 (544.61)	1812.44 (861.31)	.051	.822
Next number	1195.24 (648.49)	1404.22 (841.27)	3.582	.059
Previous number	877.69 (515.99)	1019.67 (652.59)	2.642	.105
Enumeration	3330.04 (1101.59)	3749.89 (1435.91)	4.999	.026
Addition facts retrieval	235.77 (459.77)	668.00 (947.06)	22.546	<.001
Multiplication facts retrieval	2264.78 (1782.98)	4014.78 (3827.86)	23.695	<.001

(Karagiannakis & Noël, under publication)

Mathematical Profile & Dyscalculia Test

overview

❑ Theoretical framework

❑ The MathPro Test

❑ **MLD profiles**

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MLD profiles

- Case I: [grade 5 boy typical](#)
- Case II: [grade 2 girl typical](#)
- Case III: [grade 4 girl diagnosed with dyscalculia](#)
- Case IV: [grade 6 girl diagnosed with dyscalculia](#)
- Case V: [grade 4 girl diagnosed with dyslexia](#)
- Case VI: [grade 6 girl diagnosed both with dyslexia and dyscalculia](#)
- Case VII: [grade 6 boy diagnosed with SLI](#)
- Case VIII : [grade 5 boy diagnosed with DCD](#)

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Mathematical Profile & Dyscalculia Test

Case IX: Grade 6 boy diagnosed with ADD

Case X: Grade 6 girl diagnosed with dyslexia - dysorthography



Large-scale research

Results of K-means cluster analysis (number of clusters = 6).

	Mean (SD)	Clusters					
		1 (n=6)	2 (n=29)	3 (n=37)	4 (n=31)	5 (n=23)	6 (n=39)
Core number ¹	4.75 (1.77)	1.58	5.73	6.68	3.29	5.26	3.54
Number lines ²	4.94 (1.11)	2.95	5.77	4.95	5.18	4.24	4.82
Facts retrieval ³	4.77 (2.51)	3.14	6.65	6.52	1.46	4.13	4.99
Reasoning ⁴	4.91 (1.48)	1.97	6.80	5.02	4.29	3.50	5.16
MLD (n=9)		3	0	0	4	2	0
LA (n=17)		3	0	3	4	2	5

¹F=82.03, p<.001; ²F=8.53, p<.001; ³F=132.25, p<.001; ⁴F=41.93, p<.001

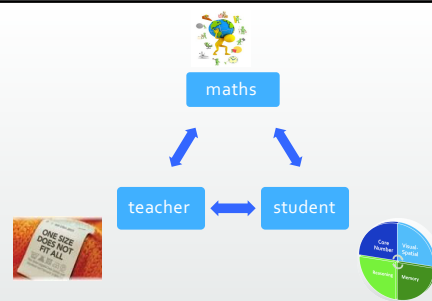
(Karagiannakis, Baccaglini-Frank & Rousos, 2017)

Mathematical Profile & Dyscalculia Test

Conclusion

...seeing the big picture

Future directions



➤ Cross-cultural MLD studies

➤ Extend the online MathPro Test for secondary education students and adults.

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Thanks!

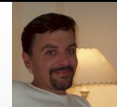
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