The effect of the ThinkMath intervention on low performing South African children's early numeracy skills

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Outline

- Need and benefit of early maths intervention programmes in SA

- ThinkMath intervention

- Method: procedure, measures, sample

- n=439 results (T1)

- Intervention initial results n=268 (T1 & T2) and also (T3)
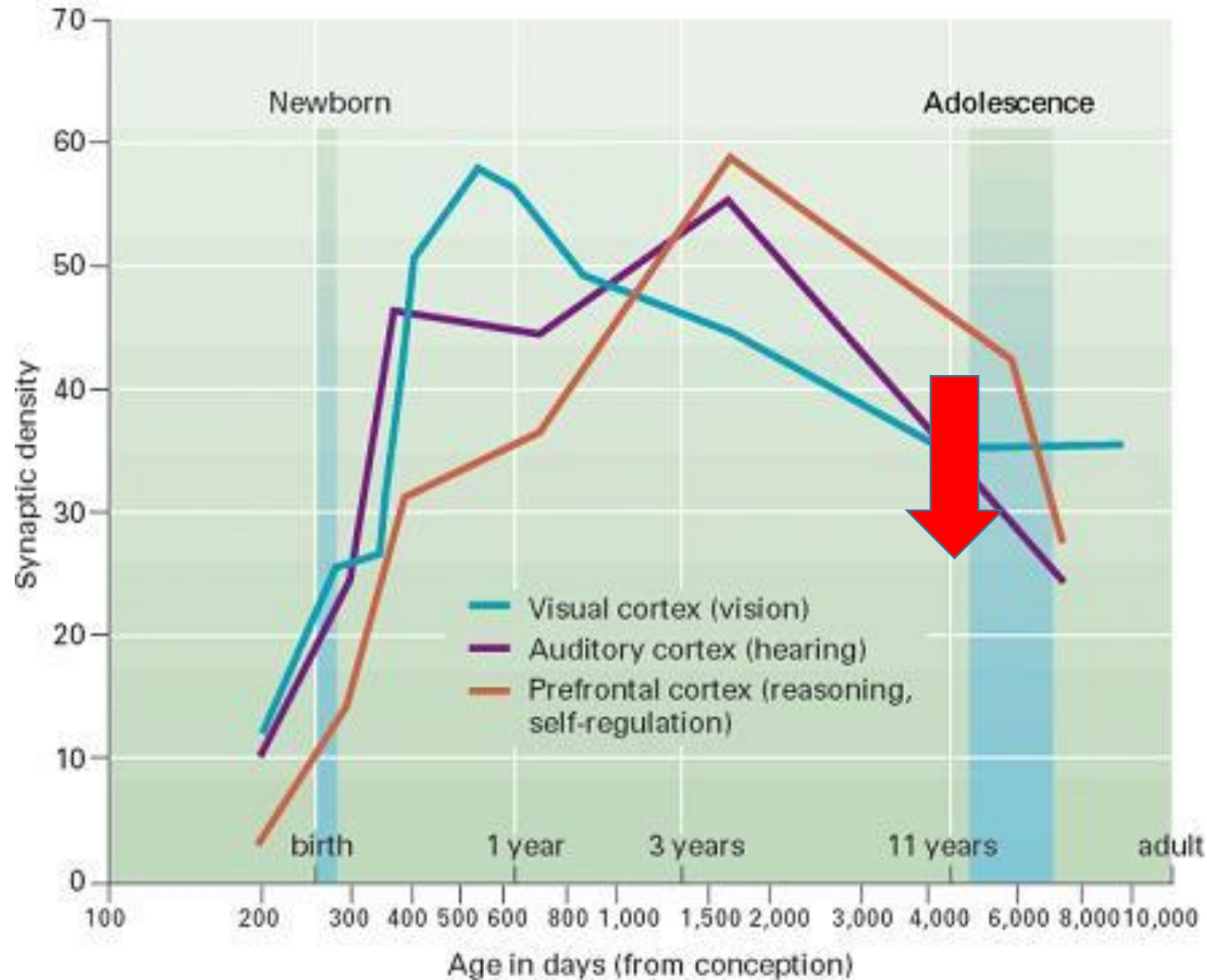
Researcher / Practitioner

- "Learners with special educational needs not properly served"
  (Motshekga, 2016)

Classrooms

Teacher

'Learning'

'Test'

Conceptual change
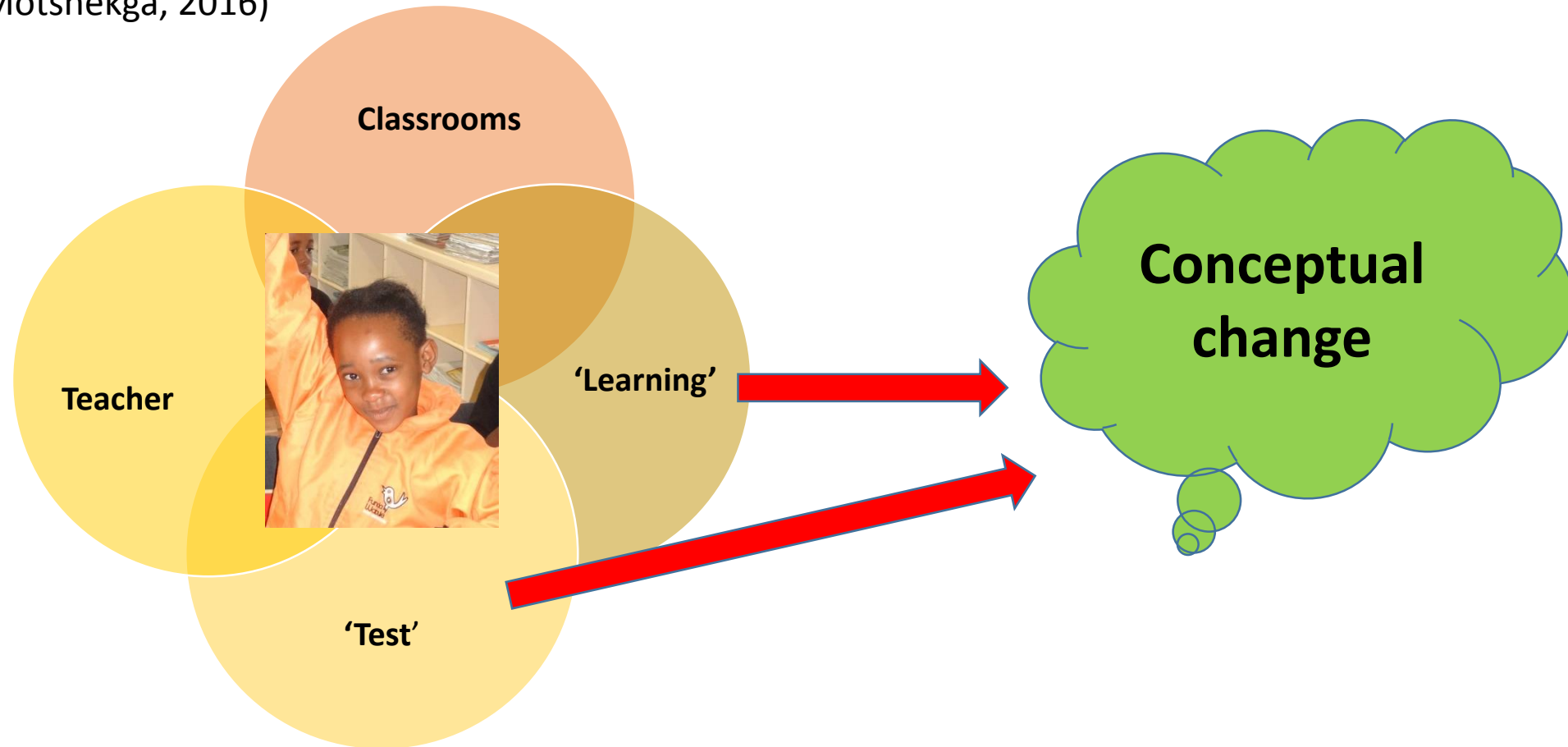
NEED FOR EARLY MATHS INTERVENTION

- SA shows very poor maths results in later grades
(Spaull & Kotze, 2015; Rademeyer, 2014; Taylor & Taylor, 2013)

- Numerous studies show the benefit of early maths intervention when the basic concepts are formed and foundation
(Korhohen & Aunio, 2016; Spaull & Kotze, 2015; Aunio & Niemivirta, 2010; Desoete, et al., 2009)

- Without adequate classroom intervention, children performing low in early mathematical skills (i.e., scoring at or below the 25th percentile in early mathematics tests), most often demonstrate continuing low mathematical performance through-out their schooling careers
(Geary, 2013; Farkas, & Wu, 2009; Aubrey, Dahl, & Godfrey, 2006)

- Achievement gap between early low performers and their peers, increases as they progress to older grades (Aunola, Leskinen, Lerkkanen, & Nurmi, 2004)

- Importance of early mathematical intervention to address, and further prevent the emergence of possible mathematical difficulties later on (Gersten et al., 2009; Dowker, 2004)

South Africa

Synaptic Density: Infancy to Adulthood

NEED – EARLY MATHS INTERVENTION

- Focus of intervention programs should be on the early grades
- No/few researched measurements or tests available
- Foxcroft et al (2004) noted that 65.8% of practitioners "indicated that they feel the tests that they use are only sometimes appropriate to test for difficulties"
- No/few researched interventions available for Foundation Phase (Grades R-3)

South Africa

INTERVENTION ➡ TO IMPROVE BASIC NUMBER CONCEPT

- a specific mathematics programme, for a specified group, in a specified time frame, and of a certain intensity (Mononen, 2013)

- Intervention implemented with Grade 1 children in and around Johannesburg (Gauteng)

- Adapted from the *Finnish ThinkMath-K Intervention*

INTERVENTION ➡ TO IMPROVE BASIC NUMBER CONCEPT

- Finnish ThinkMath –project, which produces evidence-based *mathematics and thinking skills* instruction materials

- For at risk children in K to 2 Grades

- Funded by the Finnish Ministry of Education and (2011-2015)

- Materials are provided for teachers via web service (free-of-cost) http://blogs.helsinki.fi/thinkmath/

THINKMATH-K INTERVENTION PROGRAM

Mathematical relational and counting skills (0-10)

- Making comparisons of quantities and numbers using related concepts such as more and less

- Counting number sequences orally, counting objects and matching them with number words and number symbols

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MATEMAATTISET SUHDETAIDOT
JA LASKEMINEN 0–10

Matemaattiset suhdetaidot ja laskeminen 0-10   ©ThinkMath 2014

Research Question:

What the effect of the ThinkMath intervention on low performing South African children's early numeracy skills?

Method - Procedure
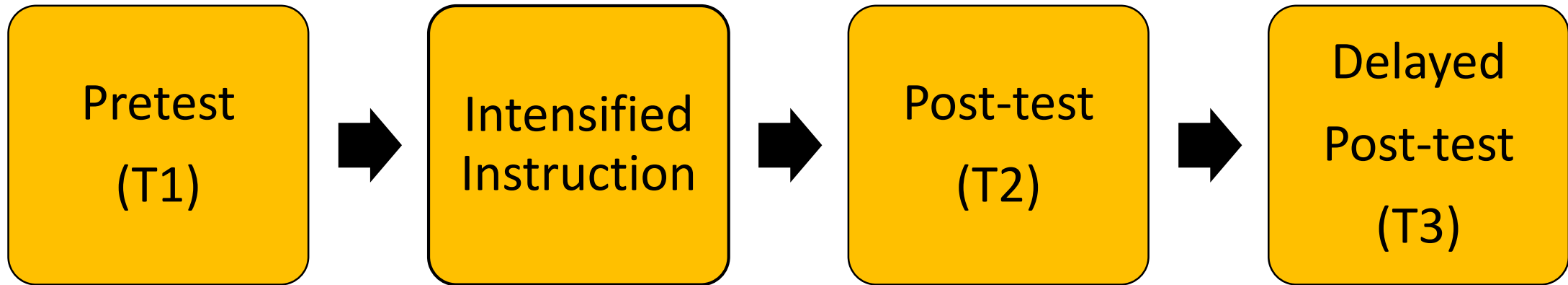
Method - measures

Maths

- ThinkMath Scale (Aunio & Mononen, 2012)
- 43 items
- α = . 930

Language

- Listening Comprehension (Ragpot & Brink, 2016)
- 15 items
- α = .701

Executive Functions

- Inhibition, working memory, cognitive flexibility
- Modified Flanker Task (Ericson & Ericson, 1974; Roebers & Kauer, 2009)
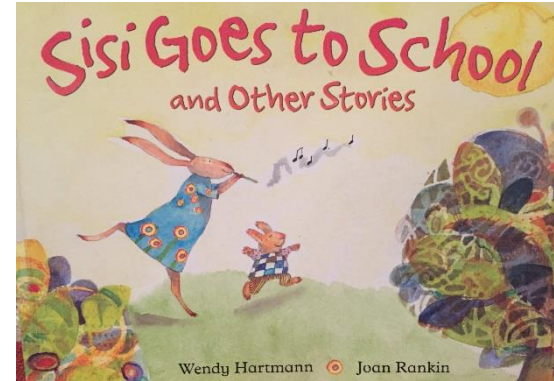
Method – Maths Measure

- ThinkMath scale for Kindergartners
(Aunio & Mononen, 2012), max. 43 p. (α = .93)

- Skills measured:
  - 1 Relational skills – comparison (more, the most, as many as, less)
  - 2 Counting skills - Oridinal numbers
  - 3 Relational skills- comparison (comparison with numbers, smallest)
  - 4 Relational skills (comparison with numbers, biggest)
  - 5 Word problem solving
  - 6 Counting skills (NWS forward)
  - 7 Counting skills (NWS backwards)
  - 8 Counting skills (enumeration 1)
  - 9 Counting skills (enumeration 2)
  - 10 Counting skills (enumeration 3)

Method – Maths Measure

- ThinkMath scale (Aunio & Mononen, 2012), max. 43 p. (α = .93)

Method – Language measure: Listening Comprehension

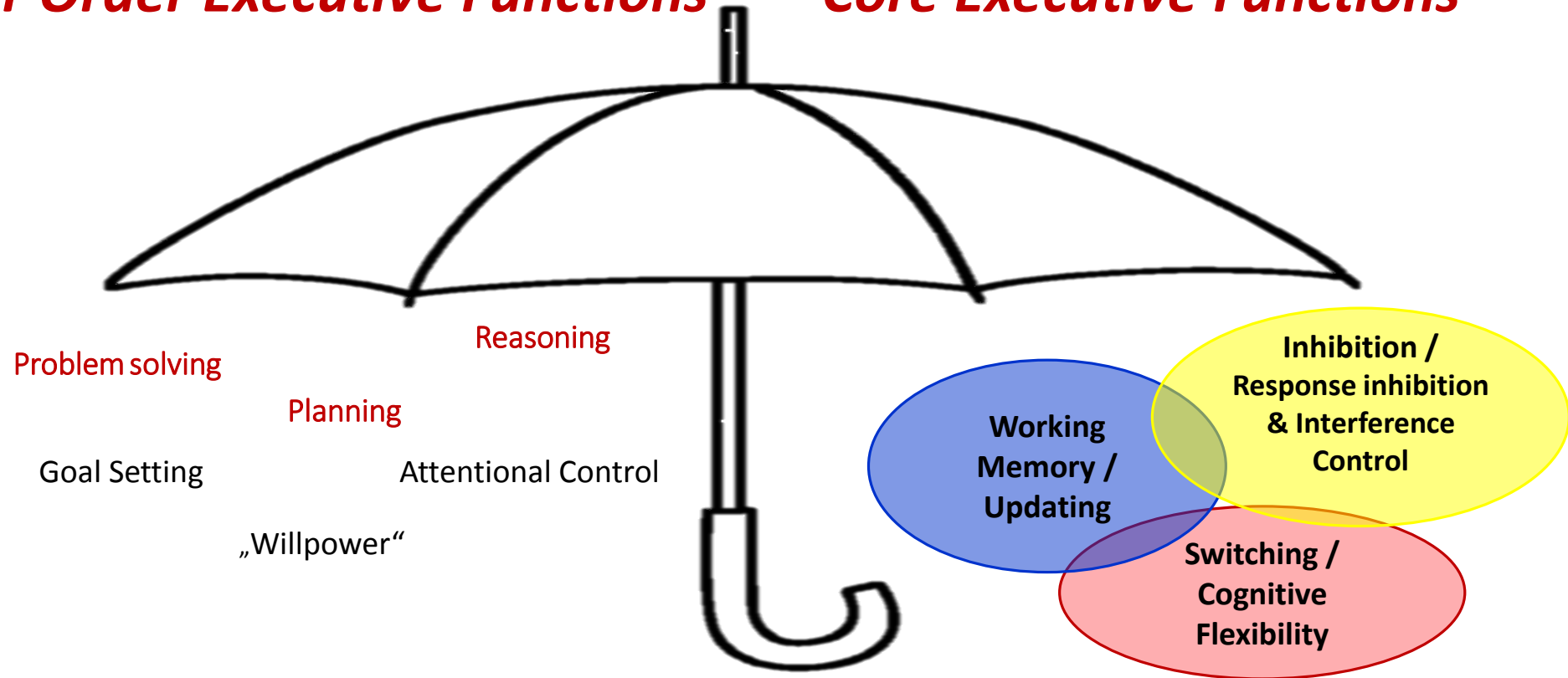- *Gogo's dog* (Hartman & Rankin, 2013) from anthology of stories: *Sisi goes to school and other stories*

- Listening comprehension scale with 15 questions in range of difficulty (Ragpot & Brink, 2016),

- Based on the Shell-K listening comprehension protocol (Snow, 2016; originally developed by Snow, et al., 1998).

- A parallel measure is currently being designed - will be used during T3 (practice effect)

Method: Executive functions:
Neuropsychological Perspective on Executive Functioning (Miyake et al. 2000)

Higher Order Executive Functions   *Core Executive Functions*

Reasoning

Problem solving

Planning

Goal Setting   Attentional Control

„Willpower"

Working Memory / Updating

Inhibition / Response inhibition & Interference Control

Switching / Cognitive Flexibility

What are Executive Functions?

- Brain functions used to manage attention, emotions, and pursuit of goals, information updating, and monitoring

- Emerge during preschool years and don't fully mature until early adulthood (Diamond, 2013; Huizinga et al., 2006; Romine & Reynolds, 2009)

- First signs of EF already during infancy

- Developmental peaks:
  - 5 to 8 years
  - Kindergarten, pre-school, first primary school years

- More predictive of school success than IQ.
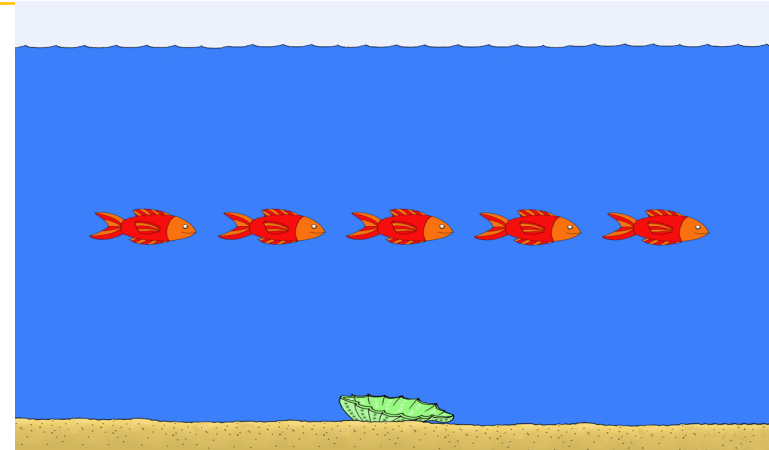
Modified Flanker Task

(Ericson & Ericson, 1974; Roebers & Kauer, 2009)

FOUR BLOCKS in the TEST

1. Congruent Block
- 4 practice
- 16 tests (congruent)

2. Standard Block
- 5 practice
- 32 tests
- (16 congruent, 16 incongruent)
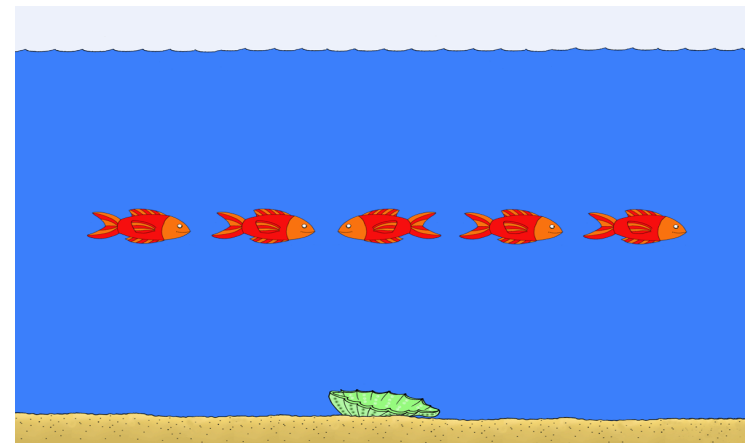
Modified Flanker Task

(Ericson & Ericson, 1974; Roebers & Kauer, 2009)

3. Reversed Block

- 8 practice

- No test
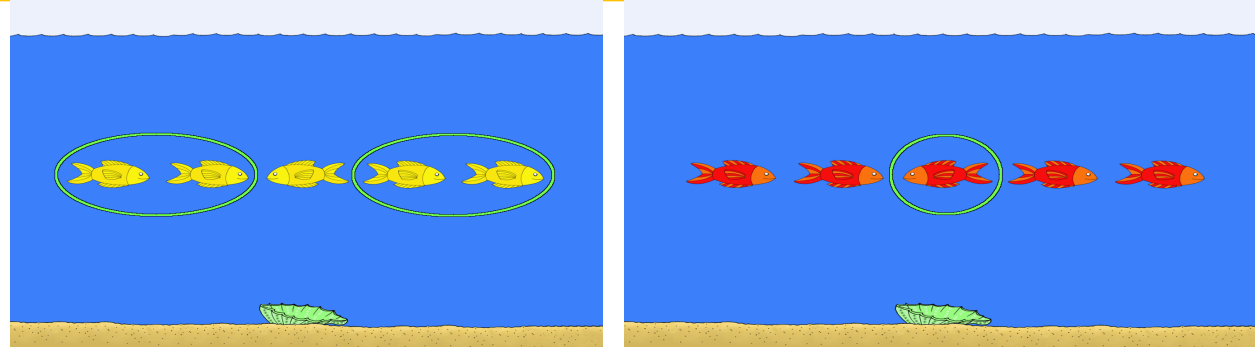
4. Mixed Block

- 5 practice

- 32 tests

- (16 congruent, 16 incongruent,

- including 8 switch and 8 non-switch trials)
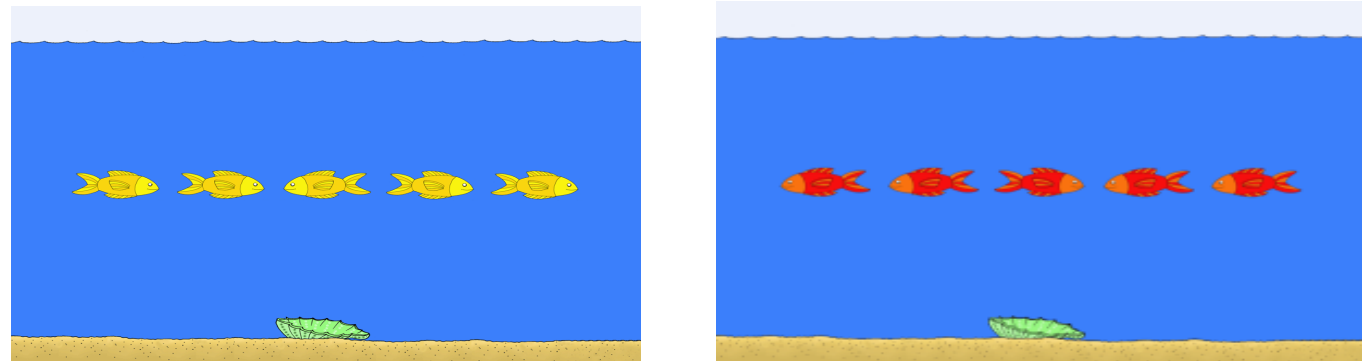
Participants are instructed to respond as fast and as accurate as possible to the fish.

Results:

n=448
(T1)

n=268
(T1 & T2)

Method (T1) - Participants

- n=448
- From 17 Grade 1 classes in 7 schools: 4 public and 3 private
- In and around Johannesburg in Gauteng province in SA
- M_{age} = 6 years and 10 months (SD 5.40 months)
- Boys_n=242
- Girls_n=206

Early Numeracy Performance of South-African School Beginners (Aunio, Mononen, Ragpot, Henning & Törmänen, submitted)

1 Relational skills – comparison (more, the most, as many as, less)
2 Counting skills - Oridinal numbers
3 Relational skills- comparison (comparison with numbers, smallest)
4 Relational skills (comparison with numbers, biggest)
5 Word problem solving
6 Counting skills (NWS forward)
7 Counting skills (NWS backwards)
8 Counting skills (enumeration 1)
9 Counting skills (enumeration 2)
10 Counting skills (enumeration 3)

schools and 109 children
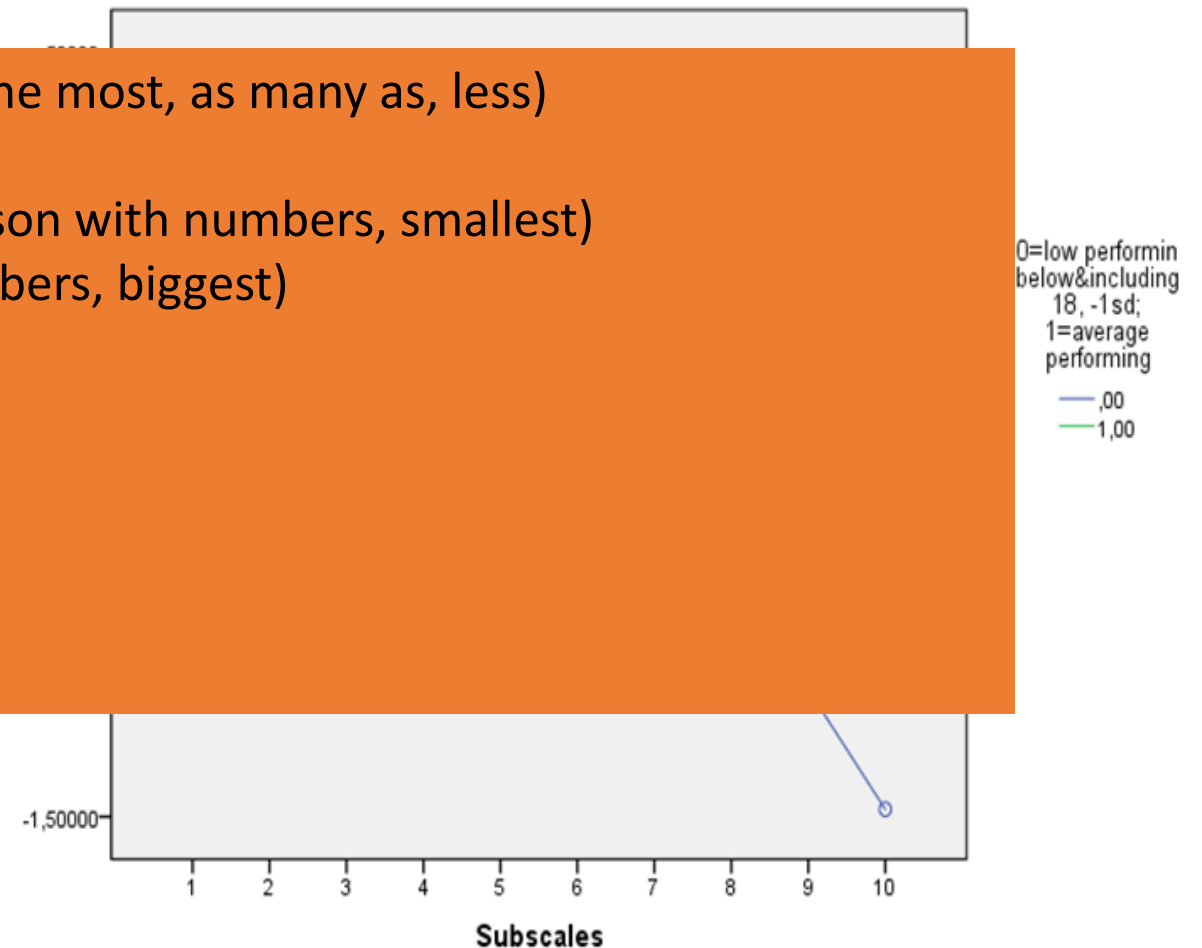in public schools

0=low performin
below&including
18, -1sd;
1=average
performing

,00
1,00

-1,50000

Subscales

Figure 1: Children's performance in subscales

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Early Numeracy Performance of South-African School Beginners (Aunio, Mononen, Ragpot, Henning & Törmänen, submitted)

School	Public or Private	Low performing children	Average performing children	All children
School 1	Public	9	39	48
School 2	Public	4	72	76
School 3	Private/remedial	0	16	16
School 4	Public	25	81	106
School 5	Private	1	37	38
School 6	Public	45	59	104
School 7	Private	0	55	55

Table 1. Low and average performing children
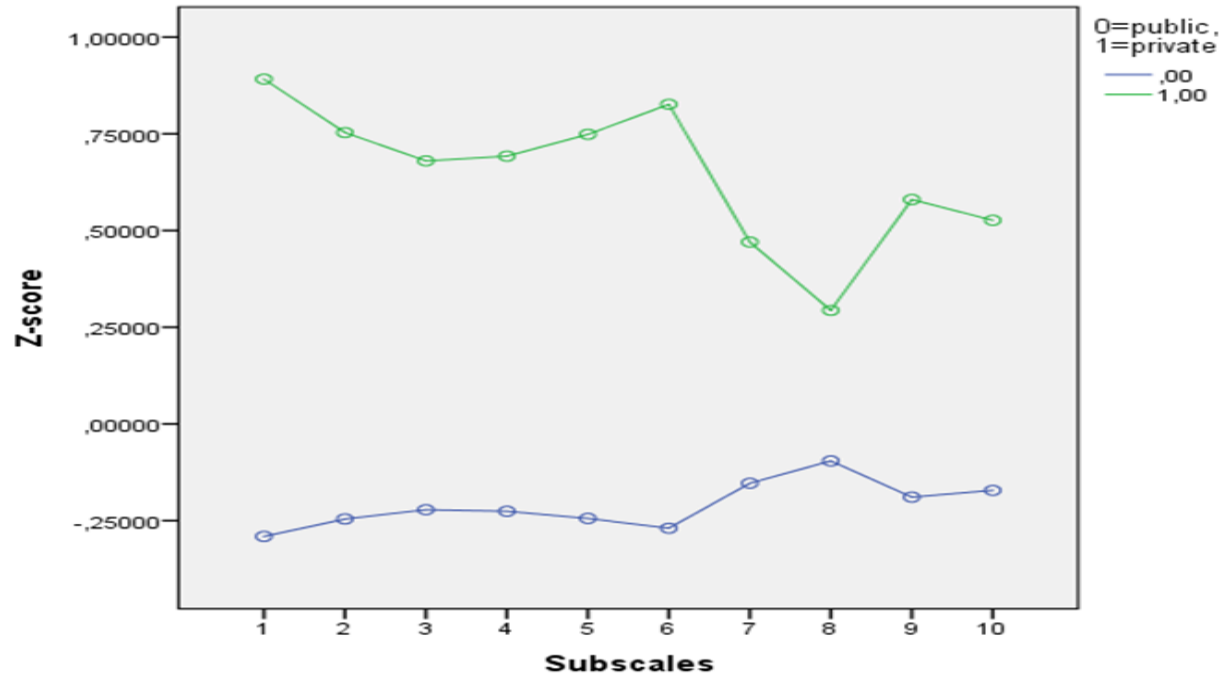In South-African private and public schools

Figure 2: The early numeracy performance subscales in public and private schools

Early Numeracy Performance of South-African School Beginners (Aunio, Mononen, Ragpot, Henning & Törmänen, submitted)

Figure 3: Early numeracy performance distribution in schools
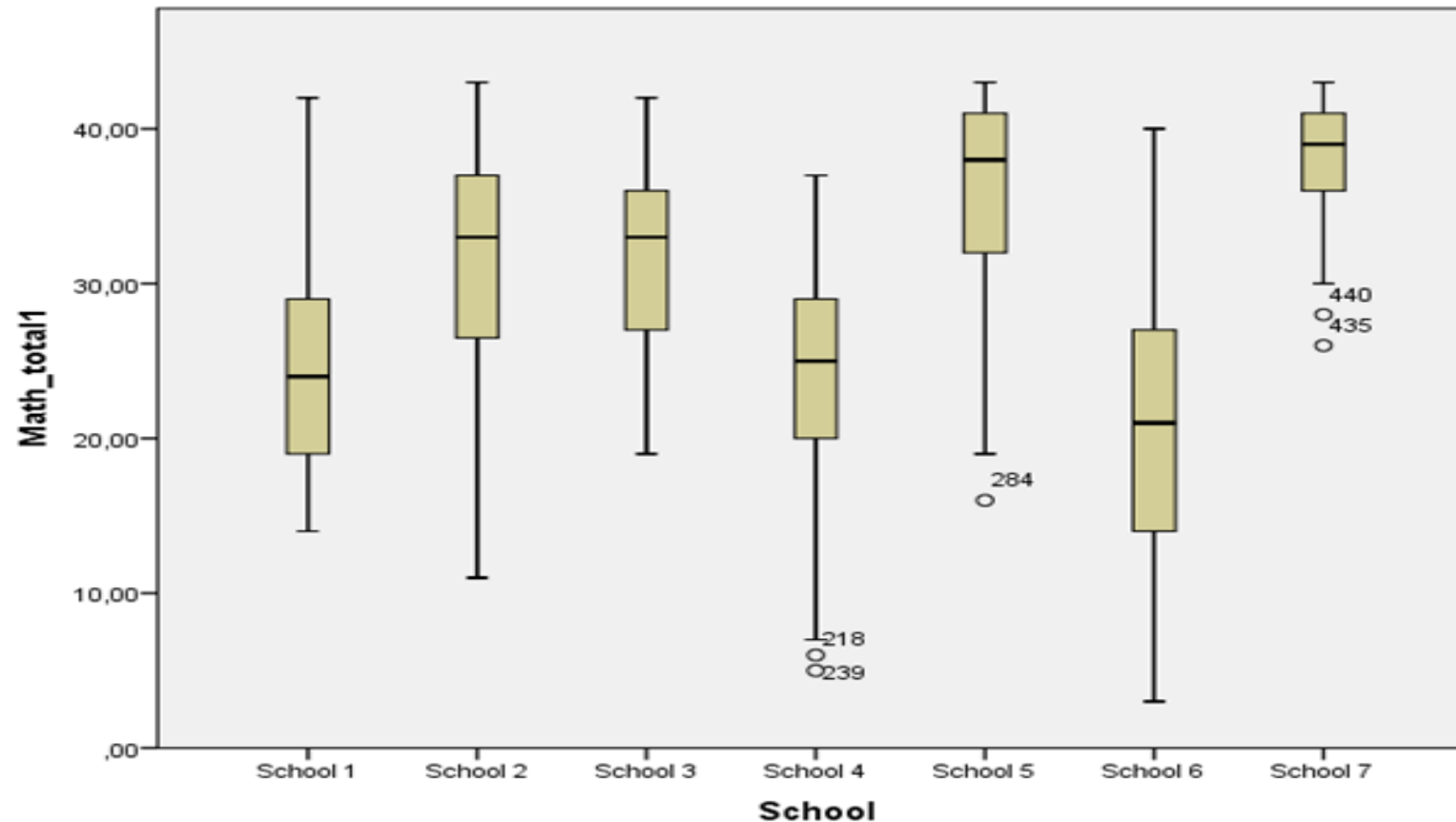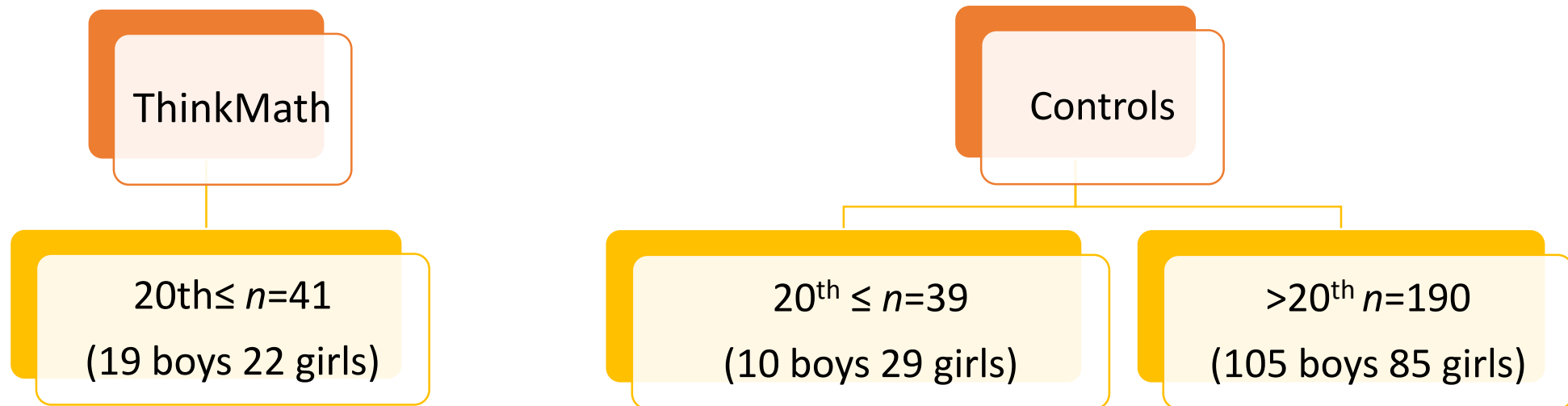
Method - Participants

- *n*=268

- From 14 Grade 1 classes in 7 schools: 4 public and 3 private

- In and around Johannesburg in Gauteng province in SA

- M$_{age}$ = 6 years and 10 months (SD 5.40 months)

ThinkMath

20th≤ *n*=41
(19 boys 22 girls)

Controls

20th ≤ *n*=39
(10 boys 29 girls)

>20th *n*=190
(105 boys 85 girls)

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Results: Overall data

- Maths: Boys performed better than girls at T1, $t(268) = 2.512$, $p = .013$, but not in T2

Gender	N	T1 (*M, SD*)	T2 (*M, SD*)
Boys	134	26.09 (9.30)	31.03 (8.45)
Girls	136	23.13 (10.03)	29.35 (8.87)

- Language: no gender difference at T1 or T2

Gender	N	T1 (*M, SD*)	T2 (*M, SD*)
Boys	134	9.97 (2.68)	11.51 (2.45)
Girls	136	9.49 (2.57)	10.95 (2.44)

RESULTS

Maths T1 and T2

	Intervention	Low controls	Average controls
■ Maths T1	12.83	13.54	29.41
■ Maths T2	23.85	22.74	33.07

(max. 43 points)
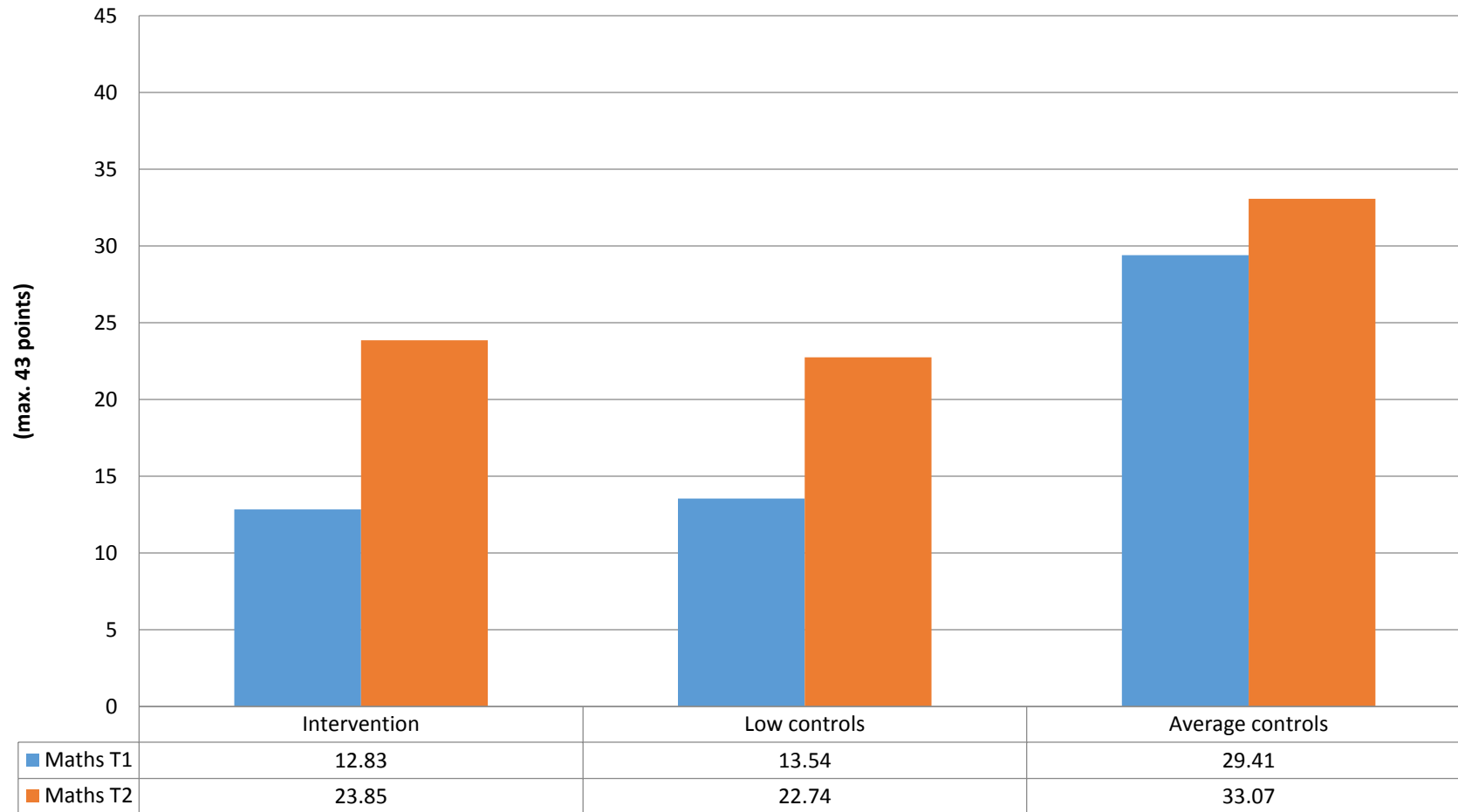
T1: $F(2,267) = 183.224$, $p < .001$
- Ave > Low C, Int

T2: $F(2,267) = 48.412$, $p < .001$
- Ave > Low C, Int

South Africa
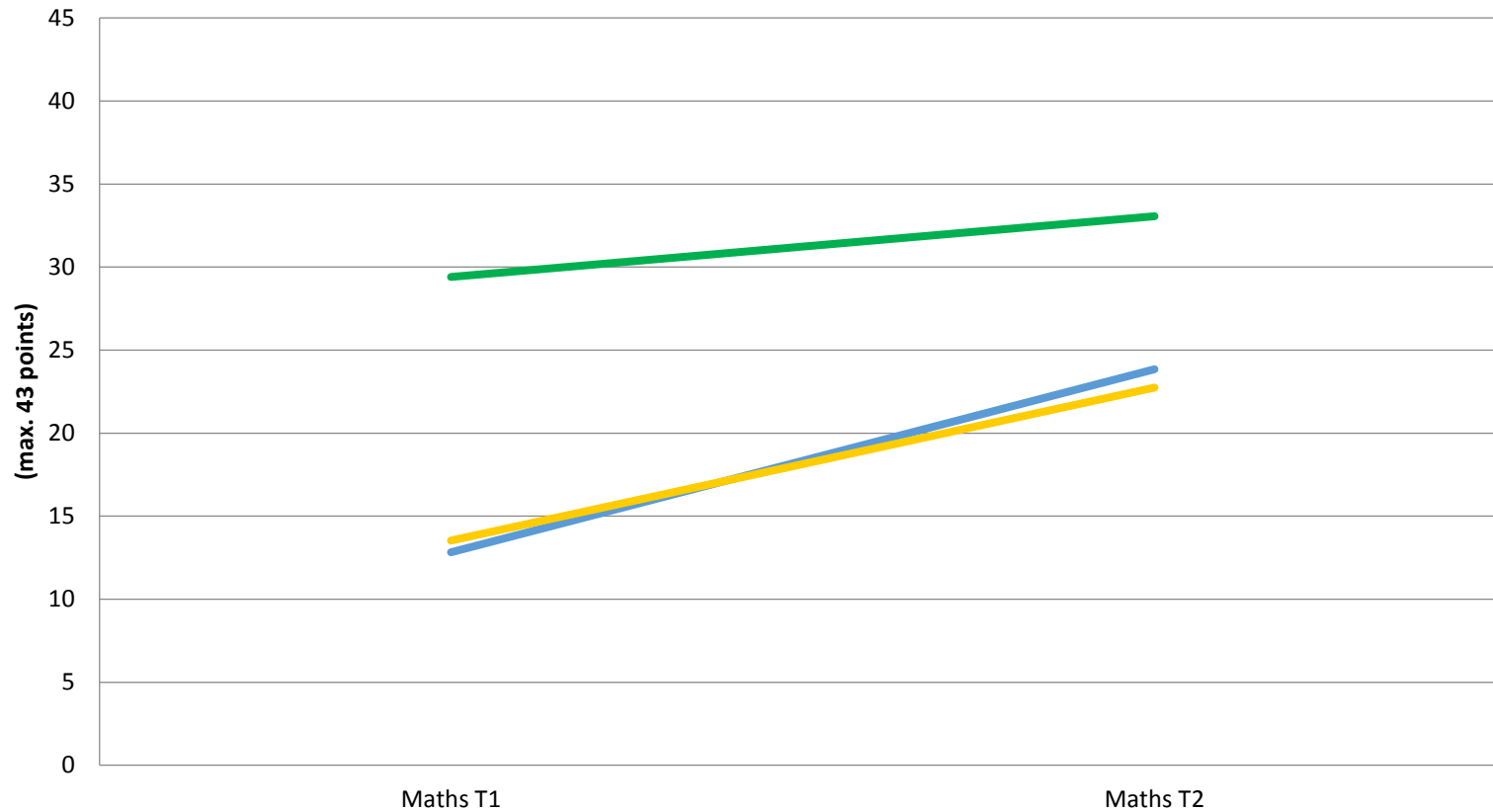
Results

Gain: $F(2,267) = 31.075$, $p < .001$
- Int, Low C > Ave C

Maths

(max. 43 points)

Intervention $M = 11.02$, $SD = 6.51$

Low controls $M = 9.21$, $SD = 6.87$

Average controls $M = 3.66$, $SD = 6.06$

Maths T1   Maths T2

Results

Language T1 and T2
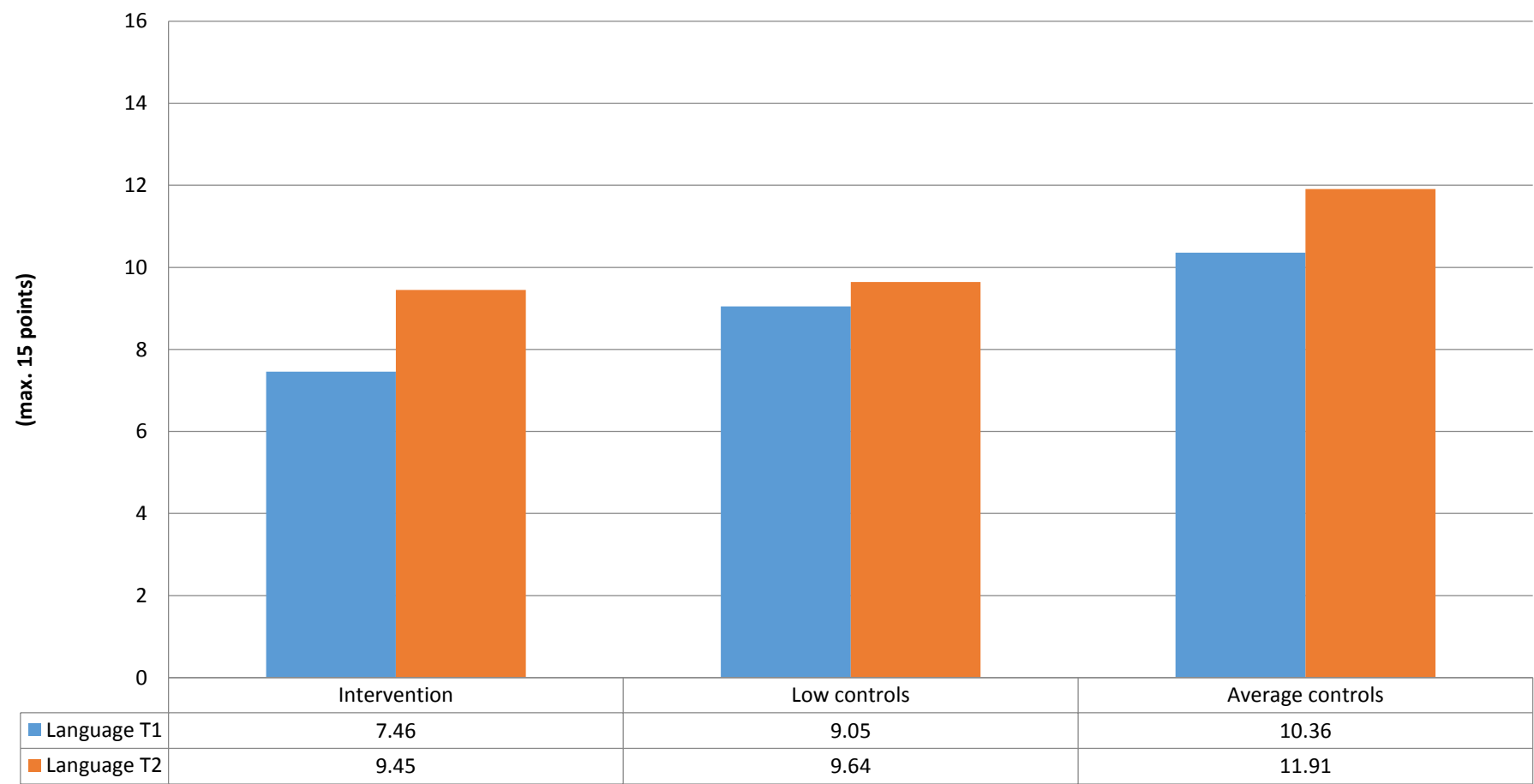
	Intervention	Low controls	Average controls
Language T1	7.46	9.05	10.36
Language T2	9.45	9.64	11.91

(max. 15 points)

South Africa

Results
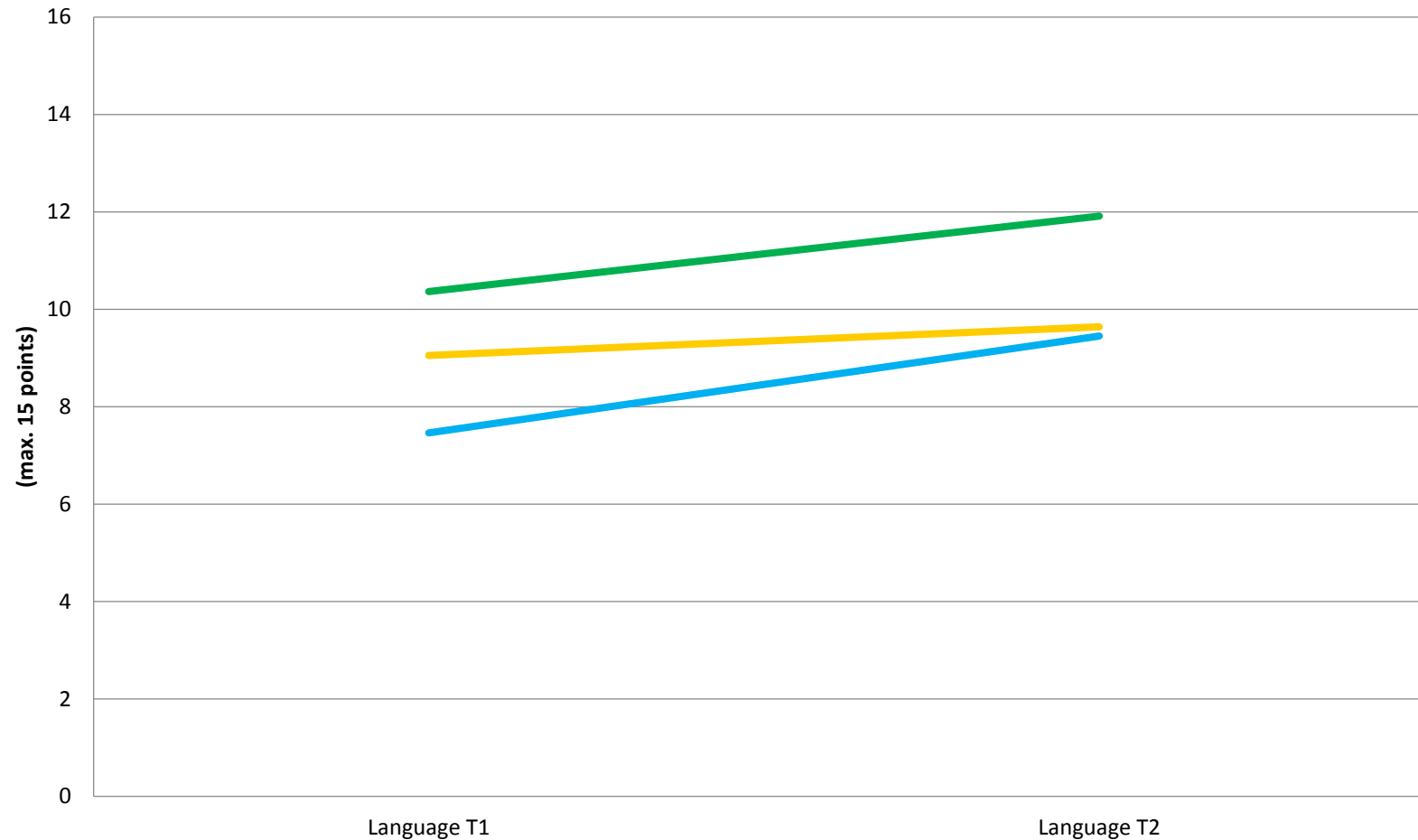
Gain: $F(2,261) = 5.501$, $p = .005$
- Int > Low C
- Ave C > Low C

Intervention	$M = 1.98$, $SD = 2.13$	
Low controls	$M = 0.50$, $SD = 2.06$	
Average controls	$M = 1.57$, $SD = 2.02$	

Language

(max. 15 points)

Language T1   Language T2

Discussion

- Low performing children improved their math skills, no difference between the intervention and the low control groups
  - Duration? Language? Socio-economical and other problems?
- Low performers all from public schools → interventions and resources needed
  - Classroom interventions, focus also more on math concepts
- General language improvement of low performers important finding

THE WAY FORWARD

- Measurement – new modified screening test

- Pre-intervention programme

- 2 x Intervention programmes

- All will be available for free download from the ThinkMath SA website

THE WAY FORWARD

- 5 Lesson pre-intervention
- Focus on language of early maths concepts
- Story-based
- As teacher reads story to children, they do activities based on the story which develops their maths vocabulary
- Children are exposed to the same story and get used to it
- Same ideas in story will be used in modified intervention

THE WAY FORWARD

- **SMALL GROUP INTERVENTION**
- Modified intervention programme
- 18 lessons
- 9 weeks x 2 lessons

- **WHOLE CLASS INTERVENTION**
- Based on the ThinkMath intervention
- Co-inside with curriculum
- Focused on three levels of differentiation
- 18 lessons
- 9 weeks x 2 lessons

References

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