Representing Numerical Primitives by Adults suffering from Dyscalculia

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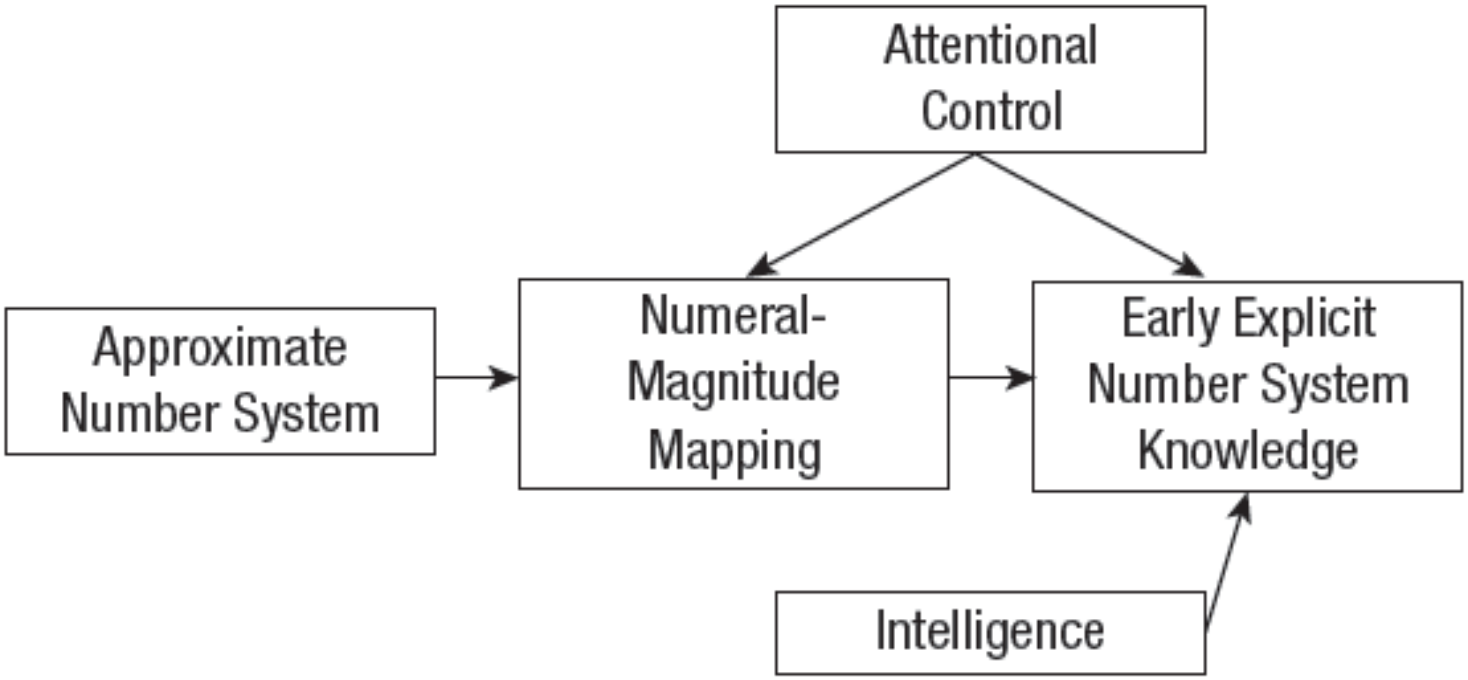
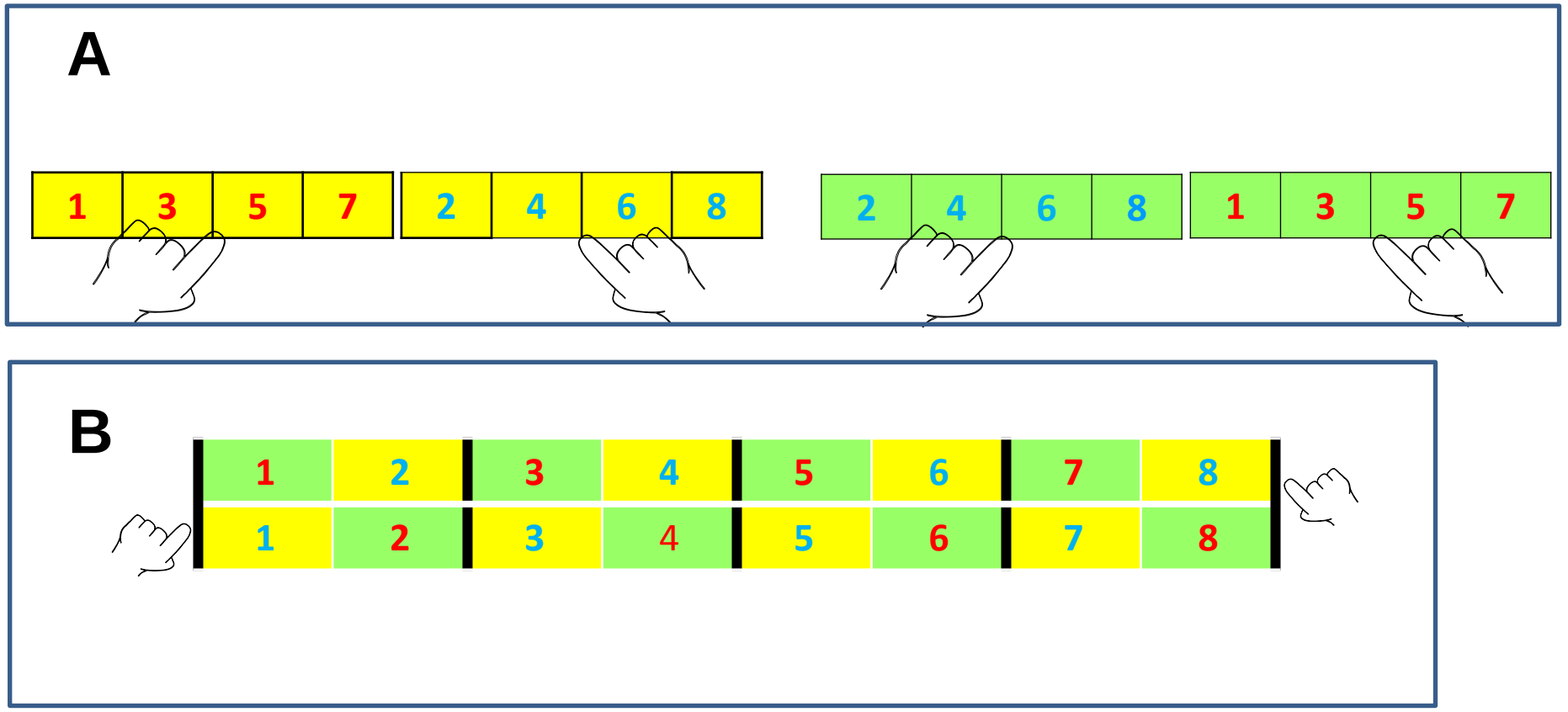
ASCL: Automaticity Skill & Consciousness Lab

- This talk is about processing numbers.
- Numbers are symbolic representations of magnitudes.
- Only some of all numbers that we understand and use in computations are stored as such in long-term memory (LTM).
- We refer to such numbers as **primitives**.

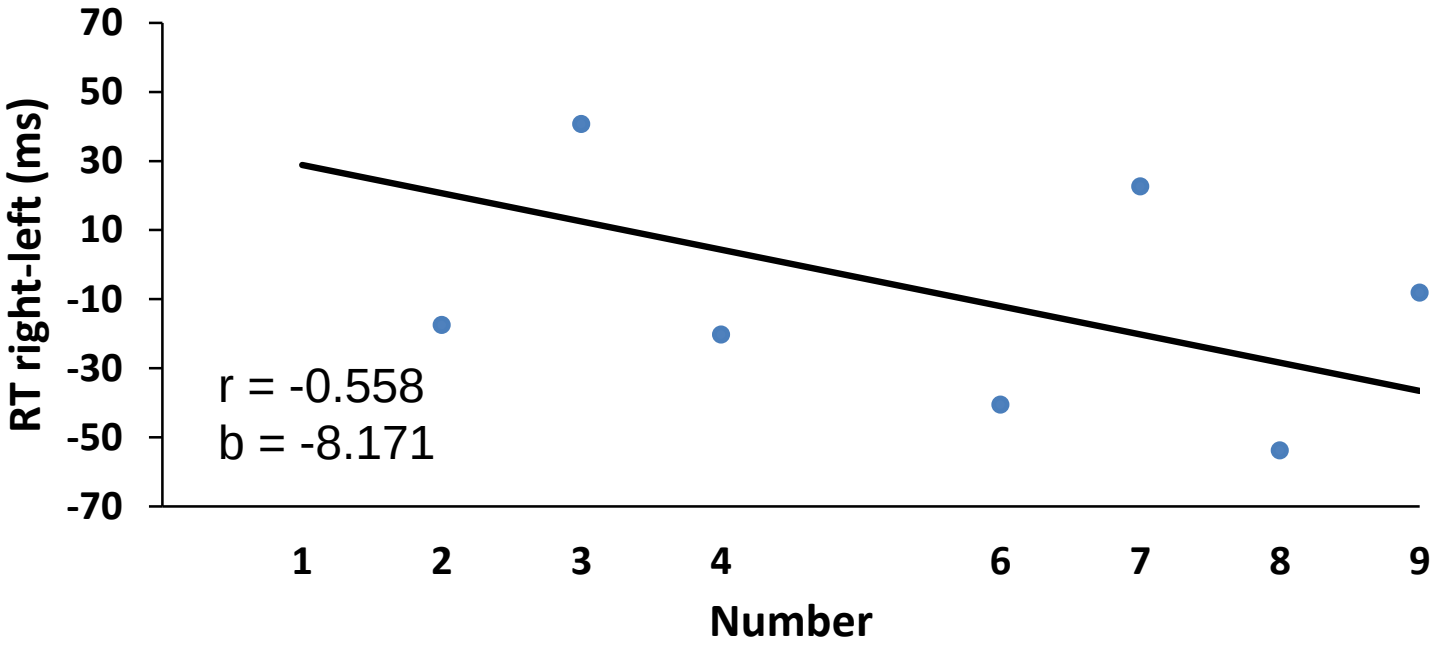
- **Primitives** are stored in semantic memory as a unit, and retrieved as a unit (Logan, 1988; Perruchet & Vinter, 2002). Primitives can be used to generate additional numbers
- **Automatic processing** allows access to primitives processing that runs without conscious monitoring (Tzelgov, 1997) relatively uncontaminated by task demands.
- Numerical primitives are arranged along the mental number line.
- This arrangement is compressed


Attentional Control
Approximate Number System
Numeral-Magnitude Mapping
Early Explicit Number System Knowledge
Intelligence

SNARC effect - arrangement from left to right on the mental number line

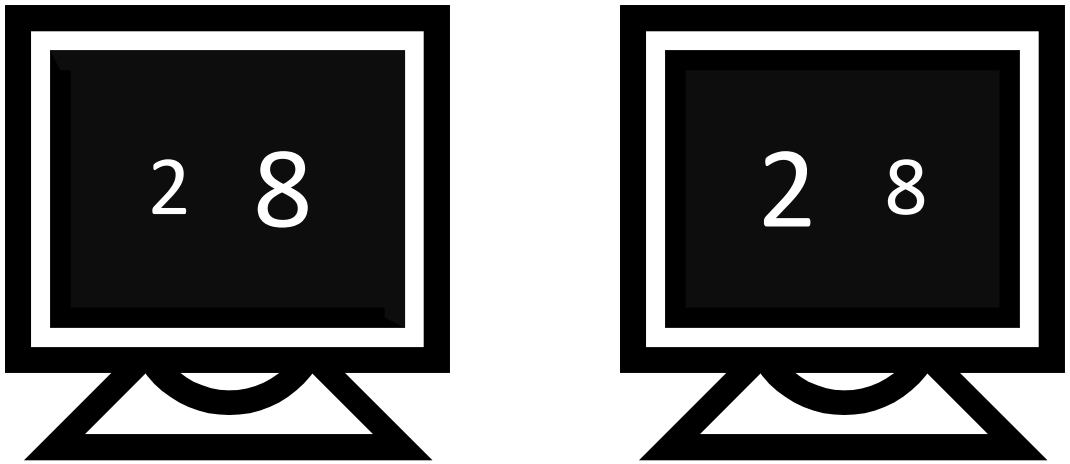


SNARC


70
50
30
10
-10
-30
-50
-70
RT right-left (ms)
r = -0.558
b = -8.171
1
2
3
4
6
7
8
9
Number

The features of the mental number line: The Physical Comparison Task

Which number is physically larger?



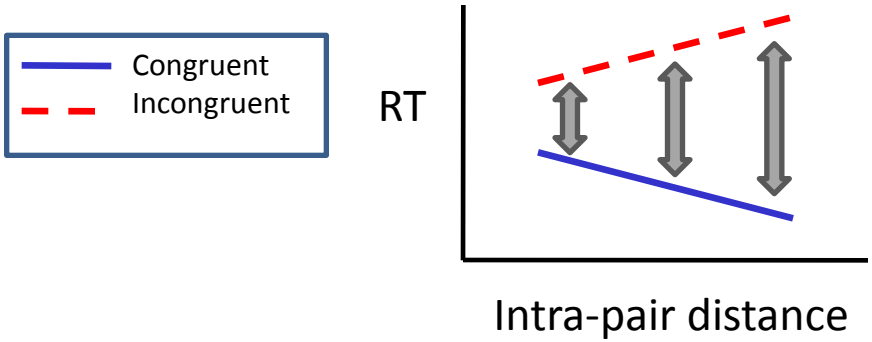
RT *(congruent)* < *(incongruent)*

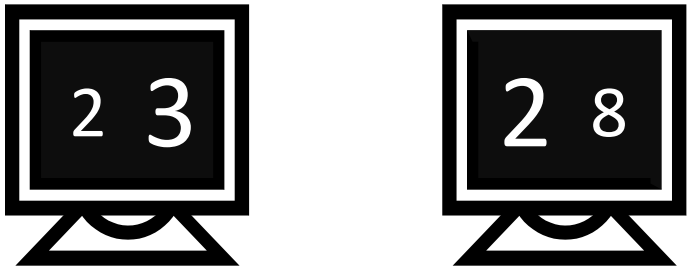
Size Congruity Effect

(SiCE; Henik & Tzelgov, 1982)

Linear arrangement on the MNL

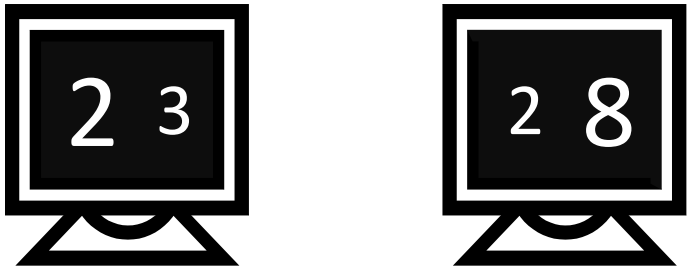
Which number is <u>physically</u> larger?





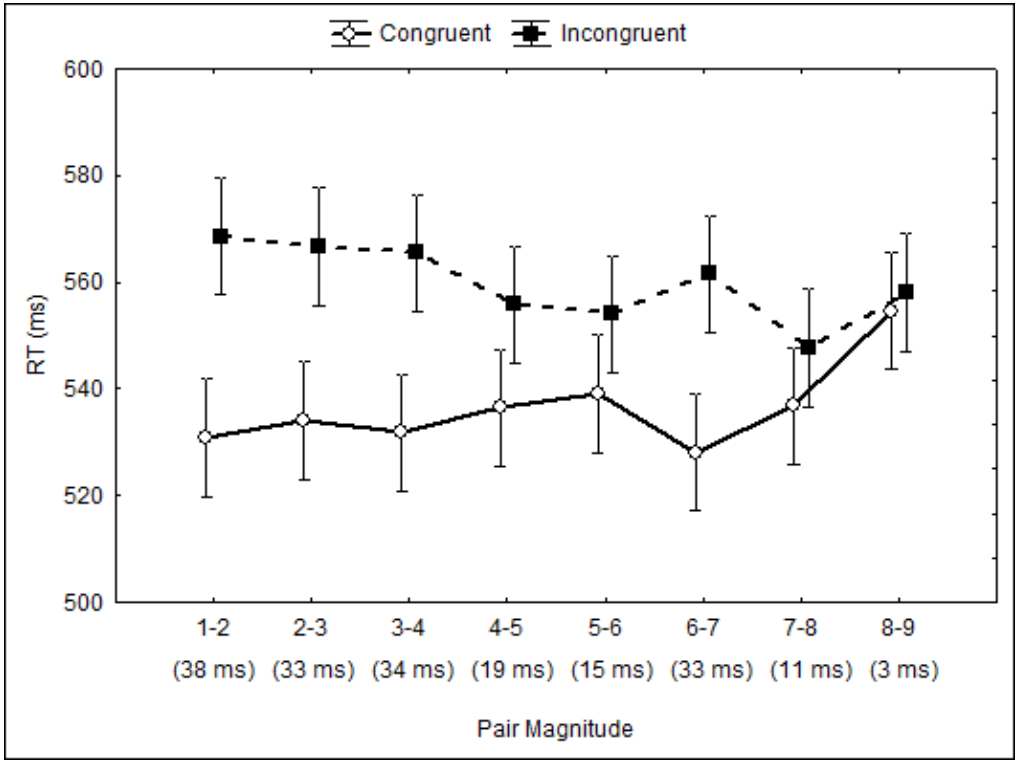
RT *(incongruent)* < *(incongruent)*

- **A SiCE that increases with intrapair distance**



RT *(congruent)* > *(congruent)*

The SiCE decreases with the numbers magnitude



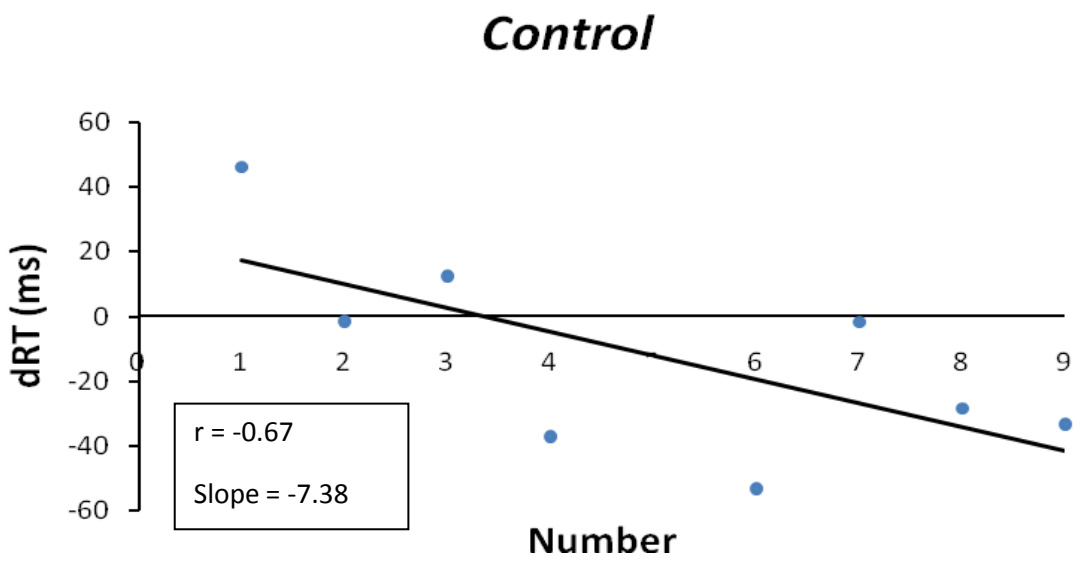
Comparing DD students and controls

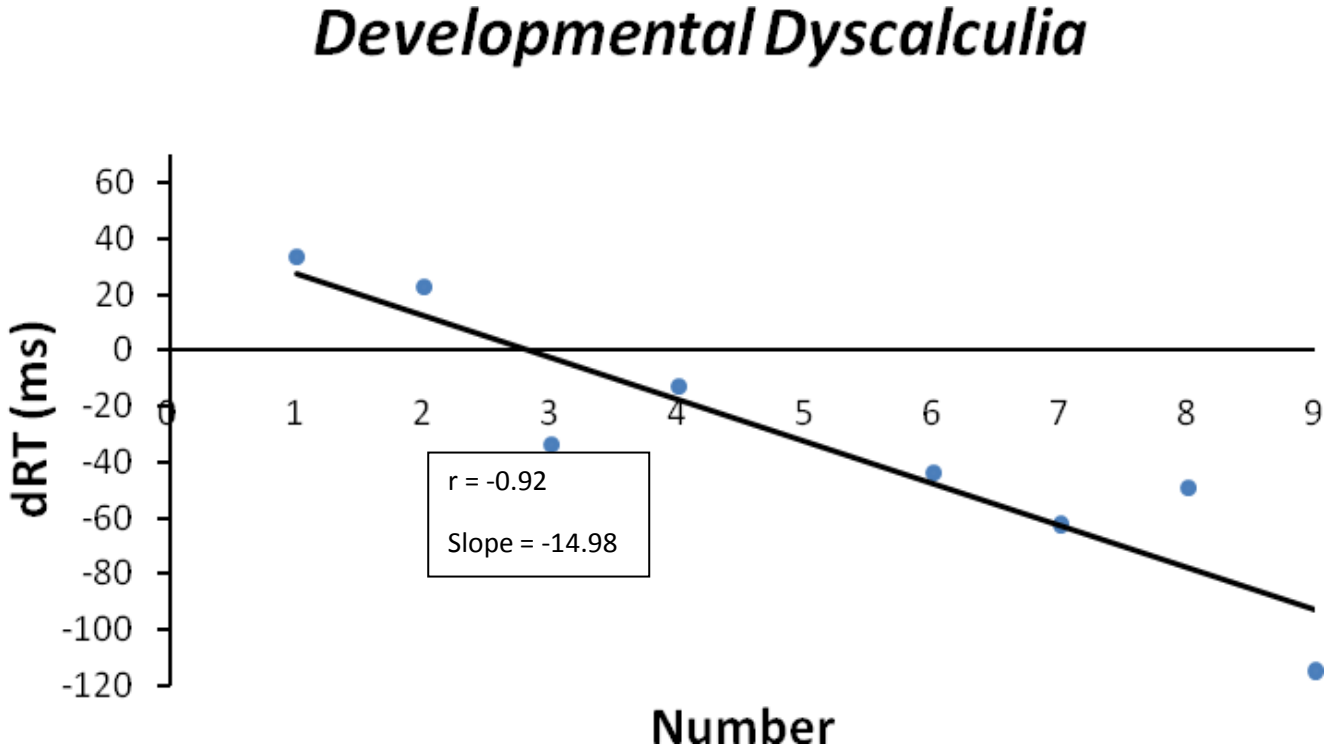
Twenty-nine young adults participated in the study; 13 of them, who were previously diagnosed with dyscalculia, composed the clinical sample while the remaining 16 composed the control sample

.

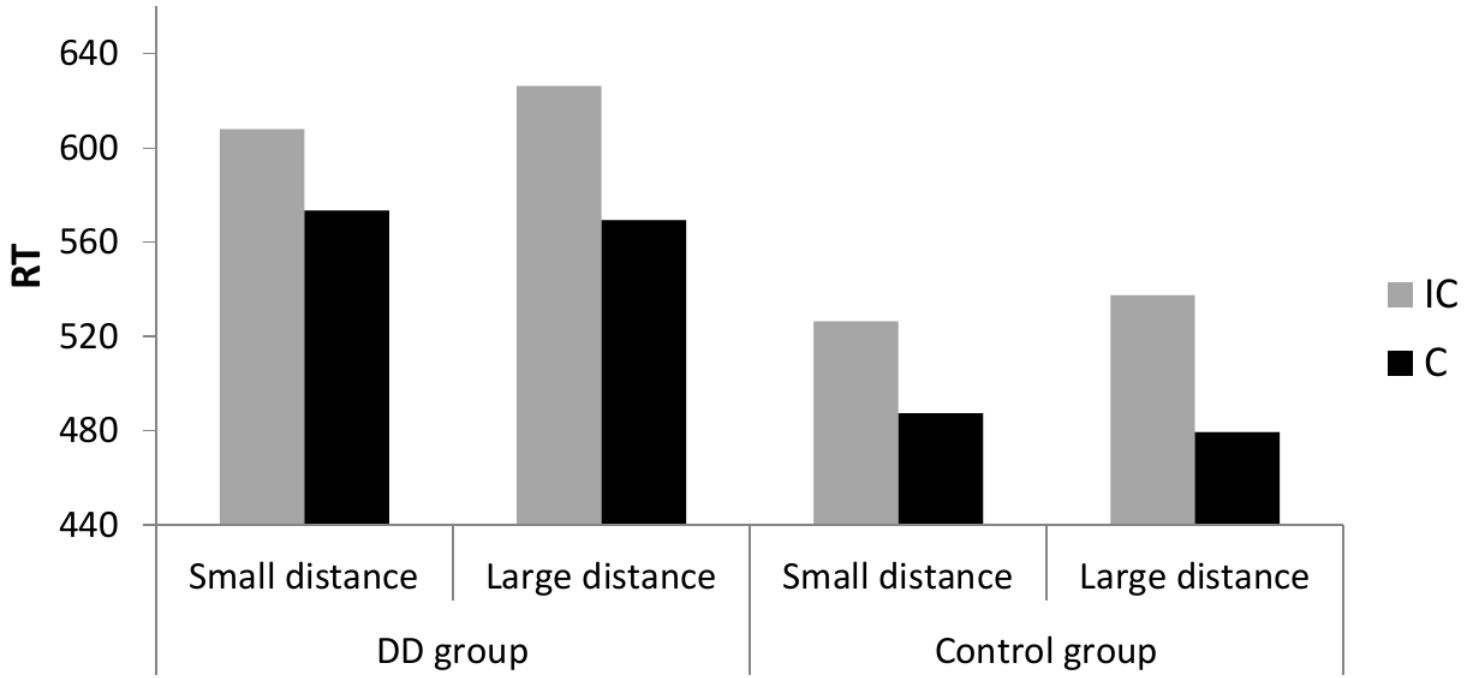
All participants but one were selected from the database of the Learning Disabilities Diagnostic Center at Achva Academic College.

It is important to note that in the clinical group only two participants were also diagnosed with mild-moderate dyslexia and five of them were diagnosed with dysgraphia. None of the participants in either the clinical or the control groups had ADHD.

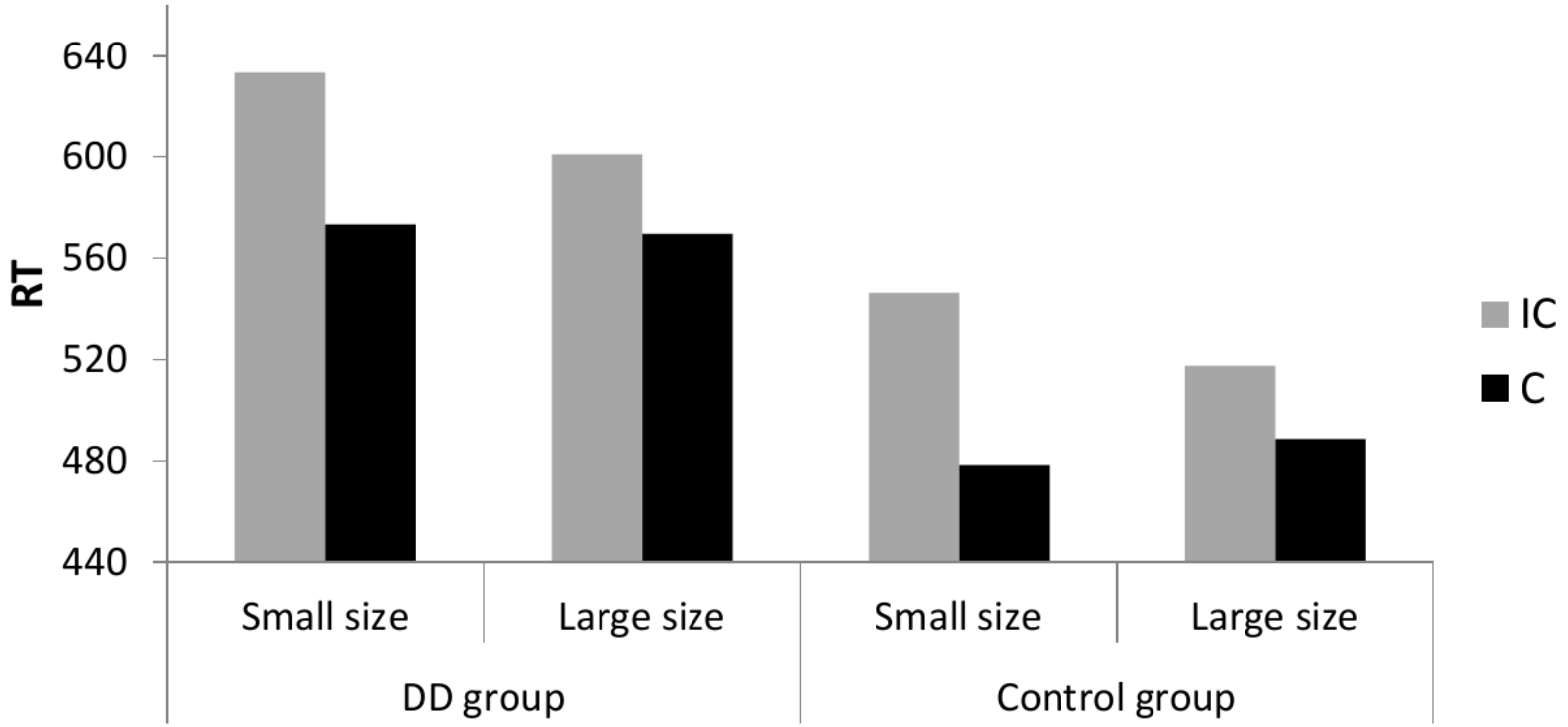

Control
60
40
20
0
-20
-40
-60
dRT (ms)
0
1
2
3
4
6
7
8
9
r = -0.67
Slope = -7.38
Number


Developmental Dyscalculia
60
40
20
0
-20
-40
-60
-80
-100
-120
dRT (ms)
0
1
2
3
4
5
6
7
8
9
r = -0.92
Slope = -14.98
Number

Modulation by distance



Modulation by Size



Conclusions & Puzzles

DD do not differ from controls in representations of numbers on the mental Number line

So what is the source of DD?

Remember that there is no comorbidity in our sample


(a)
(b)
(i)
(ii)
(iii)
(c)
(i)
(ii)
Biological level
Cognitive level
Behavioral level
Deficit in IPS
Deficit in IPS
Deficits in frontal brain areas
Deficit in IPS
Deficit in fusiform gyrus or in IPS
Deficit in IPS
Deficit in pre frontal brain areas
Deficit in angular gyrus
Deficit in processing numerical quantities
Deficit in processing numerical quantities
Deficit in working memory
Deficit in attention
Deficit in processing magnitude
Deficit in number identification
Deficit in spatial processing
Deficit in processing numerical quantities
Deficit in executive functions
Deficit in associating magnitudes with symbols
Deficit in associatin phoneme with grapheme
DD
MLD
MLD
MLD
Co-morbidity (DD + ADHD)
Co-morbidity (DD+Dyslexia)

Thanks to

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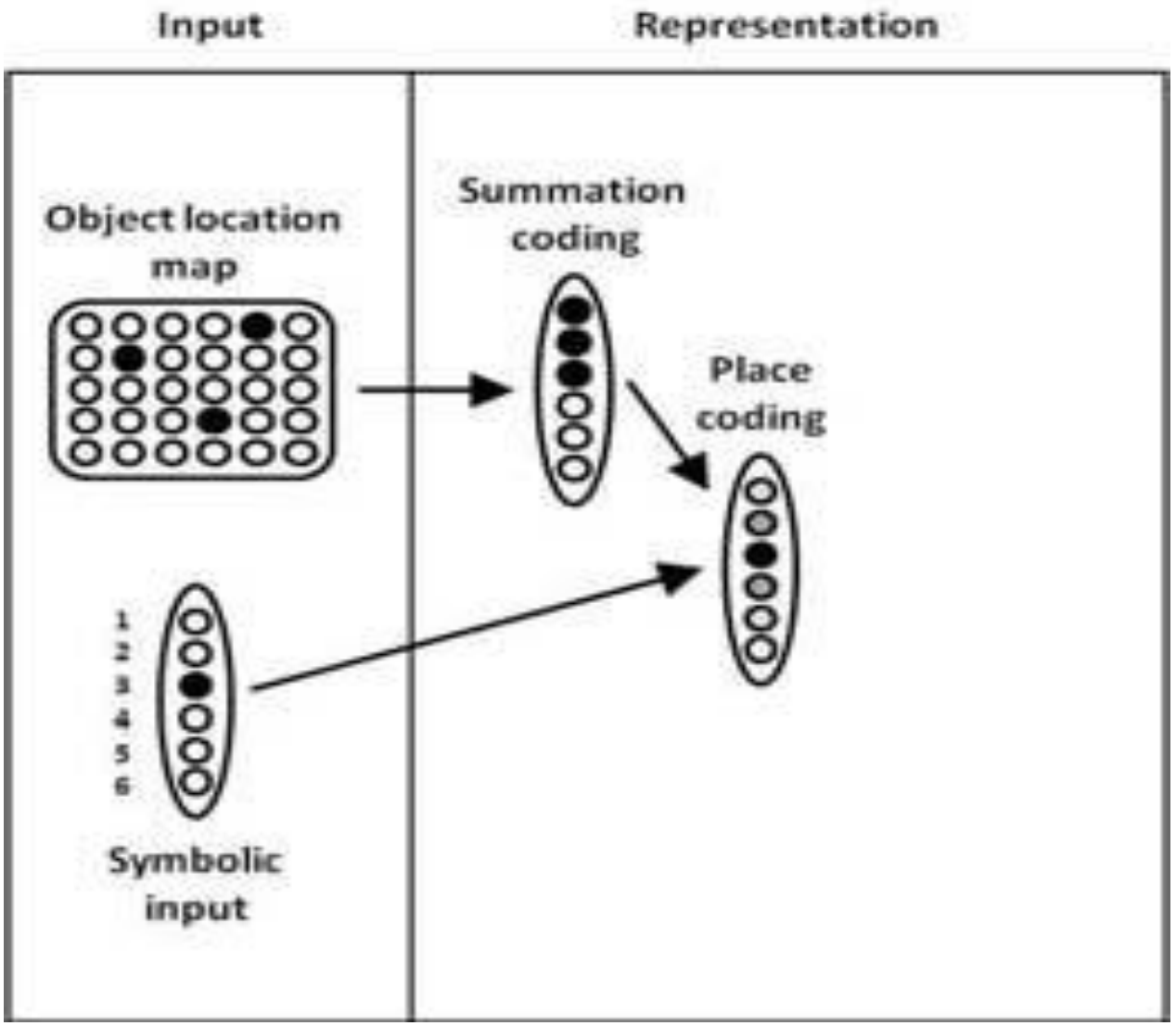

Adapted from Verguts & Fias 2008