

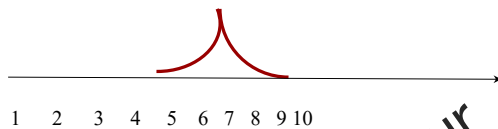
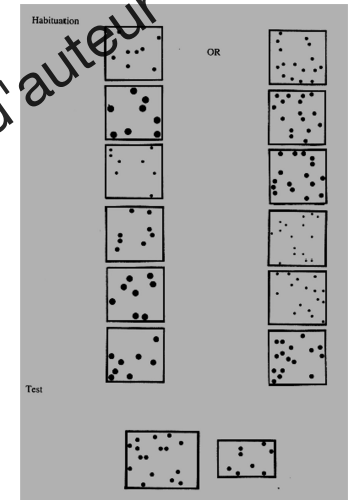
Understanding math learning disability to guide math teaching

Marie-Pascale Noël
Catholic University of Louvain

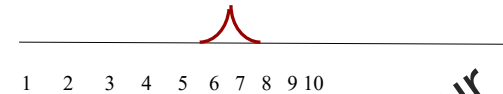
London, June 23

Babies tool kit for math

- 6 month-old babies
 - Discriminate 8 vs. 16,
 - but not 8 vs. 12,
 - Ratio of 1:2
- 9 month-old babies
 - 16 vs. 24
 - Ratio 2:3
- Adults: ratio of 9:10



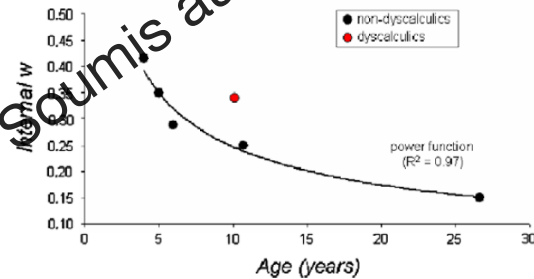
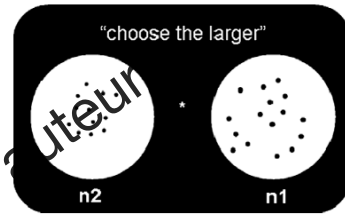
- Approximate and analogical number representation
 - Increasing acuity over development
- Math learning disability is due to an impairment at that level (lower acuity) ?
 - persistent, specific disorder of numerical competences and arithmetic skills development in children of normal intelligence



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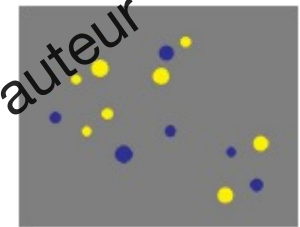
- Population

- ▶ children from age 3 to 6
- ▶ MLD children (10 y.o.)
- ▶ control children (10 y.o.)
- ▶ 20 adults



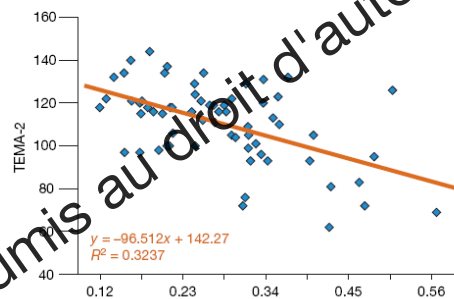
Piazza, M., Facoetti, A., & al, Cognition, 2010

In unselected population: w and math performance



- 64 teenagers of 14 y.o.
- Assessment of the acuity of their number sense
- Record of their past school performance in math

Halberda, Mazzocco & Feigenson (2008)



Score at the math test at 8 y.o. (high = good)
W: acuity of number sense, at 14 y.o., low = good

Yet ...

- Population

- ▶ 45 children with MLD (7 y.o.)
- ▶ 45 control children (7 y.o.)

- Tasks

- ▶ Non-symbolic

symbolic



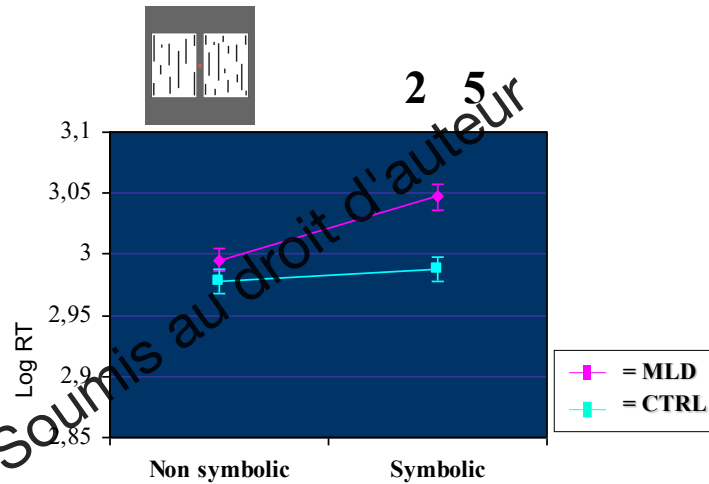
Easy
condition



Difficult
condition

2 5

Rousselle & Noël, 2007, Cognition



=> Not a deficit of the approximate number sense

In unselected populations

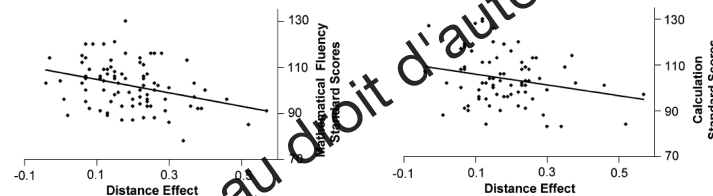
• Population

- 6 y.o. (n=26), 7 y.o. (n=31), 8 y.o. (n=27)
- Magnitude comparison
 - Comparison of two symbols (1 - 9)
 - Comparison of two sets (1 - 9 items)
- Math performance
 - Calculation score (Woodcock Johnson Math)
 - Math fluency (+,-,x in 3')

Holloway & Ansari, 2009, JECP

Symbolic task correlates with

- Calculation score: $r(85) = -.222^*$
- Math fluency: $r(86) = -.339^{**}$



Non-symbolic task does not correlate with

- Calculation score: $r(85) = -.07$
- Math fluency: $r(86) = .037$

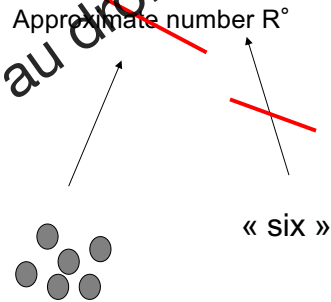
=> Not related to the approximate number sense

How can we account for these results ?

Let us take a developmental perspective
How do we learn number symbols ?

Model 1

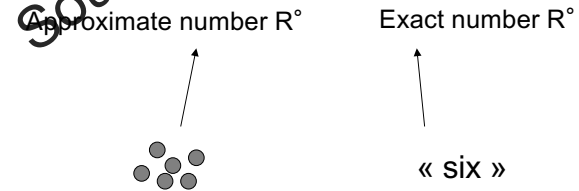
- Number symbols are learned and mapped onto the approximate number R°



Gallistel & Gelman, 1992; Verguts & Fias, 2004

Model 2

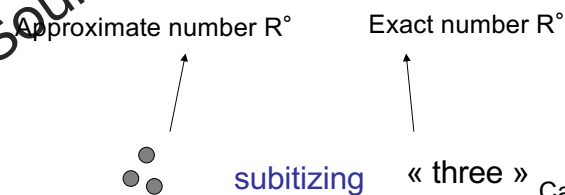
- It takes more than one year for children between the time they are able to recite the counting list and the time they are able to understand the cardinal value of the numerals in that count list (“give me”)
- children do not understand the meaning of *one, two, three, four* by referring to the approximate number R°
- They need to build a new R° : a R° of exact numbers.



Carey, 2004

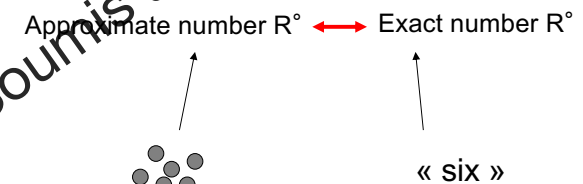
Model 2

- The representation of the words “one”, “two”, “three”, “four” is progressive and is based on the ability to represent precisely small sets on 1-4 items (object file system used in subitizing)
- For the other number words, the child needs to make the analogy between the order of the words in the counting list and the successive numbers that are related by the function “+1”



Carey, 2004

Model 2



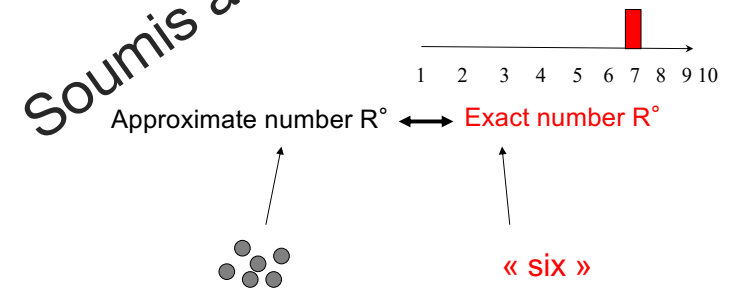
Carey, 2004

A developmental account of MLD ?

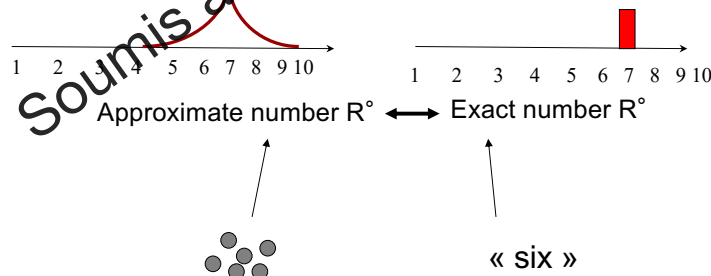
	age	symbolic	Non-symbolic
Rousselle & Noël (2007)	7 y.o.	MLD<C	MLD=C
Landerl & al. (2004)	8-9 y.o.	MLD<C	-
Iuculano et al. (2008)	8-9 y.o.	MLD<C	MLD=C
Piazza	10 y.o.	-	MLD<C
Mussolin, Mejias & Gilmore (2010)	10-11 y.o.	MLD<C	MLD<C
Price & Ansari (2007)	12 y.o.	-	MLD<C

A developmental account

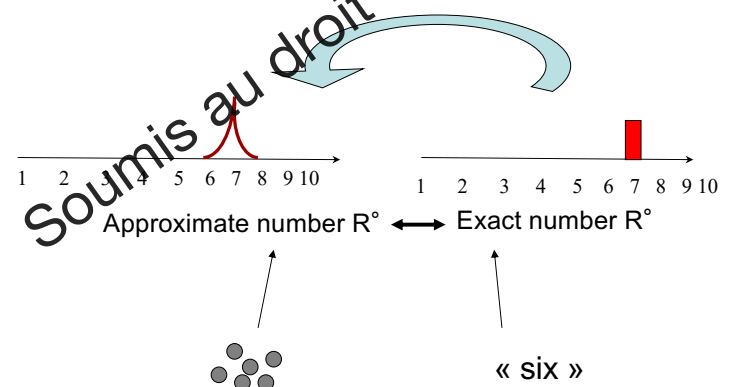
- First deficit are not seen in non-symbolic numerical tasks
 - not due to a deficit of the approximate number magnitude system
- First deficits are seen in symbolic numerical tasks
 - due to a difficulty in building an exact representation of natural numbers



- Later: deficit on non-symbolic tasks as well
 - Hypoth: connecting the exact number R° with the approximate magnitude system would increase the precision of the later
 - This refinement process would be weaker in MLD children, thus leading to $\neq$ between MLD and control children



- First deficit is on the symbolic tasks
- Later: deficit on non-symbolic tasks as well
 - Hypoth: connecting the exact number R° with the approximate magnitude system would increase the precision of the later
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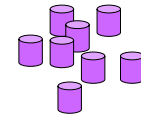


Implications for school and education

- 1. creating a representation of exact natural numbers
 - Building a comprehension of the cardinal value of the first number words
 - One, two, three, four: sequentially
 - By subitizing
 - Link between the cardinal of a set given by subitizing and the last word in the counting procedure
 - Working on the analogy between going further in the counting list and adding items in a set



- 2. Favouring the connection between the exact representation of natural numbers and the analogical representation of number magnitude
 - Guessing and counting

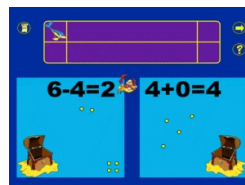
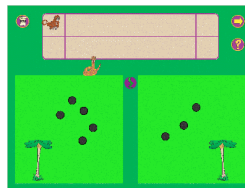
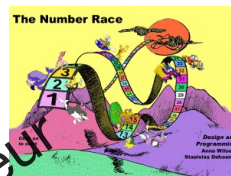


- Using space to represent number magnitude

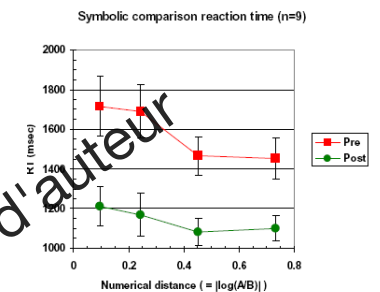
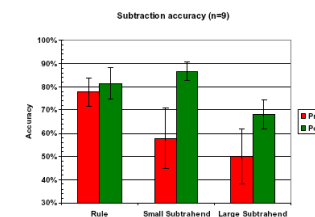


The number race

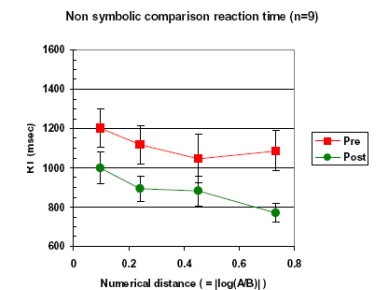
- Associating digits, collections and space
- In comparison, additions and subtraction



Wilson & al., 2006



- Faster in dots enumeration
- Increased accuracy in subtraction (but not addition)
- Increased accuracy & speed in magnitude comparison



Number board game

- Colour game

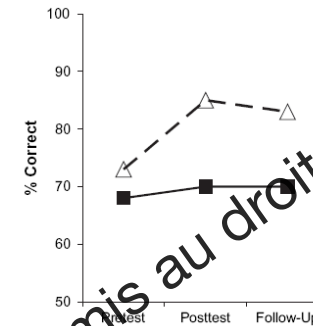


- Number board game

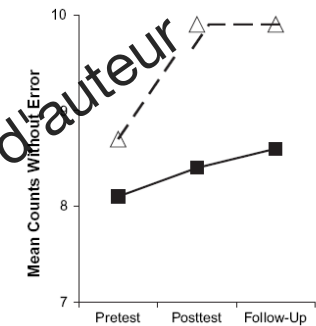


Ramani & Siegler, 2008

(b) Magnitude Comparison

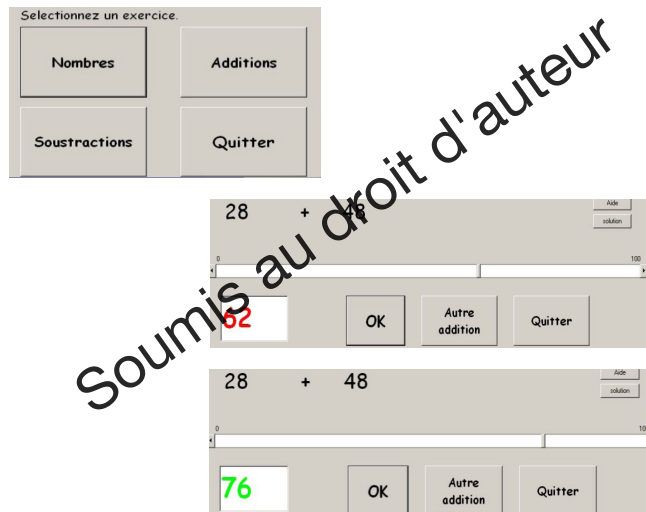


(c) Counting



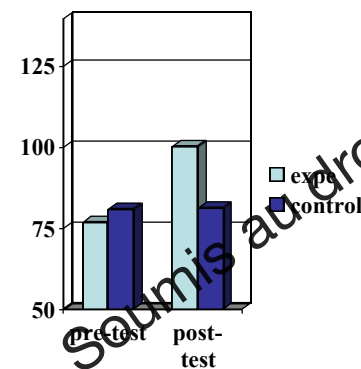
-△- Number Board Game -■- Color Board Game

The estimator

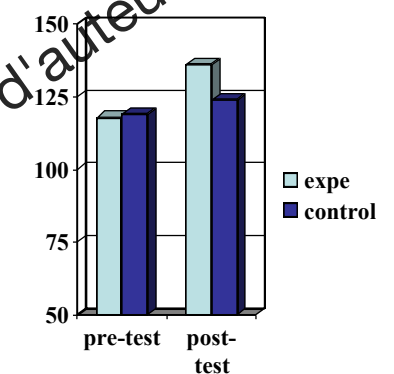


Vilette, Mawart & Rusinek, 2010

The estimator



SN on Additions-subtractions



Total SN score on the Zareki battery

Vilette, Mawart & Rusinek, 2010

- 1. Building a representation of exact numbers
- 2. Connecting this representation with the approximate number representation

Thanks for your attention !

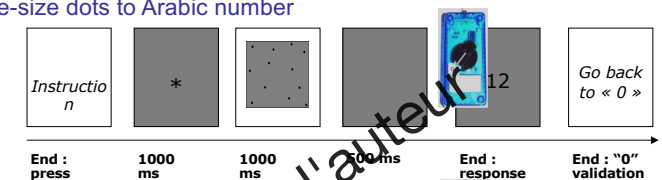


Adult study

- 22 adults who were MLD (24 ± 1 y.o.)
- 22 adults control, same age, same studies or profession

Mejias, Gregoire & Noël, submitted

Same-size dots to Arabic number



Heterogeneous-size dots to same-size dots

Heterogeneous-size dots to Arabic numbers

Arabic numbers to same-size dots



Soumis au droit d'auteur

