RESEARCH ON PEOPLE WITH DYSCALCULIA: WHAT DO WE KNOW AND WHERE SHOULD WE GO?

Marie-Pascale Noël
UCLouvain, Belgium

DEFINITION: DSM V

Dyscalculia: difficulties learning number-related concepts or using the symbols and functions to perform math calculations.

Can include difficulties with

- number sense,
- memorizing math facts,
- math calculations,
- math reasoning, and
- math problem solving

These difficulties

- (1) persist for at least 6 months, despite the provision of specific interventions;
- (2) appear during school age and can last until adulthood, interfering with the individual's academic or occupational performance;
- (3) cannot be explained as a consequence of brain damage or diseases, neurogenetic disorders, premature birth, visual or hearing impairments, intellectual disabilities, or poor psychoeducational stimulation

CRITERIA IN RESEARCH

- below **35th percentile** in both 1st and 2nd grade, IQ > 80 (Geary et al., 2000: MLD),
- below **25th percentile** (Passolunghi & Mammarella, 2012: MLD), Wilson & Lee Swanson, 2001: disabilities in mathematics)
- below 1 *SD* to mean (about the **16th percentile**) in two tests, over 4 years , IQ > 70 (Bugden & Ansari, 2016: DD)
- below **10th percentile** (Mazzocco et al., 2011: DD)
- < 2 DS on a math test (about **2nd percentile**), IQ > 85, no other neuropsychological disorder (ADHD, motor disorder …) (Decarli & al., 2023: DD)
- below **3 *SD*** on a arithmetical fact test (Landerl et al., 2004: DD)
- lagging **1.5 years** in school (van der Sluis et al., 2004: arithmetic-learning deficit).

CRITERIA IN RESEARCH

- below **35th percentile** in both 1st and 2nd grade, IQ > 80 (Geary et al., 2000: **MLD**),
- below **25th percentile** (Passolunghi & Mammarella, 2012: **MLD**), Wilson & Lee Swanson, 2001: **disabilities in mathematics**)
- below 1 *SD* to mean (about the **16th percentile**) in two tests, over 4 years , IQ > 70 (Bugden & Ansari, 2016: **DD**)
- below **10th percentile** (Mazzocco et al., 2011: **DD**)
- < 2 DS on a math test (about **2nd percentile**), IQ > 85, no other neuropsychological disorder (ADHD, motor disorder …) (Decarli & al., 2023: **DD**)
- below **3 *SD*** on a arithmetical fact test (Landerl et al., 2004: **DD**)

- lagging **1.5 years** in school (van der Sluis et al., 2004: **arithmetic-learning deficit**).

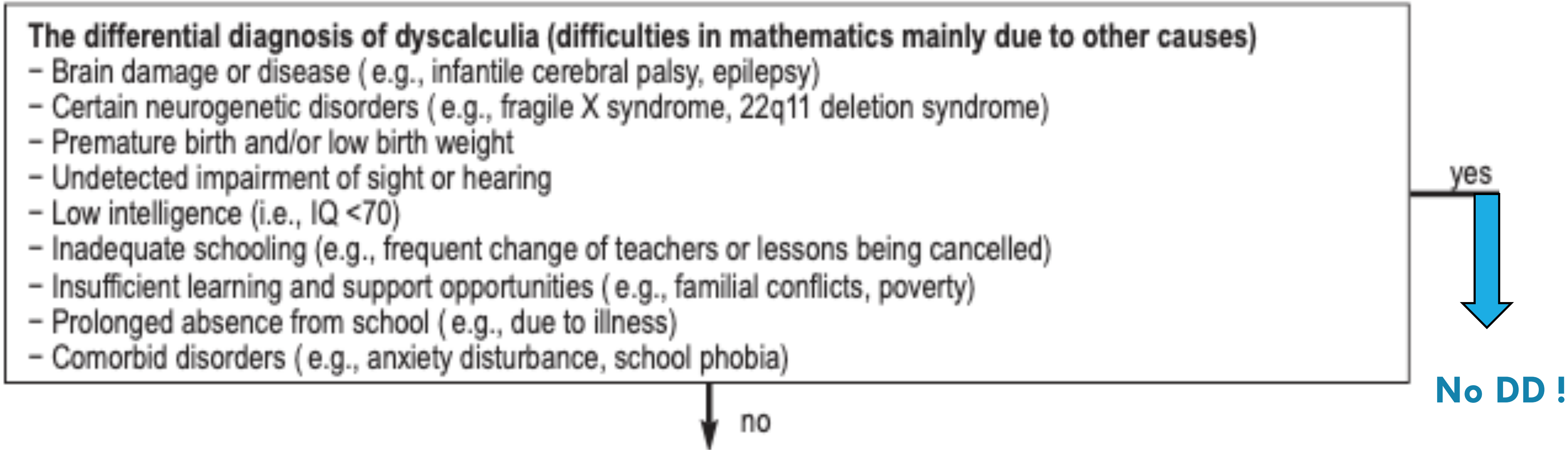
CONSORTIUM CRITERIA: HABERSTROH & SCHULTE-KÖRNE, (2019)

Conclusions of a consortium of German experts:

The Diagnosis and Treatment of Dyscalculia.

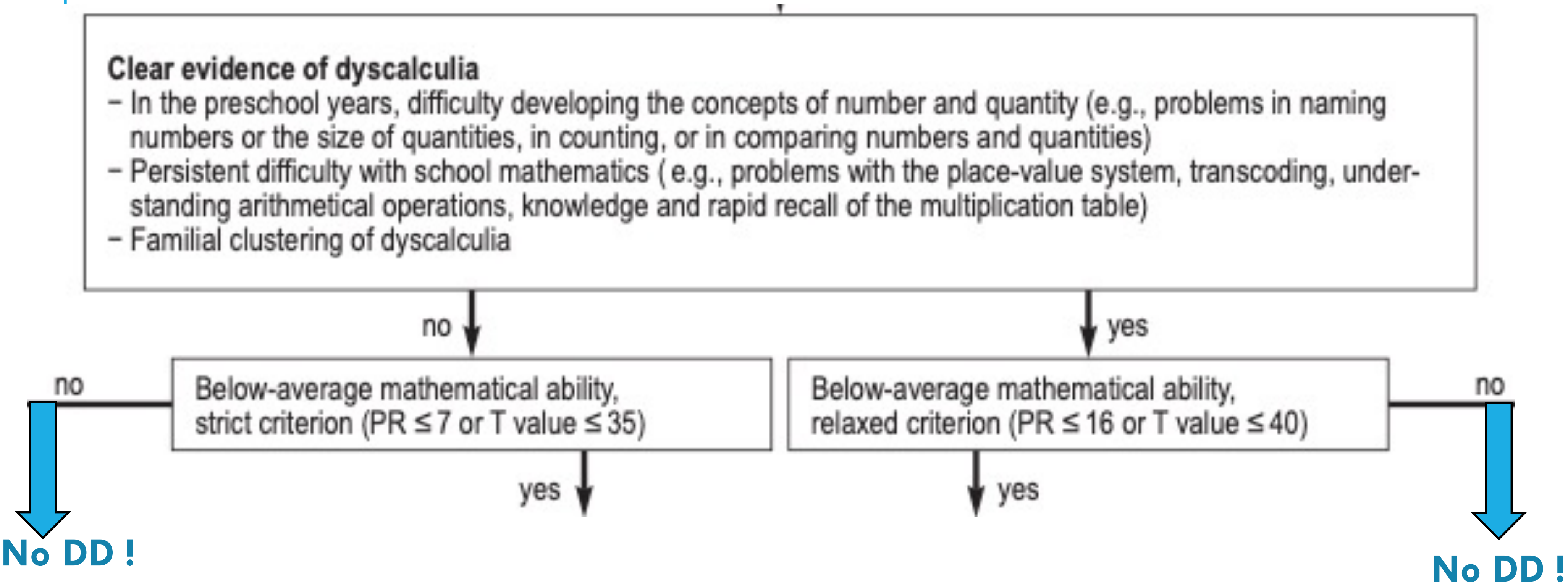
3 steps for the diagnosis

STEP 1



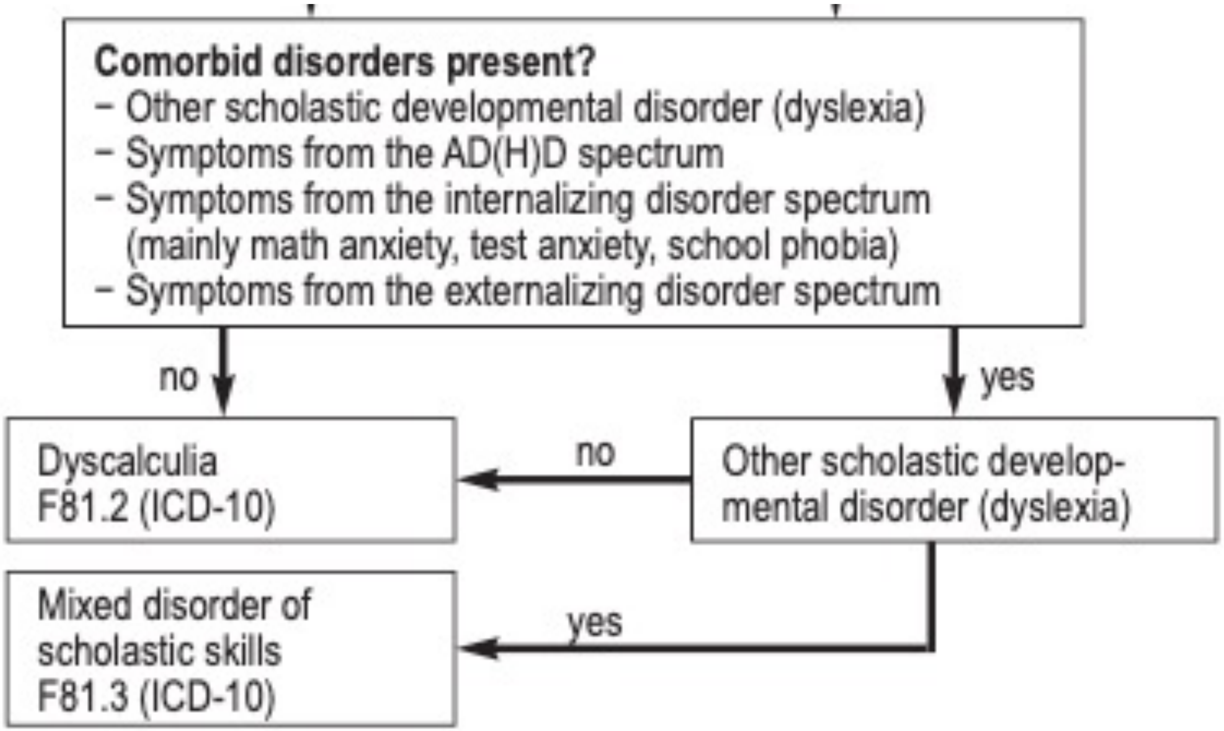
Haberstroh & Schulte-Körne, (2019)

STEP 2

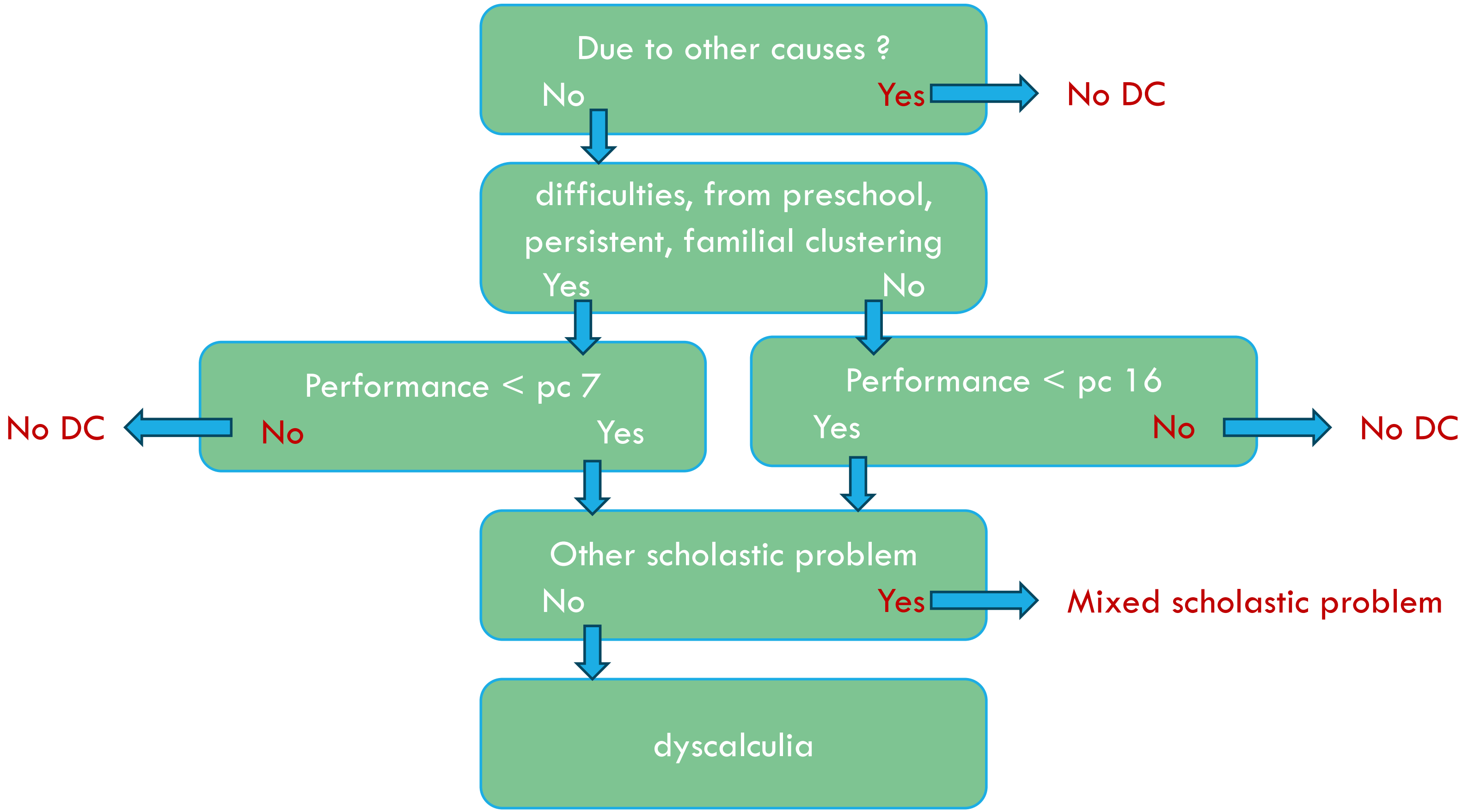


Haberstroh & Schulte-Körne, (2019)

STEP 3



Haberstroh & Schulte-Körne, (2019)



Haberstroh & Schulte-Körne, (2019)

CONCLUSION

Need of assessing also the intelligence of the person

Need a medical examination (neurological examination with testing of vision and hearing)

QUESTION

- no DD diagnostic in case of prematurity ?
- different cut-off depending on the history of the math difficulties ?
- No DD diagnostic in case of other disorders of scholaslic skills ? (1) DD + DL: two additive impairment rather than interactions, (2) ADHD or ADHD + DD ?

PREVALENCE

In Israel, 3029 children 10 y.o. (Gross-Tsur, et al. 1996)

- Criteria:
  - (1) math score : more than 2 years late
  - (2) IQ > 80
- ➢6,5 % meet the criteria

In Belgium, 3978 children (Desoete et al., 2004)

- Criteria:
  - (1) arithmetic performance at least 2 SD below the norms,
  - (2) performance lower than expected on basis of general school results or intelligence,
  - (3) not responsive to remediation at school
- ➢7.70% in third grade
- ➢6.59% in fourth grade

IMPACT

In children

- Impact in school performance
- higher math anxiety, lower self-esteem (Fritz, & al., 2019)

In adulthood

- people with low numeracy have a lower range of working opportunities, lower salaries, poorer financial well-being (Bruine de Bruin et al. 2021; Parsons & Bynner, 1997, Rivera-Batiz, 1992)
- less access to Internet technology (e.g., computers and cell phones) (Jensen & al, 2010)
- Lower performance in numerical daily activities (Vigna et al., 2022)
  - **Time** (e.g., can you tell me for how long we have been doing this interview?),
  - **Measure** (what would be the amount of pasta in an average portion?),
  - **General semantic numerical** knowledge (e.g., do you remember the dates of the last world war?),
  - **Money** (e.g., if a shirt normally costs 50 euros but it is discounted by 10%, how much would you have to pay for it?).

TESTIMONIALS

"*I've never been good with numbers, but, being articulate and an excellent reader, it was dismissed as me being lazy or disruptive … From the age of 6 when I stood stuttering and red-faced, yet again unable to recite my 3 times table and the class genius was invited to smugly recite his 13 times tables immediately after to show how easy it was, I thought something wasn't right. Not only was it not right, it wasn't ruddy fair. Hot tears would run down my cheeks and I'd creep away feeling stupid, angry, miserable and very, very alone*"

"When I was in secondary 2, they agreed to let me pass on condition that I never studied math" ... "I couldn't calculate what the cashier gave me back, so I never dared do a student job" ... "I don't manage my budget very well, or I have to write everything down" (26-year-old woman).

"*In secondary school, I had a teacher who was not at all supportive and who openly mocked my difficulties, which contributed to my feeling even worse about it*". (23-year-old woman)

PERSISTENT DIFFICULTIES

Gross-Tsur et al. (1996):

- 3029 Fourth grade children
- 6.5% of them are 2-years behind despite normal intelligence and schooling

Shalev & al. (2005).

- 6 years later, retest those children with learning difficulties
- Half of them are still DD (performance below pc 5)
- 95% of them are performing in the lower quarter of a math test

Many adults still have difficulties

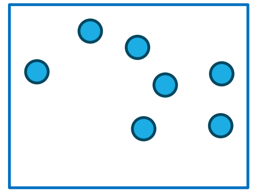
- According to OECD (2016) and IES (2022) estimates, the share of adults at or below Level 1 (scale 1 to 5) in numeracy ranged from 61.9% in Chile to 8.1% in Japan, with the United States at around 33%.

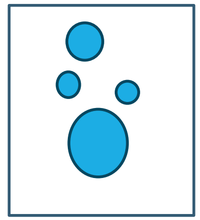
DIFFICULTIES EVEN IN BASIC NUMERICAL TASKS

CHILDREN WITH DD

Reciting the counting sequence: slower (7 y.o., Landerl & Butterworth, 2004)

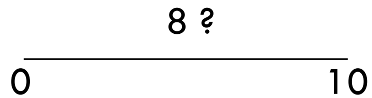
Enumeration of sets: slower, weaker understanding of the underlying principles (Landerl & Butterworth, 2004, Geary & al., 1992, Karagiannakis & Noël, 2020))





Reading and writing numbers (Temple 1989, Sullivan et al., 1996, Karagiannakis & Noël, 2020

Positioning numbers on a number line: less precise (Geary, Hoard et al., 2008, Karagiannakis & Noël, 2020

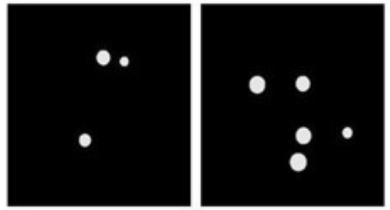


One-digit calculation: more errors, slower, less mature strategies (Karagiannakis & Noël, 2020)

Subitizing: smaller range (Moeller & al., 2009, but see Decarli, 2020, Karagiannakis & Noël, 2020)

Comparing the magnitude of two numbers: slower and less accurate (Rousselle & Noël, 2007)

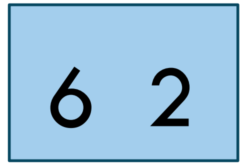
DIFFICULTIES THAT REMAIN EVEN IN ADULTS

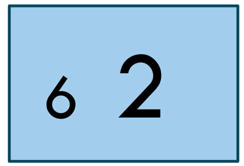


« affected children do not ‘grow out’ of DD » (Kaufmann et al., 2020)

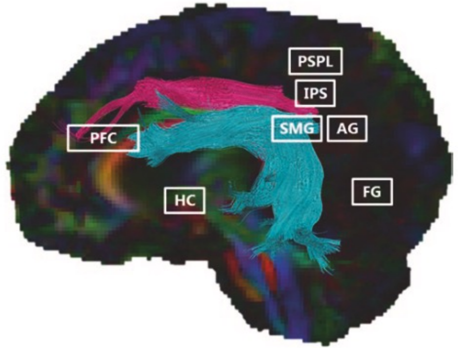
Difficulties in adults in very basic numerical skills

- Smaller subitizing range [Cohen & al., 2019; Gliksman & al., 2019]
- Difficulties in number magnitude comparison [Ashkenazi, & al., 2010, Mussolin & al. 2011, Cappelletti & Price, 2014, De Visscher & al., 2018]
- Reduced stroop effect when comparing the physical size of the digits [Rubinsten & al, 2005]
- difficulties with basic arithmetical concepts such as the base-10 system and calculating with decimals and fractions (Eckstein, 2016)





BRAIN PECULIARITIES



Children with DD show brain peculiarities

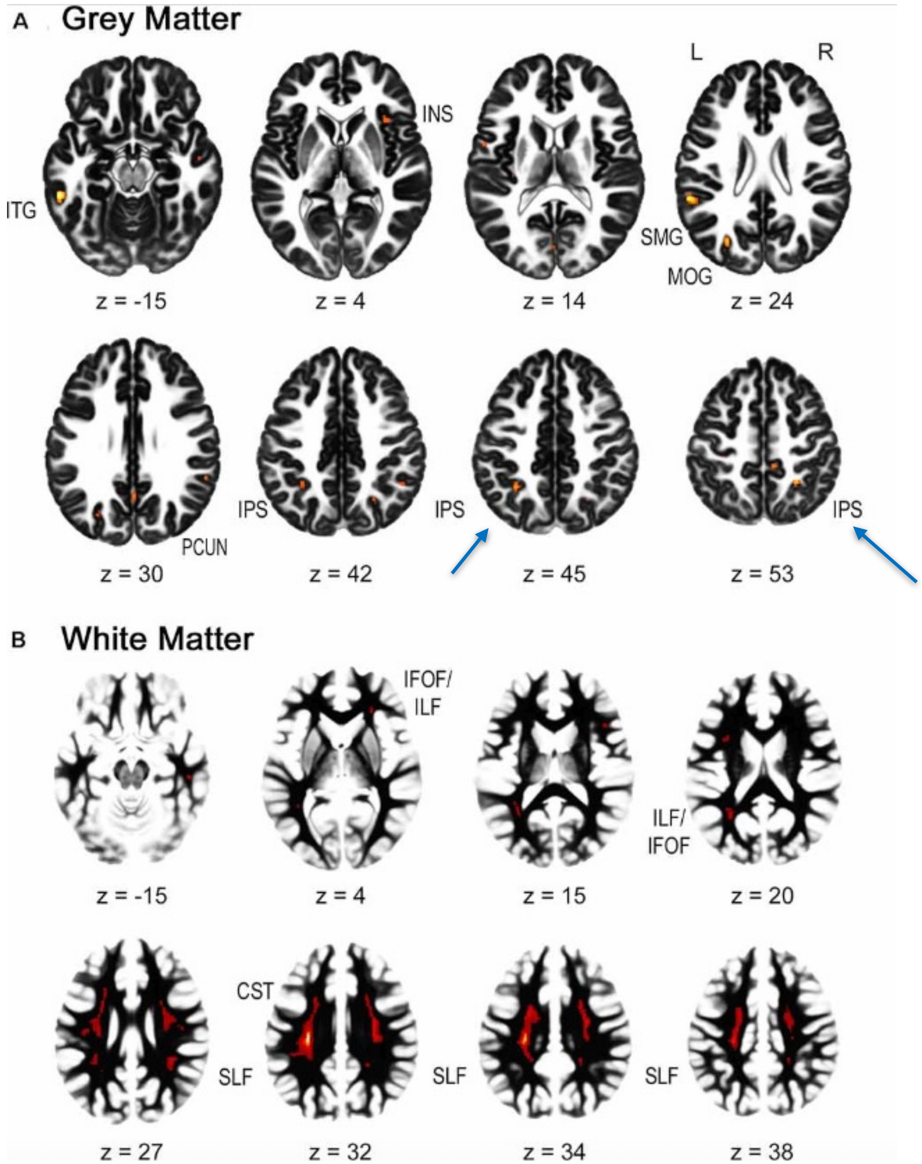
- The brain structure: less gray matter in the **posterior parietal cortex**, including the IPS (Isaacs, & al., 2001; Rotzer et al., 2008; Rykhlevskaia, & al., 2009), in **prefrontal cortex** (Rotzer et al., 2008) and in **hippocampal areas** (Rykhlevskaia et al., 2009)
- Brain connectivity: weaker connections between the **prefrontal cortex and the posterior parietal** cortex (Tsang, & al., 2009; Van Beek, & al., 2014, Rykhlevskaia et al., 2009, Kucian et al., 2014).
- Less brain activity in **the IPS** during nonsymbolic comparison (Price, Holloway, Räsänen, Vesterinen, & Ansari, 2007), symbolic comparison (Mussolin et al., 2010; Soltész, & al., 2007), and symbolic ordering (Kucian et al., 2011).
- Sometimes, increased brain activity in the frontoparietal network (e.g., during arithmetic, Davis et al., 2009; Rosenberg-Lee et al., 2015), maybe compensatory mechanisms characterized by stronger recruitment of supporting areas associated with working memory or control processes
- Often, no difficulty-related modulation of the frontoparietal network in children with DD

PERSISTENT BRAIN ABNORMALITIES

MCCASKEY, VON ASTER, O'GORMAN, & KUCIAN, 2020

Structural abnormalities in children with MLD have been shown to persist across 4 years of development from 9 to 13 years of age

- reduced gray matter volumes in the parietal lobes specifically, but also in the occipital, temporal, and frontal parts of the brain
- Reduced white matter volumes in various regions and prominent tracts of the frontoparietal numerical network.



COMORBIDITIES

Dyslexia

- about half of the DD children are poor readers (43% in Badian, 1983 and in Barbaresi 2005; 64% in Lewis et al., 1994)

ADHD

- Between 25% (Gross-Tsur, Manor, & Shalev, 1996; Silva et al., 2015) and 42% (Desoete, 2008) of DD children have attentional problems
  - Ashkenazi and Henik (2010) observed deficient attentional functions in adults diagnosed with DD

Math anxiety

- children with DD,
  - have more math anxiety than typical children (Kucian, 2018)
  - are twice as likely to have high mathematics anxiety (Devine et al., 2018)
  - but 77% of children with high mathematics anxiety had typical or high mathematics performance, so DD ≠ math anxiety) (Devine et al., 2018)

ASSOCIATED COGNITIVE WEAKNESSES

children with DD might also show impairments in domain-general abilities, such as working memory, language abilities, attention, and executive functions (Fias & al., 2013; Peng & al., 2016).

GENERAL COGNITIVE ABILITIES: AGOSTINI & AL., (2022)

Systematic review of 46 studies

Table 1. Number of studies finding worse performance in the MD group than in the CG for each cognitive domain.

Domain (*N* of Studies)	MD-CG Difference (*N* of Studies)
Processing speed (22)	MD < CG (17/22)
STM verbal (12)	MD < CG (9/12)
STM visuospatial (4)	MD < CG (1/4)
LTM verbal (2)	MD < CG (1/2)
Attention (9)	MD < CG (9/9)
WM verbal (21)	MD < CG (16/21)
WM visuospatial (14)	MD < CG (9/14)
Inhibition (8)	MD < CG (6/8)
Cognitive Flexibility (7)	MD < CG (4/7)
Phonological processing and awareness (4)	MD < CG (2/4)

MD: Group with Mathematical Difficulties; CG: Control Group; STM: Short-Term Memory; LTM; Long-Term Memory; WM: Working Memory.

SUMMARY

Prevalence of about 6%

Persistent

Difficulties even in very basic numerical skills

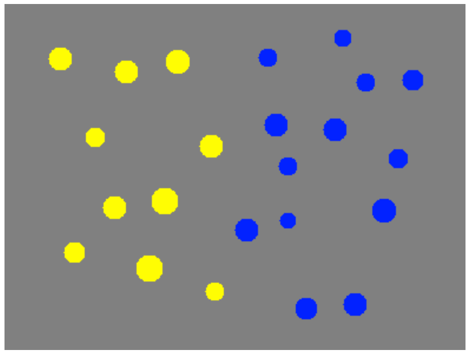
Associated with brain peculiarities

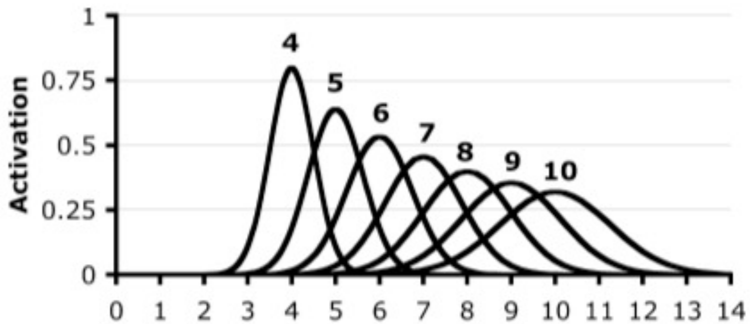
Comorbidities with other neurodevelopmental disorders

Characterized by lower abilities in other general cognitive skills

Q1: WHAT IS THE BASIC NUMBER DEFICIT?

- Babies are able to discriminate between two dots collections if they are sufficiently numerically distant from one another (Xu & Spelke, 2000)
- The underlying mechanisms is called the Approximate number sense: ANS
- Dyscalculia would be due to an impaired ANS (Wilson & Dehaene, 2007)

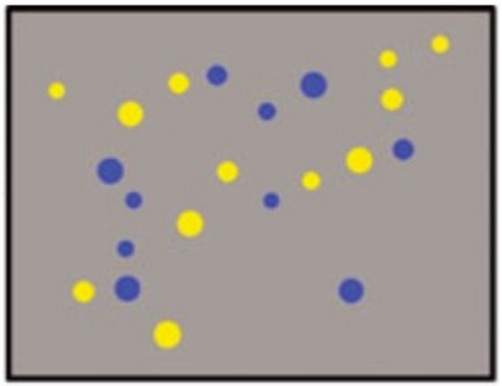




Approximate number system

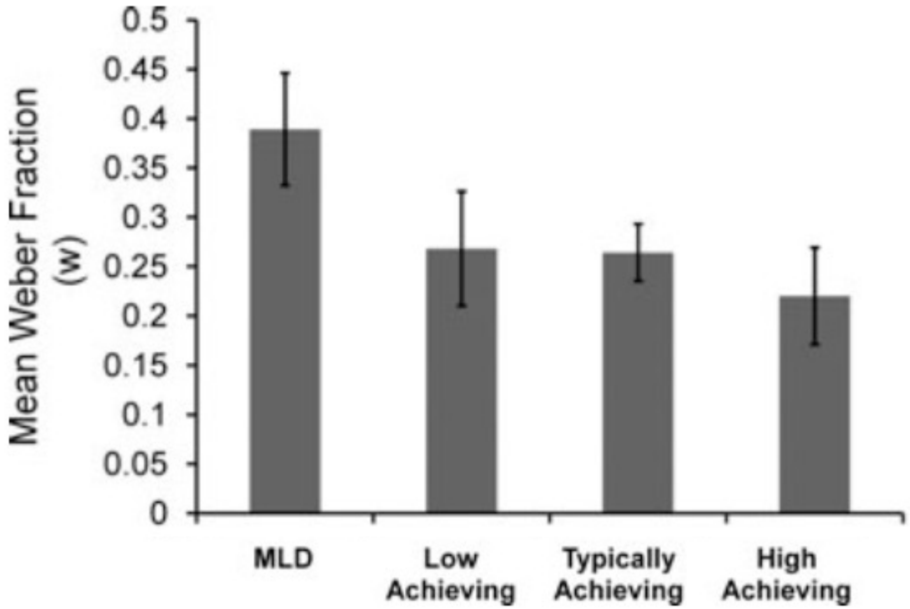
DEFICIT IN THE ANS: MAZZOCCO, FEIGENSON, AND HALBERDA, 2011

14 y.o. children, 10 MLD who performed < pc 10 on a math test



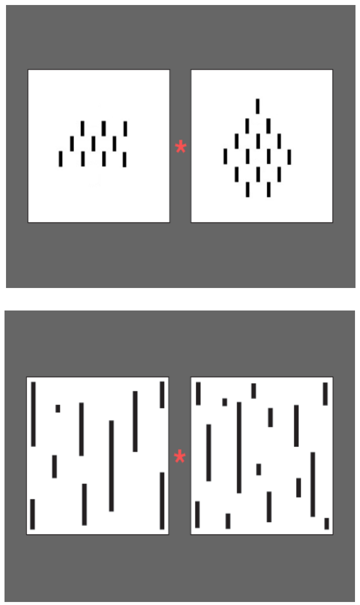
Question: Are there more blue dots or more yellow dots?

Degree of imprecision of the ANS

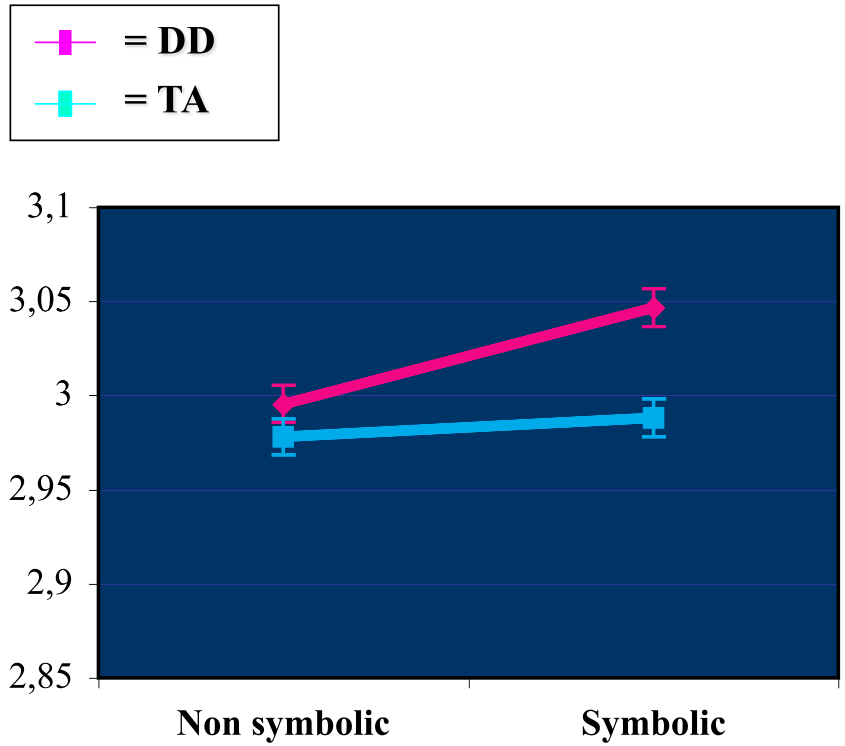


NO DEFICIT IN THE ANS ROUSSELLE & NOËL, 2007

45 DC, 45 controls, same age, sex, IQ



2 5



SUMMARY OF RESULTS

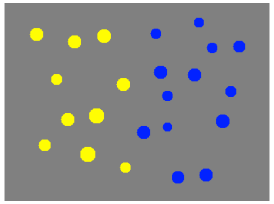
	age	symbolic	Non-symbolic
De Smedt & Gilmore, 2011	6 y.o.	DD<C	DD=C
Rousselle & Noël, 2007	7 y.o.	DD<C	DD=C
Landerl & al., 2004	8-9 y.o.	DD<C	-
Iuculano et al., 2008	8-9 y.o.	DD<C	DD=C
Decarli & al. 2020	9 y.o.	DD < C	DD=C
Piazza & al., 2010	10 y.o.	-	DD<C
Mussolin, Mejias & Noël, 2010	10-11 y.o.	DD<C	DD<C
Price & Ansari, 2007	12 y.o.	-	DD < C
Anobile & al. 2018	12 y.o.		DD < C
Mazzocco, Feigenson & al. 2011	14 y.o.		DD < C

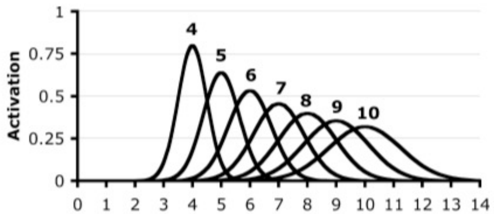
The first deficit is not in the non-symbolic comparison

(updated Noël & Rousselle, 2011)

SCAFFOLDING OR REFINEMENT ?

- Scaffolding: the ANS is the basis for all math learning

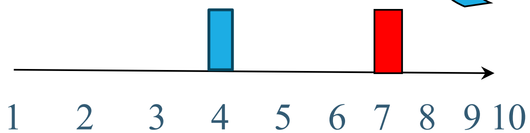


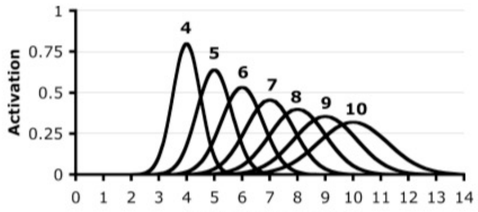


5, 3

- Refinement: learning symbolic numbers and processing them (arithmetic) leads to a better (more precise) ANS (Noël & Rousselle, 2011)

4, 7





SCAFFOLDING OR REFINEMENT ? LAU & AL. 2021

Debate

- children's approximate number (ANS) abilities predict later symbolic number abilities (the scaffolding account)
- children's symbolic number abilities predict later approximate number (ANS) abilities (the refinement account).

622 kindergarten children (5 y.o.),

- dot comparison, Arabic number comparison, mixed comparison skills assessed over 3 time-points
- math achievement assessed over 4 time-points

Results:

- earlier symbolic number ability (Arabic number comparison) is consistently the strongest predictor of approximate number ability (dot comparison), mixed-comparison ability, and arithmetic skills
- And **not** the other way around
- => consistent with the refinement account

SCAFFOLDING OR REFINEMENT ? SUAREZ-PELLICINI & BOOTH, 2018

38 children tested at 10 and 13 y.o.

- Magnitude comparison of two sets of dots: performance and brain activation in the IPS
- Symbolic math : solving additions, subtractions and multiplications

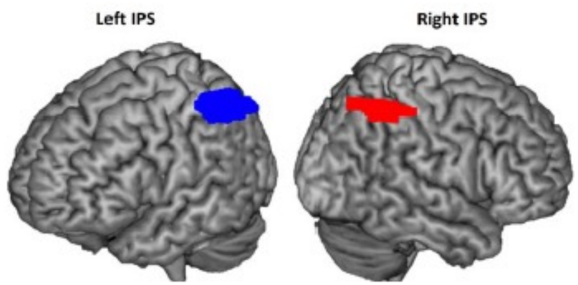


FIGURE 3 ROIs in the left and right IPS. ROIs were anatomically

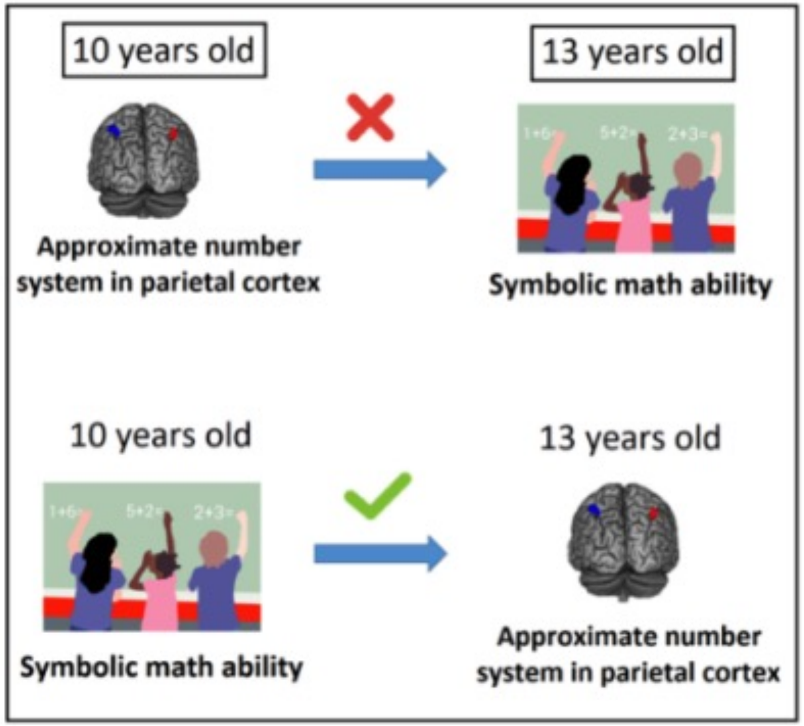
SCAFFOLDING OR REFINEMENT ? SUAREZ-PELLICINI & BOOTH, 2018

Results:

Dot comparison (performance and brain activation) at 10 y.o. does **not** predict math skills at 13 y.o (~~scaffolding account~~)

But math skills at 10 y.o. predicts both performance and brain activation in the dot comparison at 13 y.o.

=> supports the refinement account



Q1: CONCLUSION

The core number deficit is still debated

- A problem in the ANS ?
- A problem in accessing the number magnitude for symbolic numbers?
- How do these two interact with one another developmentally ?

=> Current data are in favour of the refinement account

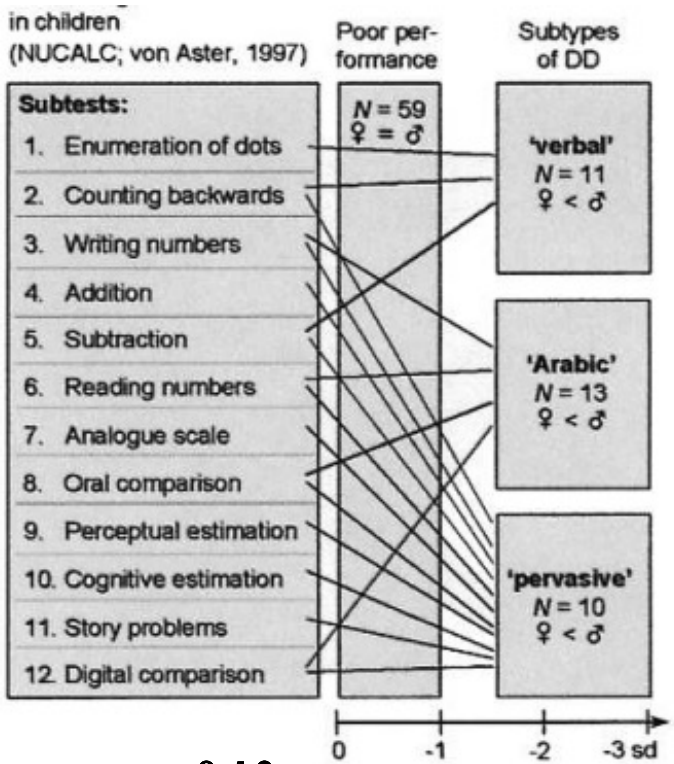
Q2: SUBTYPES OF DYSCALCULIA ? VON ASTER (2000)

Sample of 8-10 y.o. with learning disabilities; cluster analysis

(1) 'verbal subtype': greatest difficulty with counting, failed to use counting procedures to perform mental calculations. 9 out of 11 also had difficulties in reading and spelling and about 50% of them had ADHD

(2) 'Arabic subtype': severe difficulties in reading and writing Arabic numbers aloud, difficulties in number comparison, 50 % of these children, German was a second language.

(3) 'pervasive subtype': severe problems in almost all subtests; 9 out of 10 also had reading and spelling difficulties, and the majority (7 out of 10) manifested behavioral and emotional problems of clinical significance, including ADHD.



8-10 y.o.

Q2: SUBTYPES OF DYSCALCULIA ? OUYANG & AL. (2023)

1839 children followed from preschool (age 6) to fourth grade : 99 identified as MLD children based on their development trajectory of arithmetic fluency from first to fourth grade

Three numerical tasks used at age 6:

- counting (e.g., “counting forward from 6 to 13”,
- basic arithmetic concepts (e.g., “please draw one more ball than the balls in the picture”),
- number-numerosity mapping (e.g., “draw as many balls as the Arabic numeral represents”)

Five subtypes from this analysis

- 40 children (40%) : no deficits but deficits in arithmetic fluency at grade 4 : *arithmetic fluency* deficit subtype.
- 22 children (22%) : deficit in counting only: *the counting deficit* subtype.
- 8 children (8%) : deficits in counting and number-numerosity mapping : *symbolic deficit* subtype.
- 8 children (8%) : difficulties in counting and basic arithmetic concepts: *counting and concept deficit* subtype.
- 12 children (12%) : deficits in all three attributes: the *pervasive deficit* subtype.

Q2: SUBTYPES OF DYSCALCULIA ? OUYANG & AL. (2023)

Associated cognitive skills

- arithmetic fluency deficit subtype: **higher scores in arithmetic reasoning** test at grade 4 than the other groups
- counting deficit subtype: associated **with weaker spatial visualization**, *maybe bacause counting objects requires pointing objects on a spatial layout*
- symbolic deficit subtype.
- counting and concept deficit subtype.
- pervasive deficit subtype: associated with **weaker language skills**

“subtyping has not yielded consistent domain-specific differences among children with dyscalculia, and has not proved useful in understanding or treating the disorder” (Shalev & von Aster, 2008).

- Very different profiles obtained in the different studies using cluster analyses
- We still not do know the mechanisms underlying these different subtypes of dyscalculia

Q2: SUBTYPES OF DYSCALCULIA ? DE VISSHER, & AL. 2015

- case of a woman who had specific and strong difficulty with AF, especially multiplication facts => shown to be due to an hypersensitivity to interference in memory (DeVisscher & Noël, 2013, *Cortex*)
- Group study of grade 4 children: those with low arithmetic fluency show greater sensitivity to interference in memory (*De Visscher & Noël, 2014 Developmental Science)*
- Adults with DD: two types of DD (De Visscher, Szmalec, Van der Linden & Noël, 2015, *Cognition*)
  - math difficulties since primary school; reasoning (Raven) > 30^{th} percentile; no other difficulties
  - Global DD: < 7^{th} percentile on a global math test
  - Specific AF deficit: in the norms for the global math test but < grade 5 children on an AF test

.

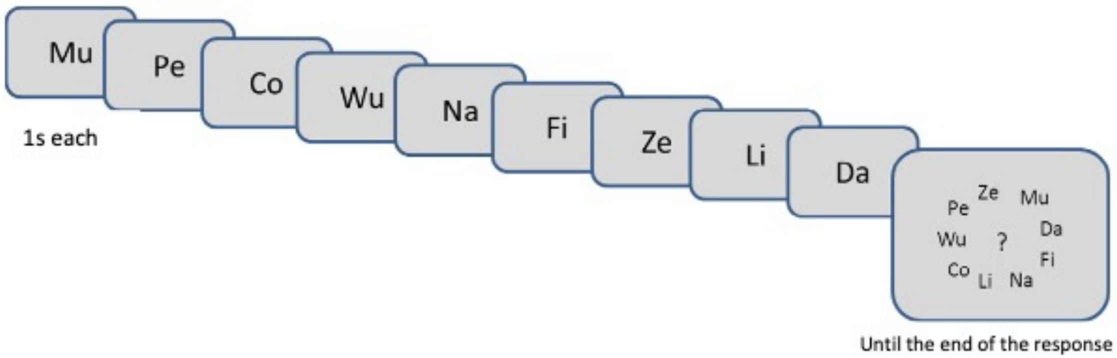
TASK

Learning non-sense sequences

Fillers: all different sequences

Experimental: 2 sequences are repeated several times during the experiment

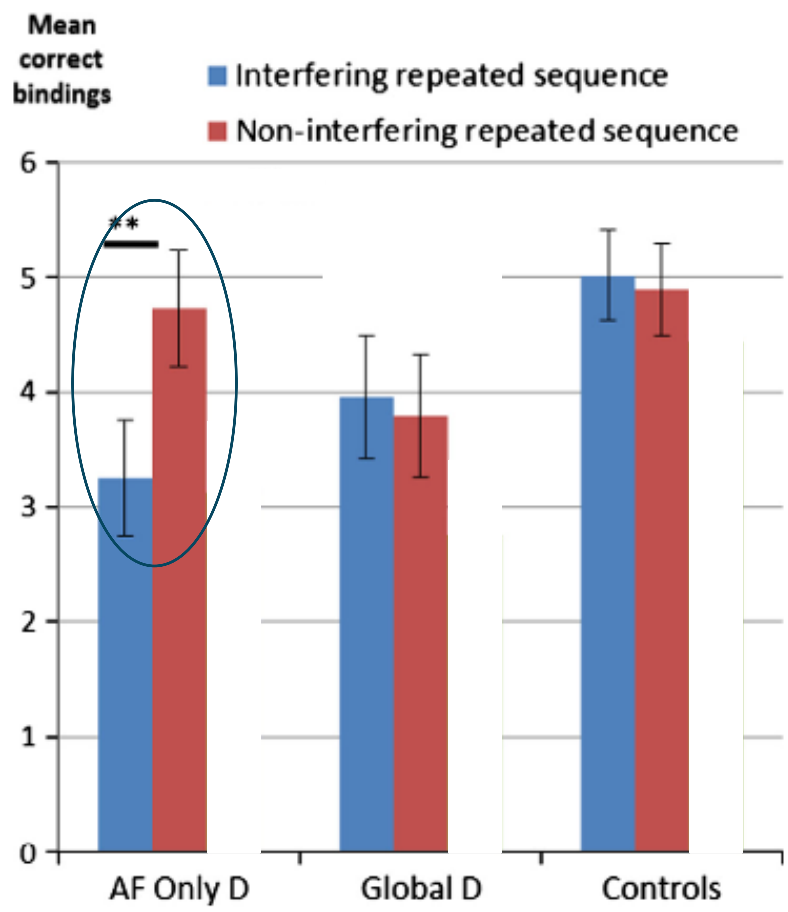
- One made of the same syllables as the fillers => interfering
- The other made of other syllables: non interfering



De Visscher, Szmalec, Van der Linden & Noël, 2015, *Cognition*

RESULTS

- People with a specific AF impairment show an hypersensitivity to interference in memory



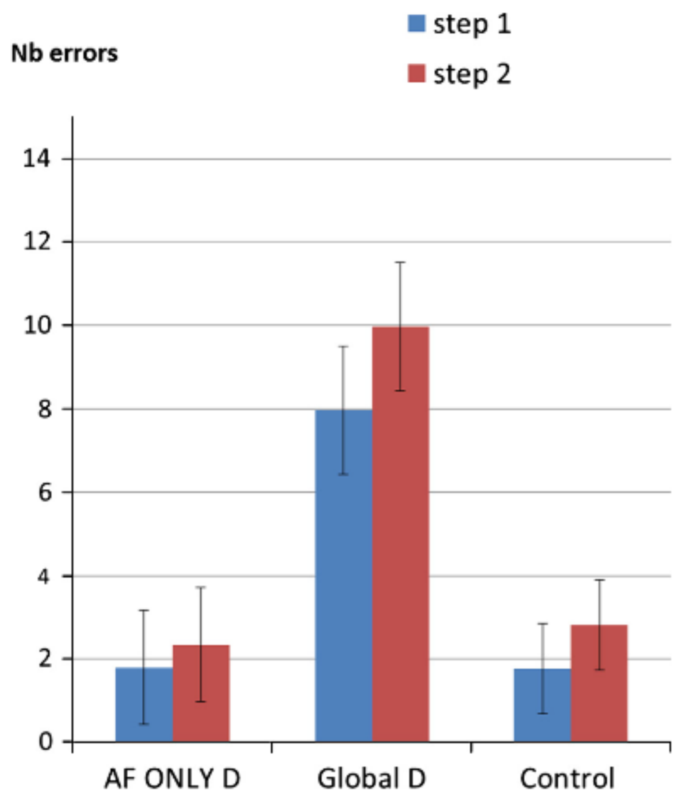
De Visscher, Szmalec, Van der Linden & Noël, 2015, *Cognition*

People with global deficit show reduced learning in all the conditions

When asked to say the syllable one, or two steps further in the sequence, much more errors

=> global problem of memory (order memory)

=> two types of profiles, two underlying mechanisms



* AF deficit: due to an hypersensitivity to interference in memory
* Global deficit: associated with a problem in order memory

Q2: CONCLUSION

Profiles of persons with DD can be quite different

There is not yet a clear categorization of these profiles, nor or their underlying mechanisms

De Visscher, Szmalec, Van der Linden & Noël (2015) made a first attempt in this direction

Future research should follow this avenue and try to associate specific math profiles with specific cognitive mechanisms and, related to this, specific interventions programs

Q3: DD - MLD ? PRIMARY - SECONDARY DD?

Rubinsten and Henik (2009) differentiate between

- "developmental dyscalculia" : primary disability in mathematics caused by a core deficit in numerical magnitude representation (related to parietal lobe dysfunction)
- "mathematical learning disability" (MLD): secondary deficiencies in mathematics due to general cognitive impairments such as inattention or a working memory deficit (related to frontal lobe dysfunction)

Kaufmann et al., (2013) differentiate between primary and secondary dyscalculia, with the latter being entirely caused by non-numerical impairments.

"*Different factors can lead to MLD (ADHD, WM problems, emotional problems …), but this is not DD as the core number sense is preserved*"

Q3: DD - MLD ? PRIMARY - SECONDARY DD?

MLD or secondary DD: due to general cognitive impairments

- treating ADHD (Elia et al., 1993; Lindsay et al., 1999; von Aster, 2000) and math anxiety (Hembree, 1990; Ramirez & Beilock, 2011) alleviated poor performance in mathematics. So, if mathematical difficulties are secondary to another problem, this should always be treated first.

- YET: sometimes an impairment in a general cognitive skills leads to a very specific disabnility in the math domain

➢ an hypersensitivity to interference in memory can lead to a very specific cognitive impairment markedly observable in the learning of arithmetical facts …a specific type of DD

Q3: DD - MLD ? PRIMARY - SECONDARY DD?

DD or primary dyscalculia : caused by a core deficit in numerical magnitude representation

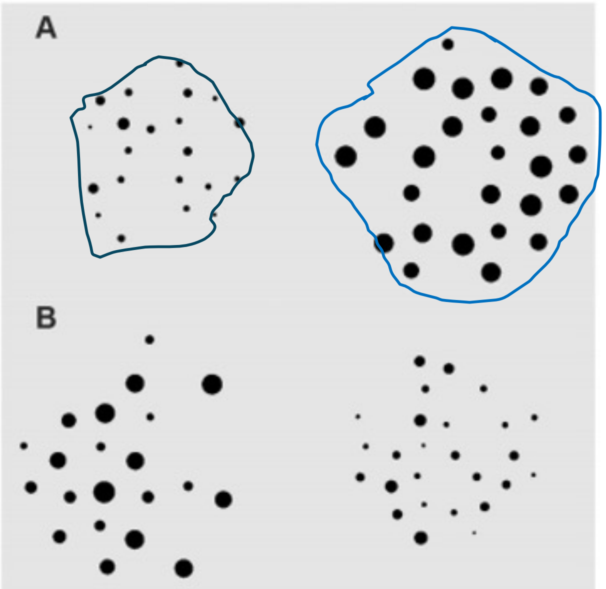
Yet:

- clinicians do not have accurate measurement tools of the number magnitude representation
- Difficulties in the number magnitude representation may be due to inhibition difficulties (Bugden & Ansari, 2015; Gilmore et al., 2013)

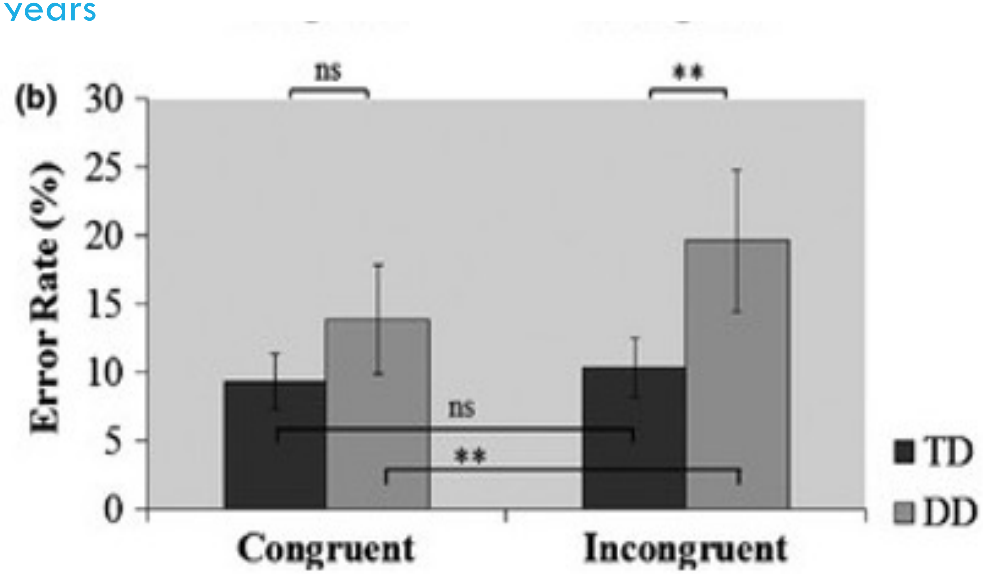
Q3: DD - MLD ? PRIMARY - SECONDARY DD? BUGDEN & ANSARI 2015

21-26 dots
Congruent

incongruent



Children with math difficulties during 4 consecutive years

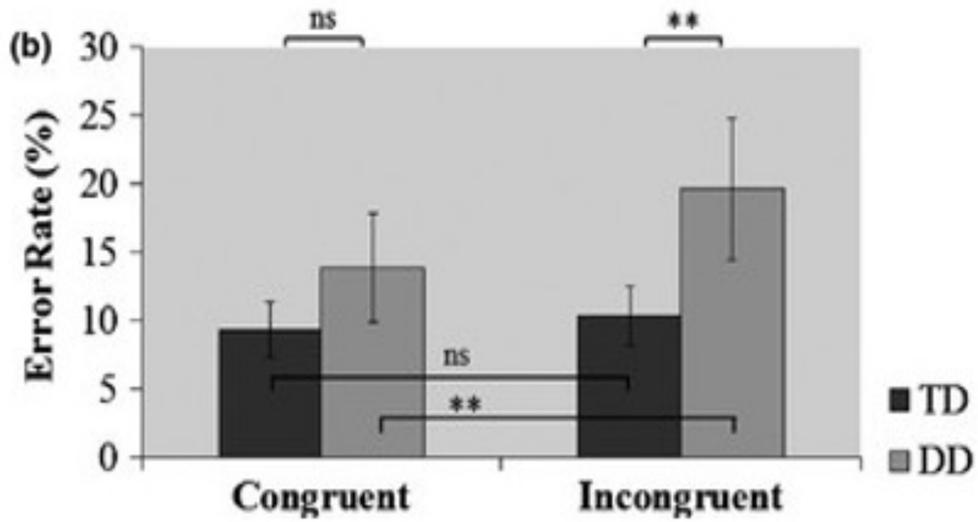


See also Wilkey et al. (2020) for similar results

Q3: DD - MLD ? PRIMARY - SECONDARY DD? BUGDEN & ANSARI 2015

A "core deficit in numerical magnitude representation" could actually reflect a difficulty in resisting to the influence of irrelevant dimension (dot size, external envelope of the collection) ; thus not a number difficulty !

Children with math difficulties during 4 consecutive years



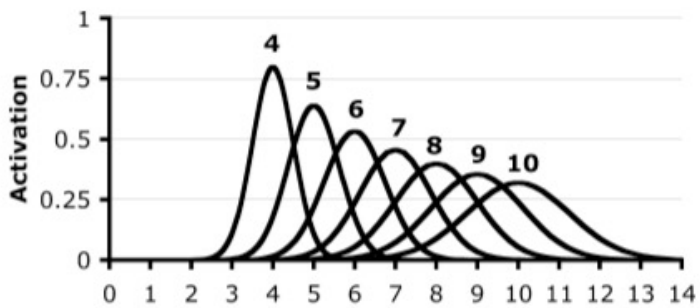
See also Wilkey et al. (2020) for similar results

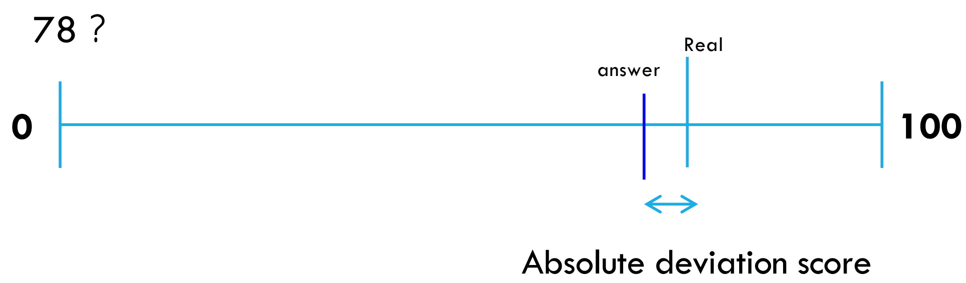
Q3: DD - MLD ? PRIMARY - SECONDARY DD? CROLLEN, VANDERCLAUSEN, ALLAIRE, POLLARIS, & NOËL, 2015

The ANS is supposed to be spatially oriented with, in our culture, small numbers on the left and large numbers on the right

Children diagnosed with visuo-spatial impairment (n=15) vs typical children (n=15), ± 10 y.o

Less precise in positioning numbers on a line (see also Gomez, Piazza & al., 2015





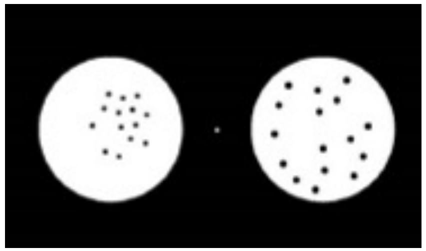
Q3: DD - MLD ? PRIMARY - SECONDARY DD?

CROLLEN, VANDERCLAUSEN, ALLAIRE, POLLARIS, & NOËL, 2015

- Less precise in comparing two Arabic numbers (see also Gomez, Piazza & al., 2015)

- No indication of a spatial orientation of their magnitude representation

- Also less precise in comparing dots collections (Gomez, Piazza & al., 2015)



➢ Children diagnosed with visuo-spatial impairment show all signs of a deficit at the core number magnitude representation

Q3: CONCLUSION

Primary or secondary DD ?

Secondary DD?

- In some cases, general cognitive factors may lead to secondary math difficulties (eg., ADHD and inattentive errors)
- In other cases, some very specific cognitive skill disorder may lead to a very specific impairment in one numerical domain (hypersensitivity to interference and AF DD)

Primary DD?

- Difficulties in the collection comparison (ANS) can be due to difficulties in inhibiting irrelevant dimension (size of the dots, convex hull) => secondary ?
- Children with general cognitive disorder (visuo-spatial impairment) may show many difficulties, and , in the number domain, difficulties on the number magnitude => secondary ?

GLOBAL CONCLUSION

Most of the research about dyscalculia has been made those last 40 years

We have pointed out three questions that will need further research:

- Q1: What is the core number deficit ?
  - Hypothesis of the scaffolding (ANS is the first deficit) or
  - **the refinement** (accessing the magnitude of symbolic numbers is the first deficit)

Q2: Are there different subtypes of DD?

- **Maybe a specific AF subtype and a more-general subtype** ?

Q3: Can we differentiate DD (or primary DD) from MLD (or secondary DD)?

- This differentiation is **far from clear**

THANKS VERY MUCH FOR YOUR ATTENTION !