

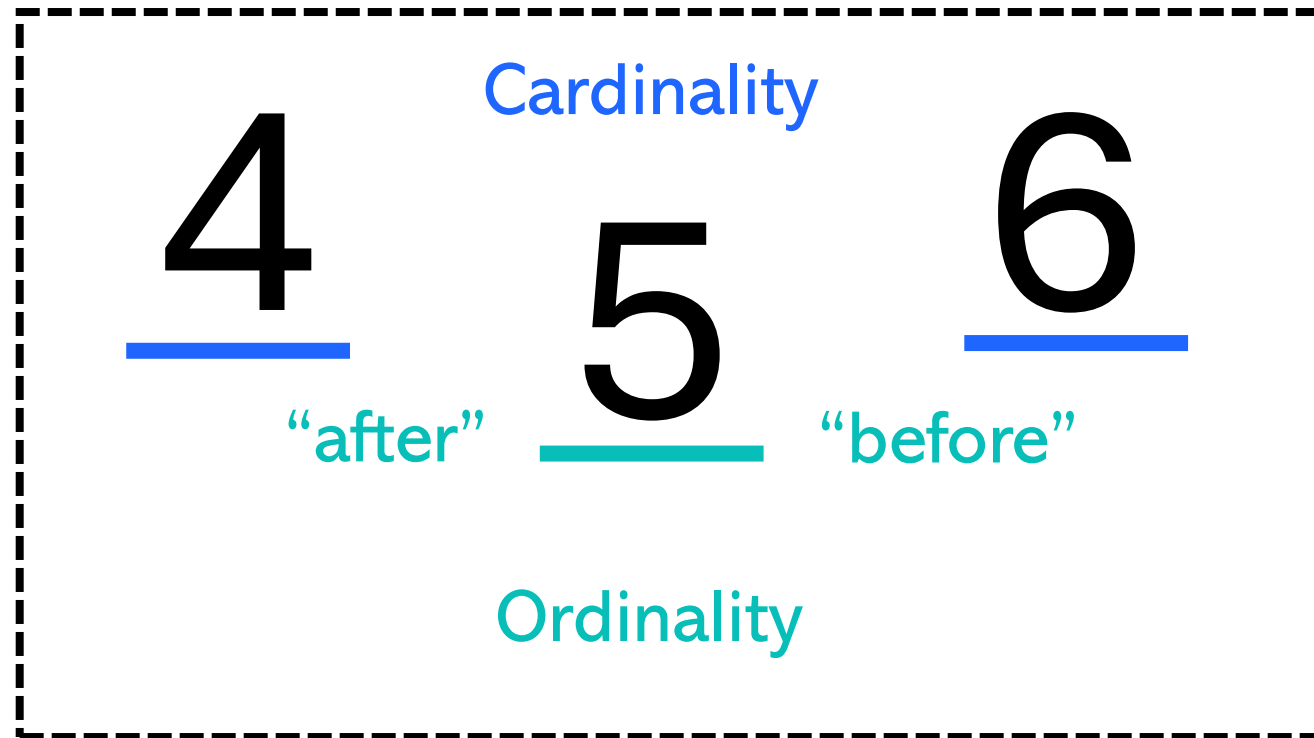
The nature of order processing deficits in developmental dyscalculia

Declan Devlin*, Natalia Dubinkina*, Eveline De Praetere,
Francesco Sella, Bert Reynvoet

*shared first-authors

Ordinality & Cardinality

Ordinality and cardinality represent two foundational aspects of numerical understanding:

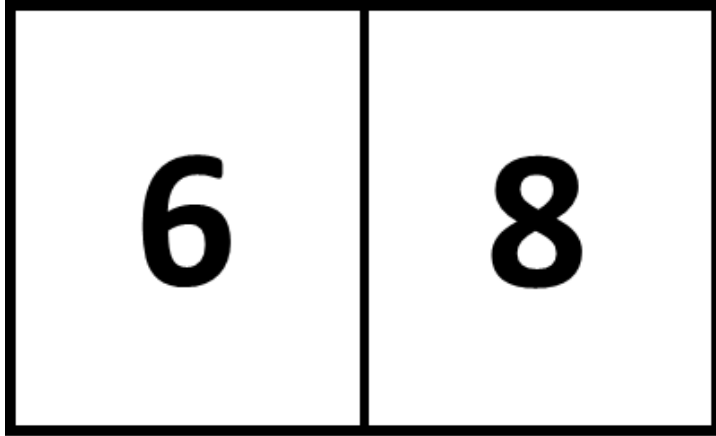


“Understanding of numerical relations”

Order processing & magnitude processing

Cardinality

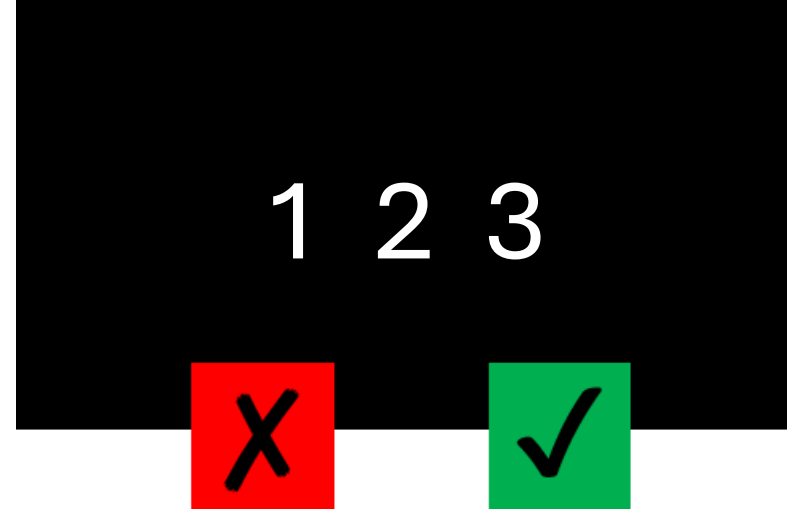
Magnitude comparison



Which number is numerically larger?

Ordinality

Order verification



Are these numbers in order?

But what actually is order processing?

“the ability to judge the relative positions of items within sequences”

Harju & Van Hoof (2025)

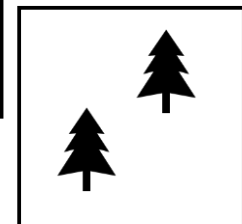
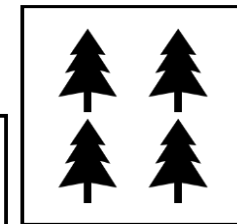
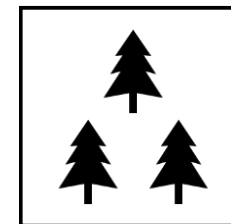
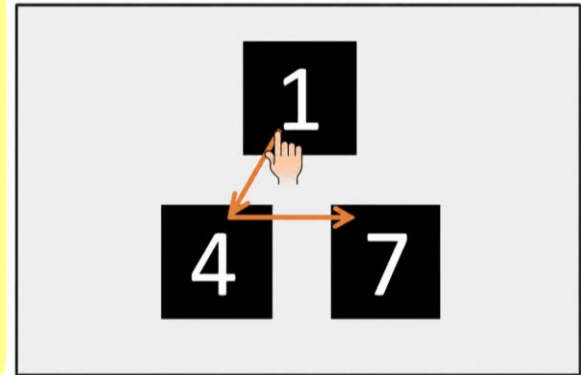
638 unique terms referring to ordinality

151 distinct descriptions of ordinality,
clustered into ten categories.

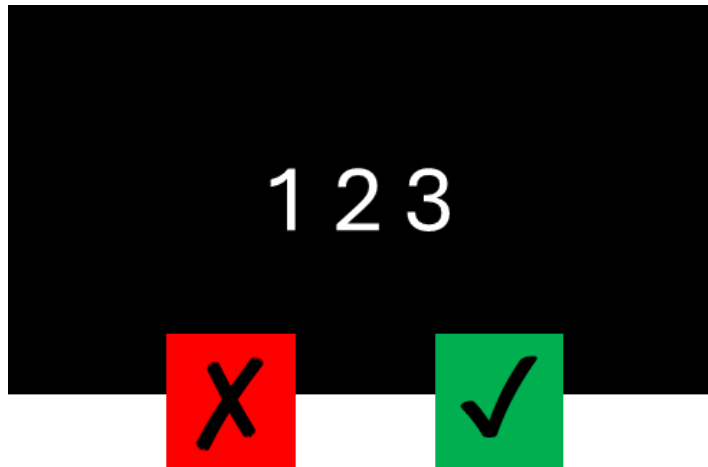
18 different types of measures were
used to assess ordinality

MOST FREQUENTLY USED!

1 2 3



Why do we care?



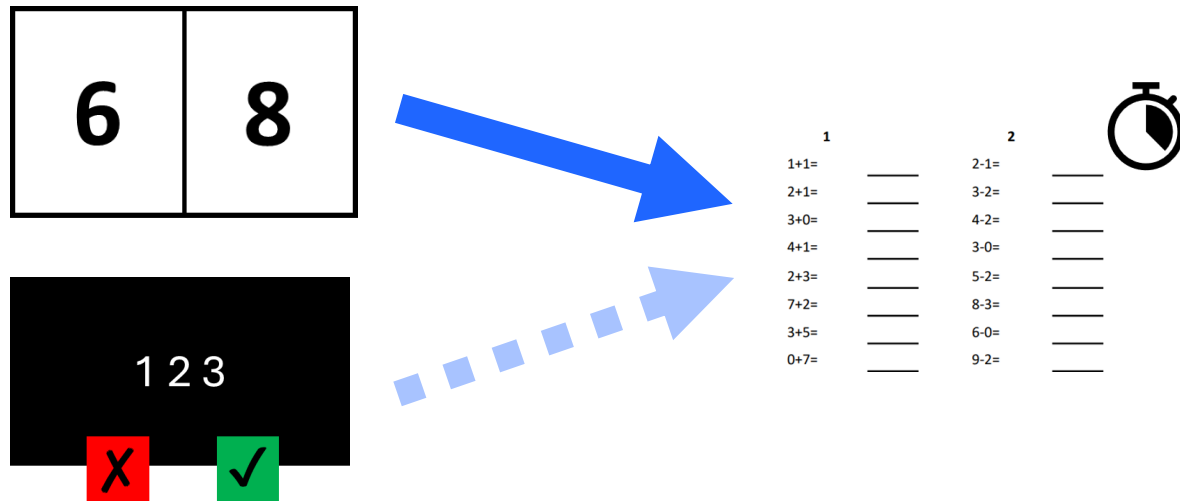
1		2	
1+1=	_____	2-1=	_____
2+1=	_____	3-2=	_____
3+0=	_____	4-2=	_____
4+1=	_____	3-0=	_____
2+3=	_____	5-2=	_____
7+2=	_____	8-3=	_____
3+5=	_____	6-0=	_____
0+7=	_____	9-2=	_____



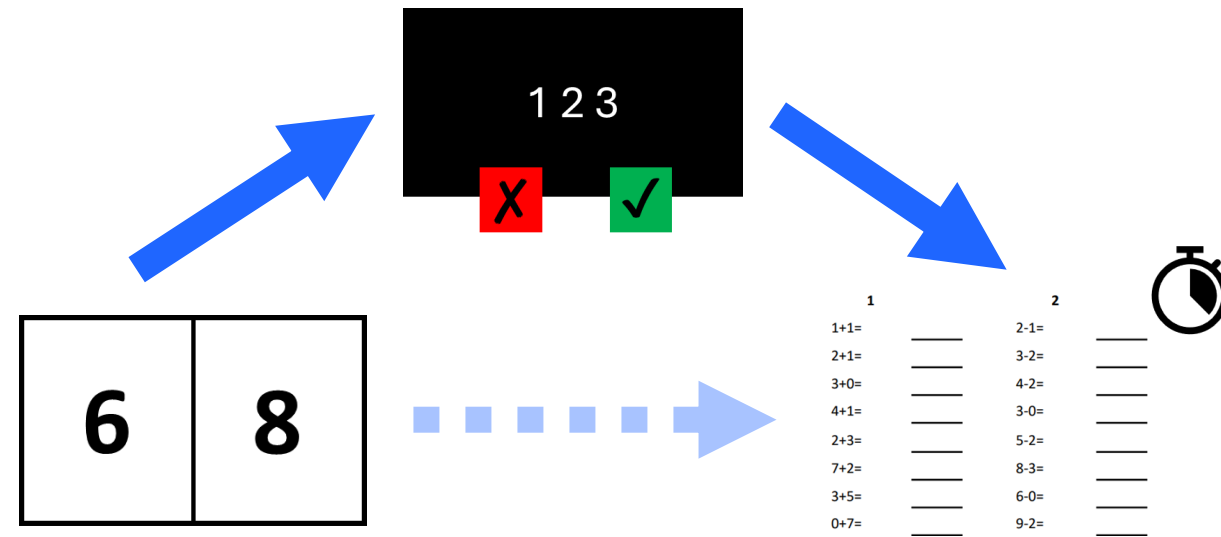
Arithmetic

Increasingly important over time...

First grade

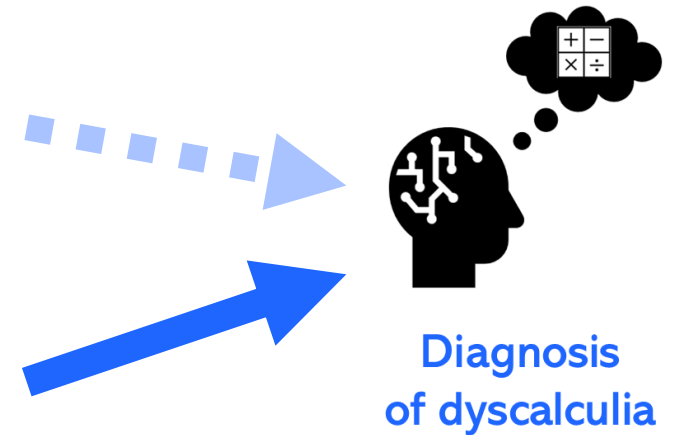
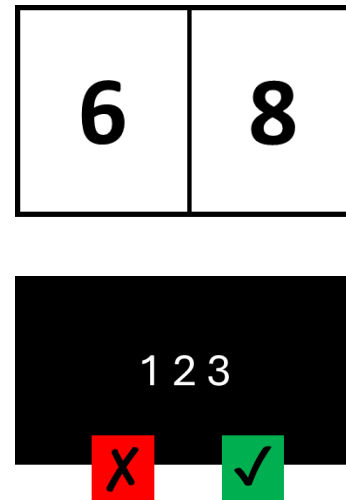


Second grade



(e.g., Lyons et al., 2011; Sasanguie & Vos, 2018)

Particularly relevant to dyscalculia...



Order processing deficits in dyscalculia: Ashkenazi et al., (2025); Attout & Majerus (2015); Decarli et al., (2023)

Order processing strongest predictor of dyscalculia diagnosis: Morsanyi et al. (2018)

Overview of the literature

The association between dyscalculia / MLD and order processing has received limited attention:

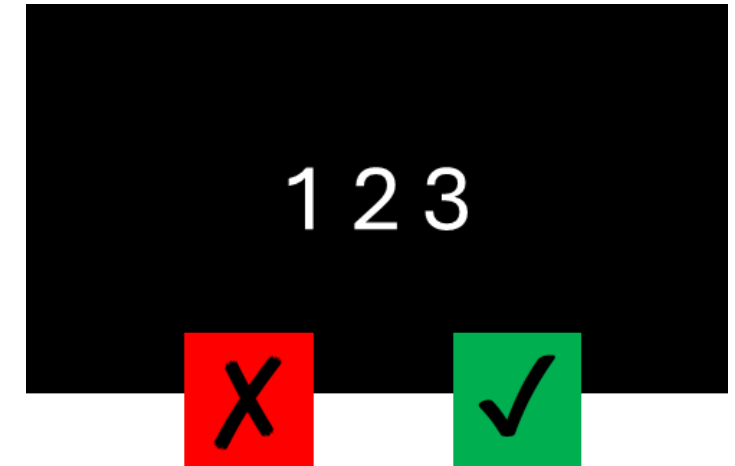
15 studies between 2006 and 2026

Almost all (87%) include an order verification task

Approximately half (54%) do so exclusively

**Different populations
(DD / MLD)**

Variety of ages



Other tasks:

Letter ordering

Event ordering

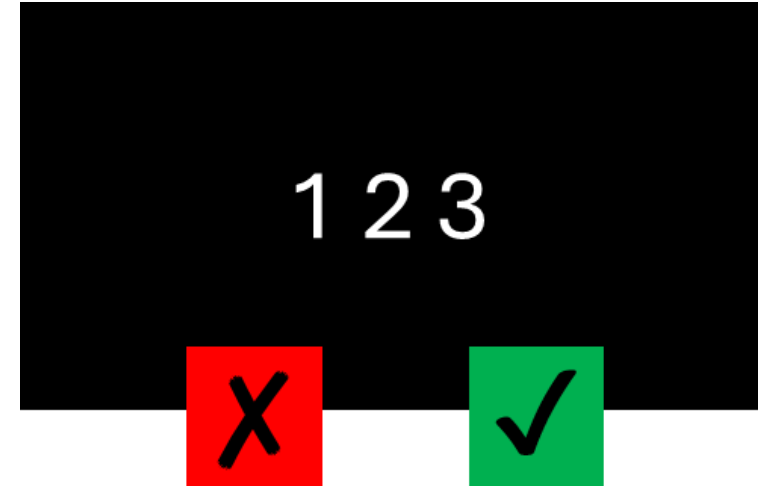
Nonsymbolic ordering

WARNING

**This presentation focuses only on the
order verification task...**

It is also very cognitive...

**Focuses a lot on understanding typical
development of order processing / ordinal
understanding**



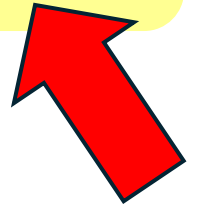
**Understanding the mechanisms underlying order processing in general – may
be key to understanding order processing deficits in dyscalculia specifically**

How we investigate order processing

To identify the mechanisms
underlying order processing...
we try to explain its associated
effects

Reverse distance effect

123 vs 135



**We only care about this
one (for some reason)**

The “Reverse Distance Effect”

1-2-3

Consecutive

1-3-5

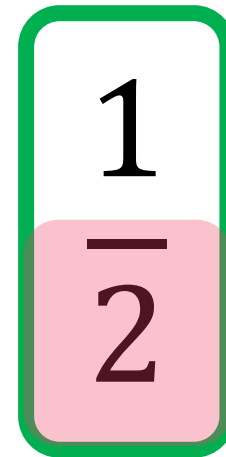
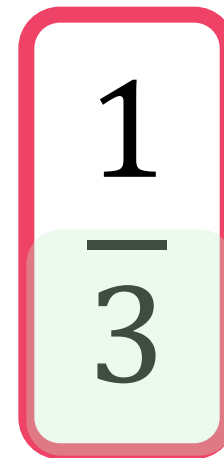
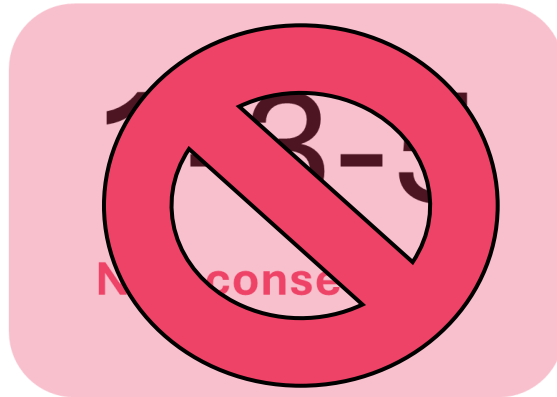
Non-consecutive

The count-list explanation

Early experiences with order come from learning the verbal count-list

“one, two, three, four, five...”

Leading to an intuition that “in order” == “matches the count-list”

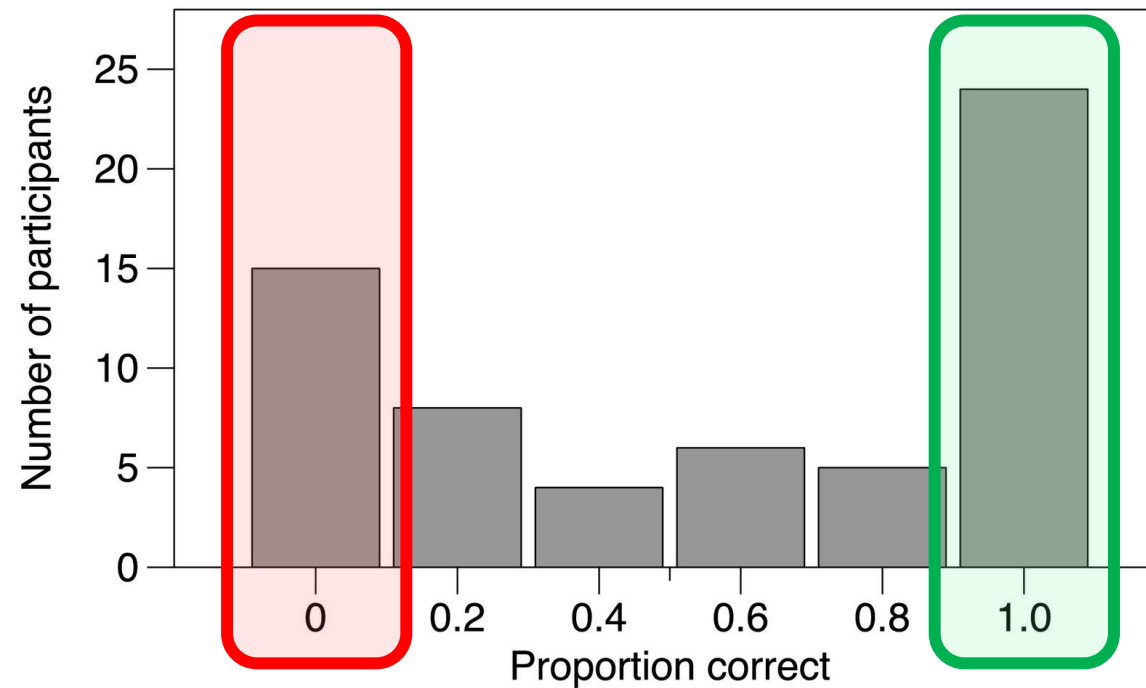


(e.g., Gattas et al., 2021; Hutchison et al., 2022)

Evidence in children

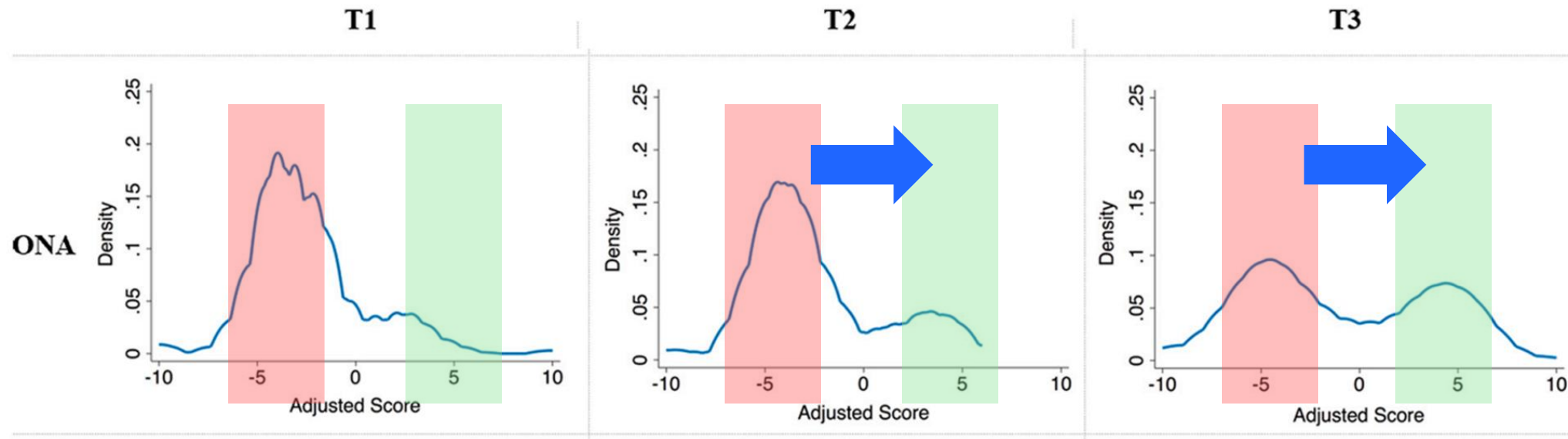
Gilmore & Batchelor (2021)

Many children (mean age = 7.58 years) consistently rejected non-consecutive sequences during an order verification task:



Hutchison et al. (2022)

Replicated this finding in a longitudinal study:



This transition occurred as a sudden **qualitative shift**, rather than as incremental improvement – suggesting this represents a shift in **conceptual understanding**.

Evidence in adults

Gattas et al. (2021)

Even after learning that non-count-list sequences can be ordered, we still observe a reverse distance effect ...even in adults:

1-2-3

Consecutive

1-3-5

Non-consecutive

Gattas et al. (2021) propose this may reflect the lasting impact of this count-list-based intuition about what constitutes “in order” (Similar to the natural number bias!)

Gattas et al. (2021)

Standard condition

Consecutive
Non-consecutive
Mixed-order

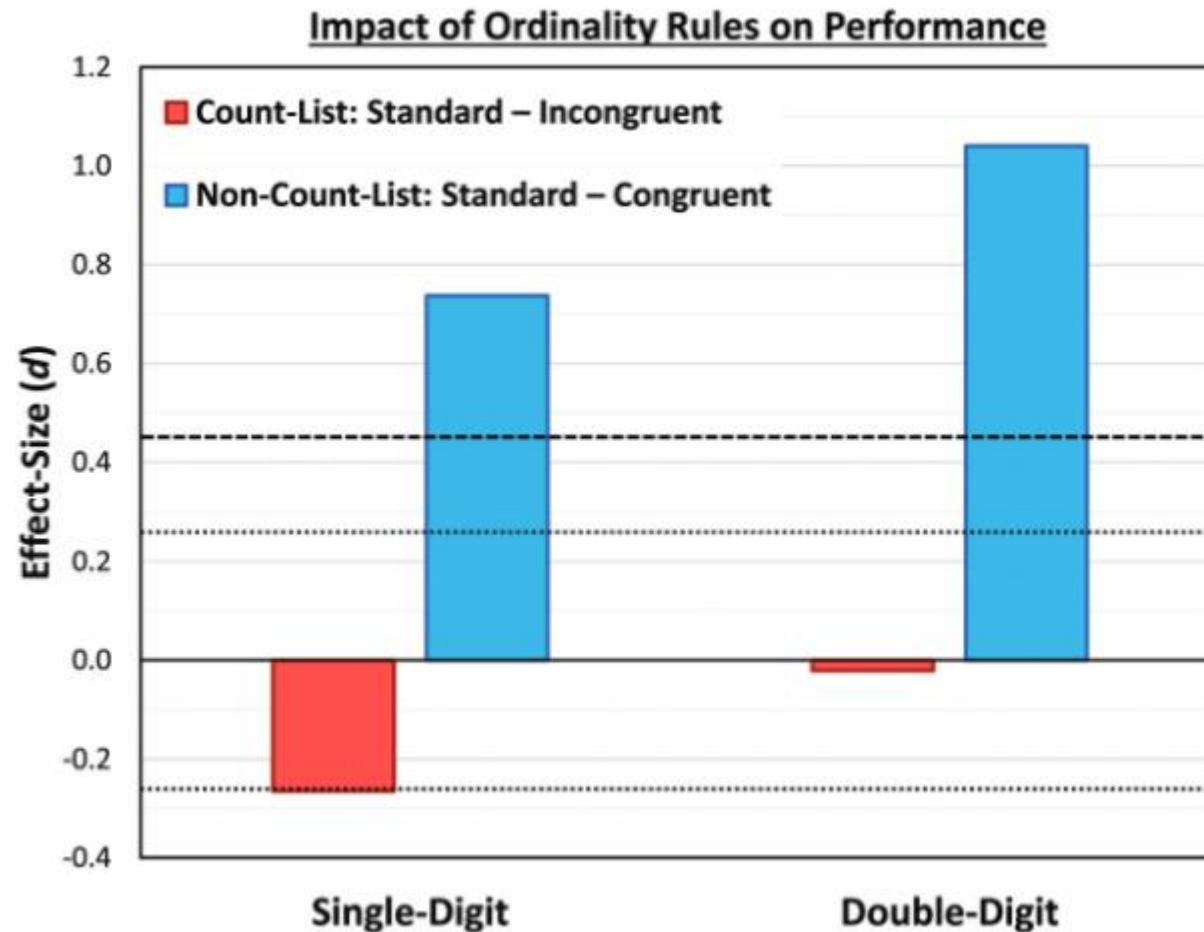
Congruent condition

Consecutive
Non-consecutive
Mixed-order

If this count-list intuition exists, performance should improve in the congruent condition

 In order
 Not in order

Gattas et al. (2021)

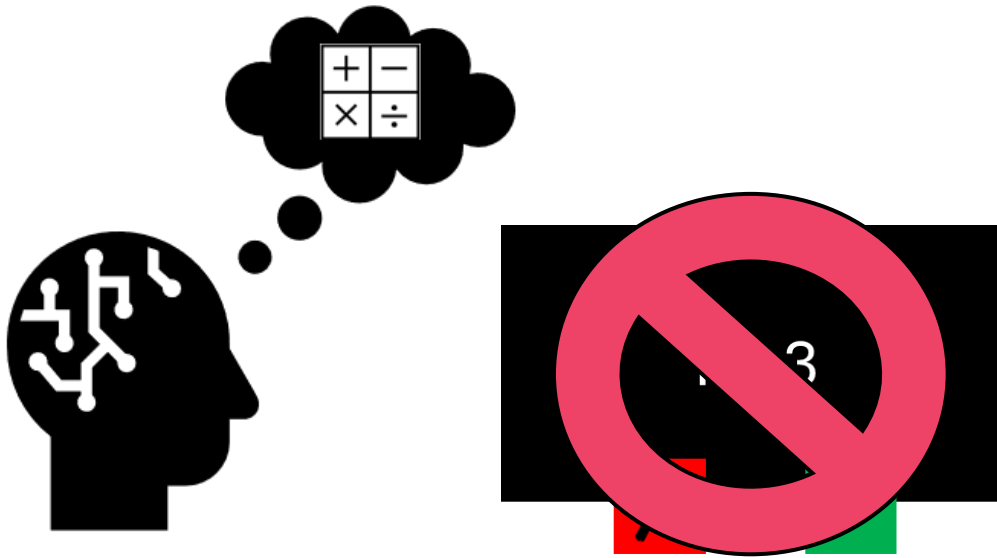


Performance improved in the **congruent condition...**

Adults were faster at classifying non-consecutive sequences as **not ordered** than as **ordered**!

Evidence in dyscalculia

General or specific deficit?

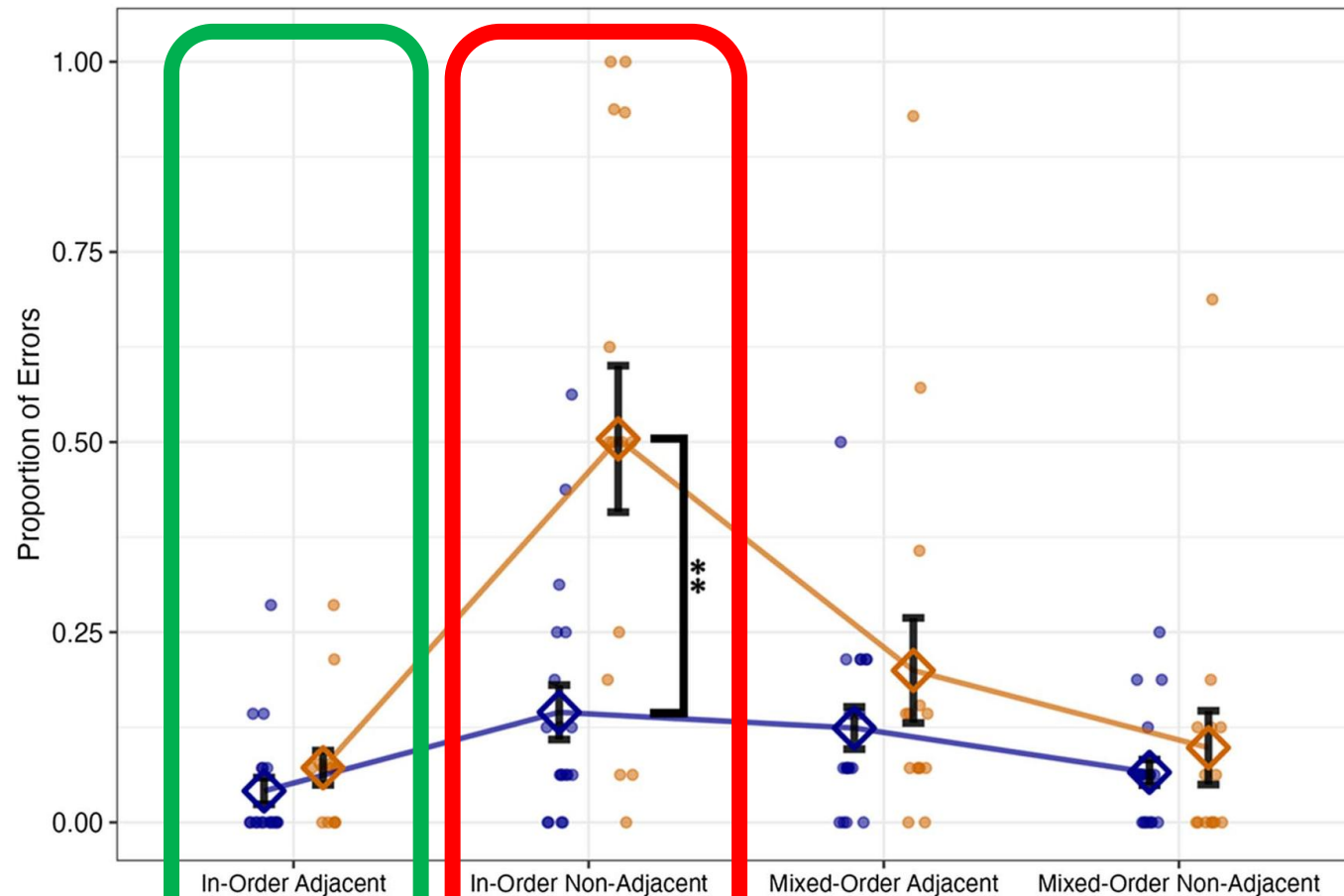


Developmental
dyscalculia

**Are these deficits
general in nature?**

**Or are they specific to
non-count-list
sequences?**

Slipenkyj et al. (2025)

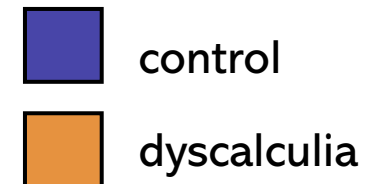


consecutive

non-consecutive

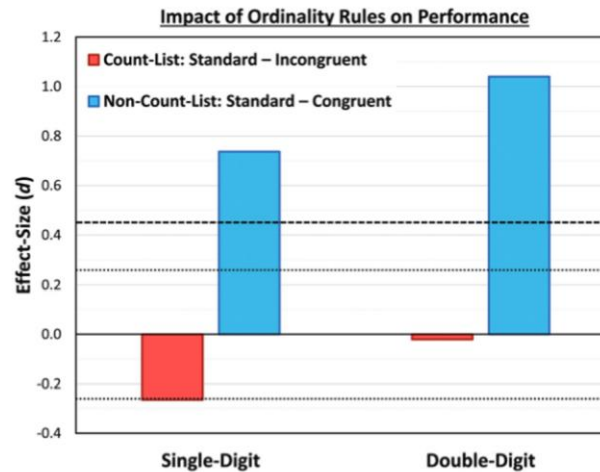
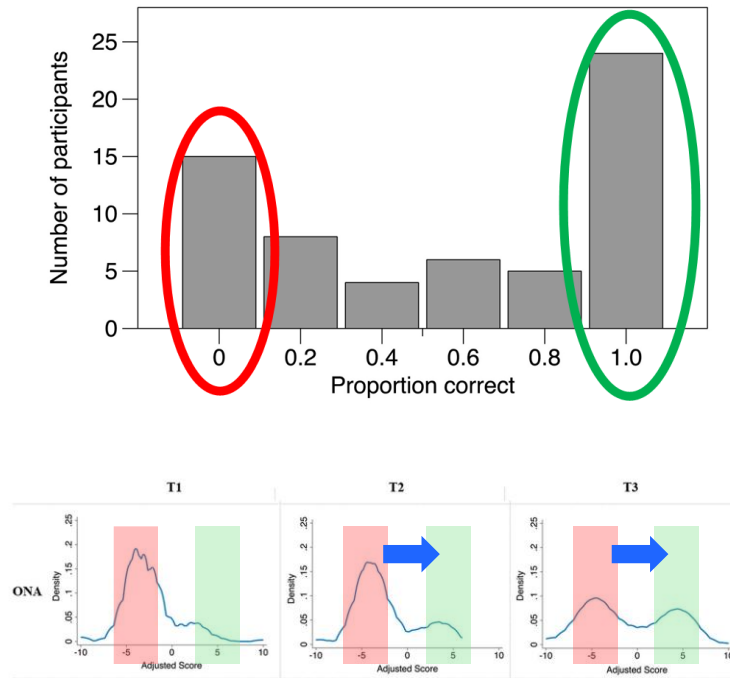
Poorer order processing performance **overall**...

...but this seems specific to **non-consecutive** sequences



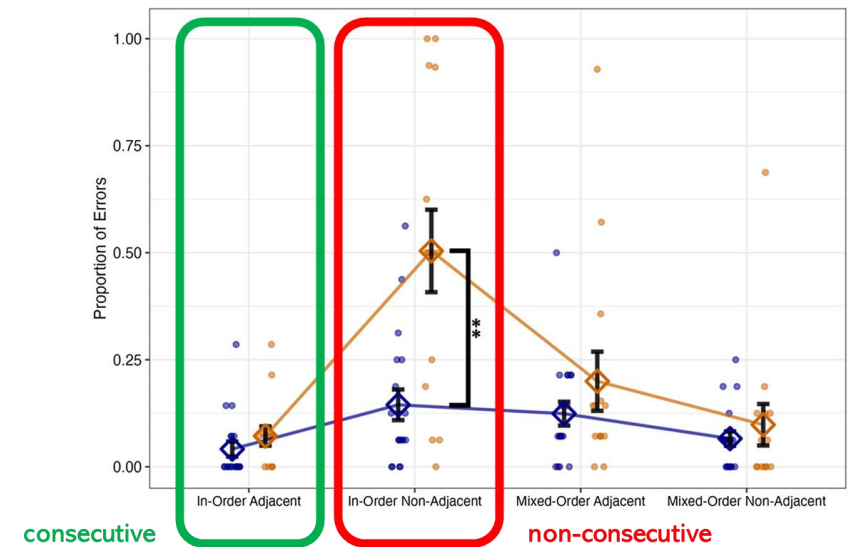
Summary of the count-list perspective

Summary of the count-list perspective



1-2-3
Consecutive

1-3-5
Non-consecutive



children



adults



dyscalculia

This presentation:

(1) Discuss limitations

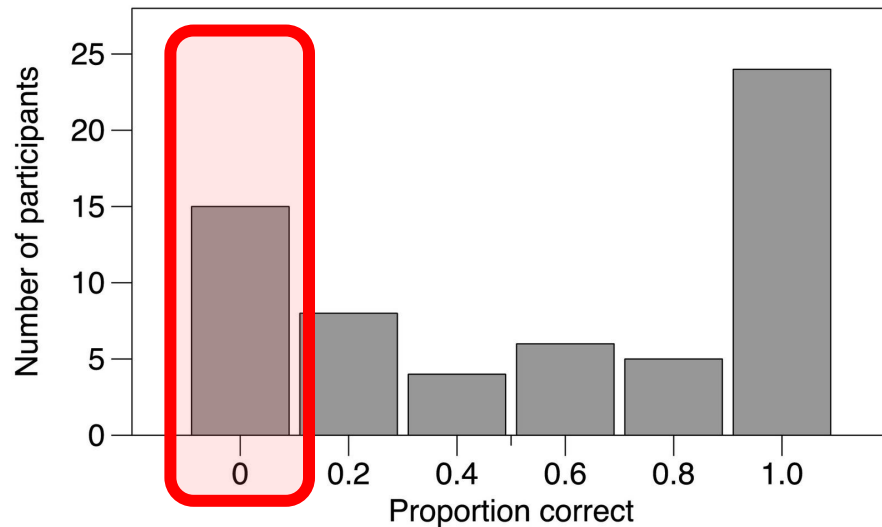
(2) Discuss limitations

(3) The present study

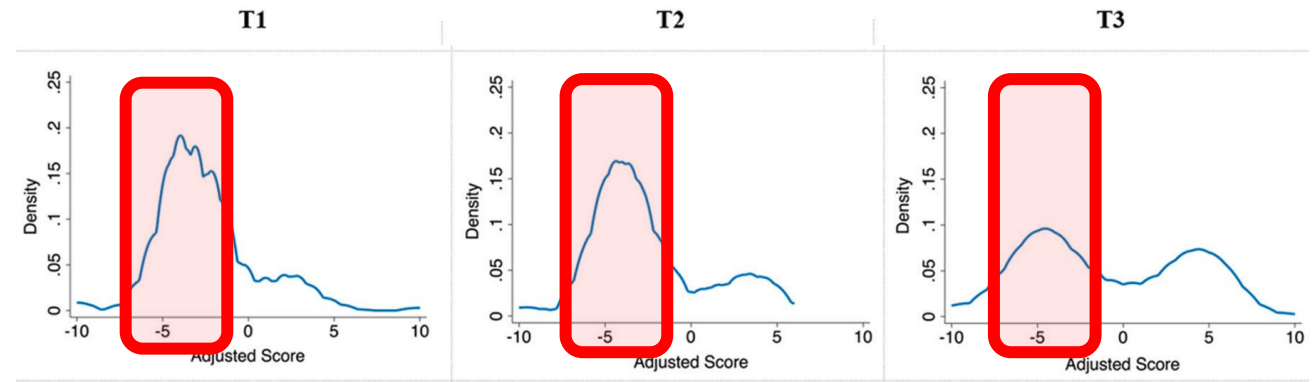
Limitations w/ evidence in children

Interpretation of poor performance

Gilmore & Batchelor (2021)

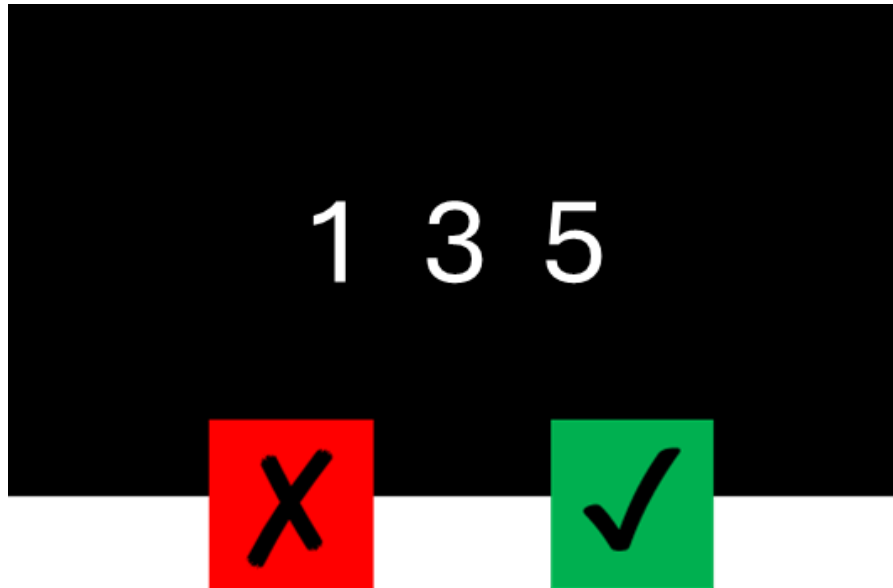


Hutchison et al. (2022)



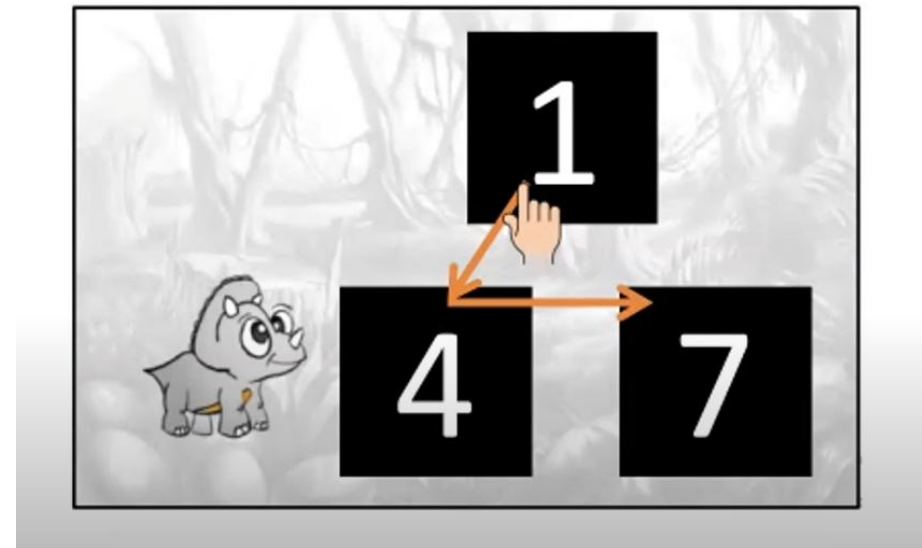
We assume that poor performance on non-consecutive sequences indicates a lack of conceptual understanding that non-count-list sequences can be considered as ordered...

Order processing in other contexts



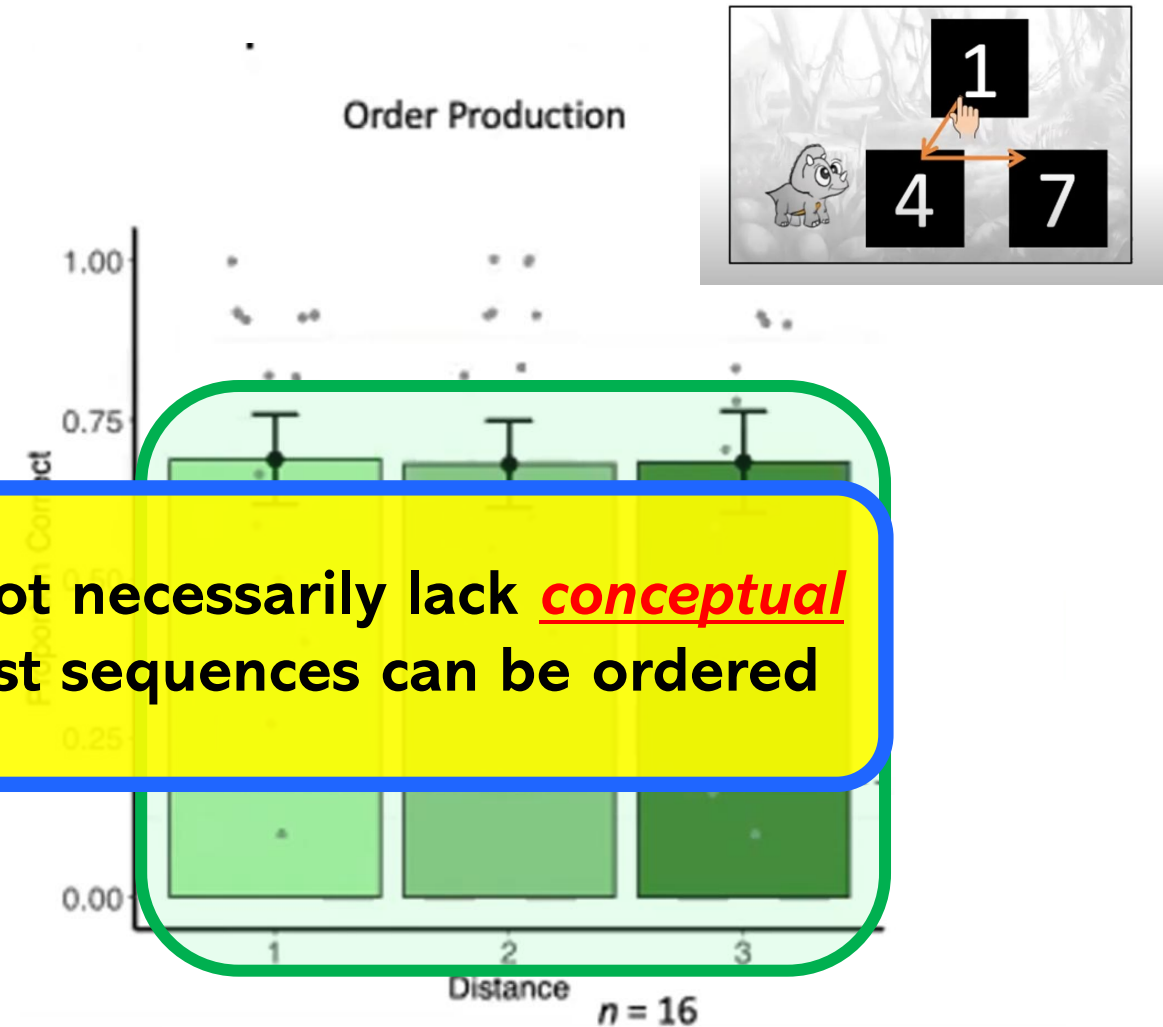
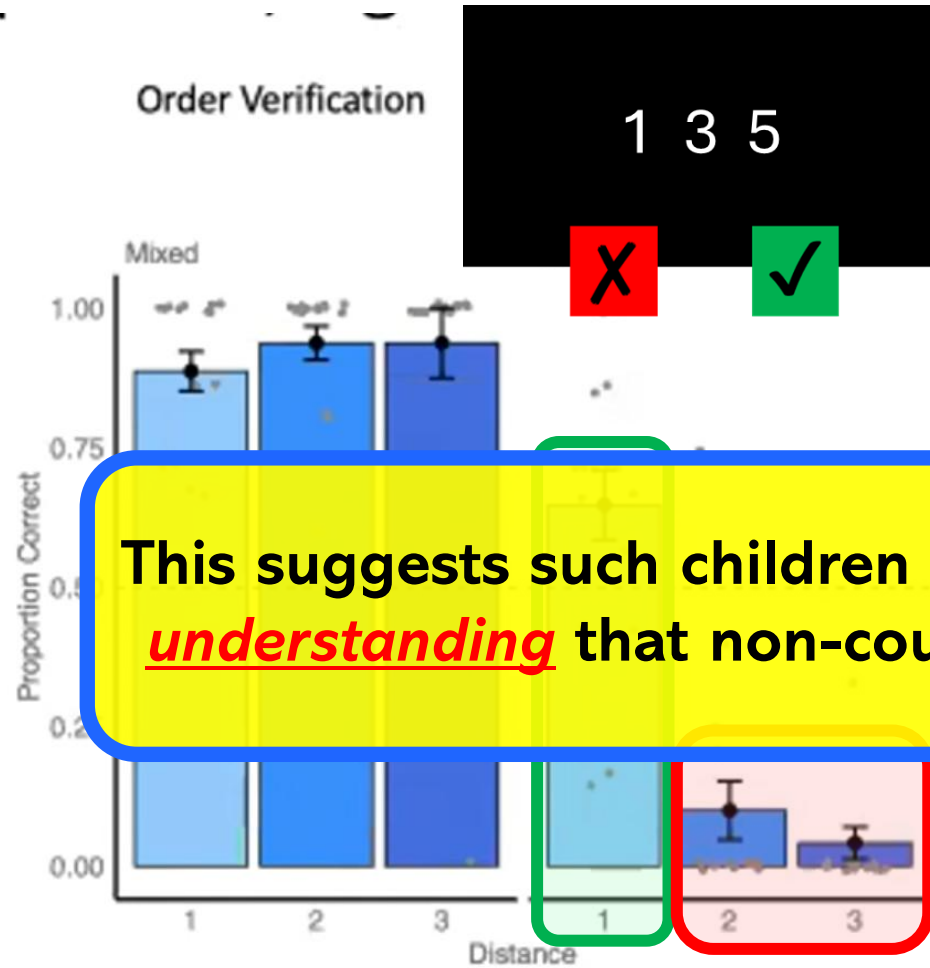
Order verification

Order production



e.g., Bugden & Brannon (MCLS, 2021); Sanina et al. (MCLS, 2025)

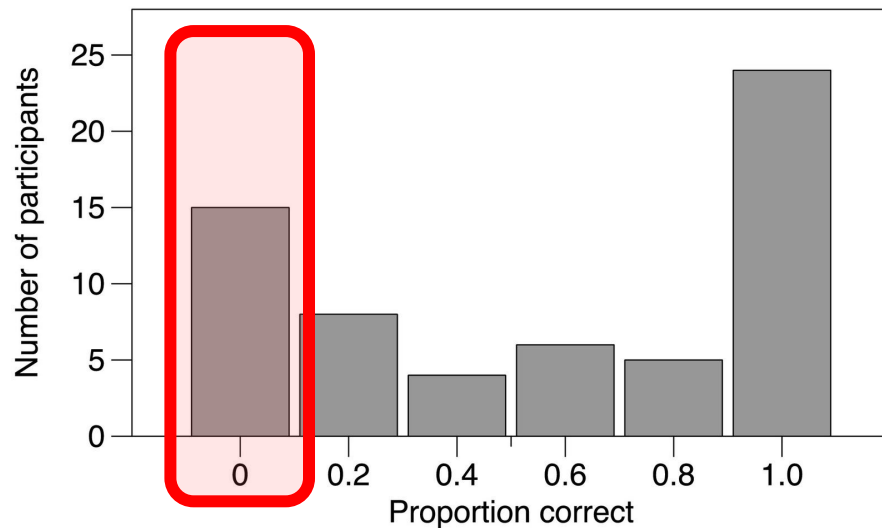
Bugden & Brannon (MCLS, 2021)



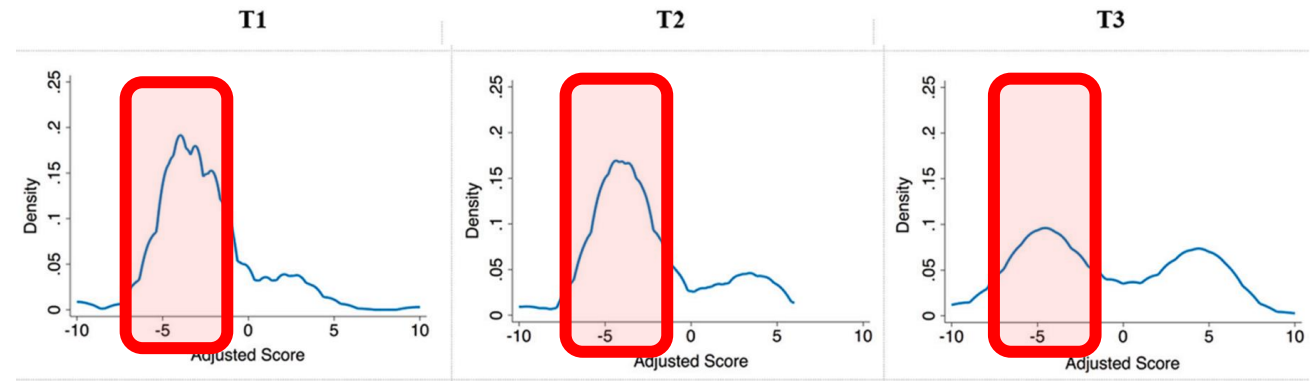
This suggests such children do not necessarily lack conceptual understanding that non-count-list sequences can be ordered

Interpretation of poor performance

Gilmore & Batchelor (2021)

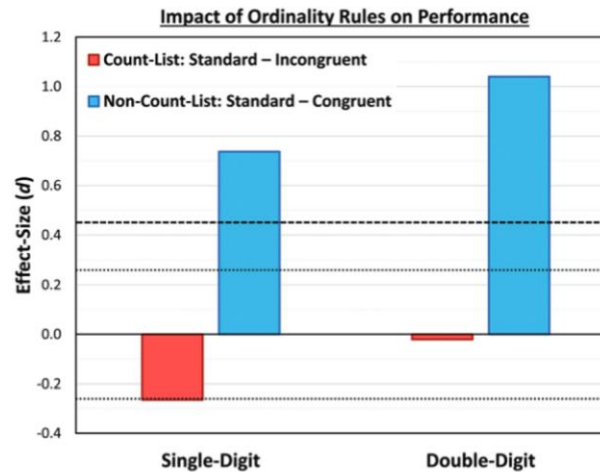
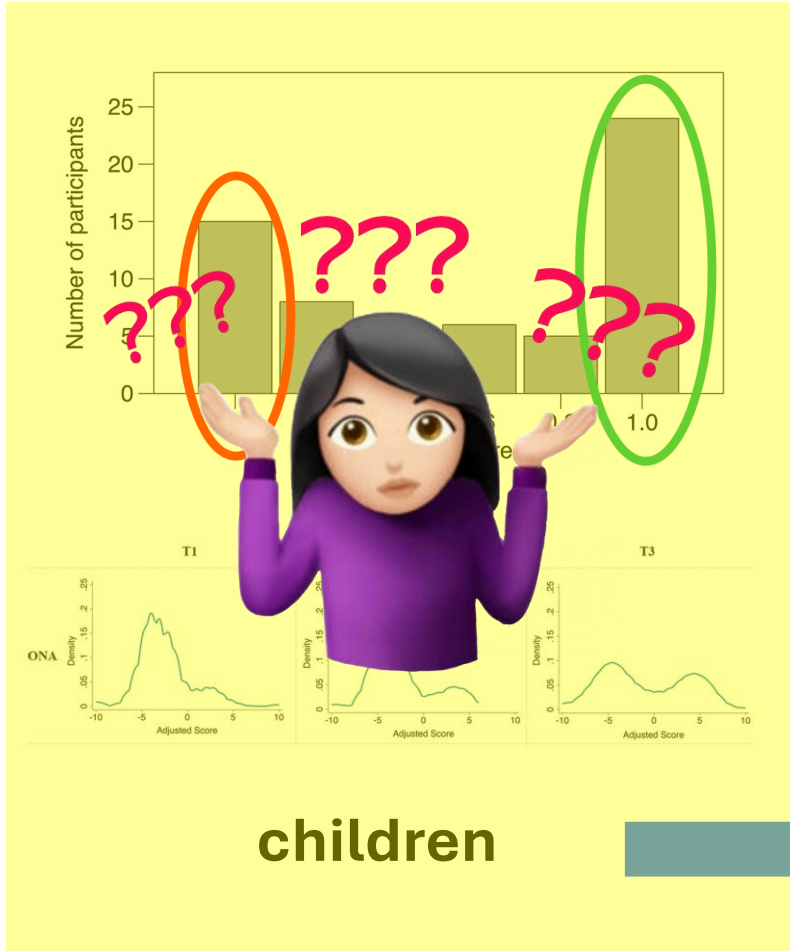


Hutchison et al. (2022)



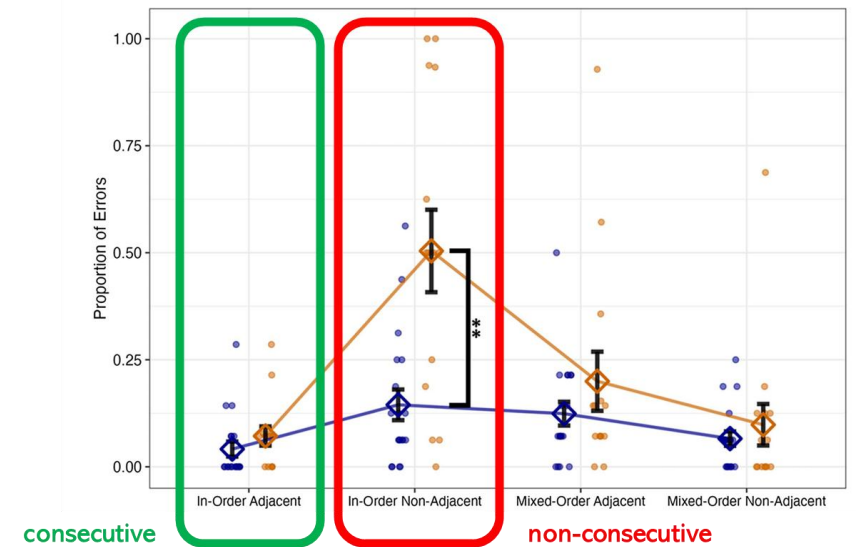
It is not necessarily the case that poor performance on non-consecutive sequences results from a lack of conceptual understanding that non-count-list sequences can be ordered

Summary of the count-list perspective



1-2-3
Consecutive

1-3-5
Non-consecutive



adults

dyscalculia

Limitations w/ evidence in adults

Count-list vs. familiarity explanations

1-2-3

Consecutive

1-3-5

Non-consecutive

Inhibited due to not
matching the count-list?

Methodological limitation w/ Gattas21

Standard condition

Consecutive

Non-consecutive

Mixed-order

Hard

Congruent condition

Consecutive

Non-consecutive

Mixed-order

Easy

In the congruent condition, participants now only had to discern whether or not a sequence was consecutive...

Non-consecutive sequences

4-6-

Standard condition - ???

Congruent condition

Non-consecutive sequences

Therefore, faster processing of non-consecutive sequences in the congruent condition is perhaps expected...

4-6-8

...because you can **reject** these sequences more easily in the congruent condition than you can **verify** them in the standard condition.

Mixed-order sequences

Notably, performance improved on both **non-consecutive** and **mixed-order** sequences in the congruent condition.

If improved performance resulted from eliminating the count-list bias for **non-consecutive** sequences, the improvement should arguably be limited just to **non-consecutive** sequences?

Non-consecutive

1	3	Mixed	1
2	4	Mixed	1
3	5	Mixed	1
4	6	Mixed	1
5	7	Mixed	1
6	8	Mixed	1
7	9	Mixed	1
1	5	Mixed	2, 3
2	6	Mixed	2, 3
4	8	Mixed	2, 3
5	9	Mixed	2, 3
1	7	Mixed	2, 3
2	8	Mixed	2, 3
3	9	Mixed	2, 3
2	1	Mixed	1
3	2	Mixed	1
4	3	Mixed	1
5	4	Mixed	1
6	5	Mixed	1
7	6	Mixed	1
8	7	Mixed	1
3	1	Mixed	2, 3
4	2	Mixed	2, 3
6	4	Mixed	2, 3
7	5	Mixed	2, 3
4	1	Mixed	2, 3
5	2	Mixed	2, 3
6	3	Mixed	2, 3

In the congruent condition:

Easy

Can reject after first two digits

Can reject after first two digits

Table A1

All Trials

Single-digit				
Left	Center	Right	Trial type	Distance
1	2	3	Count-list	1
2	3	4	Count-list	1
3	4	5	Count-list	1
4	5	6	Count-list	1
5	6	7	Count-list	1
6	7	8	Count-list	1
7	8	9	Count-list	1
1	3	5	Non-count-list	2, 3
2	4	6	Non-count-list	2, 3
4	6	8	Non-count-list	2, 3
5	7	9	Non-count-list	2, 3
1	4	7	Non-count-list	2, 3
2	5	8	Non-count-list	2, 3
3	6	9	Non-count-list	2, 3
1	3	2	Mixed	1
2	4	3	Mixed	1
3	5	4	Mixed	1
4	6	5	Mixed	1
5	7	6	Mixed	1
6	8	7	Mixed	1
7	9	8	Mixed	1
1	5	3	Mixed	2, 3
2	6	4	Mixed	2, 3
4	8	6	Mixed	2, 3
5	9	7	Mixed	2, 3
1	7	4	Mixed	2, 3
2	8	5	Mixed	2, 3
3	9	6	Mixed	2, 3
2	1	3	Mixed	1
3	2	4	Mixed	1
4	3	5	Mixed	1
5	4	6	Mixed	1
6	5	7	Mixed	1
7	6	8	Mixed	1
8	7	9	Mixed	1
3	1	5	Mixed	2, 3
4	2	6	Mixed	2, 3
6	4	8	Mixed	2, 3
7	5	9	Mixed	2, 3
4	1	7	Mixed	2, 3
5	2	8	Mixed	2, 3
6	3	9	Mixed	2, 3

Note. Table A1 provides a complete list of trials used in the numerical ordin

Table A1

All Trials

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5	6	7	Count-list	1
6	7	8	Count-list	1
7	8	9	Count-list	1
1	3	5	Non-count-list	2, 3
2	4	6	Non-count-list	2, 3
4	6	8	Non-count-list	2, 3
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1	3	2	Mixed	1
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4	6	5	Mixed	1
5	7	6	Mixed	1
6	8	7	Mixed	1
7	9	8	Mixed	1
1	5	3	Mixed	2, 3
2	6	4	Mixed	2, 3
4	8	6	Mixed	2, 3
5	9	7	Mixed	2, 3
1	7	4	Mixed	2, 3
2	8	5	Mixed	2, 3
3	9	6	Mixed	2, 3
2	1	3	Mixed	1
3	2	4	Mixed	1
4	3	5	Mixed	1
5	4	6	Mixed	1
6	5	7	Mixed	1
7	6	8	Mixed	1
8	7	9	Mixed	1
3	1	5	Mixed	2, 3
4	2	6	Mixed	2, 3
6	4	8	Mixed	2, 3
7	5	9	Mixed	2, 3
4	1	7	Mixed	2, 3
5	2	8	Mixed	2, 3
6	3	9	Mixed	2, 3

Note. Table A1 provides a complete list of trials used in the numerical ordin

In the standard condition:

Hard

Can reject after first two digits

Mixed-order sequences

Notably, performance on both **non-consecutive** and **mixed-order** sequences also improved in the congruent condition.

If improved performance resulted from eliminating the count-list bias for **non-consecutive** sequences, the improvement should arguably be limited just to **non-consecutive** sequences?

Alternative explanation

1-2-3

Consecutive

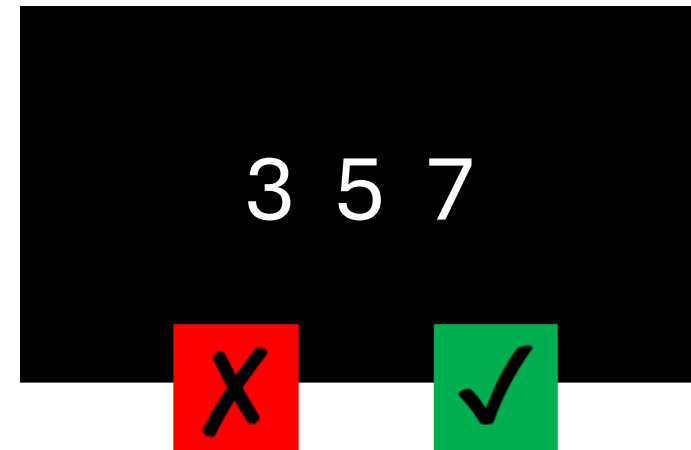
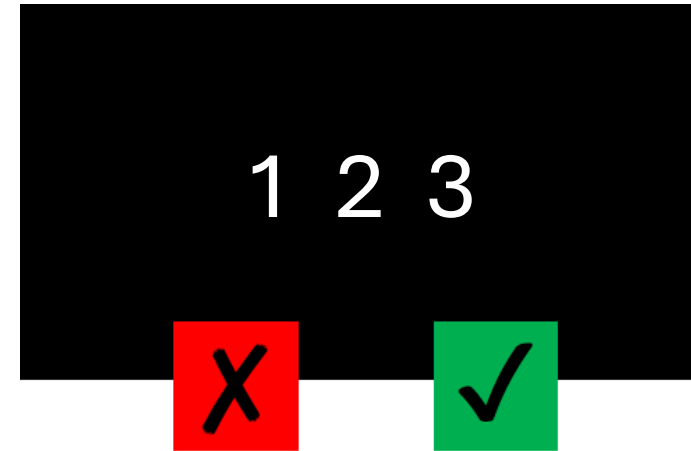
Facilitated due to being
more familiar?

1-3-5

Non-consecutive

~~Inhibited due to not
matching the count-list?~~

Associative // familiarity explanation



The familiarity explanation

Consecutive

1 2 3 4 5 6 5 6 7

2 3 4 3 4 5

6 7 8 7 8 9

Non-consecutive

1 3 5 4 6 8 3 6 9

2 4 6 5 7 9

3 5 7 2 5 8

Dubinkina et al. (2021)

Memory retrieval was the most commonly self-reported strategy, especially for familiar sequence types:

	MEMORY (%)	DECOMPOSITION (%)	ARITHMETIC (%)	OTHER (%)
AC	70.68	18.55	8.77	2.01
AnC	49.74	29.64	15.98	4.64
DC	63.73	42.35	9.59	2.38
DnC	44.09	38.22	14.70	2.89

(Dubinkina et al., 2021)

Differentiating between the familiarity and count-
list explanations

Count-list vs. familiarity explanations

1-2-3

Consecutive

Facilitated due to being
more familiar?

1-3-5

Non-consecutive

Inhibited due to not
matching the count-list?

Both perspectives seem to make the same predictions: consecutive sequences should be processed faster than non-consecutive sequences...

The familiarity explanation

~~“Consecutive sequences should be processed faster than
non consecutive sequences”~~

“Familiar sequences should be processed faster than
unfamiliar sequences”

The familiarity explanation

Consecutive

1 2 3 4 5 6 5 6 7
2 3 4 3 4 5
6 7 8 7 8 9

Non-consecutive

1 3 5 4 6 8 3 6 9
2 4 6 5 7 9
3 5 7 2 5 8

Count-list vs. familiarity explanations

Consecutive
(Count-list)

Non-consecutive
(Non-count-list)

Consecutive

1 2 3 4 5 6 5 6 7
2 3 4 3 4 5
6 7 8 7 8 9

Non-consecutive

1 3 5 4 6 8 3 6 9
2 4 6 5 7 9
3 5 7 2 5 8

2 4 6

3 6 9

How to measure familiarity?

Sequence types can be used as a proxy for familiarity

Consecutive

Non-consecutive

Ascending

Descending

2 4 6

3 2 1

Comparative judgement

Humans are very bad at making **absolute judgements**, but very good at making **relative judgements**:



How bright is this square (0–100)?

Co

ement

Humans are very bad at
making relative judgements

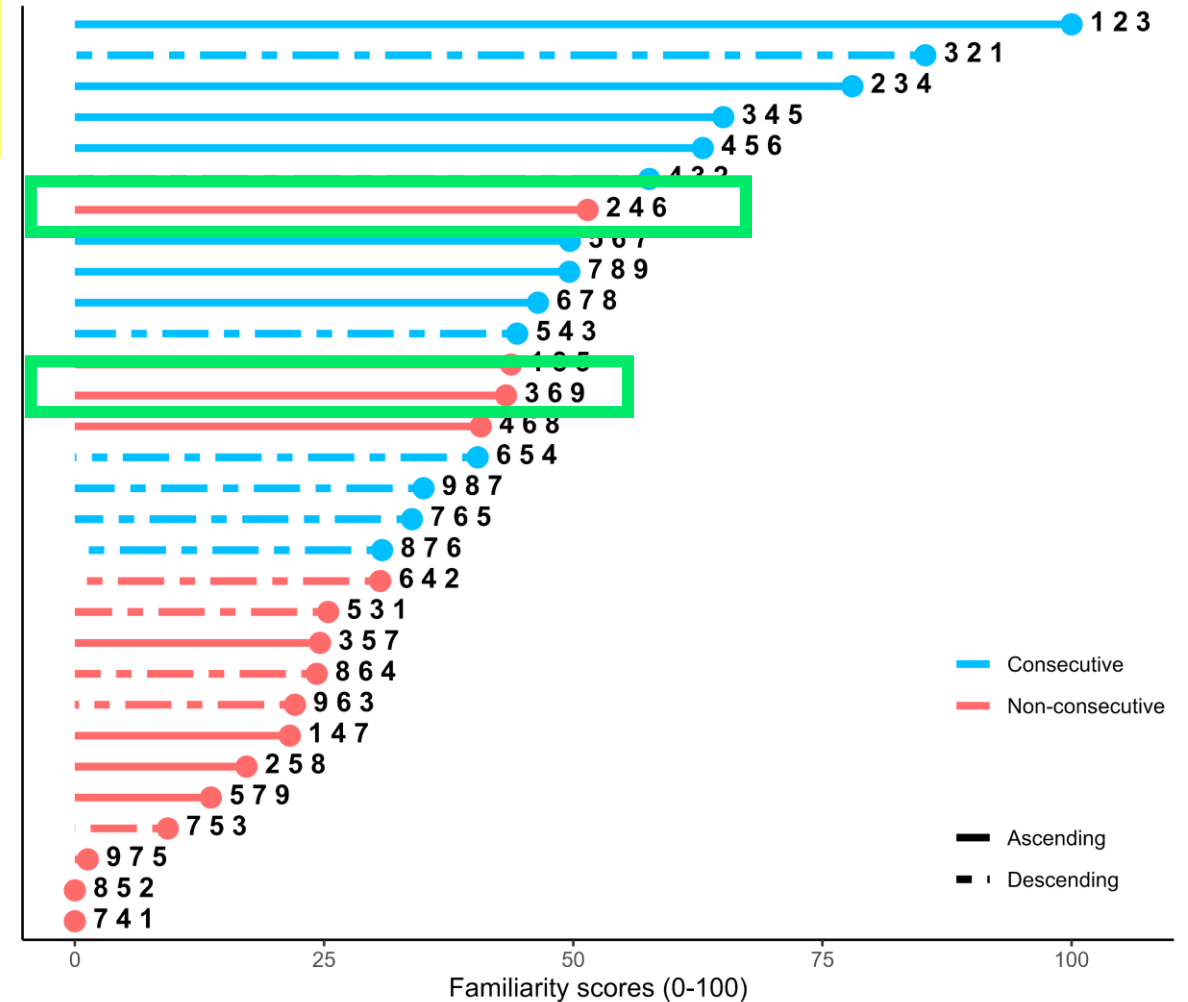
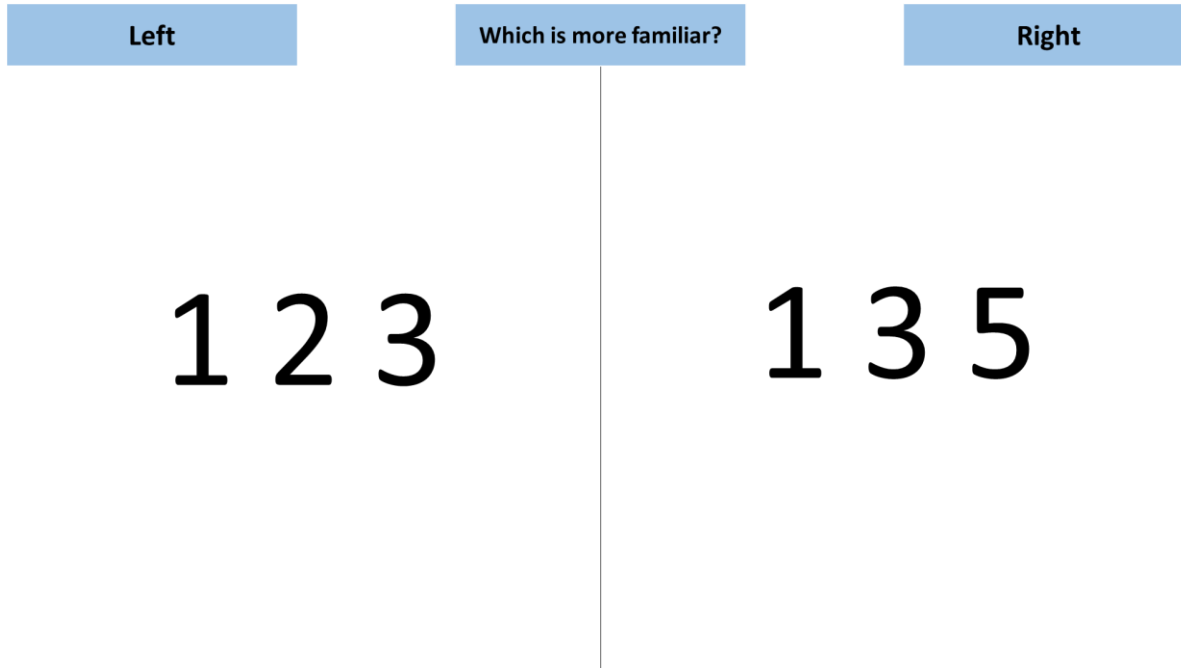
ments, but very good at

Club	MP	W	D	L	GF	GA	GD	Pts
1 Arsenal	38	26	7	5	71	27	44	85
2 Man City	38	23	9	6	77	35	42	78
3 Man United	38	20	11	7	69	50	19	71
4 Aston Villa	38	19	8	11	56	49	7	65
5 Liverpool	38	17	9	12	63	53	10	60
6 Bournemouth	38	13	18	7	58	54	4	57
7 Sunderland	38	14	12	12	42	48	-6	54
8 Brighton	38	14	11	13	52	46	6	53
9 Brentford	38	14	11	13	55	52	3	53
10 Chelsea	38	14	10	14	58	52	6	52
11 Fulham	38	15	7	16	47	51	-4	52
12 Newcastle	38	14	7	17	53	55	-2	49
13 Everton	38	13	10	15	47	50	-3	49
14 Leeds	38	11	14	13	49	56	-7	47
15 Palace	38	11	12	15	41	51	-10	45
16 Nottm Forest	38	11	11	16	48	51	-3	44
17 Spurs	38	10	11	17	48	57	-9	41
18 West Ham	38	10	9	19	46	65	-19	39
19 Burnley	38	4	10	24	38	75	-37	22
20 Wolves	38	3	11	24	27	68	-41	20

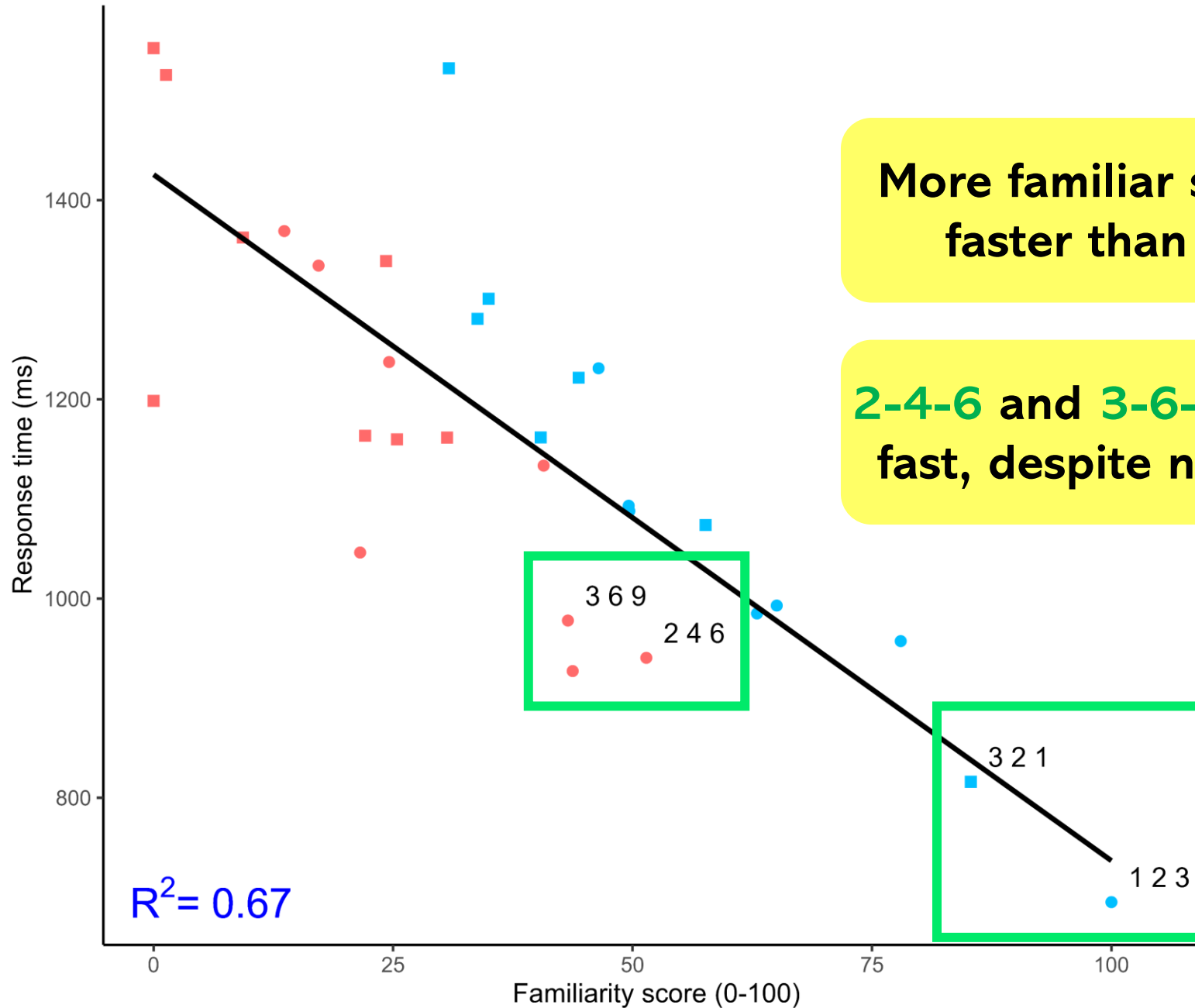
?

Devlin et al. (2024)

Used a comparative judgement approach to create a measure of sequence familiarity



$$r = -0.82, p < 0.01$$



More familiar sequences were processed faster than less familiar sequences

2-4-6 and 3-6-9 were processed relatively fast, despite not matching the **count-list!**

The familiarity perspective can also explain the
instability of the RDE

Instability of the RDE

Although considered to be a defining feature of order processing, the RDE is frequently absent at the individual level and occasionally absent at the group level:

Approximately half of individuals do not display a RDE (Sasanguie & Vos, 2018; Vogel et al., 2021)

The RDE is sometimes absent at the group level depending on the included sequences (Brunner et al., 2024; Vos et al., 2021; Vellan & LeFevre, MCLS)

Any mechanism we propose to explain the presence of the reverse distance effect must also be able to account for absences of this effect (Devlin et al., 2022)

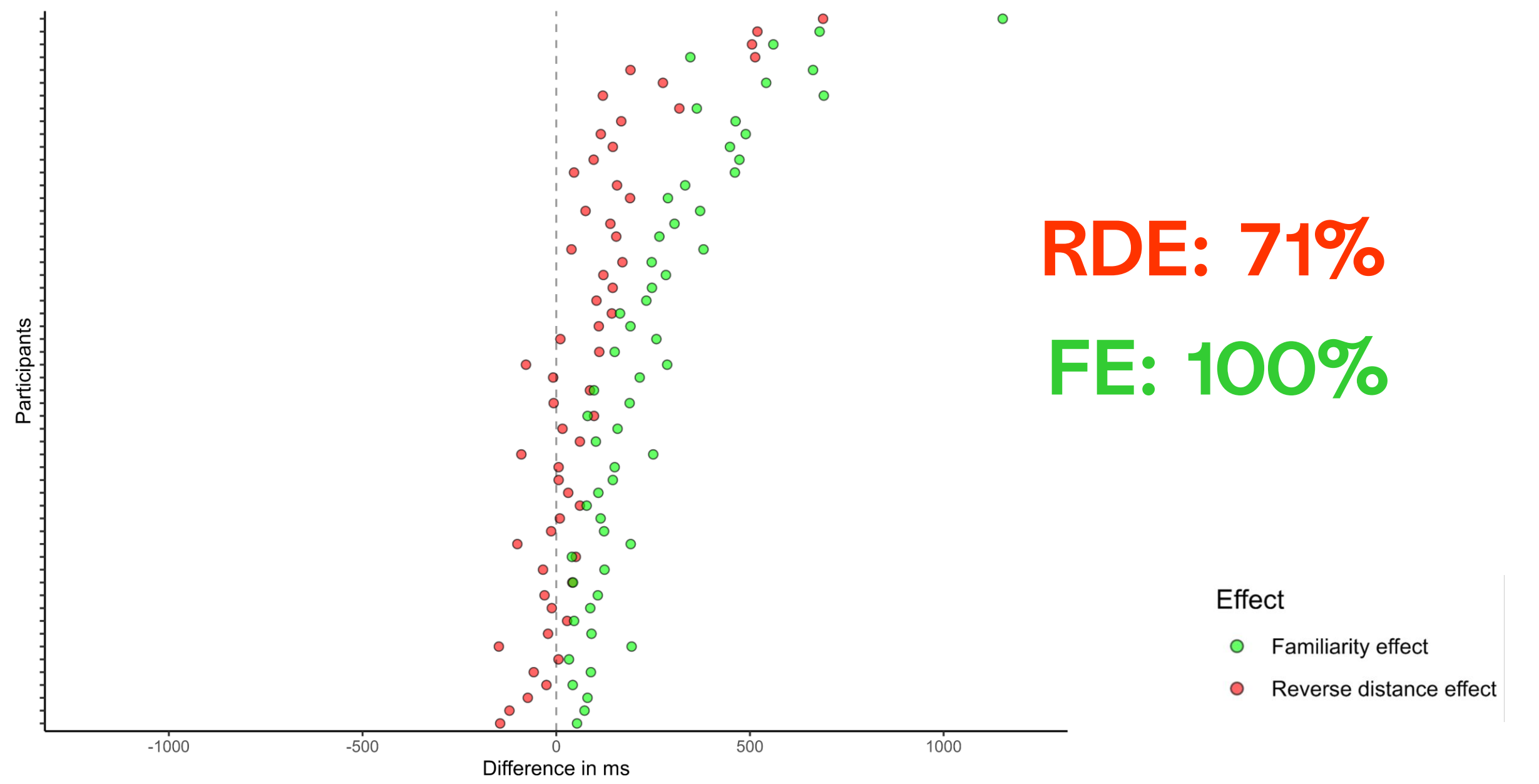
Individual absences of the RDE

It is not clear how to explain these absences from the count-list perspective, but they can be easily explained from the familiarity perspective:

~~“Consecutive sequences should be processed faster than
non-consecutive sequences”~~

“Familiar sequences should be processed faster than
unfamiliar sequences”

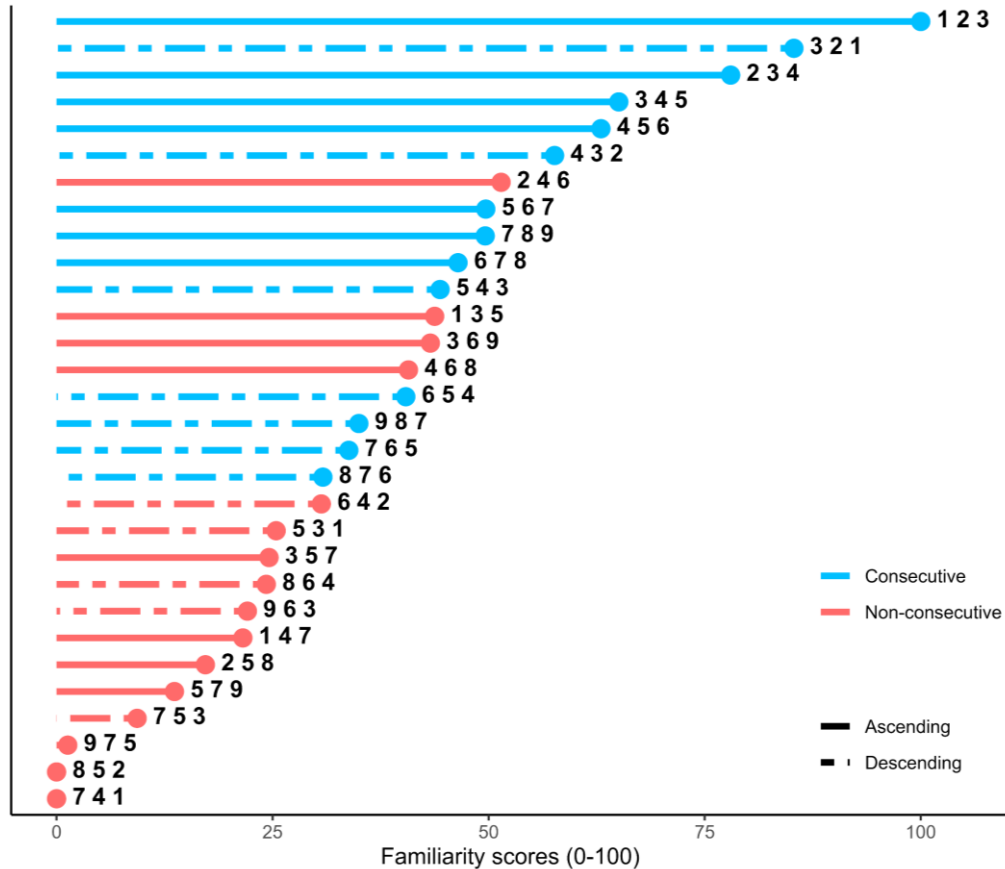
Devlin et al. (2024)



RDE: 71%

FE: 100%

Devlin et al. (2025)



Enhanced familiarity condition

Table 8.1. All ordered sequences in enhanced familiarity condition

Left	Centre	Right	Distance	Familiarity
1	2	3	Consecutive	100
2	3	4	Consecutive	78
3	4	5	Consecutive	65.06
1	4	7	Non-consecutive	21.56
2	5	8	Non-consecutive	17.22
5	7	9	Non-consecutive	13.64

Strong RDE

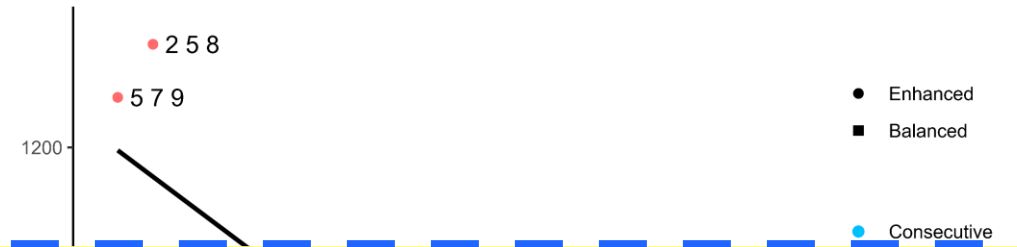
Balanced familiarity condition

Table 8.2. All ordered sequences in inversed familiarity condition

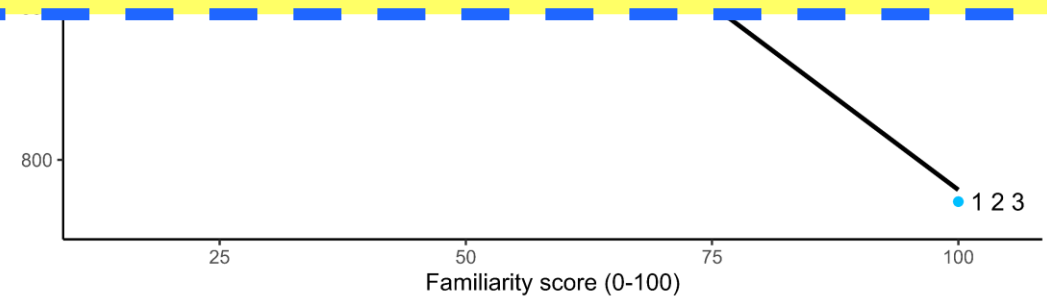
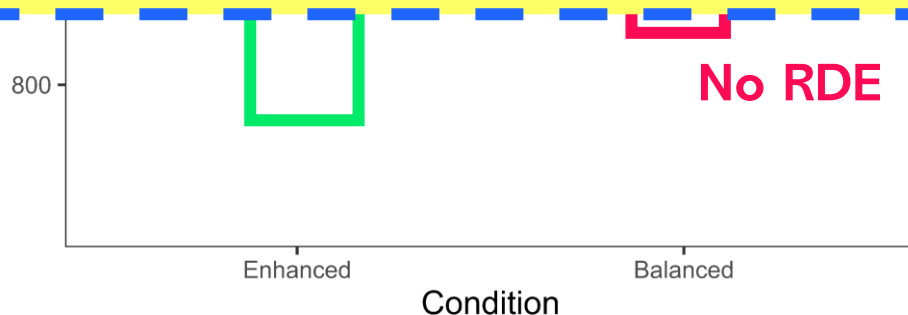
Left	Centre	Right	Type	Familiarity
5	6	7	Consecutive	49.67
7	8	9	Consecutive	49.60
6	7	8	Consecutive	46.46
2	4	6	Non-consecutive	51.44
1	3	5	Non-consecutive	43.75
3	6	9	Non-consecutive	43.25

No RDE

Devlin et al. (2025)

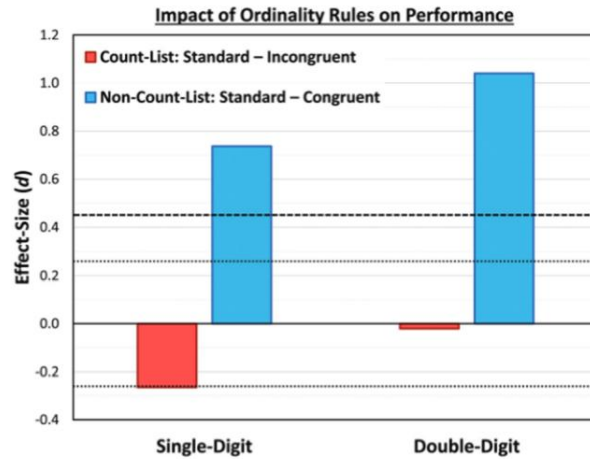


In other words: consecutive sequences are only processed faster than non-consecutive sequences when they are also more familiar, but more familiar sequences are processed faster than less familiar sequences, irrespective of their consecutiveness!



$$r = -0.88$$

Count-list vs. Familiarity Explanations

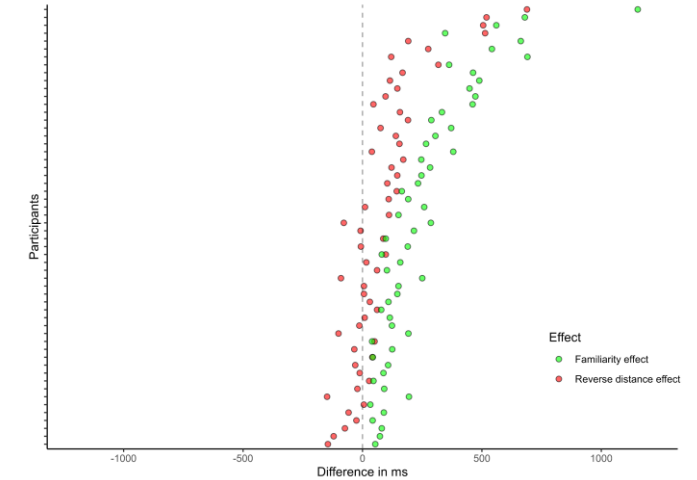


1-2-3
Consecutive

Facilitated due to being
more familiar?

1-3-5
Non-consecutive

Inhibited due to not
matching the count-list?



In the congruent
condition:

Easy

Can reject after
first two digits

Can reject after
first two digits

Table A1
All Trials

Left	Center	Right	Single-digit	Distance
1	2	3	Count-list	1
2	3	4	Count-list	1
3	4	5	Count-list	1
4	5	6	Count-list	1
5	6	7	Count-list	1
6	7	8	Count-list	1
7	8	9	Count-list	1
1	3	5	Non-count-list	2,3
2	4	6	Non-count-list	2,3
3	5	7	Non-count-list	2,3
4	6	8	Non-count-list	2,3
5	7	9	Non-count-list	2,3
6	8	1	Non-count-list	2,3
7	9	2	Non-count-list	2,3
8	1	3	Non-count-list	2,3
9	2	4	Non-count-list	2,3
1	4	5	Mixed	1
2	5	6	Mixed	1
3	6	7	Mixed	1
4	7	8	Mixed	1
5	8	9	Mixed	1
6	9	1	Mixed	1
7	1	2	Mixed	1
8	2	3	Mixed	1
9	3	4	Mixed	1
1	5	6	Mixed	2,3
2	6	7	Mixed	2,3
3	7	8	Mixed	2,3
4	8	9	Mixed	2,3
5	9	1	Mixed	2,3
6	1	2	Mixed	2,3
7	2	3	Mixed	2,3
8	3	4	Mixed	2,3
9	4	5	Mixed	2,3
1	6	7	Mixed	1
2	7	8	Mixed	1
3	8	9	Mixed	1
4	9	1	Mixed	1
5	1	2	Mixed	1
6	2	3	Mixed	1
7	3	4	Mixed	1
8	4	5	Mixed	1
9	5	6	Mixed	1
1	7	8	Mixed	2,3
2	8	9	Mixed	2,3
3	9	1	Mixed	2,3
4	1	2	Mixed	2,3
5	2	3	Mixed	2,3
6	3	4	Mixed	2,3
7	4	5	Mixed	2,3
8	5	6	Mixed	2,3
9	6	7	Mixed	2,3
1	8	9	Mixed	1
2	9	1	Mixed	1
3	1	2	Mixed	1
4	2	3	Mixed	1
5	3	4	Mixed	1
6	4	5	Mixed	1
7	5	6	Mixed	1
8	6	7	Mixed	1
9	7	8	Mixed	1
1	9	1	Mixed	2,3
2	1	2	Mixed	2,3
3	2	3	Mixed	2,3
4	3	4	Mixed	2,3
5	4	5	Mixed	2,3
6	5	6	Mixed	2,3
7	6	7	Mixed	2,3
8	7	8	Mixed	2,3
9	8	9	Mixed	2,3

Note: Table A1 provides a complete list of trials used in the numerical order.

In the standard
condition:

Hard

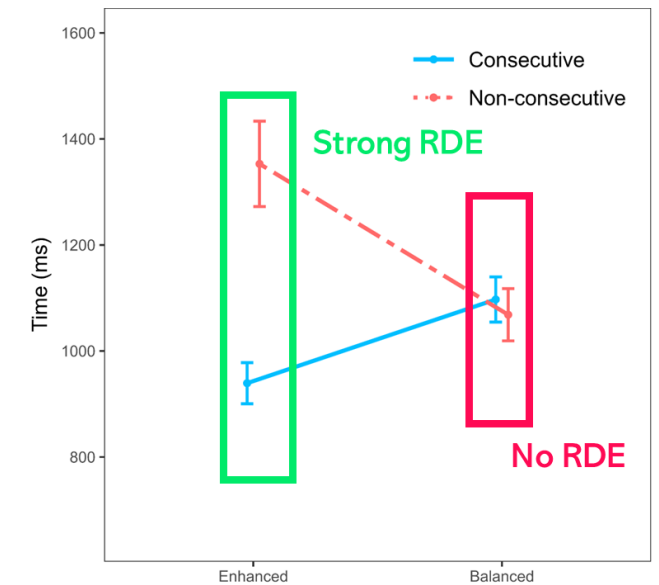
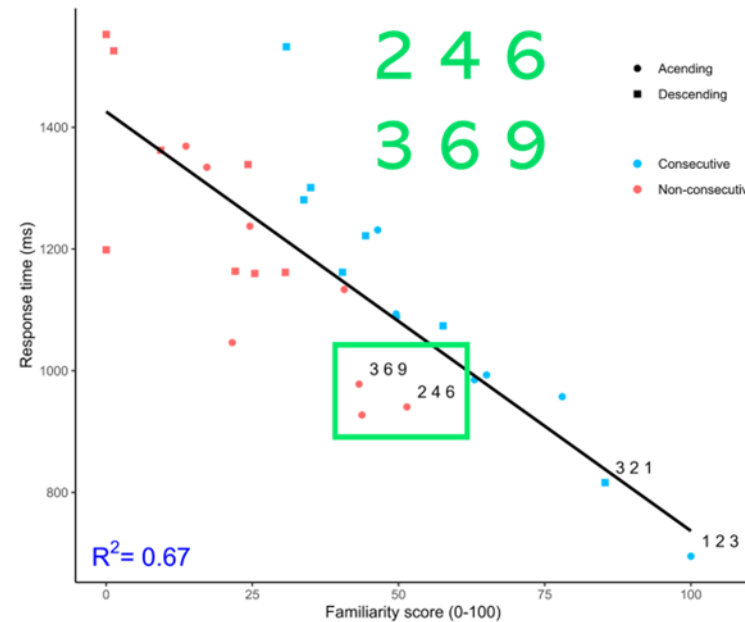
Can reject after
first two digits

Can reject after
first two digits

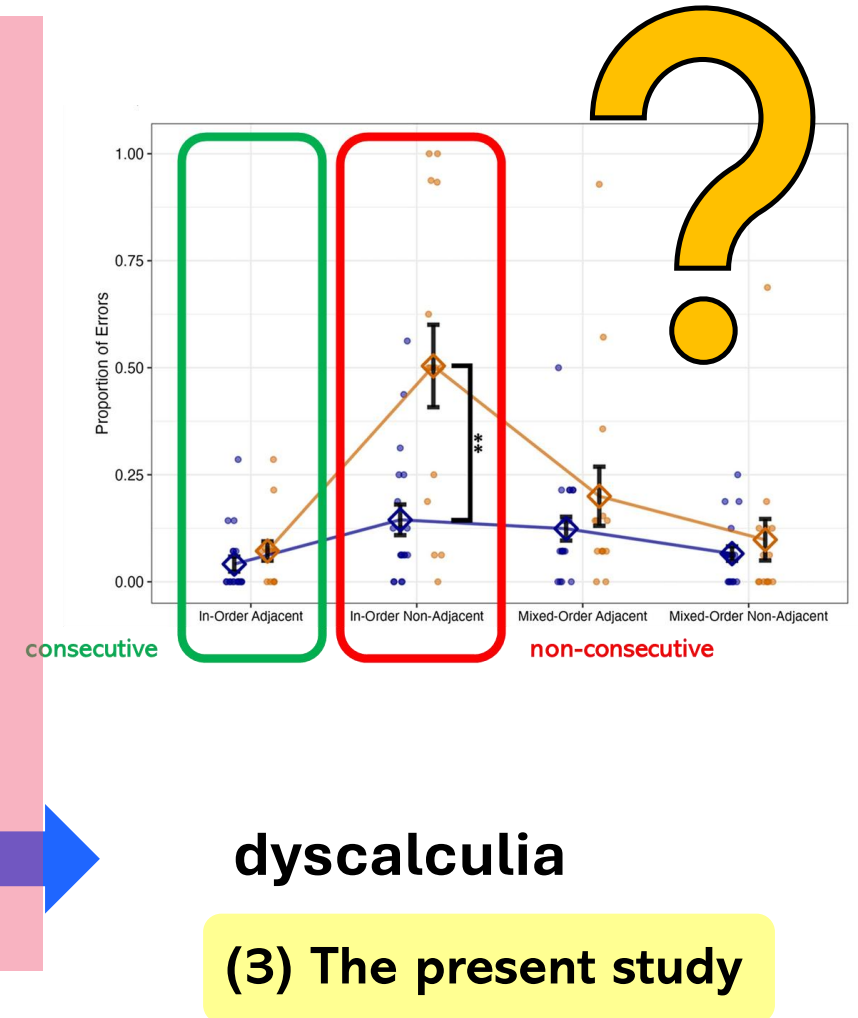
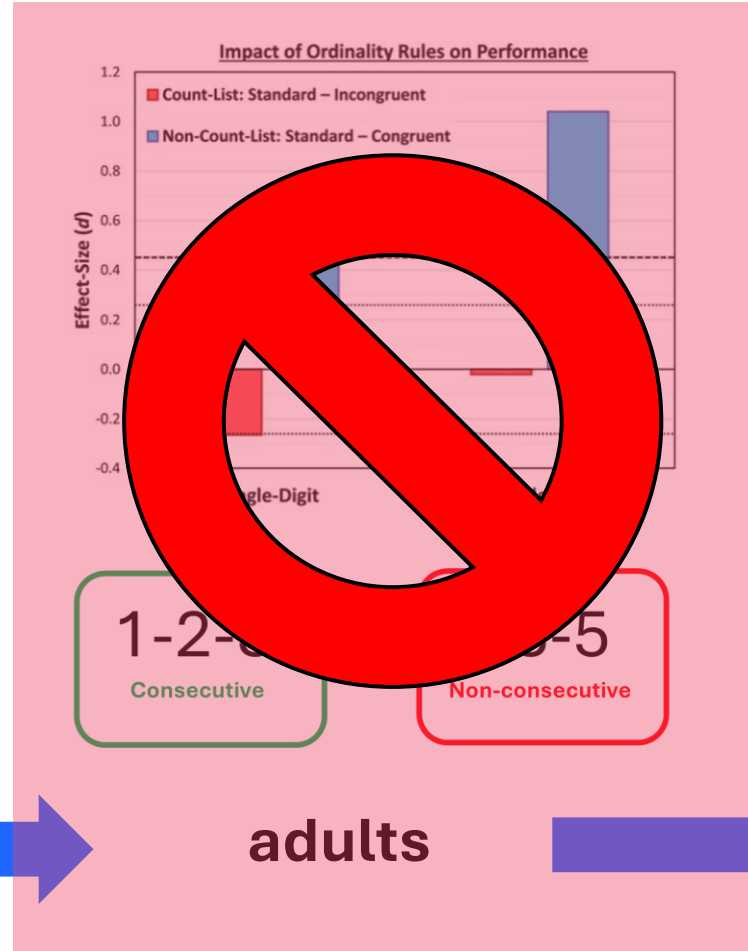
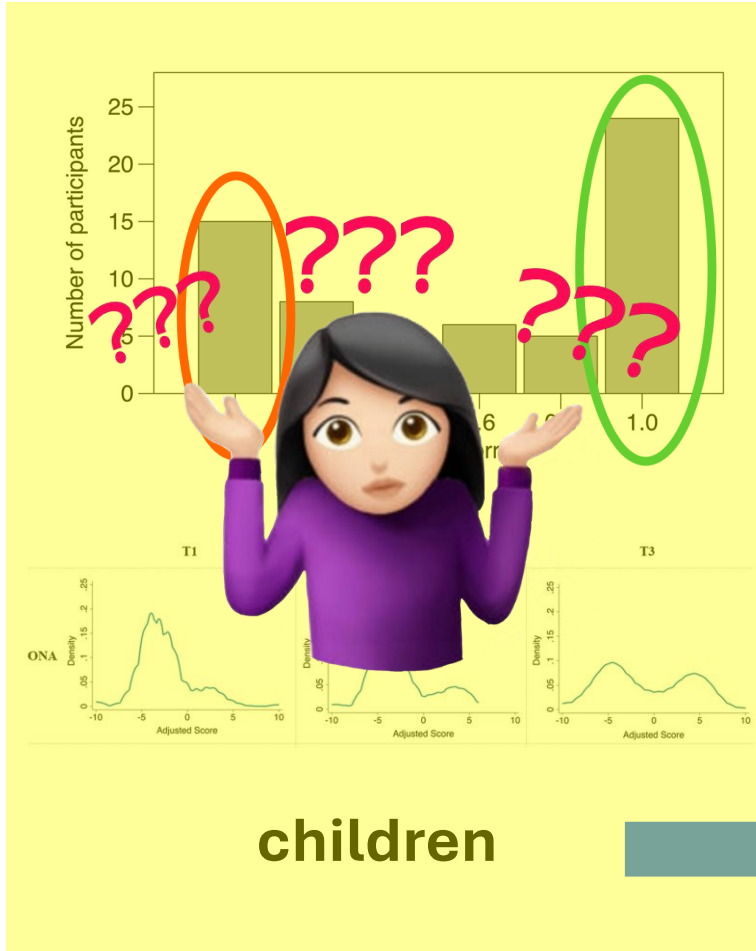
Table A1
All Trials

Left	Center	Right	Single-digit	Distance
1	2	3	Count-list	1
2	3	4	Count-list	1
3	4	5	Count-list	1
4	5	6	Count-list	1
5	6	7	Count-list	1
6	7	8	Count-list	1
7	8	9	Count-list	1
1	3	5	Non-count-list	2,3
2	4	6	Non-count-list	2,3
3	5	7	Non-count-list	2,3
4	6	8	Non-count-list	2,3
5	7	9	Non-count-list	2,3
6	8	1	Non-count-list	2,3
7	9	2	Non-count-list	2,3
8	1	3	Non-count-list	2,3
9	2	4	Non-count-list	2,3
1	4	5	Mixed	1
2	5	6	Mixed	1
3	6	7	Mixed	1
4	7	8	Mixed	1
5	8	9	Mixed	1
6	9	1	Mixed	1
7	1	2	Mixed	1
8	2	3	Mixed	1
9	3	4	Mixed	1
1	5	6	Mixed	2,3
2	6	7	Mixed	2,3
3	7	8	Mixed	2,3
4	8	9	Mixed	2,3
5	9	1	Mixed	2,3
6	1	2	Mixed	2,3
7	2	3	Mixed	2,3
8	3	4	Mixed	2,3
9	4	5	Mixed	2,3
1	6	7	Mixed	1
2	7	8	Mixed	1
3	8	9	Mixed	1
4	9	1	Mixed	1
5	1	2	Mixed	1
6	2	3	Mixed	1
7	3	4	Mixed	1
8	4	5	Mixed	1
9	5	6	Mixed	1
1	7	8	Mixed	2,3
2	8	9	Mixed	2,3
3	9	1	Mixed	2,3
4	1	2	Mixed	2,3
5	2	3	Mixed	2,3
6	3	4	Mixed	2,3
7	4	5	Mixed	2,3
8	5	6	Mixed	2,3
9	6	7	Mixed	2,3
1	8	9	Mixed	1
2	9	1	Mixed	1
3	1	2	Mixed	1
4	2	3	Mixed	1
5	3	4	Mixed	1
6	4	5	Mixed	1
7	5	6	Mixed	1
8	6	7	Mixed	1
9	7	8	Mixed	1
1	9	1	Mixed	2,3
2	1	2	Mixed	2,3
3	2	3	Mixed	2,3
4	3	4	Mixed	2,3
5	4	5	Mixed	2,3
6	5	6	Mixed	2,3
7	6	7	Mixed	2,3
8	7	8	Mixed	2,3
9	8	9	Mixed	2,3

Note: Table A1 provides a complete list of trials used in the numerical order.



Summary of the count-list perspective



The present study...

Aim of study

We aimed to extend Slipenkyj et al. (2025) in two main ways:

- 1. Consider a broader range of sequences
(i.e., descending sequences)**
- 2. Account for sequence familiarity**

Participants

Dyscalculic group

N = 12

Mean age = 8.69

**Recruited via speech
therapists**

**Most had official diagnosis, 3 only
suspected of having dyscalculia**

Control group

N = 28

Mean age = 9.24

**Recruited from
schools in Belgium**

* Final sample after exclusions

** Difference in age not statistically significant

Considering a broader range of sequences

Slipenkyj et al. (2025)

Ascending consecutive

Count-list

Ascending non-consecutive

Non-count-list

From the count-list perspective, we **predict deficits** in these sequences **for dyscalculic ppts** as they are **non-count-list...**

The present study

Ascending consecutive

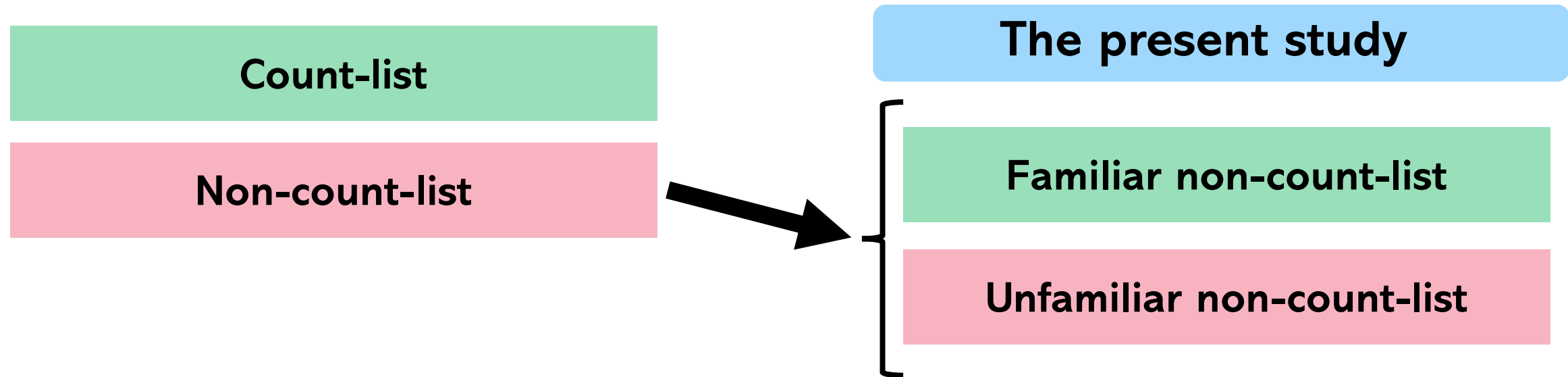
Ascending non-consecutive

Descending consecutive

Descending non-consecutive

Considering familiarity

Slipenkyj et al. (2025) did not consider **sequence familiarity**



We tested whether deficits on non-count-list sequences differed between **familiar non-count-list** and **unfamiliar non-count-list** sequences

Summary of predictions:

From the count-list perspective:

- DD ppts should show comparable performance on count-list sequences...
- But impaired performance on all non-count-list sequences...

From the familiarity perspective:

- DD ppts should show comparable performance on familiar non-count-list sequences...
- But impaired performance on unfamiliar non-count-list sequences...

Ascending consecutive

Ascending non-consecutive

Descending consecutive

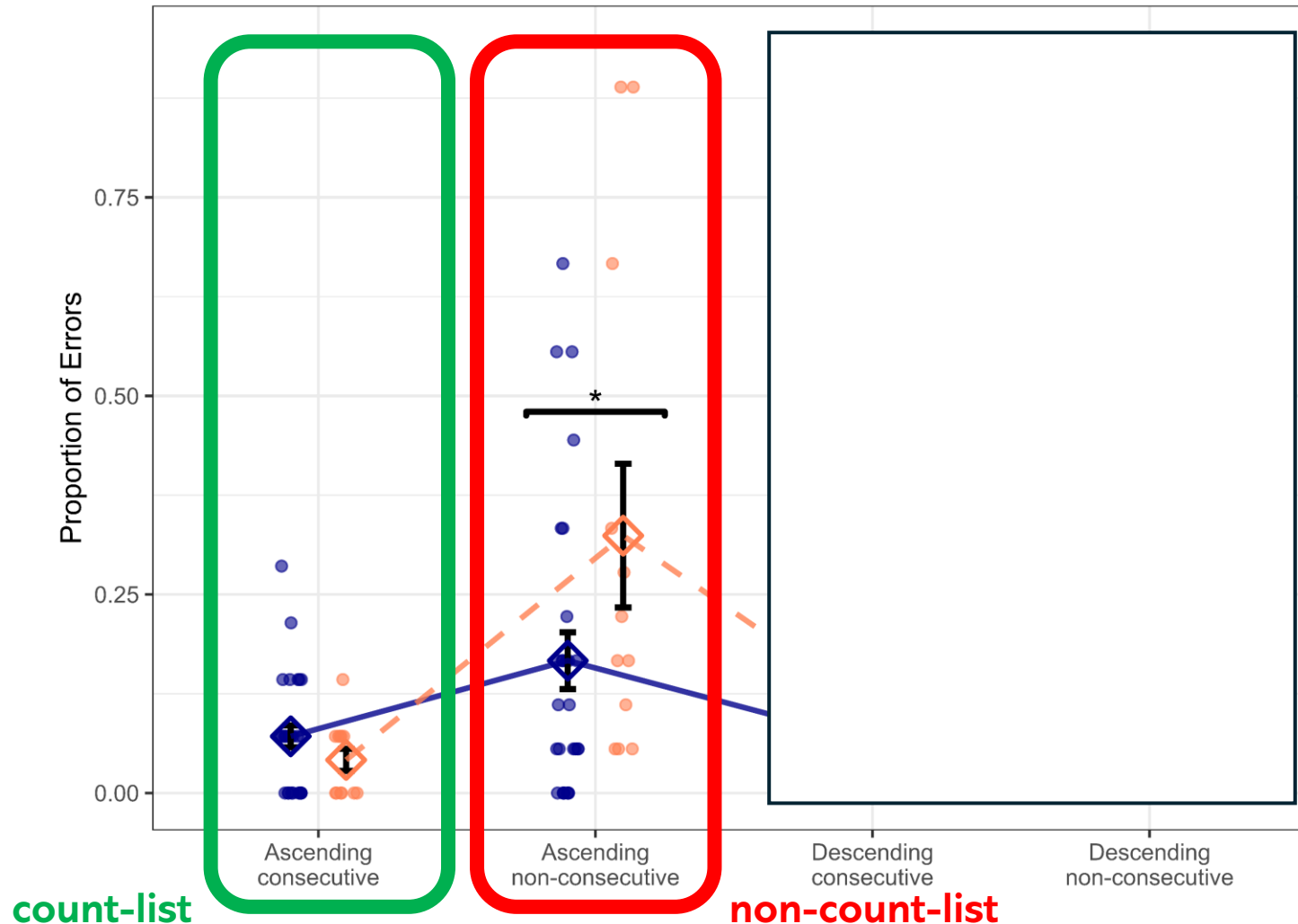
Descending non-consecutive

Familiar non-count-list

Unfamiliar non-count-list

Results

Ascending sequences

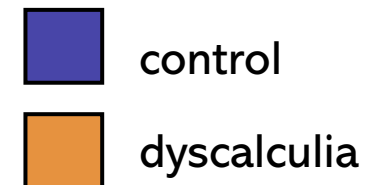


Replicated Slipenkyj et al. (2025):

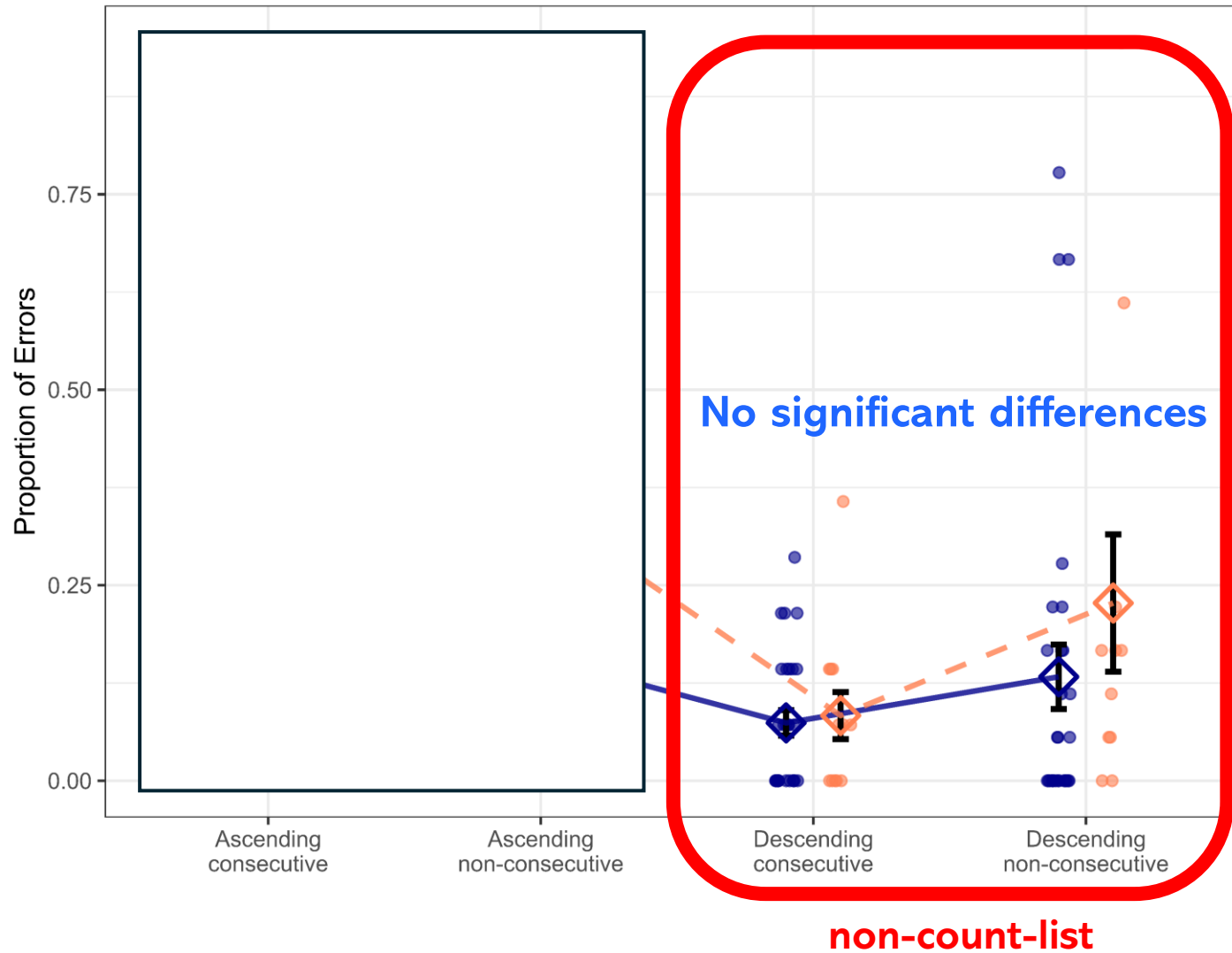
Comparable performance on
ascending consecutive sequences

Impaired performance on
ascending non-consecutive
sequences

Consistent with the
count-list perspective



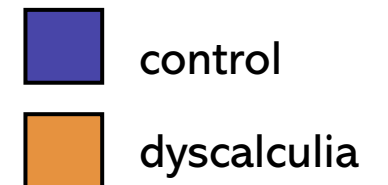
Descending sequences



But in descending sequences:

Dyscalculic children displayed comparable performance even though none of these sequences match the count-list...

Inconsistent with the count-list perspective



The influence of familiarity (1)

Next, we tested whether the deficits on **ascending non-consecutive sequences** were driven by sequence familiarity:

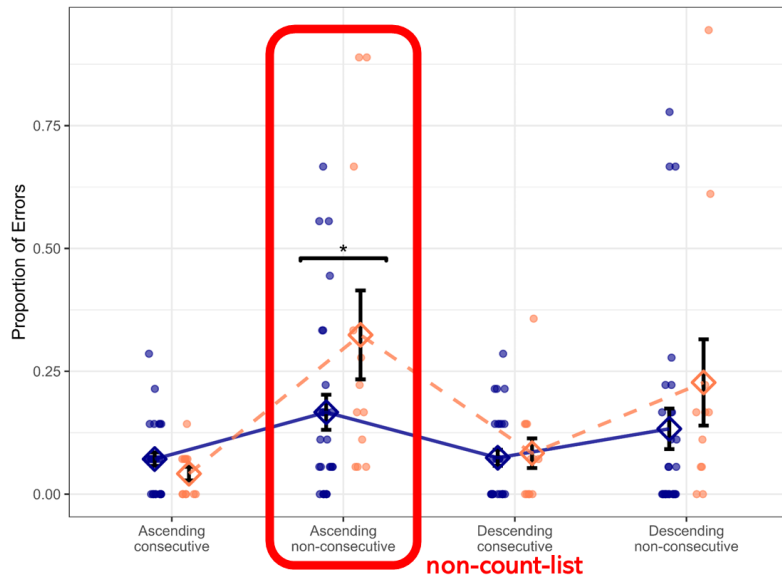
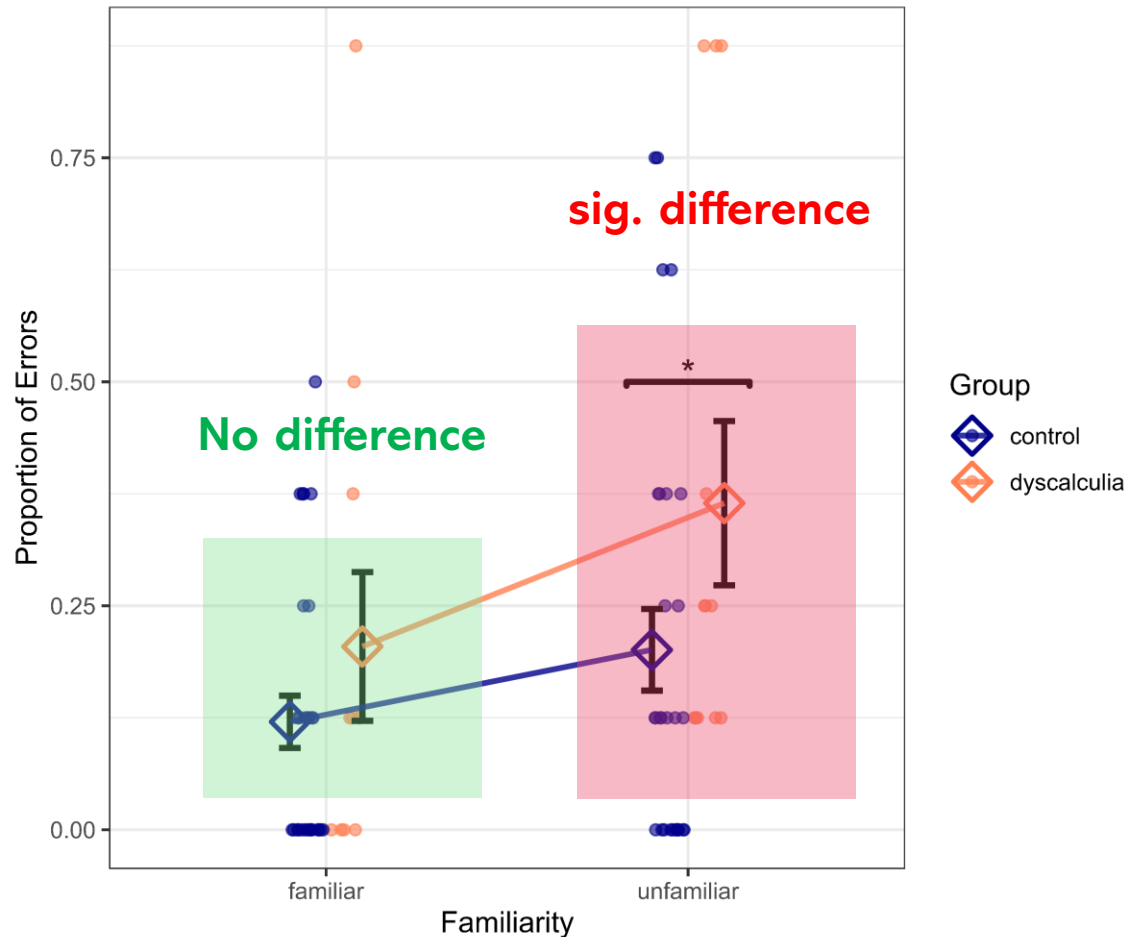


Table 1. Most familiar and least familiar ascending non-consecutive sequences

Sequence			Type	Familiarity score
2	4	6	Familiar	51.44
1	3	5	Familiar	43.75
3	6	9	Familiar	43.25
4	6	8	Familiar	40.72
3	5	7	Unfamiliar	24.59
1	4	7	Unfamiliar	21.56
2	5	8	Unfamiliar	17.22
5	7	9	Unfamiliar	13.64

We separated the **ascending non-consecutive** sequences into “**familiar**” and “**unfamiliar**”

The influence of familiarity (2)

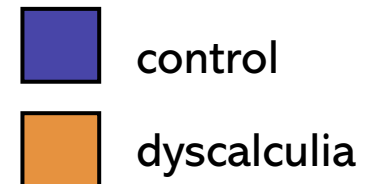


Dyscalculic children displayed:

Comparable performance on
familiar non-count-list sequences

Impaired performance on
unfamiliar non-count-list
sequences

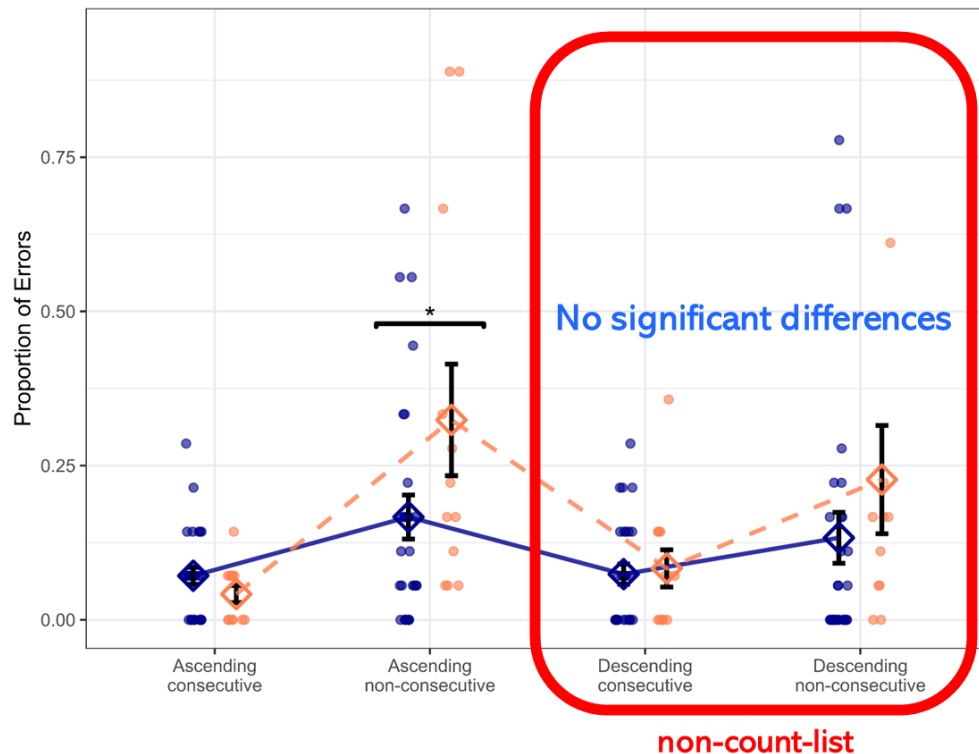
Consistent with the familiarity
perspective



The influence of familiarity (3)

This suggests dyscalculic children may struggle specifically with **unfamiliar sequences**...

However:



Dyscalculic children showed no deficits with descending sequences, which are relatively unfamiliar...

Inconsistent with the familiarity perspective!

Mixed findings...

Count-list perspective

DD children showed deficits on *ascending non-consecutive sequences* but not *ascending consecutive sequences*

DD children showed typical performance on both *descending consecutive* and *descending non-consecutive sequences*

Familiarity perspective

DD children showed deficits on unfamiliar *non-count-list sequences* but not familiar *non-count-list sequences*

DD children showed typical performance on both *descending consecutive* and *descending non-consecutive sequences*

Inconsistent support for both the count-list and familiarity perspectives!

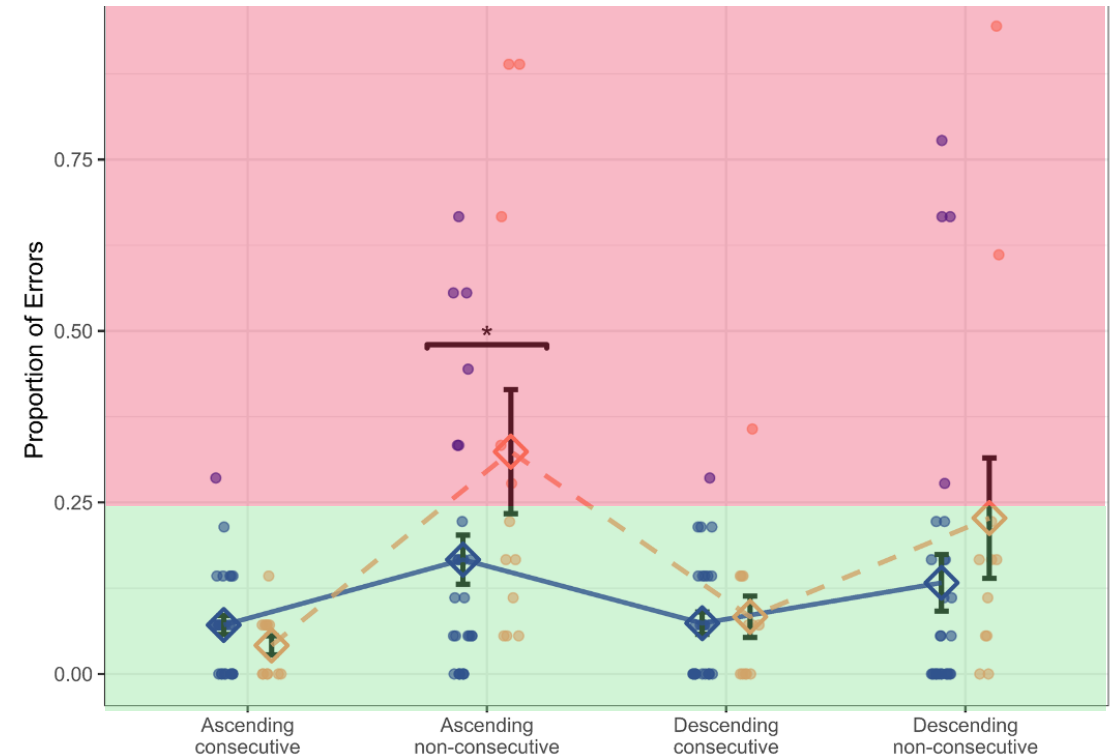
Limitations & Implications

Age

The **age** of the current sample presents a challenge for interpretation:

Relatively high accuracy on all sequence types:

If expanding one's concept of order occurs as a sudden qualitative shift (*e.g., Hutchison et al., 2022*) – most participants appear to have already undergone this transition.



Order deficits in developmental dyscalculia may be better investigated using a **younger sample** in which any order processing **deficits are more pronounced**.

Interpretation

We need to consider descending sequences!

Most of our understanding of order processing in general, and ordering deficits in dyscalculia specifically come from studies including only ascending sequences:

In general:

- Gattas et al. (2021)
- Gilmore & Batchelor (2021)
- Hutchison et al. (2022)

In dyscalculia:

- Attout & Majerus (2015)
- Morsanyi et al. (2018)
- Slipenkyj et al. (2025)

Only considering ascending sequences can lead to *oversimplified conclusions*.
Therefore, future studies need to include a broader range of sequences!

What do we mean by the “count-list”? (1)

We assume that the “**count-list**” refers specifically to **ascending consecutive** sequences...

But perhaps children also develop concepts of other kinds of count-lists?

“Reverse count-list”

“three-two-one”

“5-4-3-2-1”

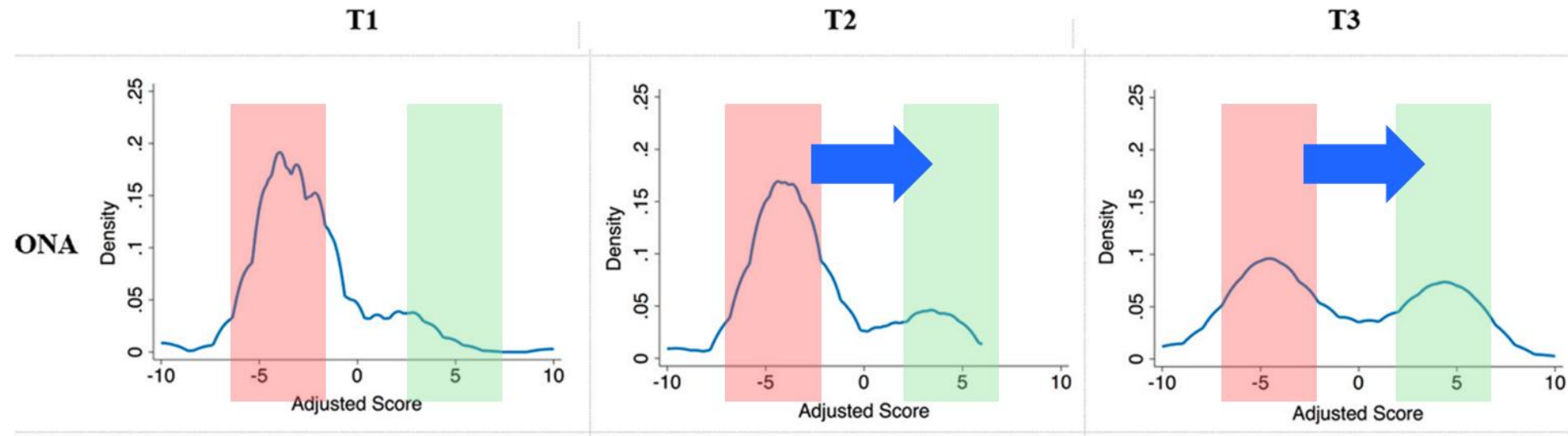
“skip-counting” lists

“2-4-6-8”

“5-10-15-20”

What do we mean by the “count-list”? (2)

If true, what would this mean for how children expand their concept of order?



Does this transition occur all at once? (count-list $\rightarrow$ non-count-list).

Or is there an iterative process? (e.g., count-list $\rightarrow$ reverse count-list $\rightarrow$ skip-count lists $\rightarrow$ non-count-list)

Conclusion

In conclusion... (1)

Order processing deficits in dyscalculia do appear to be **specific** rather than general in nature...

Specific to which kinds of sequences exactly?

Not really sure...

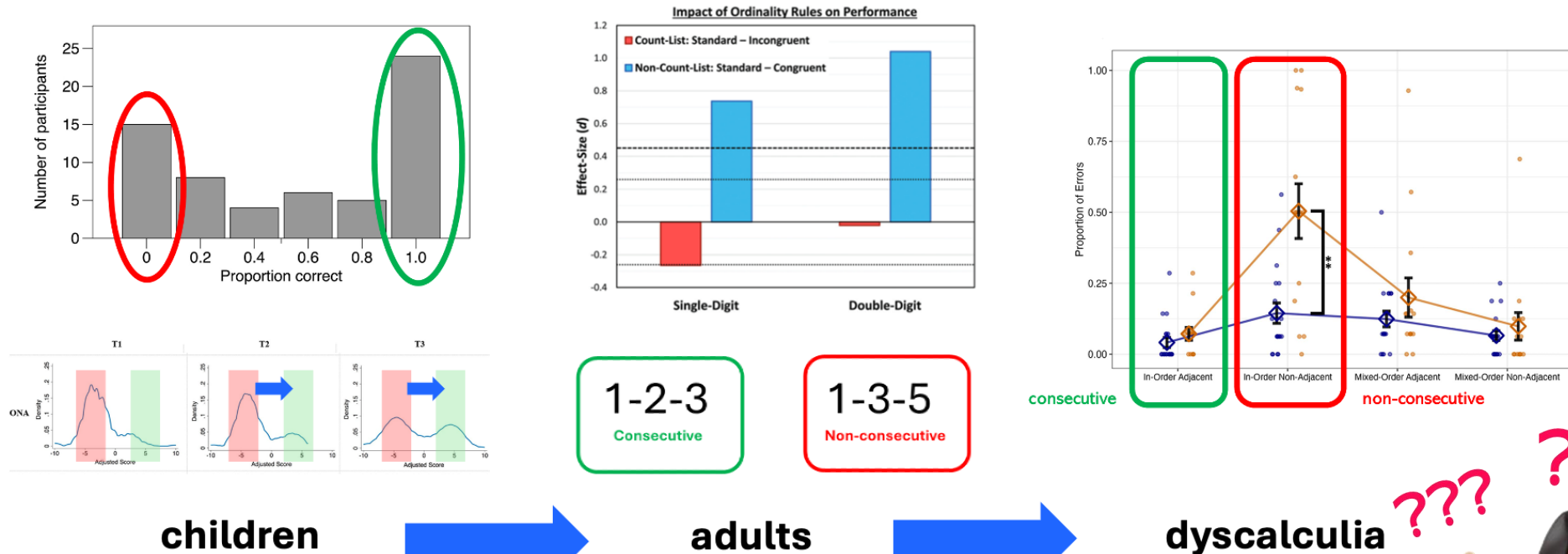
...but cannot be reduced simply to “**non-count-list**” or “**unfamiliar**” sequences



Future research should consider a broader range of sequence types and clarify specifically what we mean by “**count-list**” sequences

In conclusion... (2)

This narrative seems very clear and compelling...



But it is probably not this simple in reality...



Lots of open questions and debates

How does early ordinal knowledge typically develop?

Do children have different concepts of order for “count-list” “skip-count-list” and “reverse count list sequences?”

What aspects of ordinal understanding do dyscalculic children struggle with?

Do deficits differ between DD, MLD, low achievers?

How do deficits vary depending on the specific tasks or items used?

Are these persistent deficits in a specific mechanism that lasts into adulthood, or simply slower to acquire “typical performance?”

What strategies to TD and DD children use during order production tasks?



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The nature of order processing deficits in developmental dyscalculia: The influences of familiarity and the count-list

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ABSTRACT

Children with developmental dyscalculia often show impaired performance on number order processing tasks. Recent findings suggest these deficits are not general in nature, but instead specific to certain kinds of sequences. In particular, one proposal is that dyscalculic children struggle specifically to understand that “in order” can refer to sequences outside of the (ascending-consecutive) count-list (e.g., 1-3-5 is in order). However, previous findings in support of this view were limited by (i) only considering ascending sequences and (ii) not accounting for other factors known to influence order processing performance, such as sequence familiarity. To address this, the present study compared a control ($n = 28$) and dyscalculic group ($n = 12$), aged between 7-12 years, across ascending and descending sequences varying in familiarity. As expected, dyscalculic children showed impaired performance on ascending non-consecutive sequences (e.g., 1-3-5) but not on ascending consecutive sequences (e.g., 1-2-3). Notably, however, this deficit appeared to remain only for unfamiliar sequences (e.g., 2-5-8) and not familiar ones (e.g., 2-4-6), although this interaction was non-significant. Moreover, dyscalculic children displayed typical performance across both consecutive (e.g., 5-4-3) and non-consecutive (e.g., 5-3-1) descending sequences, neither of which match the traditional count-list. Accordingly, although order processing deficits in developmental dyscalculia do appear specific in nature, they are not necessarily specific to non-count-list sequences.

Introduction

The ability to process the relative positions of items within sequences appears to play an influential role in the development of early number skills. For example, faster and more accurate identification of sequences such as 1-2-3 as ordered, and sequences such as 2-1-3 as non-ordered, is associated with better performance on arithmetic tasks (e.g., Attout et al., 2014; Lyons et al., 2014; Sasanguie & Voe, 2015). In this context, order processing has received increasing research attention (for review, see Harju & Van Hoof, 2025).

More crucially, deficits in this order processing capacity are a prominent feature of mathematical learning difficulties such as developmental dyscalculia. For example, various studies show that children with developmental dyscalculia perform significantly worse on order processing tasks than typically-developing children (e.g., Ashkenazi et al., 2025; Decarli et al., 2023; Šlipenkij et al., 2025; Träff et al., 2025). In fact, Morsanyi et al. (2018) found that order processing performance was a better predictor of dyscalculia diagnosis than a range of other cognitive and numerical skills, such as magnitude processing. Accordingly, because order processing appears particularly challenging for individuals with developmental dyscalculia, a better understanding of how early ordinal

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¹ Shared first-authorship.

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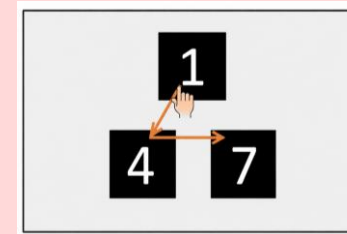
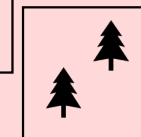
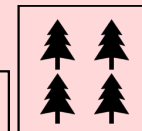
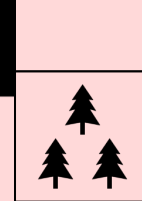
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Devlin, Dubinkina et al. (2026)

Review paper...



Coming soon....

Feel free to contact me with any thoughts, questions, feedback!

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Takk! 

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