

The count-list explanation of the reverse distance effect

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The Reverse Distance Effect

Facilitation explanation



Count-list explanation



The count-list explanation

The count-list explanation of the RDE

We may have an intuition that “in order” refers only to sequences that directly match the count-list:

1-2-3
In order!

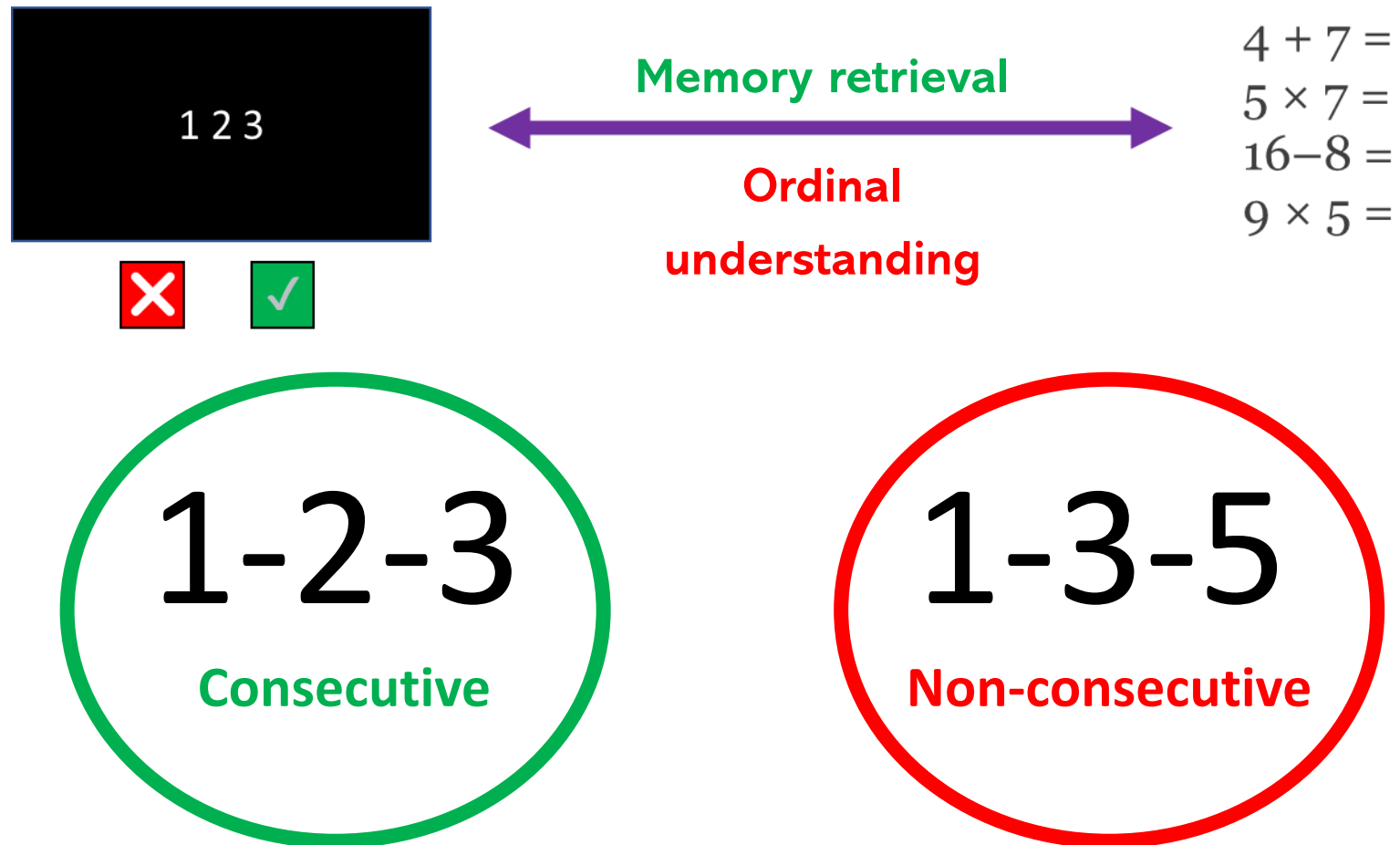
1-3-5
?????

Perhaps analogous to the natural number bias:

$$\frac{1}{3}$$

$$\frac{1}{2}$$

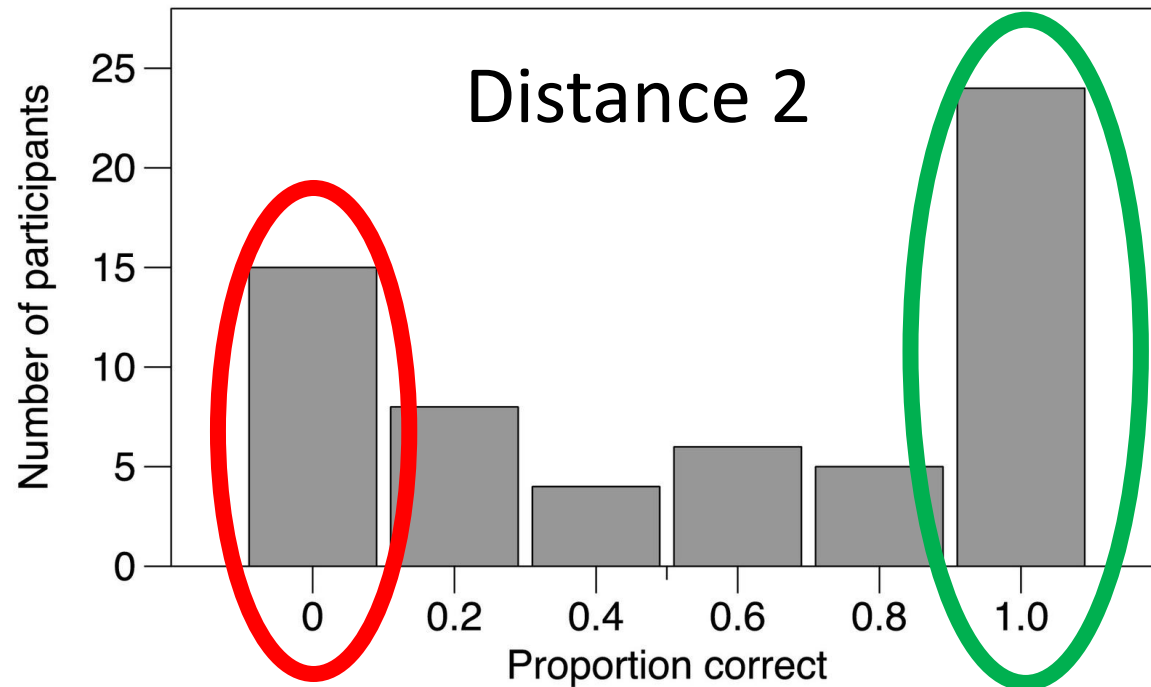
Why this is important?



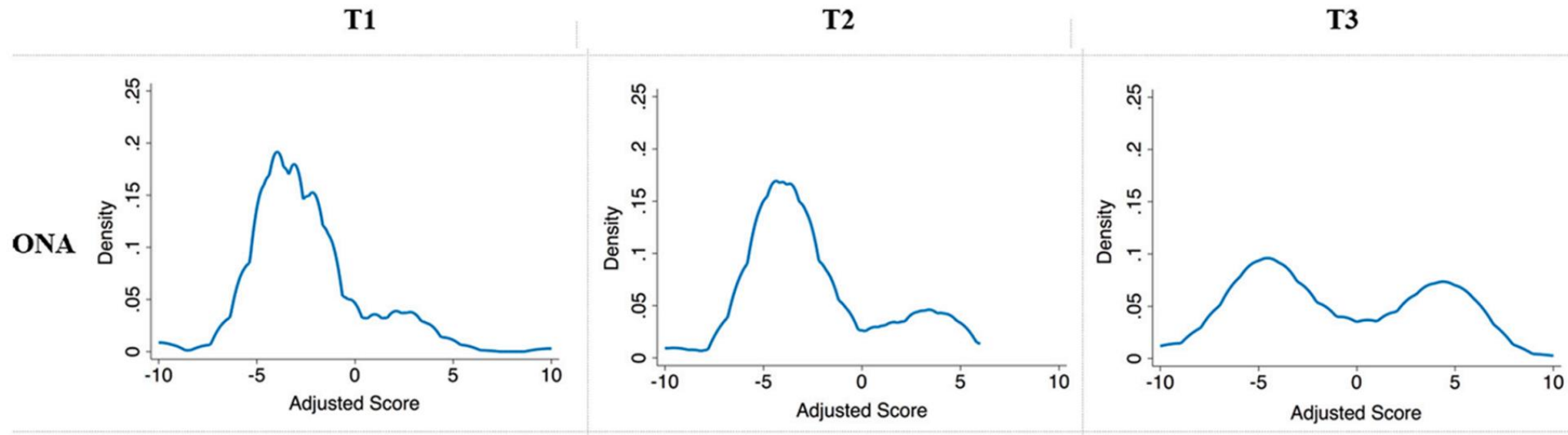
Evidence in children

Gilmore & Batchelor (2021)

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



Hutchison et al. (2022)



The transition between consistently rejecting to consistently verifying non-consecutive sequences occurs 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)



To differentiate between the familiarity and count-list explanations, they changed the rules given to participants during an order task:

Standard Rule Condition

In order

Consecutive (ordered)

**Non-Consecutive
(ordered)**

Not in

Non-ordered

Congruent Rule Condition

In order

Consecutive (ordered)

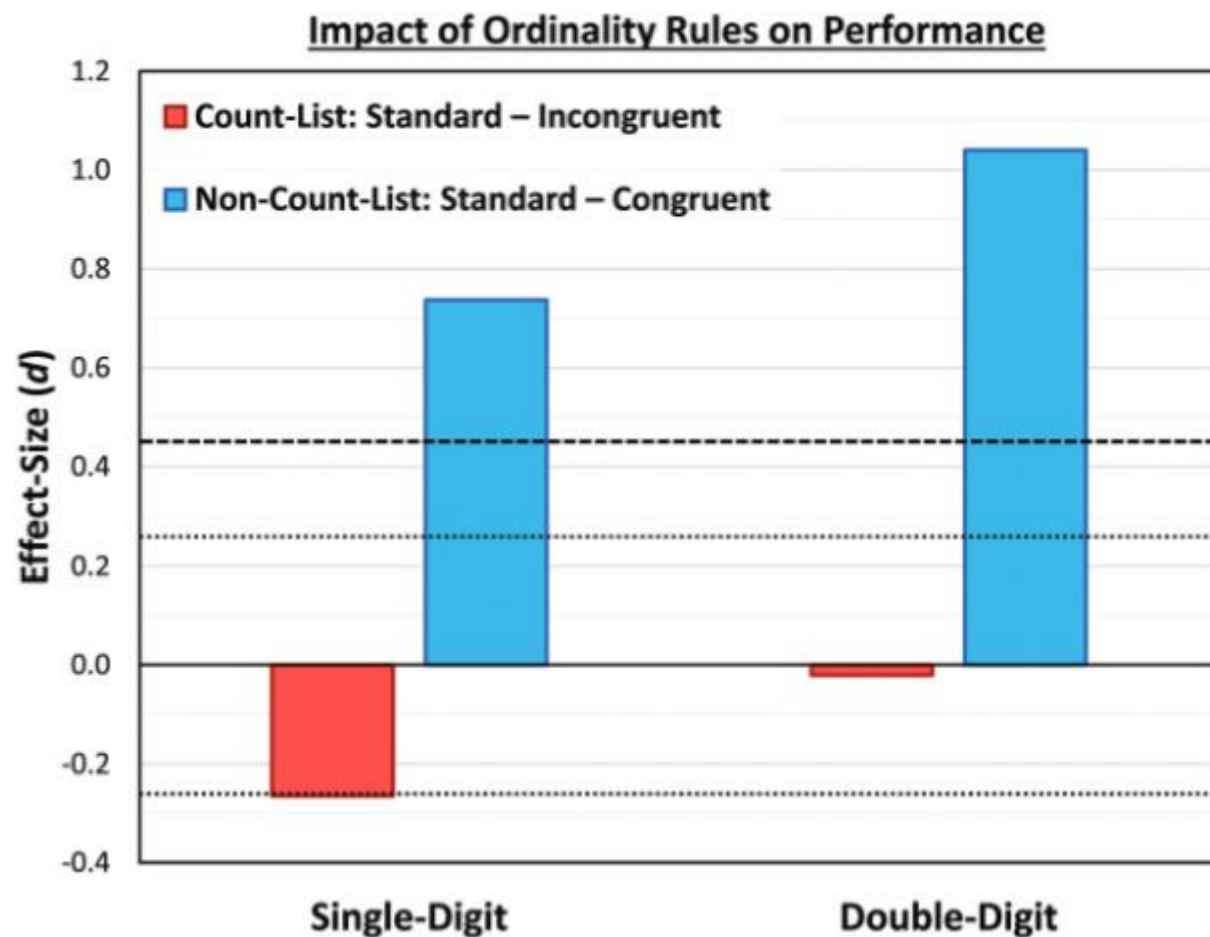
Not in

Non-ordered

**Non-Consecutive
(ordered)**

If the count-list explanation is true, this condition should improve performance because it matches our intuitions about order.

Gattas et al. (2021)



Really strong and consistent support for a **count-list effect**.

Two-step Process

Gattas et al. (2021) speculated on the mechanism by which a count-list effect would impair non-consecutive sequences, suggesting a **two-step process**:

	1-2-3	1-3-5
Count-list?	✓	✗
In order?		✓

Evidence for the Count-List Explanation

- People are faster at classifying non-consecutive sequences as “not in order” than they are at classifying them as “in order”
- In adult participants!
- Really compelling evidence for the count-list hypothesis...

WHY IT'S ALL WRONG!!! 1

Instability of the RDE

At the individual level:

The majority of first graders and approximately half of second graders did not display a RDE (Sasanguie & Vos, 2018).

Less than half of adults displayed a RDE (Vogel et al., 2021).

At the group level:

Vos et al. (2021) repeatedly failed to observe RDEs when using an order task involving a novel range of sequence types.

Possible Explanation

Some people may be better at overcoming this intuition than others; therefore, would be less likely to display a RDE.

Overcoming similar intuitions is important in math (e.g., natural number bias), so those who can more easily overcome their intuitions about order should perform better in math?

However, the association between ordering and mathematics was stronger in those who displayed a RDE (Vogel et al., 2021).

Methodological Limitation

Standard Rule Condition

In order

Consecutive (ordered)

Non-Consecutive (ordered)

Not in order

Non-ordered

Hard

Congruent Rule Condition

In order

Consecutive (ordered)

Not in order

Non-ordered

Non-Consecutive (ordered)

Easy

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

Non-consecutive sequences

4-6-8

Standard condition

Congruent condition

Non-consecutive sequences

4-6-8

Non-consecutive sequences

4-6-

Non-consecutive sequences

4-6-
8
5

Non-consecutive sequences

4-6-

Standard condition -
???

Non-consecutive sequences

4-6-

Standard condition -

???
Congruent condition

Non-consecutive sequences

So, participants processing non-consecutive sequences faster in the congruent condition is perhaps expected...

4-6-8

Non-consecutive sequences

So, participants processing non-consecutive sequences faster 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.

Non-consecutive sequences

- Performance improved for all sequence types, not just non-consecutive sequences.
- If improved performance resulted from eliminating the disadvantage for non-consecutive sequences, this should be limited just to non-consecutive sequences?

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

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

Non-consecutive

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

Mixed	1
Mixed	1
Mixed	1
Mixed	1
Mixed	1
Mixed	1
Mixed	1
Mixed	2, 3
Mixed	2, 3
Mixed	2, 3
Mixed	2, 3
Mixed	2, 3
Mixed	2, 3
Mixed	2, 3
Mixed	1
Mixed	1
Mixed	1
Mixed	1
Mixed	1
Mixed	1
Mixed	2, 3
Mixed	2, 3
Mixed	2, 3
Mixed	2, 3
Mixed	2, 3
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Mixed	2, 3

Descending

In the congruent
condition:

Easy

Can reject after
first two digits

Can reject after
first two digits

Table A1

All Trials

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In the standard
condition:

Hard

Can reject after
first two digits

Methodological Limitation

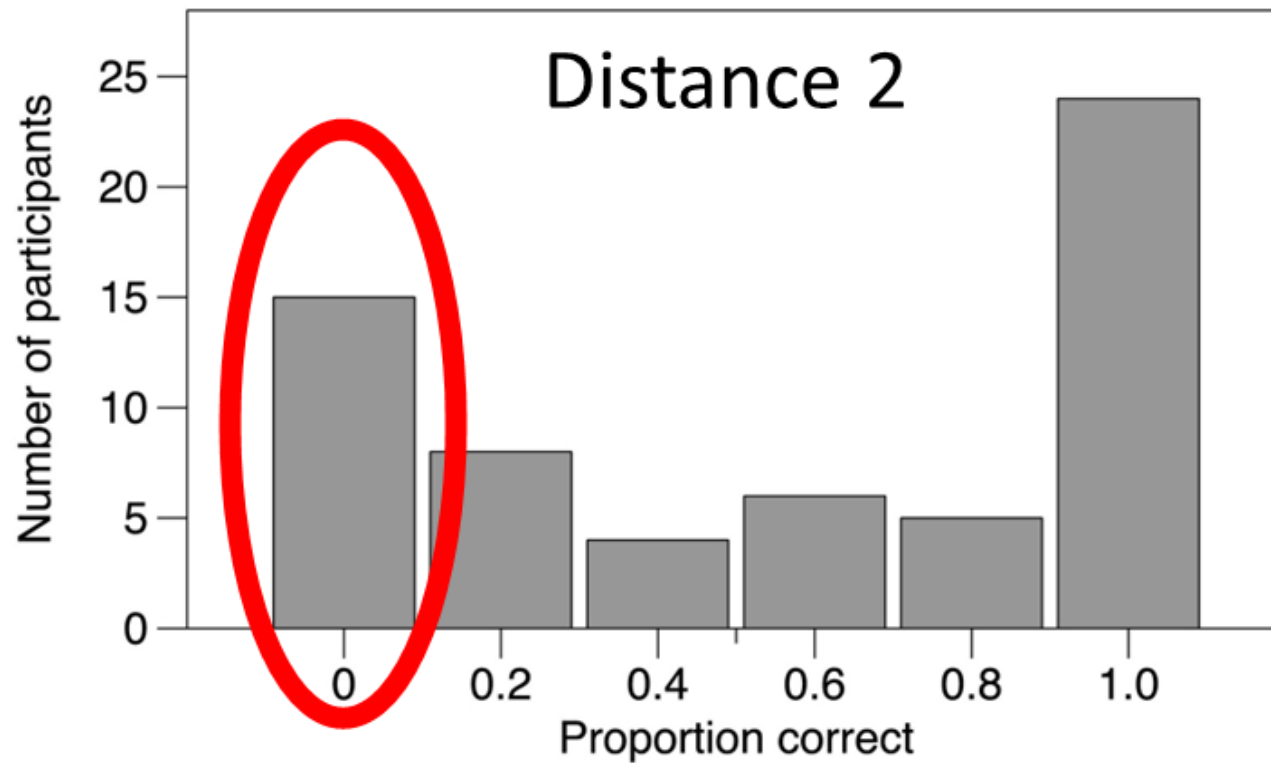
- Performance improved for all sequence types, not just non-consecutive sequences.
- If improved performance resulted from eliminating the disadvantage for non-consecutive sequences, this should be limited just to non-consecutive sequences?

Issues with Count-List Hypothesis

- **Theoretical argument:** I'm unsure whether/how the count-list explanation can account for the instability of RDE.
- **Methodological argument:** I think there are plausible alternative explanations for the Gattas et al. (2021) findings.

However...

Gilmore & Batchelor (2021)



Cognitive Demands Explanation

Maybe they understand that non-consecutive sequences are correctly ordered, but simply failed to indicate this due to the cognitive demands of the task.

The task requires both:

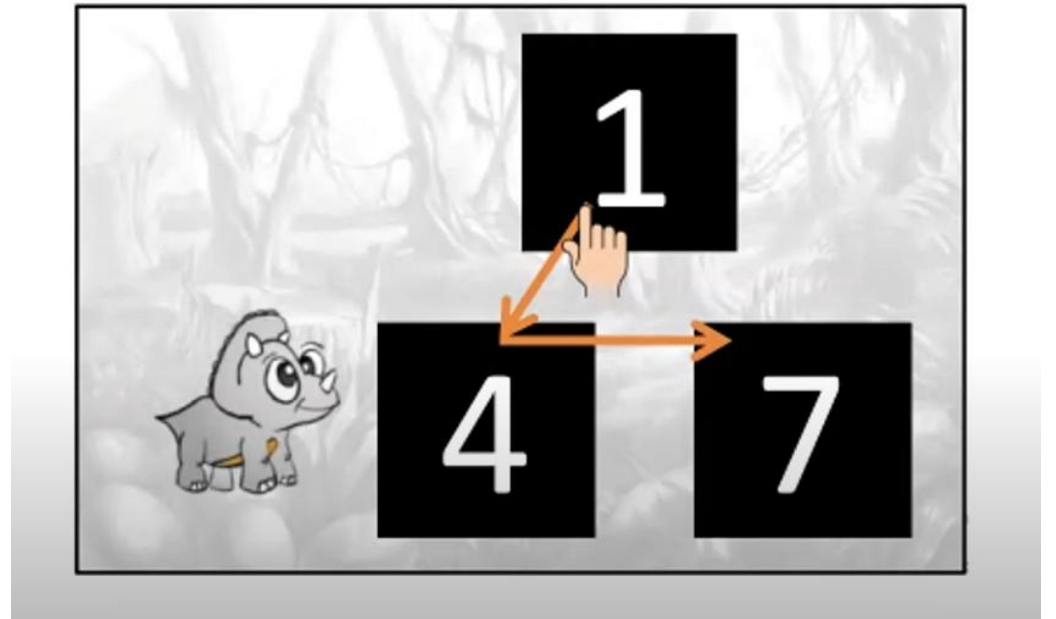
- 1.** Understanding that consecutive and non-consecutive are both valid concepts of order.
- 2.** Repeatedly switching between these two concepts during the task.

Cognitive Demands Explanation

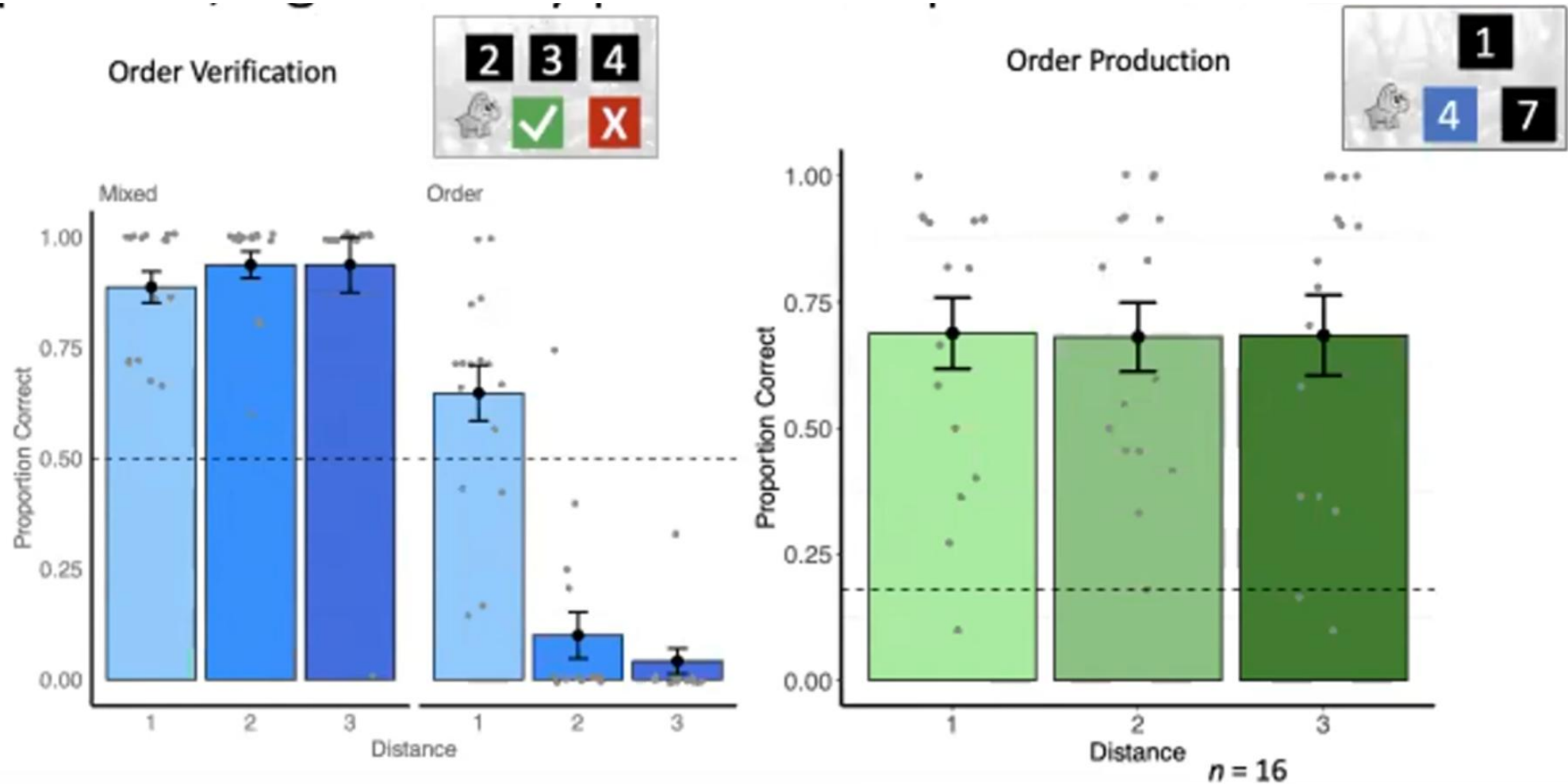
If poor performance on non-consecutive sequences results from the demands of the task, you would expect:

1. Children to be able to indicate non-consecutive sequences as “in order” in other contexts.

Bugden & Brannon (2021)



Bugden & Brannon (2021)



Cognitive Demands Explanation

If poor performance on non-consecutive sequences results from the demands of the task, you would expect:

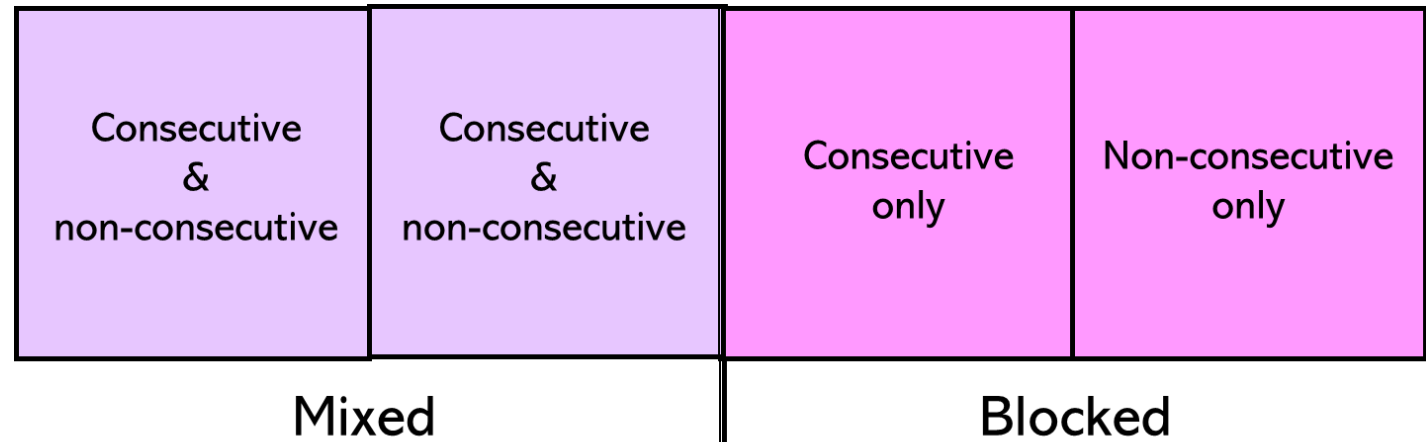
1. Children to be able to indicate non-consecutive sequences as “in order” in other contexts. **i.e., Bugden & Brannon (2021)**
2. Reducing the demands of the task to improve performance on non-consecutive sequences. **The present study**

The present study

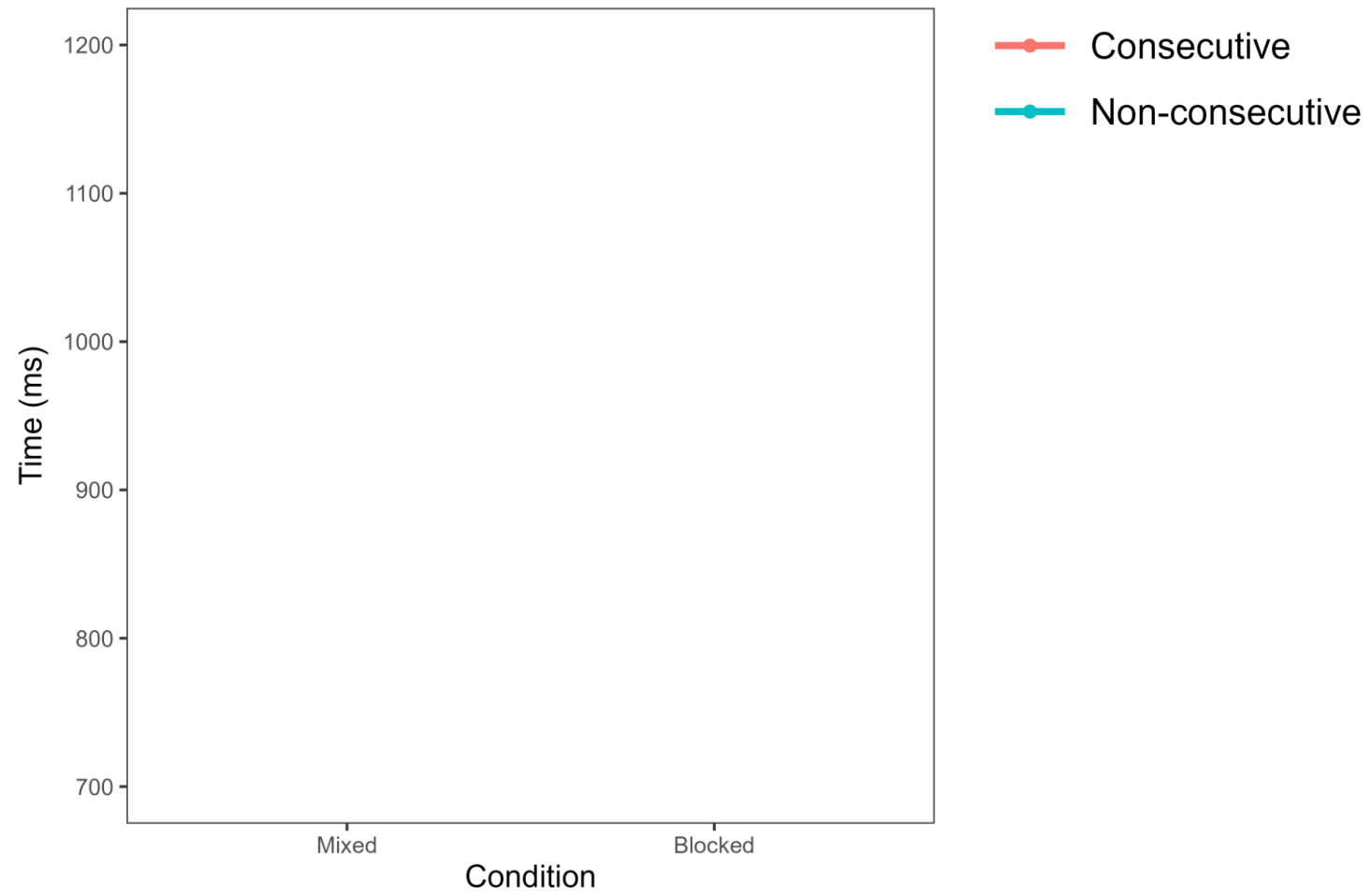
Design

We recruited 100 adult participants via Prolific.

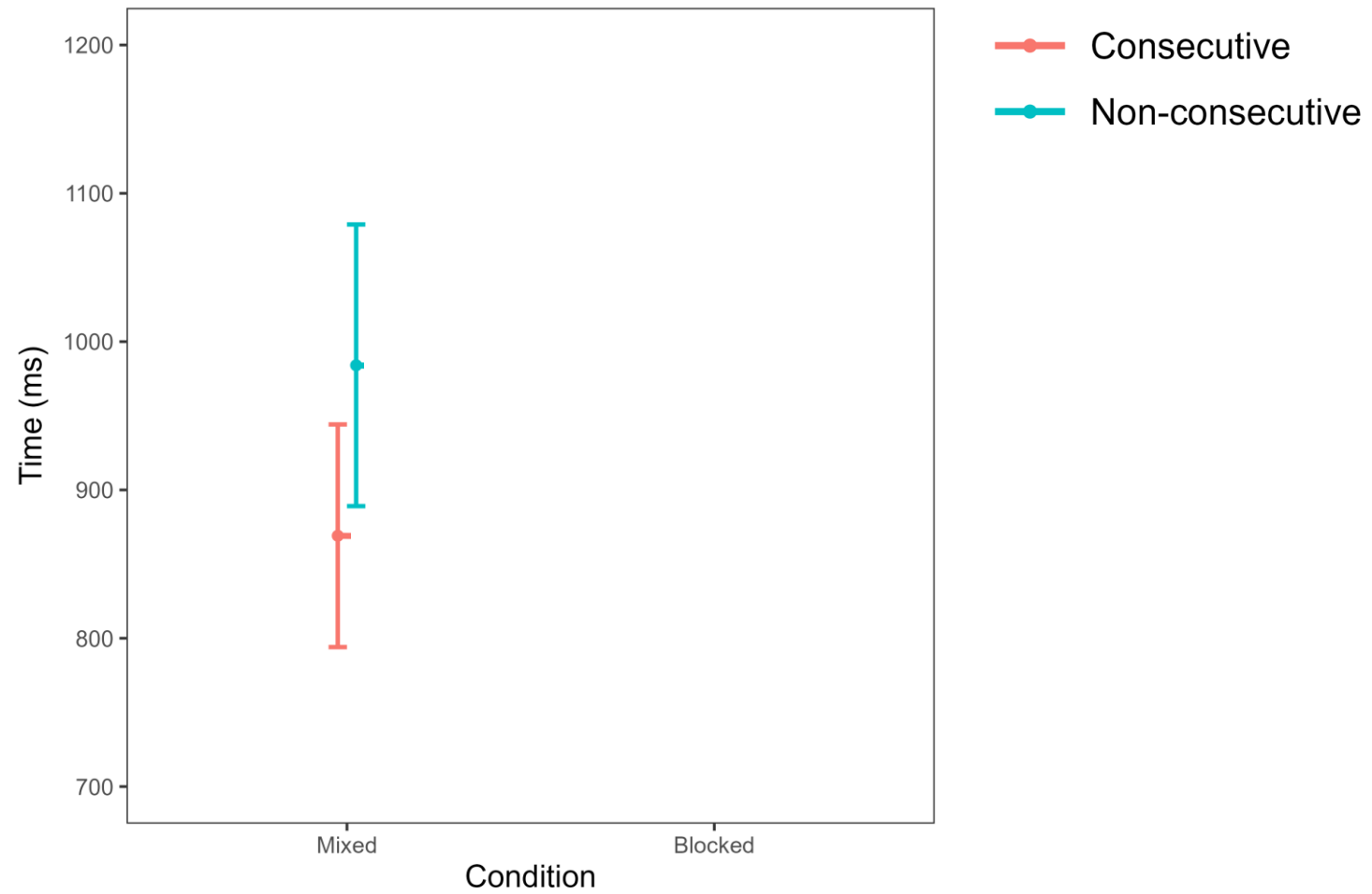
Participants completed an order judgement task under two conditions:



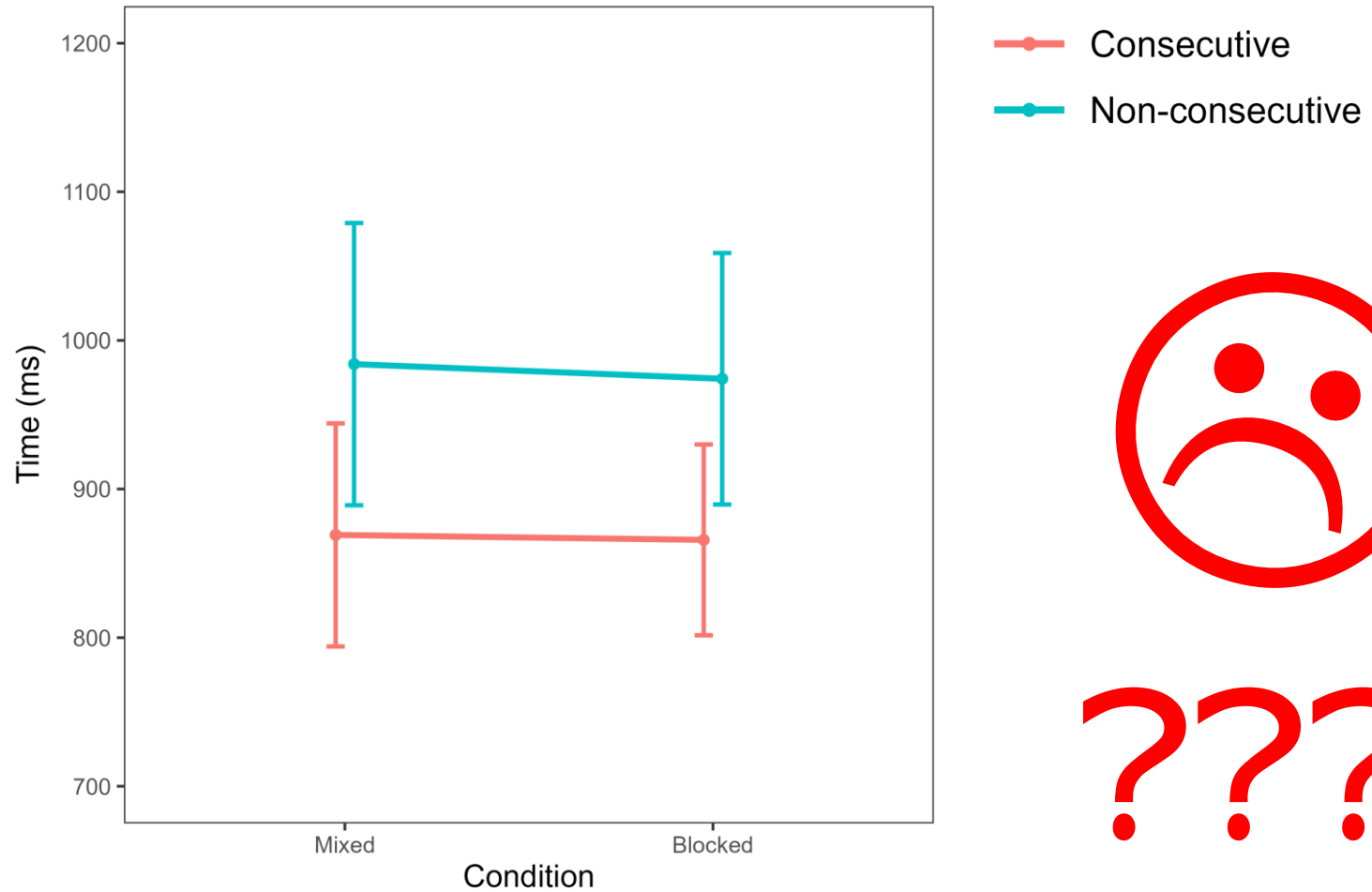
Results



Results



Results

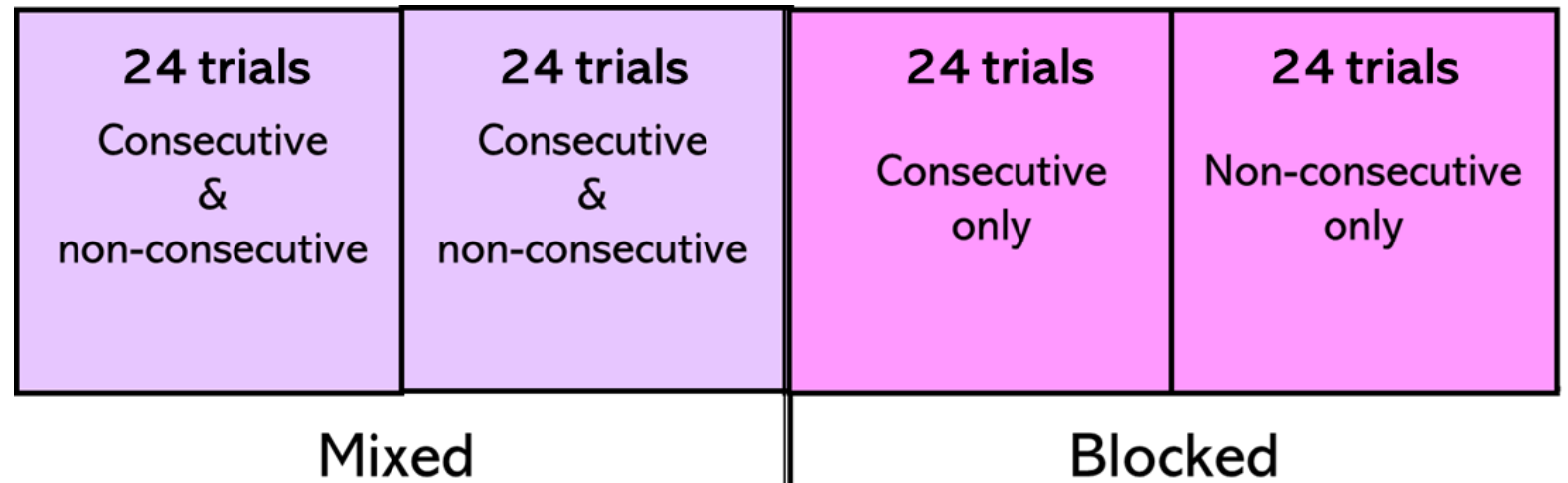


???

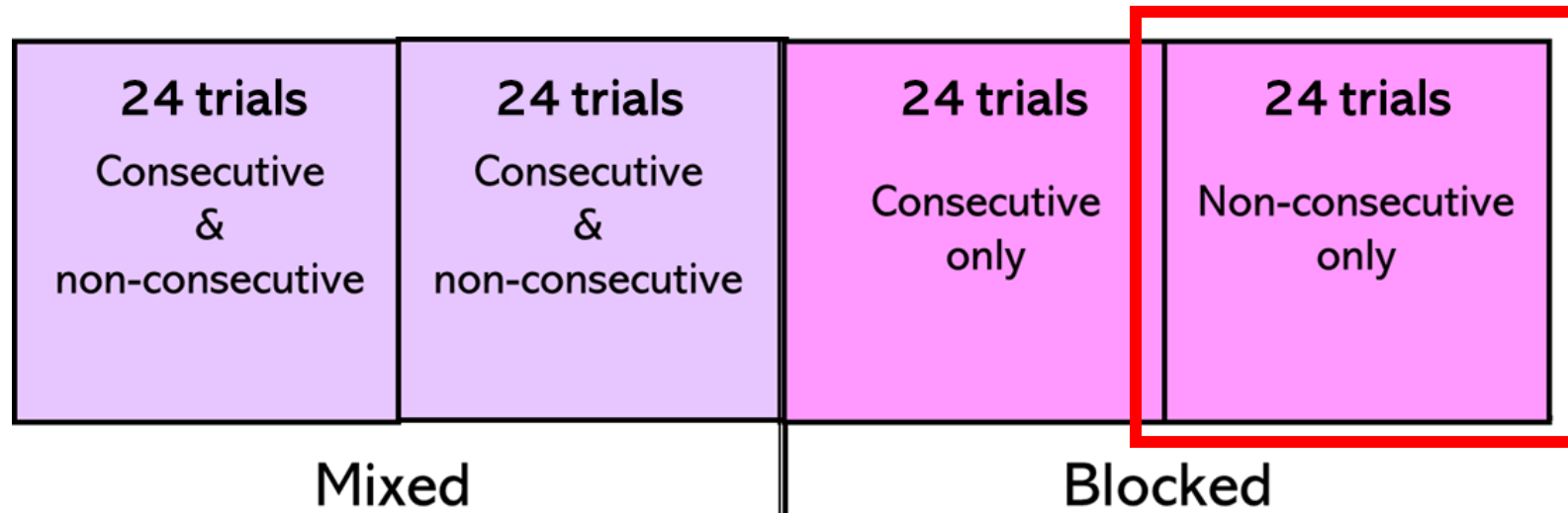
Results

No cognitive demand in adults?

But.... Relatively short task?? (96 trials)



Two-step Process

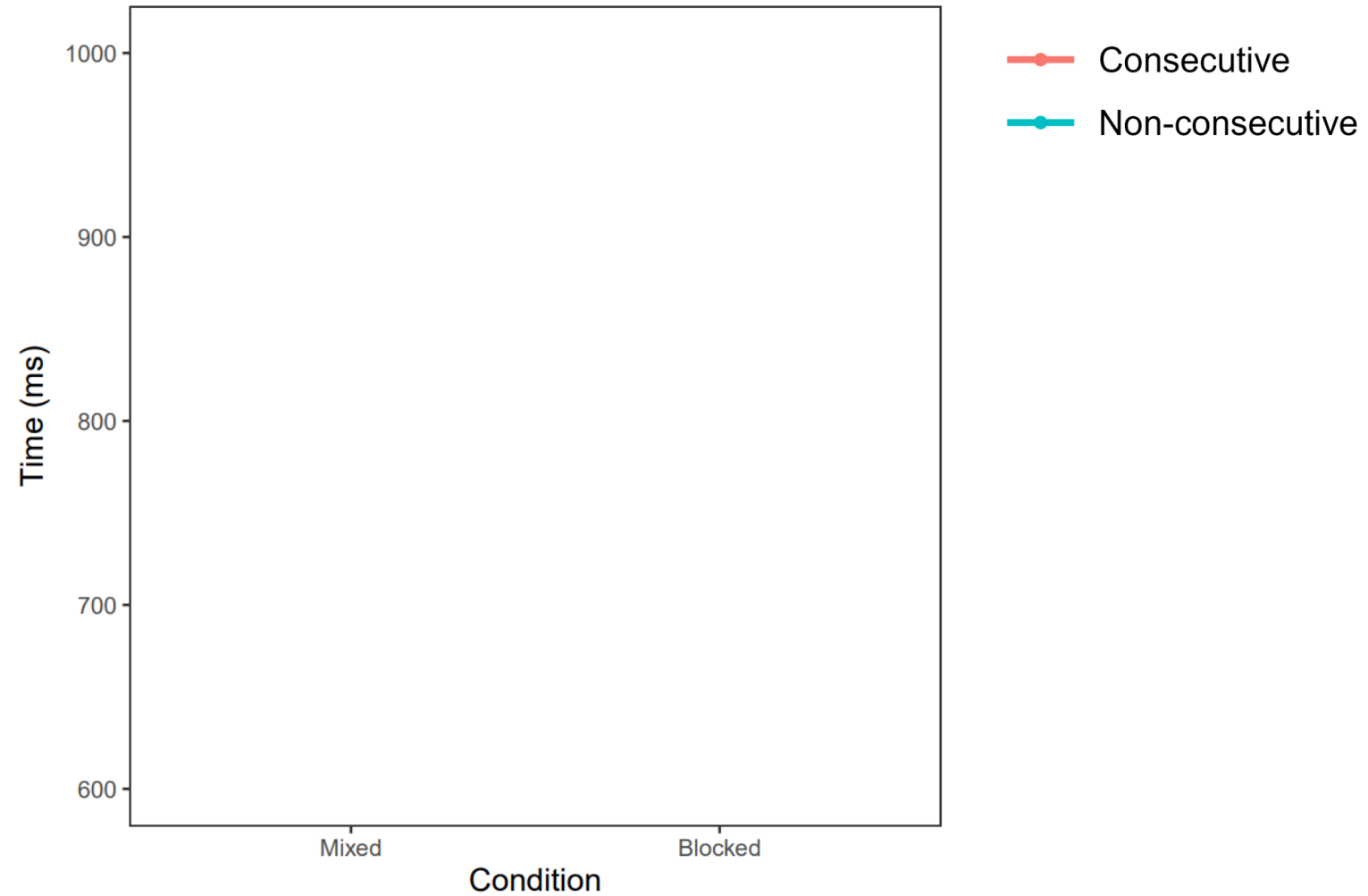


	1-2-3	1-3-5
Count-list?	✓	✗
In order?		✓

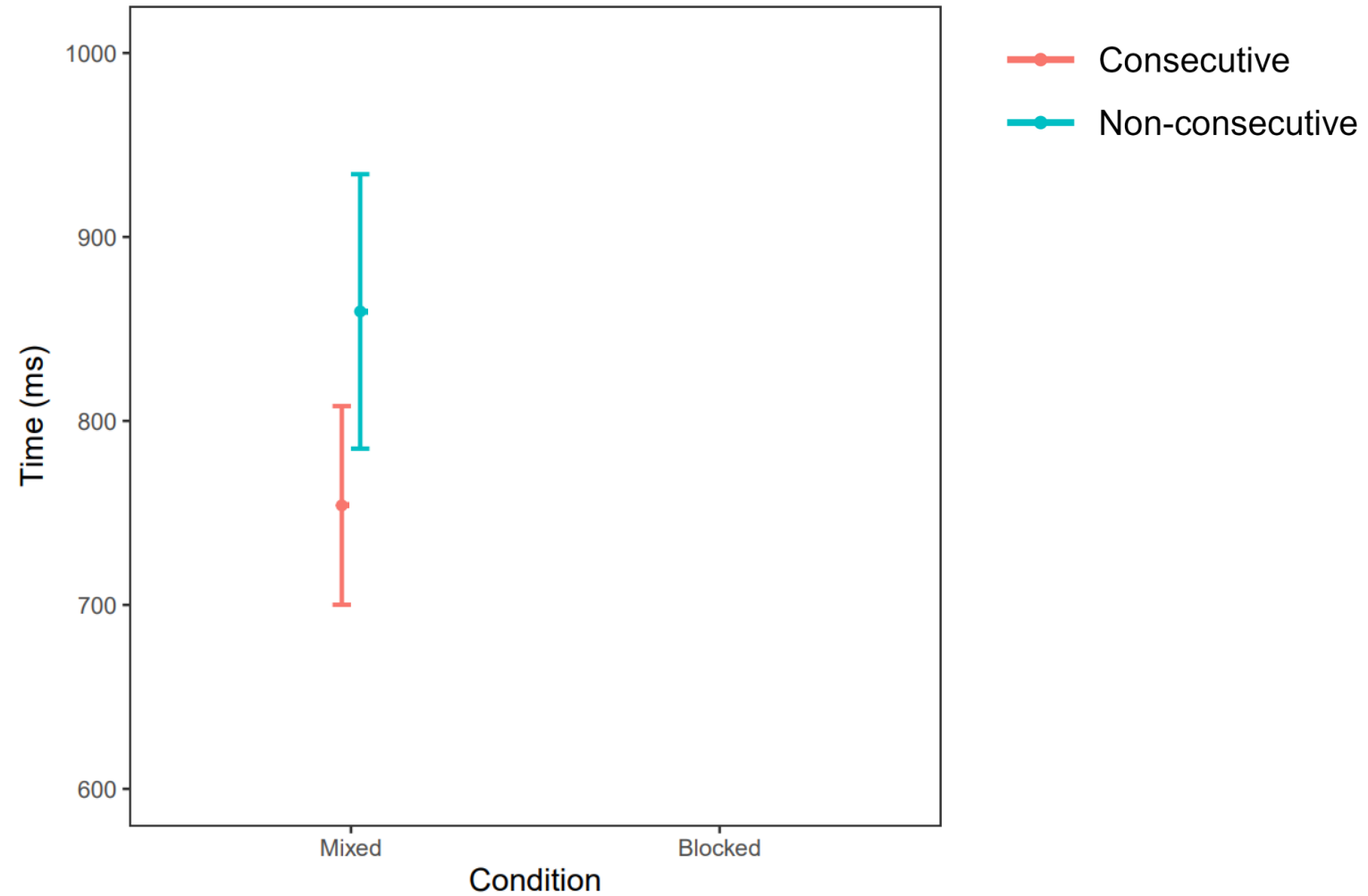
Experiment 2

1. We **doubled the number of trials** to allow more time for any cognitive demand effects to become noticeable.
2. We **emphasised the distinction between mixed and blocked conditions** to participants to better test the two-step hypothesis.

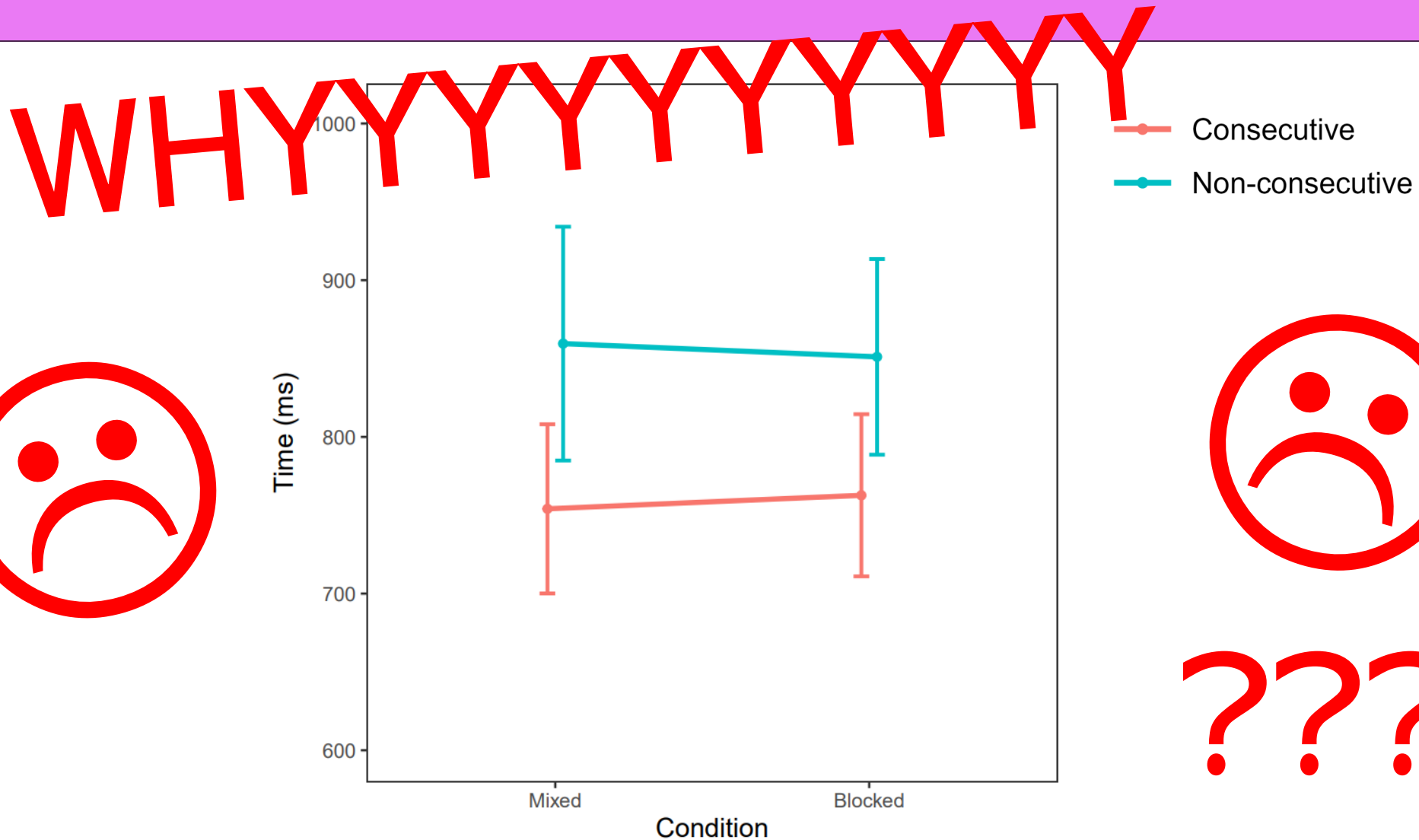
Results (Experiment 2)



Results (Experiment 2)



Results (Experiment 2)



???

Results

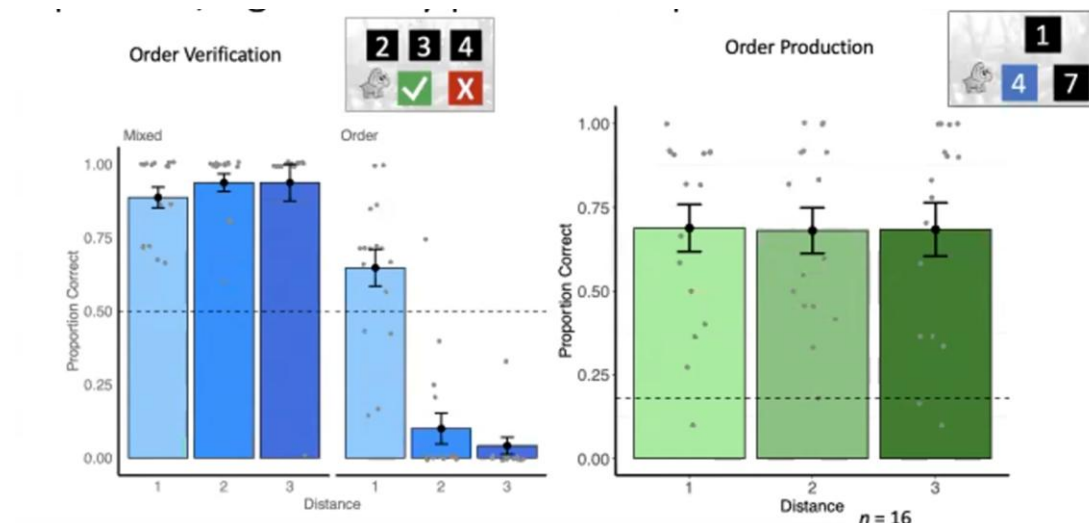
Switching between consecutive and non-consecutive concepts of order is not cognitively demanding - at least not for adults.

Future research should attempt to replicate these findings in children.

No support for adults implementing a two-step process during order processing.

- If there is a count-list effect in adults, it is not a result of such a process.

Verification/Production tasks



Current evidence suggests children may initially consider only count-list sequences as correctly ordered. It remains unclear why such children appear able to correctly produce ordered non-consecutive sequences.

Future research should aim to better establish what strategies/mechanisms underlie order production tasks.

END