Psycholinguistics and Planning: A Focus on Individual Differences

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Overview

Psycholinguistic researchers sometimes overlook variance due to individual differences.

The scope of sentence planning varies both across situations and among individuals.

Individual differences in working memory might help explain something general about language processing.

There is opportunity to explore more individual differences factors in speech planning, but we must be cautious in doing so.

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Psychology and Variance

The purpose of psychological research is to find *systematic variance* in behaviors and cognitive processes.

Psycholinguists *typically* examine linguistic behaviors and thoughts by searching for systematic variance across situations (by manipulating independent variables experimentally) or over time (acquisition).

Another source of systematic variance to consider is variance *among individuals (individual differences)*.

Studied more in comprehension than in production.

Illustrative Example

The modularity debate in sentence comprehension once balanced on the issue of cross-linguistic differences in relative clause attachment preferences.

Variation across situations.

Relative Clause Attachment Ambiguity

The maid of the princess who scratched herself in public ...
NP1 NP2 RELATIVE CLAUSE

- Ambiguous, two possible interpretations:

1. "The maid scratched herself in public."
   - Termed NP1 attachment or "high" attachment.
2. "The princess scratched herself in public."
   - Termed NP2 attachment or "low" attachment.

Late Closure

How does the parser make decisions about what to do with new, ambiguous constituents?

Frazier (1987) postulated Late Closure, a universal parsing principle based on syntax alone (modular): "If grammatically possible, attach new items into the clause or phrase currently being processed."

The Universality of Late Closure

The sister of the actress who shot herself on the balcony...
NP1 NP2 RELATIVE CLAUSE

This was based on evidence from English (Frazier, 1979):
Speakers of English prefer NP2 attachment.
- Make relative clause part of current phrase (actress)

Cuetos & Mitchell (1988) quite reasonably wondered whether we should examine languages besides English before drawing conclusions about universal parsing strategies.

The Universality of Late Closure

The sister of the actress who shot herself on the balcony...
NP1 NP2 RELATIVE CLAUSE

As it turns out, many languages show an NP1 preference.
Spanish, Dutch, etc. (Cuetos & Mitchell, 1988; Brybaert & Mitchell, 1996)

Because preferences varied across languages, Late Closure must not be "universal".

Swets, Desmet, Hambrick & Ferreira (2007)

Could variation in working memory among speakers of the same language account for variance in relative clause attachment preferences?
Individual differences in the "recency" (late closure) preference?

Could individual differences explain more variance than cross-linguistic differences?

What would such individual differences imply for the role of working memory in language processing?

Method

- Overview:
  - 3 tasks:
    1. Relative clause attachment task
    2. Reading Span (WM_V): verbal task
    3. Spatial Span (WM_S): non-verbal task
  - Large sample: n = 150 (English), n = 96 (Dutch)

The uncle of the fireman who criticized himself far too often was painting the bedroom.

+

Who criticized himself far too often?

the fireman

the uncle

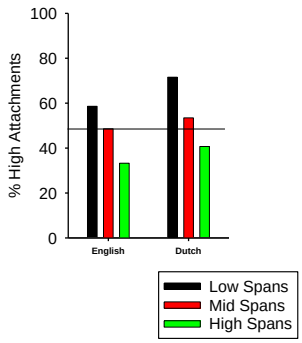
Reading Span

- We measured Verbal WM using a variant of the Reading Span task (Daneman & Carpenter, 1980).
  - Participants read sequences of 3 to 6 sentences and judged whether they made sense.
  - Following each sentence was a word to memorize.
  - After the sequence, they were prompted to write down these words in the correct order.

The cat chased the mouse in the banana. ?

TYPE

Attachment Preferences as a Function of Reading Span (categorical view)



Comparison of Effect Sizes

Effect size of cross-language differences in attachment preference: Cohen's *d* = .29.

Small effect

Effect size of individual differences in attachment preference (computed with scores on reading span):

Cohen's *d* = .72 in the English sample and .90 in the Dutch sample

Large effects.

Swets, Desmet, Hambrick & Ferreira (2007)

"Thus, although cross-linguistic differences are theoretically interesting in psycholinguistics, *they are not nearly as robust as the individual differences that may be observed within a homogeneous language community.*"

Swets, Desmet, Hambrick & Ferreira (2007)

"The individual differences were roughly three times larger than the cross-linguistic differences. Because studies that have shown cross-linguistic differences in attachment preference never controlled for this substantial variation…*it is likely that these differences have been overinterpreted as evidence against universal late closure strategies. However, the finding of large individual differences in itself could be viewed as strong evidence against the universality of late closure*: Individuals clearly differ in the extent to which they use it, regardless of whether their native language has an independent effect."

Implication

Psycholinguistic processing principles once thought to be inflexible and automatic can be shown to be more flexible when examining individual differences.

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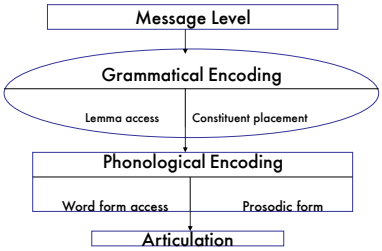
Language Production Models

Levelt (1989)



Assumptions of Production Models

Incremental planning: Scope of planning not over entire sentence at each processing level

Planning is resource-free (automatic)

Increments are **stable**

Fixed Planning

Syntactic priming effects only found on initiation times for first phrase of utterance (Smith & Wheeldon, 2001)

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Syntactic priming effects only found on initiation times for first phrase of utterance (Smith & Wheeldon, 2001)

Eye movements (Griffin, 2001)

Griffin (2001)

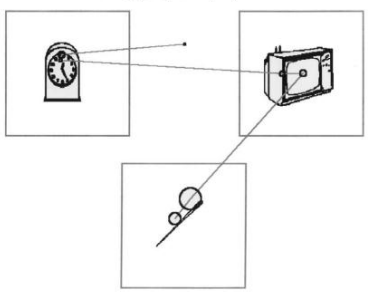


Fig. 1. Example display with a typical eye movement pattern superimposed. Circle positions indicate the fixation locations, and size, duration. The top center fixation is where the validation point was presented before the display. Squares around objects indicate regions used for defining gazes. The critical object in this display is the television, which is medium codable with a high frequency name. The clock is a high frequency first object.

Picture description, 3 objects

"The A and the B are above the C"

Only frequency of A affected speech latency, even if B was fixated first.

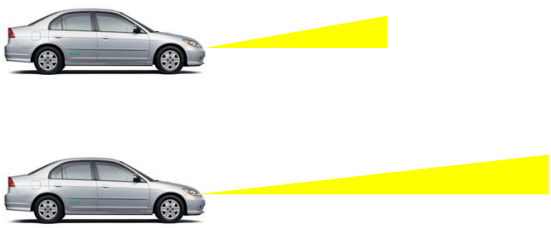
Problems with Fixed Planning

Different researchers find different "units" of planning

Few attempts to find variation in planning scope across situations.

Little evidence from individual differences

Flexible Incrementality



Evidence for Flexibility Across Situations

Producing sentences with arithmetic problems (Ferreira & Swets, 2002)

Easy

21 + 22

"The answer is forty-three."

Difficult

25 + 23

"The answer is forty-eight."

No Time Pressure

[RT] [The answer is] [forty] [eight].

Time Pressure

[RT] [The answer is] [forty] [eight].

More evidence

More recent experiments also demonstrate flexibility in planning scope across situations:

Wagner, Jescheniak, & Schriefers (2010): Increase in task load reduces the scope of grammatical encoding.

Fuchs, Petrone, Krivokapic, & Hoole (2013): Different measures of planning reveal different simultaneous planning scopes (some local, some global).

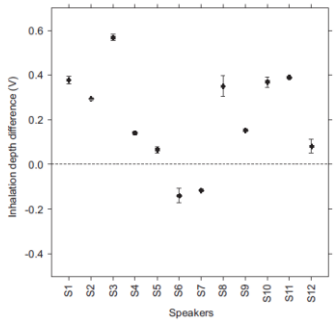
Individual Differences in Planning Scope?

Interestingly, both of these studies also allude to the possibility of individual differences in planning.

Wagner, Jescheniak, & Schriefers (2010): Fast responders plan less in advance than slow responders.

Fuchs, Petrone, Krivokapic, & Hoole (2013): Large speaker-specific variation in sensitivity to long vs. short sentences.

Fuchs et al. (2013)



"Means and standard errors for the difference in inhalation depth between long and short sentences (y-axis). Results are split by speakers (x-axis). The dashed line at 0 indicates no difference between the two conditions. Positive values indicate that inhalation was deeper in long sentences, negative values that it was deeper in short sentences."

Swets, Jacovina & Gerrig (in press)

Could a working memory factor account for such individual differences in planning scope?

Pet Shopping

"I'll take the cat!"

"Which one?"

"I'll take the cat!"

"Which one?"

"I'll take the four-legged cat."

Sentence Planning

We often plan sentences in contexts that may lead to ambiguity.

Difference between sentences that resolve reference and leave reference ambiguous often hinges on planning.

Are some speakers more likely to plan carefully than others?

Flexibility of Planning Scope

Scope is flexible in response to external pressures

Do internal pressures produce similar flexibility in planning scope?

RESOURCE CONSTRAINTS (cont.)

Evidence suggests that high-level sentence planning, including grammatical encoding, requires working memory resources

(Hartsuiker & Barkhuysen, 2006; Horton & Spieler, 2007; Kellogg et al., 2007; Kemper et al., 2003; Kemper & Sumner, 2001; Petrone, Fuchs & Krivokapic, 2011; Slevc, 2007, 2011)

RESOURCE CONSTRAINTS (cont.)

Individual differences:

Older adults less likely to integrate audience design information into utterance plans (Horton & Spieler, 2007)

High span speakers begin articulation of complex subject phrases at a higher f0 pitch than low span speakers, although preparation time was equivalent (Petrone, Fuchs & Krivokapic, 2011)

RESEARCH QUESTIONS

Do individual differences in working memory predict individual differences in the scope of speech planning?

What role does working memory play in the process?

APPROACH

Moving-picture paradigm (Meyer, 1996; Smith & Wheeldon, 1999)

Eyetracking (Griffin, 2001; Griffin & Bock, 2000)

Contrasts in conversation (Brown-Schmidt & Tanenhaus, 2006)

Individual differences

DISPLAYS

CONTRAST CONDITION

METHOD

CONTROL CONDITION

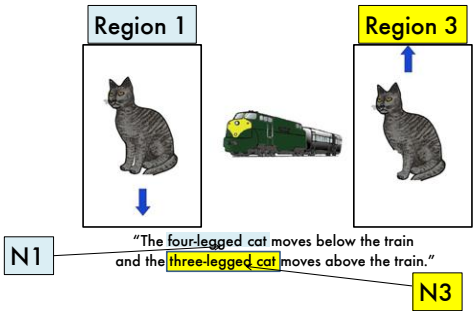
EXPERIMENT

Phase I: Working memory assessment

Phase II: Participants from a wide range of working memory scores returned to act as Directors in a matching game

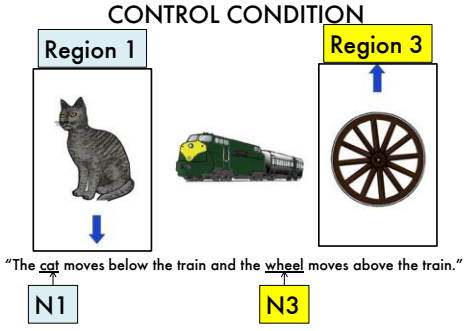
DISPLAYS

CONTRAST CONDITION



DISPLAYS

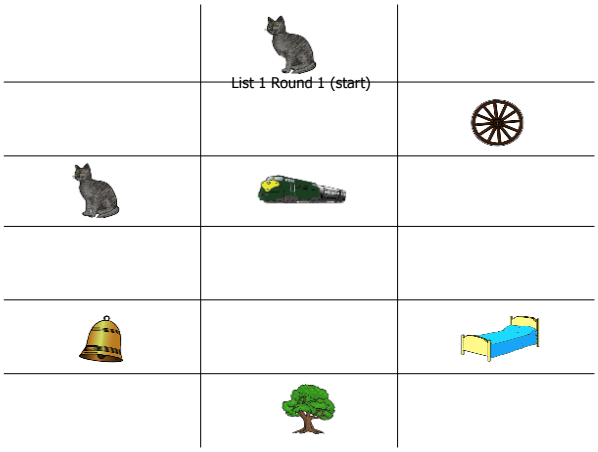
CONTROL CONDITION

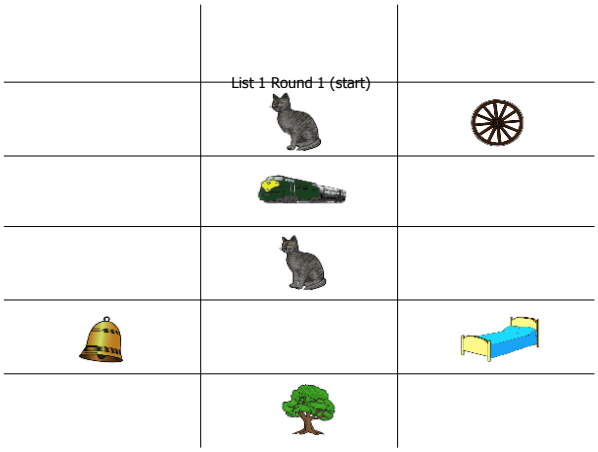


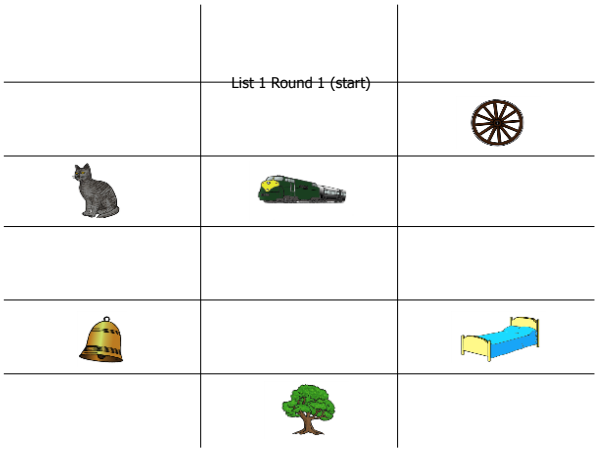
MATCHER TASK

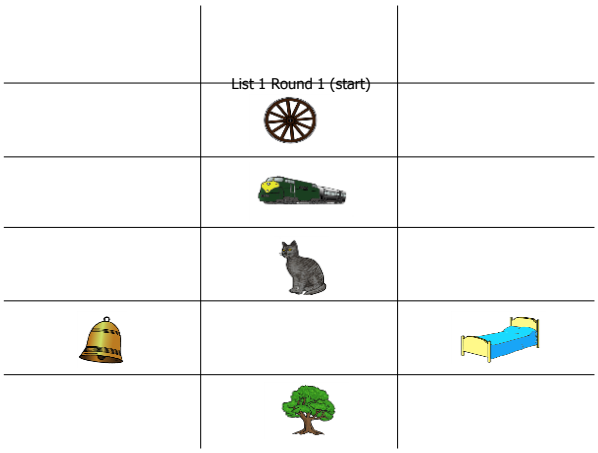
Moved objects around in Powerpoint to match descriptions

Free to interact with Director









INDEPENDENT VARIABLES

Individual differences variable: Working memory

- Reading span
- Left as continuous for statistical analyses

Manipulated variable: Display type

- Control vs. contrast displays

MEASURES

Initiation time

Fixation patterns

Duration and content of N1/N3 descriptions

ANALYSES

Working memory (WM) treated as continuous measure

- Best to avoid artificial dichotomization, which removes a lot of variance that could account for planning differences

Linear mixed effects models in R

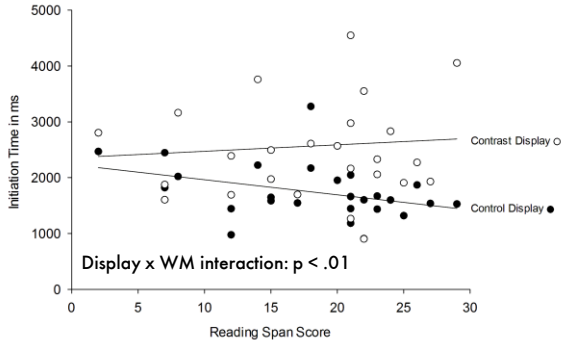
- WM and display type entered as interactive fixed effects, participants and items entered as random effects

HYPOTHESES AND PREDICTIONS

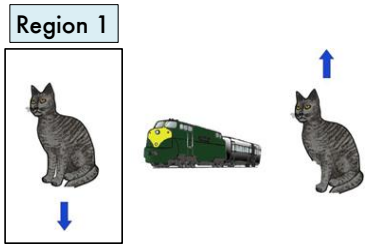
If working memory supports planning processes, WM score should correlate with advance planning tendencies

- More looks to contrast object before speaking
- Higher likelihood of modifying N1, but only in presence of contrast displays
- Time course can help distinguish between possible roles of WM (simple capacity vs. efficient capacity).

Initiation Time



Pre-articulatory fixation patterns



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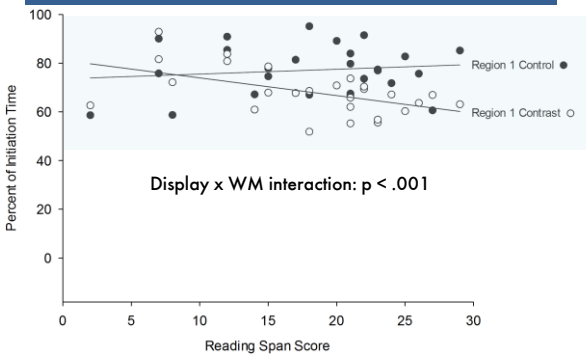

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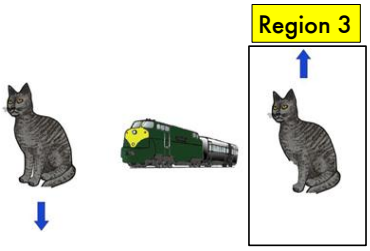

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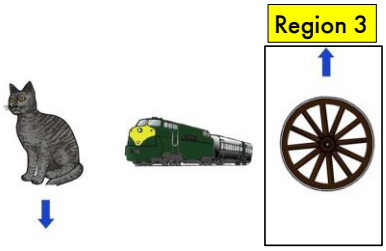

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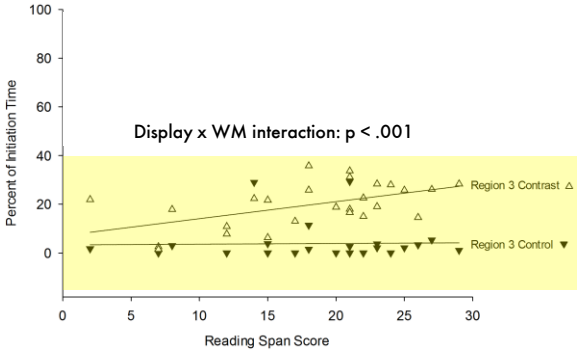

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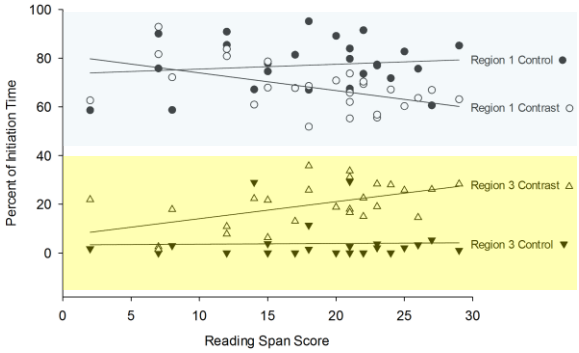
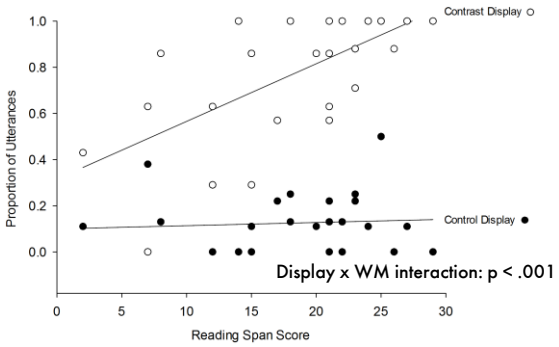


N1 Modification Likelihood



Summary of Results

Working memory did not predict initiation time in situations of ambiguity, but…

High spans spent more during this window fixating the third object if there was a contrast with the first object

High spans were more likely to modify N1 to verbalize the contrast with N3

Better/more specific utterances

Conclusions (for now)

Working memory facilitates a longer scope of speech planning

High spans are able to gather more information in advance and integrate it into speech plans

Working memory allows speakers to plan more/better without temporal cost (consistent with Petrone et al. results)

Efficient capacity

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Working Memory in Language Processing

Do similar individual differences in processing scope arise in other language domains?

What would such results across domains imply about the general role of working memory in language processing?

Summary of Results (RC study)

- Working memory predicted RC attachment.
  - **High-spans** attached **low**.
  - **Low-spans** attached **high**.
- But why do high-spans prefer low (NP2) attachment?

Potential Explanation: "Chunking"

- Maybe the reason high-span readers attach to NP2 is that they create larger "processing chunks" as they read silently.
  - More WMC → Larger chunks
  - Complex NP and RC all one unit

The maid of the princess who scratched herself in public…

- On the other hand, low-span readers may insert a "break" between NP2 and the RC.

The maid of the princess who scratched herself in public…

- If we forced readers to use the same chunking strategies during reading, would everyone attach the same?

Study 2: Chunked Presentation

- Same as Study 1, but sentences presented in 3 chunks:

The maid of the princess…

…who scratched herself in public…

…was terribly embarrassed.

- Forced break between N2 and the RC.

The nephew of the fisherman

who drowned himself in the ocean

didn't know about the tricky current.

Who drowned himself in the ocean?

+

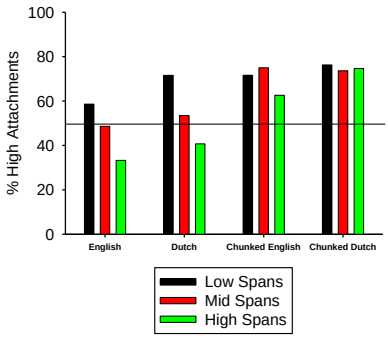
the fisherman

the nephew

Study 2: Predictions

- If WM underlies the size of the processing chunks people use to parse syntax…
- Then forcing a break between N2 and the RC should:
  - Reduce or eliminate the relationship between WM and attachment preference by making everyone behave like low spans.
    - High attachment.

Attachment Preferences as a Function of Reading Span (categorical view)



Summary

- The direction of the relationship between WM and attachment preference was the same in both English and Dutch:
  - Individuals low in WM attached high.
  - Individuals high in WM attached low.
- Chunking the text reduced these relationships significantly.
  - Because it effectively turned everyone into a low span.

Implications

Final products of parsing are bounded by the limits of working memory capacity.

Working memory predicts informational chunking in parsing.

General Implications

Working memory helps to determine the size of the informational chunks that are parsed **or** planned.

- It produces similar effects in both comprehension and production.

Currently collecting data from other domains to determine whether this applies even more generally.

- Prediction during parsing (Altmann & Kamide, 1999).
- Event segmentation during reading comprehension.

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Future Directions

Catalog of other aspects of speech planning:

- Phonology
- Prosody
- Syntax

Other individual differences measures:

- Processing speed and speech rate
- Social factors (perspective-taking, autism quotient)
- BLIRTatiousness (Brief Loquaciousness and Interpersonal Responsiveness Test, Swann & Rentfrow, 2001)
- Big 5 personality factors?

Words of Caution

Must place interpretive limits on individual differences research because it is inherently correlational.

Studies of individual differences require large numbers of participants…(and other methodological quirks).

Beware of fishing expeditions.

"What is working memory?"

THANK YOU