# Lecture 13:
# Individual Differences

COGS 153

# Research into individual differences

- Subject variables vs. independent variables
  - Can't randomly assign someone to a subject variable (e.g., bilingual vs monolingual)
- Correlation does not equal causation
- Example:
  - Author Recognition Test (ART; Stanovich & West, 1989)
    - Used to measure exposure to printed media (and how often people read)
    - Task: See a list of author and non-author names and indicate which ones are real authors
  - ART performance predicts reading skill, spelling ability, word recognition, cultural literacy, vocabulary and others
- But...
  - Do people read more because they are good at reading?
  - Does reading more often make people better at reading?
  - Does it go both ways?

# Working memory (WM)



Visuospatial sketchpad — Central executive — Phonological loop
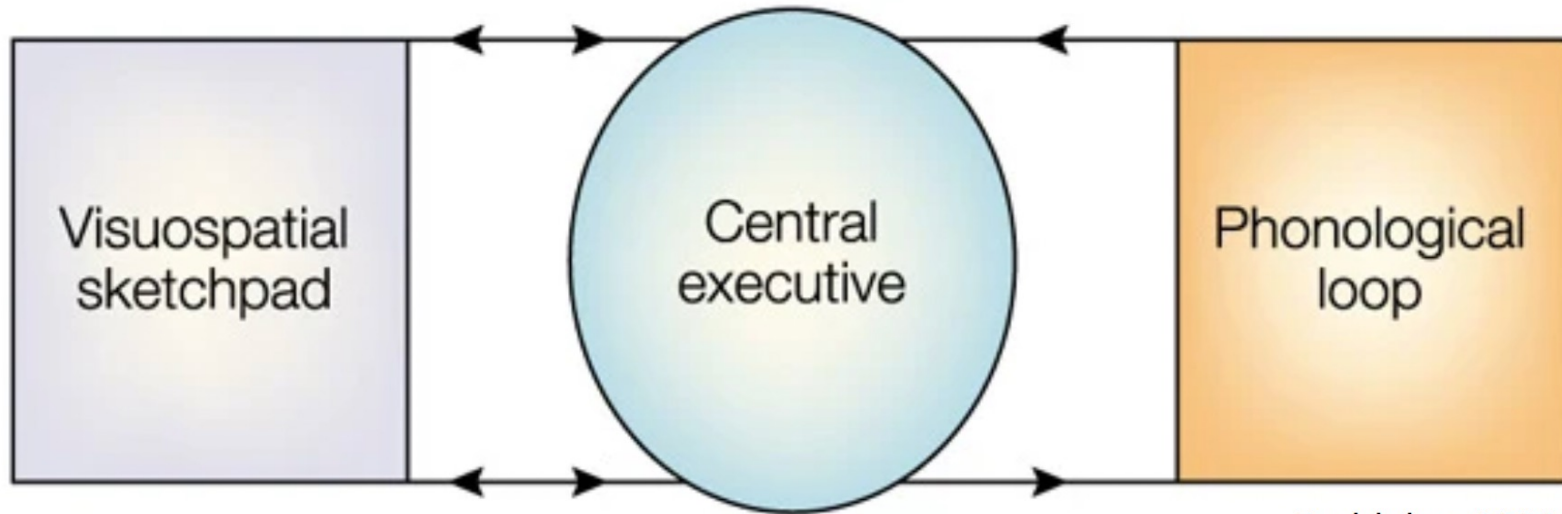
Baddeley, 2003

Sentence comprehension involves processing a sequence of symbols perceived over time (Just & Carpenter, 1992)

# Measuring individual differences in verbal WM capacity

- Reading Span Task (Daneman & Carpenter, 1980)
- **Procedure**:
- Read a series of unrelated sentences and try to remember the last word from each. After the sentences are complete, recall the last words
    - "When at last his eyes opened, there was no gleam of triumph, no shade of anger."
    - "The taxi turned up Michigan Avenue where they had a clear view of the lake."
    - Reading span = the number of sentences for which a person successfully remembers all the last words for 3 or more sets of sentences out of 5 sets.
        - If they are correct on 2 out of 5 sets, they get +0.5
            - E.g., If a person remembered all the last words on 2 out of 5 sets and the sets were 3 sentences each, their reading span would be 2.5.
    - College students typically have a reading span of 2.0 - 5.5
- Sometimes the task involves listening to sentences instead of reading them

# Verbal WM and reading comprehension

- Sentences with subject-relative clauses are easier to process than those with object-relative clauses.

- Sentence span scores
  - High: 4+
  - Mid: 3-3.5
  - Low: 2.5 or less

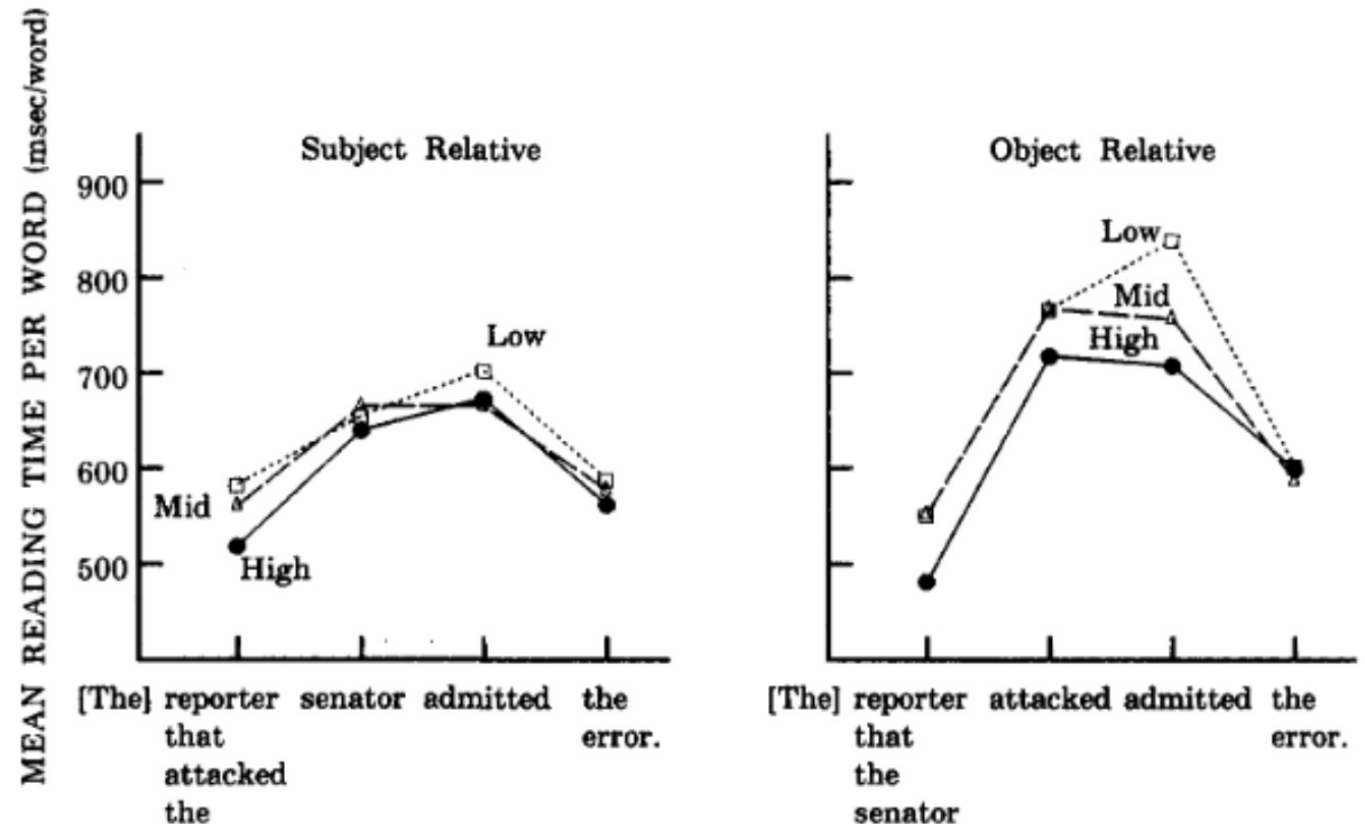- **Task**: self-paced reading

Just & Carpenter, 1992



*Figure 2.* Reading time per word for successive areas of subject- and object-relative sentences, for high, medium (Mid), and low span subjects. (The differences among the span groups are larger for the more difficult object-relative construction, which is the more complex sentence. The differences are particularly large at the verbs, which are points of processing difficulty that are expected to stress working memory capacity. The reading times for parenthesized words are not included in the plotted points.)

# Verbal WM and syntactic ambiguity

- Maintaining multiple representations of a syntactically ambiguous creates a higher WM load than maintaining only one.
  - Same methods, but with syntactically ambiguous sentences

- "The soldiers warned about the dangers before the midnight raid."
  - "Warned" is syntactically ambiguous
    - Main verb paraphrase: The soldiers warned the others about the dangers...
    - Past participle in reduced relative clause paraphrase: The soldiers that were warned about...

- Interpretation: High span individuals slower because they are holding both representations in WM, low span are not



Just & Carpenter, 1992
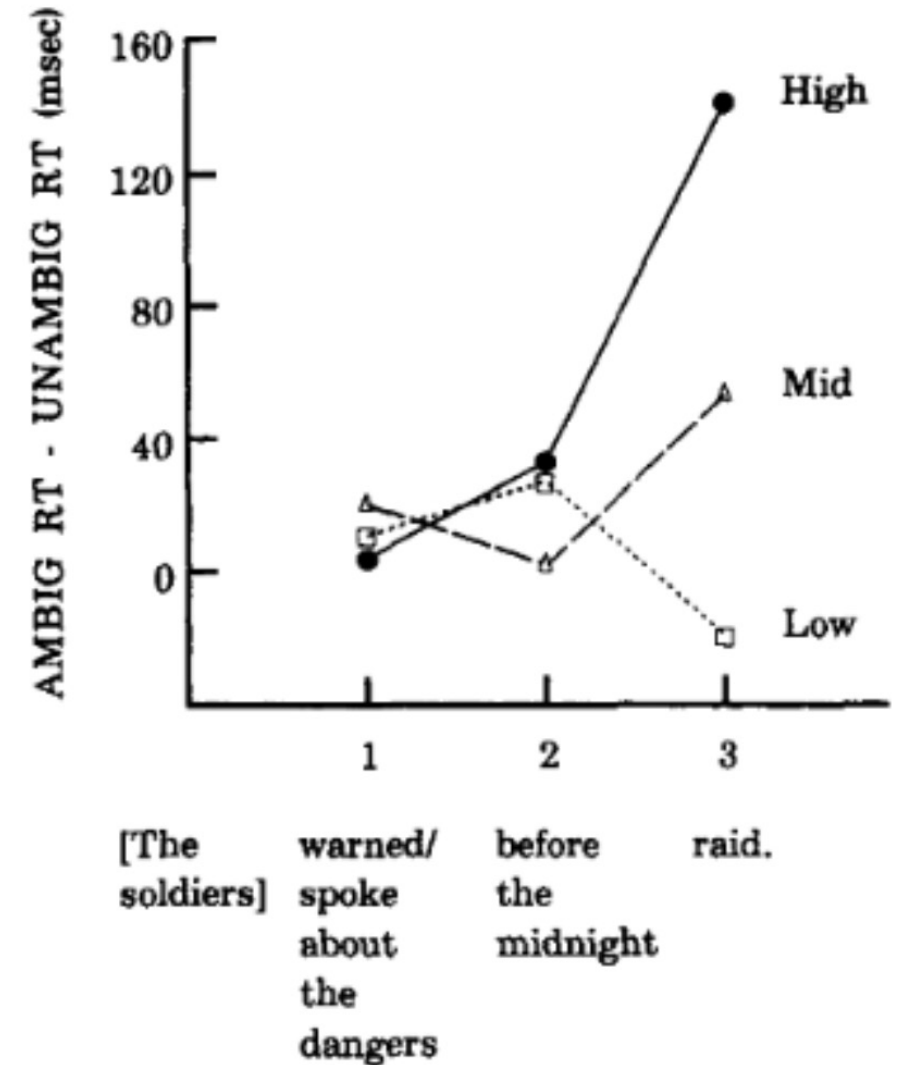
# Verbal WM and distance effects

- Language comprehension involves relating information across sentences, clauses, etc.

- **Procedure**:

- Participants read sentences
  - Number of sentences between pronoun (e.g., "he") and its referent (e.g., "Bill") is manipulated
  - Participants have high, med, low reading span

- Dependent: Measure accuracy on comprehension questions about the referent

Just & Carpenter, 1992
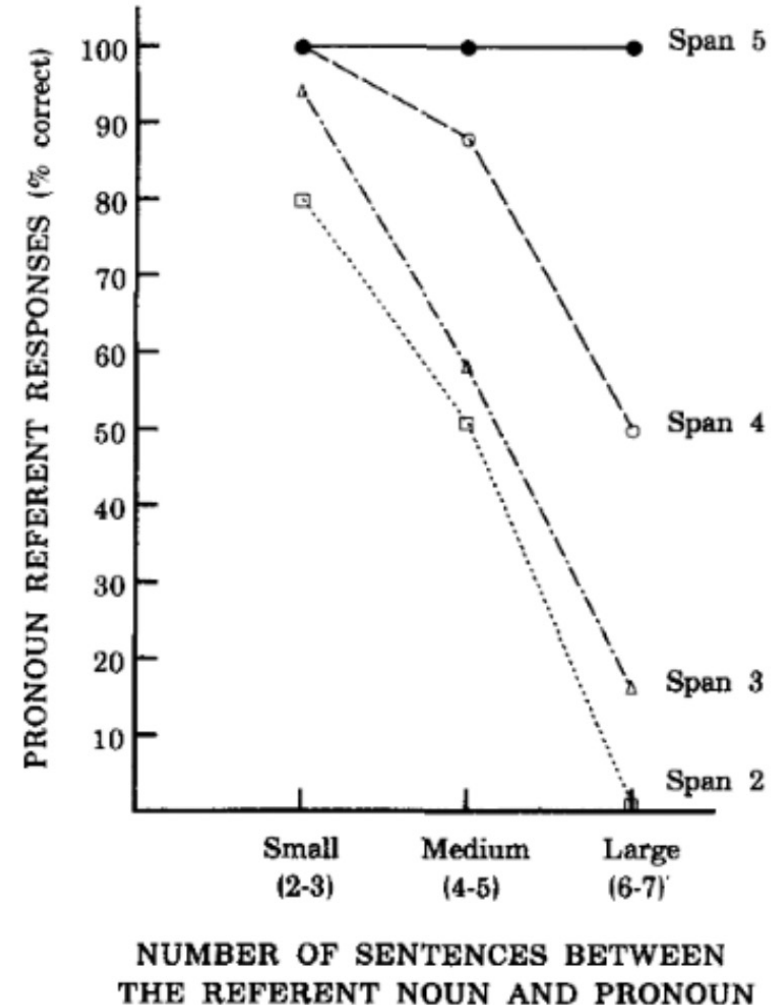
# Verbal WM and neural processing

- **Participants**:
  - High- (4+) and Low- (less than 2.5) reading span groups
- **Procedure**:
  - Read each sentence for comprehension, press a button, then answer comp. question while being scanned in fMRI
- **Stimuli**:
  - 2 x 2
  - Syntactic Complexity (Easy, Challenging) x Noun Frequency (Low, High)

**Table 1.** Sample Stimuli (from Keller et al., 2001)

*High-frequency Nouns*

Active-conjoined (easy syntax)

The *writer* attacked the *king* and admitted the *mistake* at the *meeting*.

Object-relative (challenging syntax)

The *writer* that the *king* attacked admitted the *mistake* at the *meeting*.

*Low-frequency Nouns*

Active-conjoined (easy syntax)

The *pundit* attacked the *regent* and admitted the *gaffe* at the *conclave*.

Object-relative (challenging syntax)

The *pundit* that the *regent* attacked admitted the *gaffe* at the *conclave*.

Pratt, Keller & Just, 2007

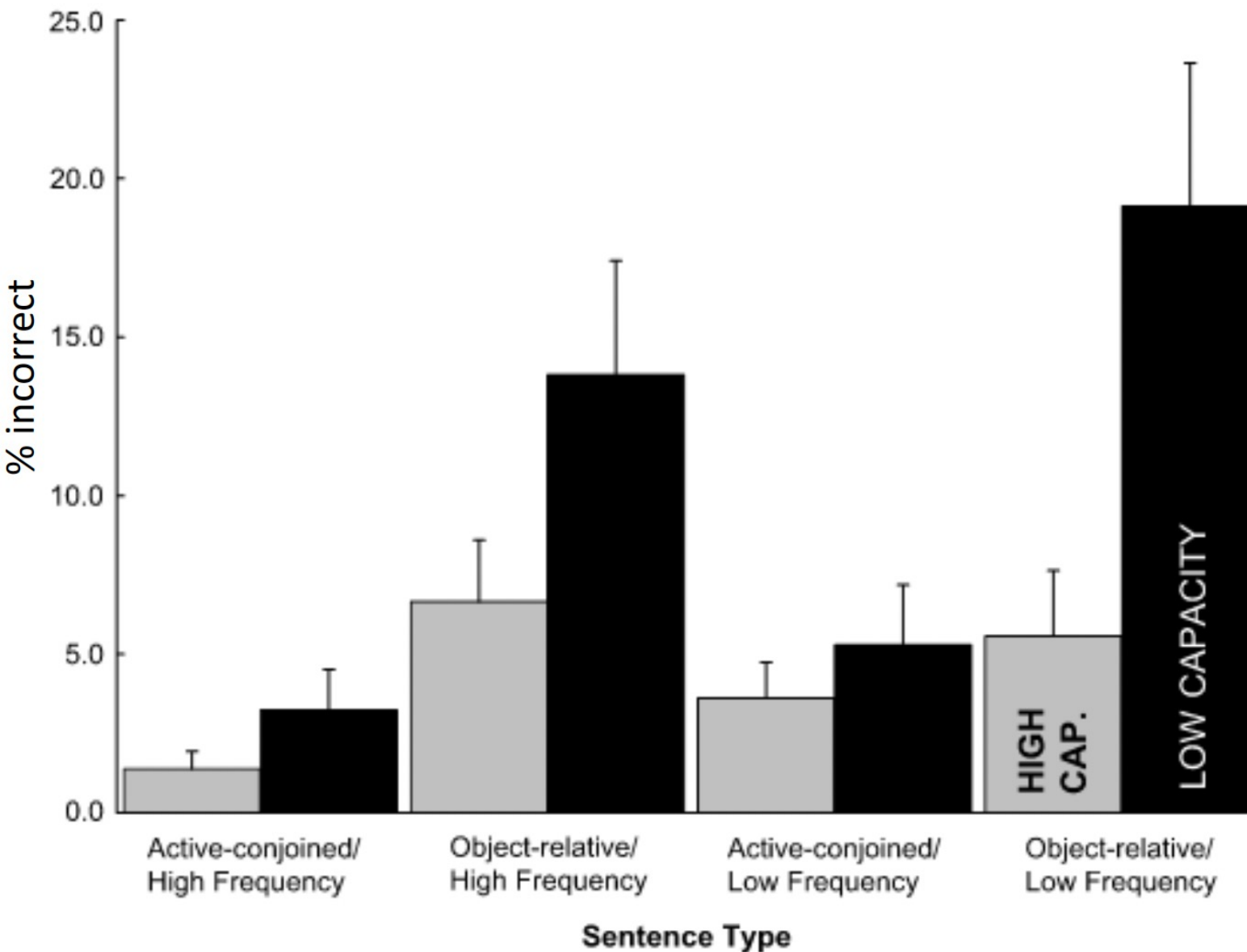# Mean Error Rates for High- and Low-capacity Readers



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Pratt, Keller & Just, 2007

- **Results**:

- Increased activation for low frequency relative to high frequency words

- Increased activation for challenging relative to easy syntactic constructions

- Overall, more activation in low-span group relative to high-span group
  - High-span process language more efficiently

- Additional analysis revealed greater synchronization of brain networks in the high relative to the low-span group



Neural Efficiency Differences Between High-and Low-capacity Readers

Low-capacity Readers

High-capacity Readers

Low-capacity > High-capacity

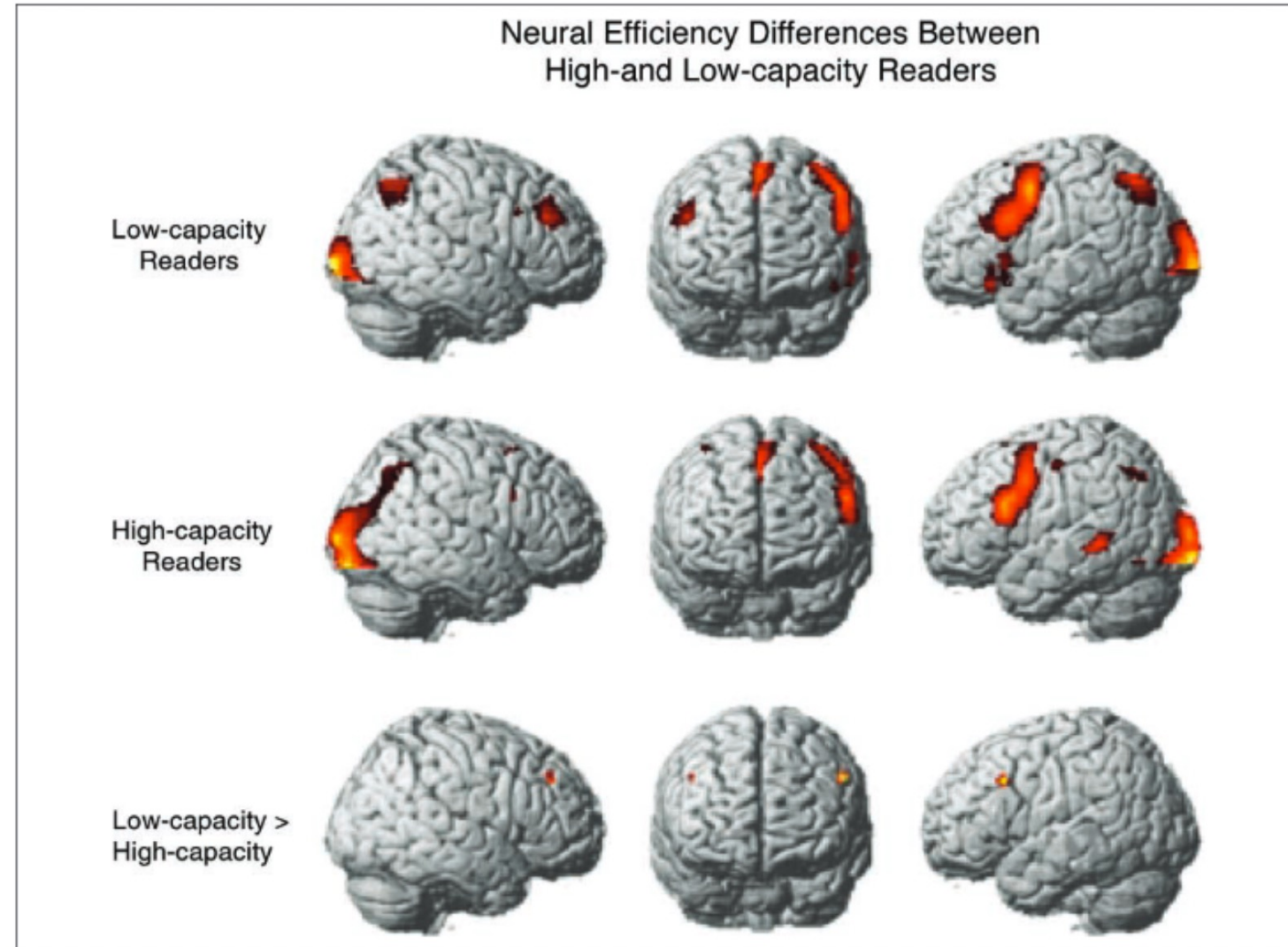**Figure 3.** Activation maps for high- and low-capacity readers as well as significant group differences based on voxelwise analyses.

Pratt, Keller & Just, 2007

# Individual differences in world knowledge

- **Procedure**:

- Participants read sentences that are either control sentences or sentences relating to the Harry Potter franchise
    - The sentences can be true or false (supported or unsupported)
    - **Participants**: Varied in their knowledge of the Harry Potter world

- Dependent: Measure N400 to supported/unsupported sentence final word

**Table 1.** Sample experimental stimuli.

| Sentence frame | Supported | Unsupported |
|---|---|---|
| **Control Sentences** | | |
| We had been watching the blue jay for days. The bird laid her eggs in the | nest | yard |
| The vampire moved in. He bit his victim on the | neck | shoulder |
| Alicia's first client was a failure. But her second was a | success | triumph |
| **Harry Potter Sentences** | | |
| The character Peter Pettigrew changes his shape at times. He takes the form of a | rat | dog |
| There are two Beaters on every Quidditch team. Their job is to protect their team from | Bludgers | Spellotape |
| Wizards are able to conjure the Dark Mark. They can use a spell called | Morsmordre | Stupefy |

Troyer & Kutas, 2020

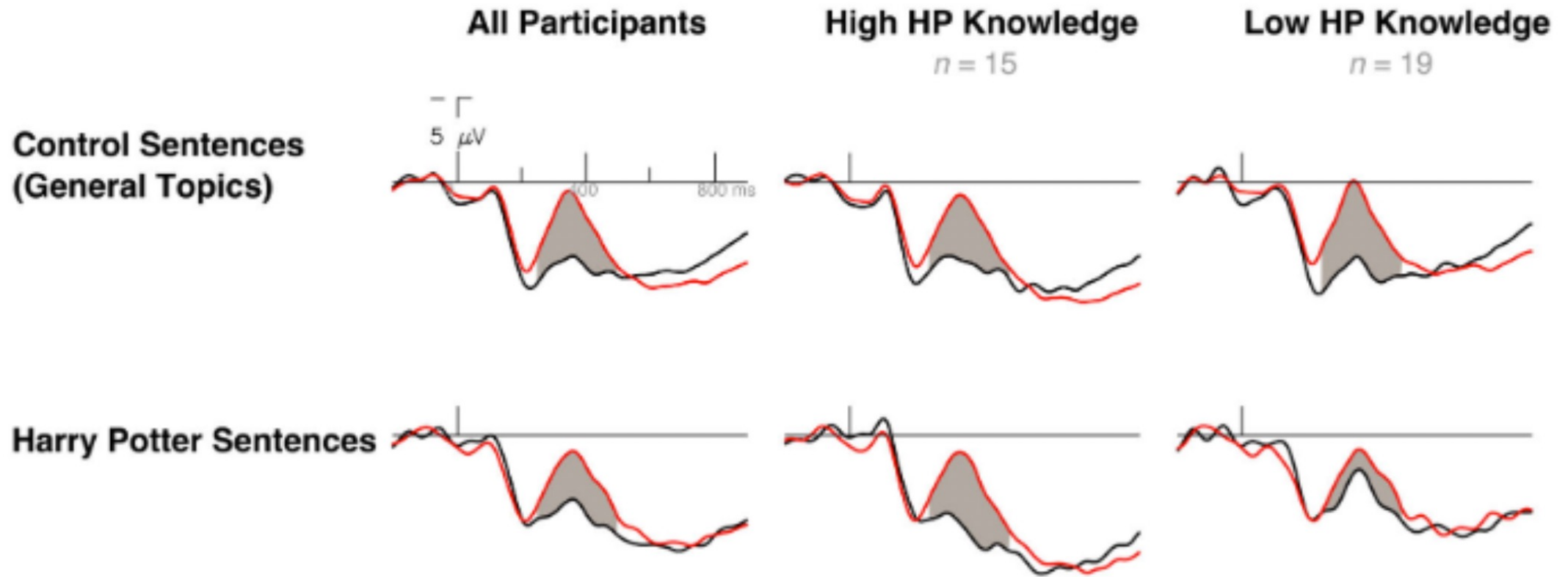|  | **All Participants** | **High HP Knowledge** $n = 15$ | **Low HP Knowledge** $n = 19$ |
|---|---|---|---|

**Figure 3.** ERPs from a centro-parietal ROI for supported (black) and unsupported (red) endings to HP sentences. Shaded region from 250 to 500 ms shows N400 effect (colour online only).

- **Results**:
- Larger N400 to unsupported Harry Potter sentences in people who know a lot about HP vs people who don't

Troyer & Kutas, 2020

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# Individual differences in emotional traits

- **Participants**: Clinically anxious ppts & non-anxious controls
- Interpretation of homophones (Mathews, Richards, & Eysenck, 1989)
    - **Task**: Hear a list of words and write each one down.
        - The list included ambiguously threatening homophones (e.g., "die/dye")
    - **Results**: Anxious ppts more likely to interpret them in a threatening manner
        - e.g., "die" instead of "dye" and "slay" instead of "sleigh"
- Interpretation of sentences with lexical ambiguity (Eyseneck et al., 1991)
    - **Task**: Paraphrase ambiguous sentences that could be interpreted in a neutral or negative manner,
        - e.g., "The doctor examined little Emma's growth."
    - **Results**: Clinically anxious participants were more likely to interpret the ambiguity in a negative manner
        - e.g., tumor as opposed to height

# Temporary emotional state and homophones

- Not really an individual differences study since it's about temporary states

- **Procedure**:

- Listen to a list of words & write them down
  - Critical trials were happy or sad homophones
    - e.g.: heal-heel; won-one; die-dye; mourning-mornin
  - Manipulate temporary emotional state via (happy/sad) music

- Temporary emotional state is a context that can influence language comprehension

Table 2 *Mean proportion of affective meanings for happy and sad homophones spelled by happy and sad subjects*

| Homophone type | Emotional state | |
|---|---|---|
| | Happy (N = 30) | Sad (N = 34) |
| Happy | 547 (102) | 546 (137) |
| Sad | 403 (112) | 494 (127) |

*Note* Standard deviations are in parentheses

Halberstadt et al, 1995

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# Need for cognition and persuasive messages

- Does 'need for cognition' influence how readers evaluate, engage with, and remember persuasive messages that had weak or strong arguments?
  - "Need for Cognition Scale": survey that measures a person's tendency to engage in and enjoy effortful analytic thinking

Cacioppo, Petty, & Morris, 1983

# Need for cognition and persuasive messages

- Does 'need for cognition' influence how readers evaluate, engage with, and remember persuasive messages that had weak or strong arguments?
    - "Need for Cognition Scale": survey that measures a person's tendency to engage in and enjoy effortful analytic thinking
- **Procedure**:
- Participants read an argument for instituting comprehensive senior exams, and then take a survey on their opinions, etc.
    - Participants are matched on their attitude toward instituting comprehensive senior exams, but they differed in need for cognition
- 2x2 Design: "Need for Cognition" Score (High, Low) x Message Coherence (Strong, Weak)
- Dependent Variables: message evaluation, cognitive effort, & recall

Cacioppo, Petty, & Morris, 1983

- Experiment 1 found that for high-NFC individuals...
  - The quality of the argument had a stronger influence on their evaluation of the quality of the message
  - They reported spending more cognitive effort when evaluating the messages
  - They recalled more of the message overall
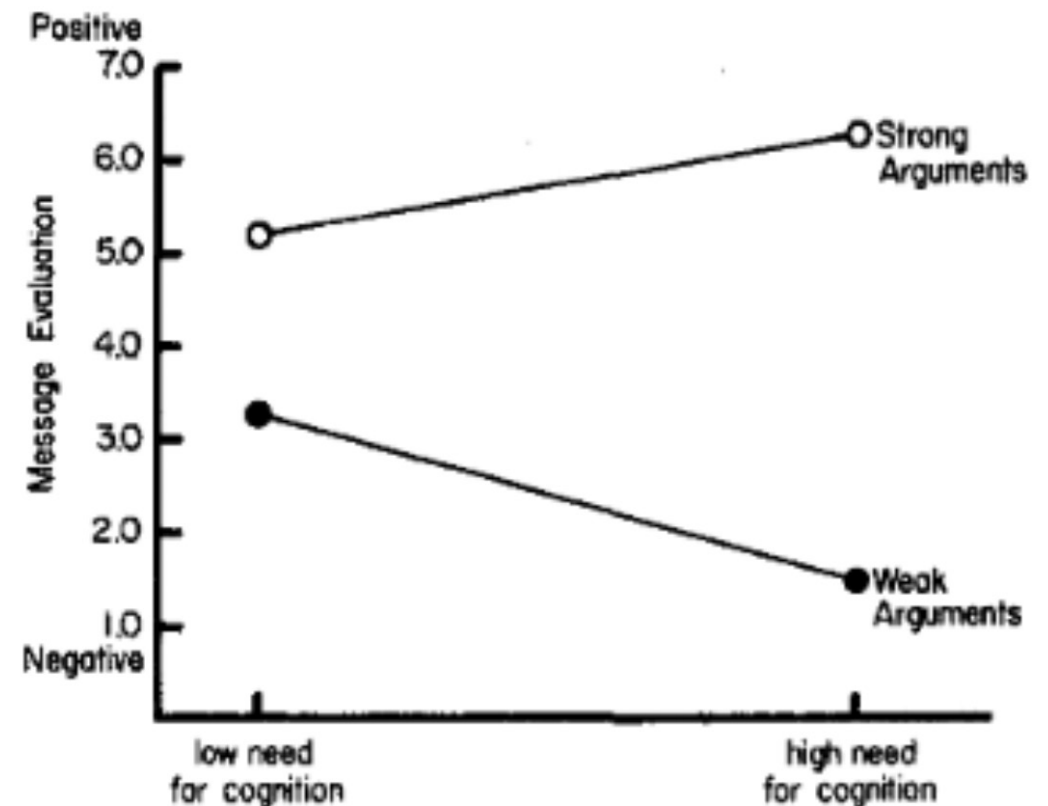- Experiment 2 replicated this pattern using the topic of raising tuition



Figure 1. Message evaluation as a function of argument quality and need for cognition.

Cacioppo, Petty & Morris, 1983