

Processing of Referential Ambiguity with Multiple Referents

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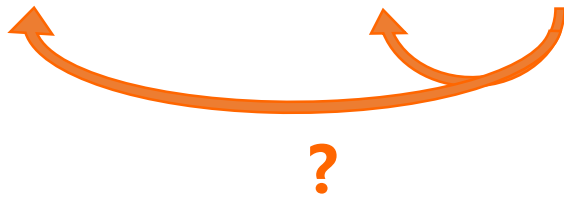
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Referential ambiguity

- **Referential ambiguity** arises when there is **more than one available referent** in the context and the receiver is unable to establish the anaphoric relationship

"David shot at John as he jumped over the fence" (Van Berkum et al., 2007)



- Referentially ambiguous anaphors elicit a brain response called the **Nref** effect

Nref

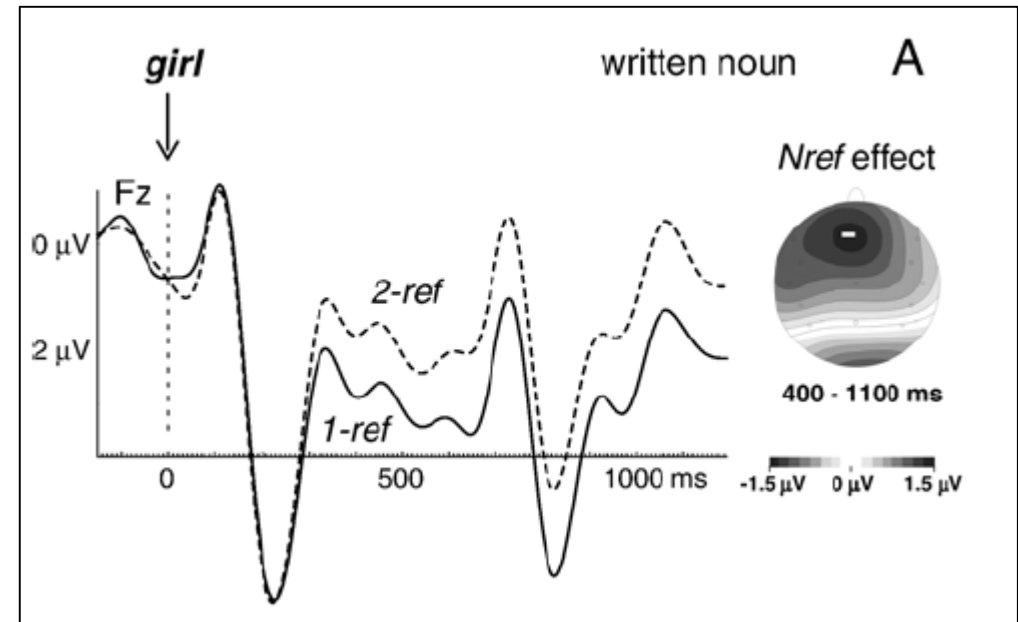
- **Sustained frontal negativity**

Nref

- Sustained frontal negativity

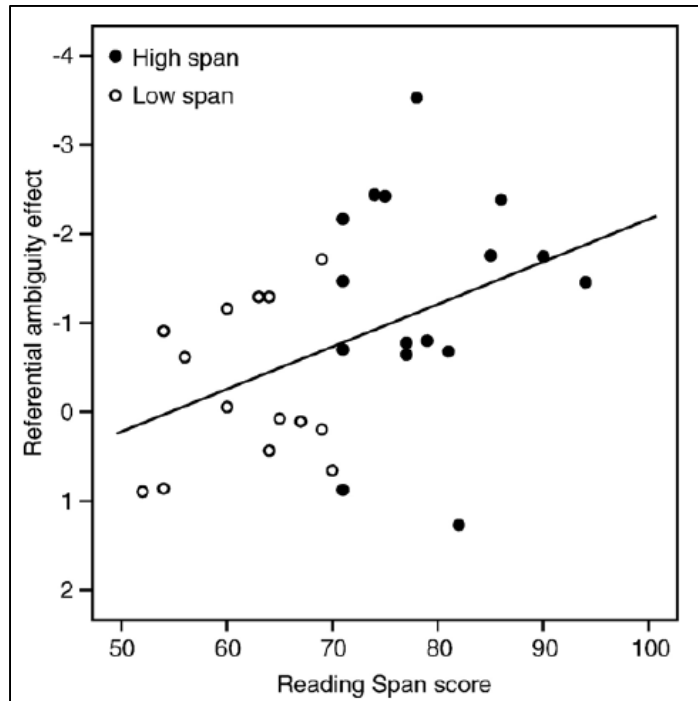
“David had asked the two girls to clean up their room before lunchtime. But **one of the girls** had stayed in bed all morning, and **the other** had been on the phone all the time. David told **the girl** that had been on the phone to hang up.”

(Van Berkum et al., 1999)



Nref

- **Sustained frontal negativity**
- Positively correlated with **memory capacity**



(Nieuwland & Van Berkum, 2006)

Nref

- **Sustained frontal negativity**
- Positively correlated with **memory capacity**
- “**Deep**” ambiguity, rather than “superficial” ambiguity

“At the family get-together, Jim had been talking to **one nephew** who was very much into politics and **another one** who was really into history...The nephew who was into history **left early**, but the nephew who was into politics kept rambling on. Jim didn't understand one bit and got rather bored. He told **the nephew...**”

(Nieuwland et al., 2007)

David **apologized** to John because **he** according to the witnesses was the one to blame.

(Nieuwland & Van Berkum, 2006)

Nref

What processing does the Nref effect reflect?

- **Maintenance of competing referents** (Barkley et al., 2015; Van Berkum et al., 2007)

Suitable referential interpretations are kept in working memory for disambiguation

→ When more referents are available, there should be a **larger Nref effect**

- **Detection of ambiguity** (Nieuwland & Van Berkum, 2006; Van Berkum et al., 2007)

→ When more referents are available, there should be **no difference/smaller Nref effect.**

Research questions

- **Is the Nref effect sensitive to the increase in referential load?**
 - In this study, the number of possible referents was manipulated up to **three**
- **Is the Nref effect associated with visual working memory?**
 - In this study, a **change detection task** is adopted to measure VWM span

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Nref

- Other **sustained negativities**:
 - **LAN** – long-distance syntactic dependency
 - **CDA** – strongly sensitive to the number of items held in visual working memory
 - **NSW** – sensitive to the number of items & vary in topography with **the type of information**
- This effect may **NOT** be an exclusively **referential-specific** or **language-specific effect**
(Van Berkum et al., 2007; Barkeley et al., 2015)

→ the Nref effect may also be associated with **visual working memory?**

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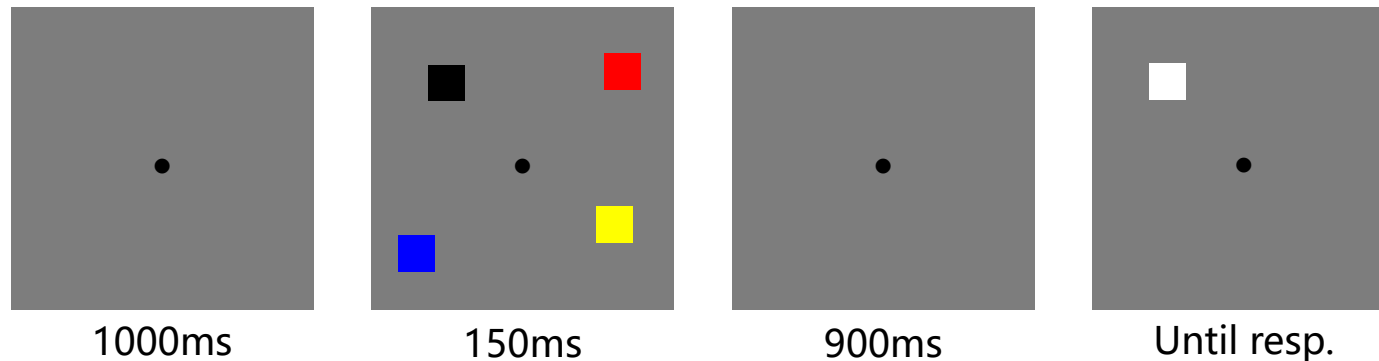
- **Is the Nref effect sensitive to the increase in referential load?**
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 - In this study, a **change detection task** is adopted to measure VWM span

Method

- 36 subjects
 - native speakers of Taiwan Mandarin
 - no exposure to other languages except for Taiwanese before age 5
 - had normal or corrected-to-normal vision
 - no history of neurological or psychiatric disorders
- Change detection task
- Discourse comprehension task

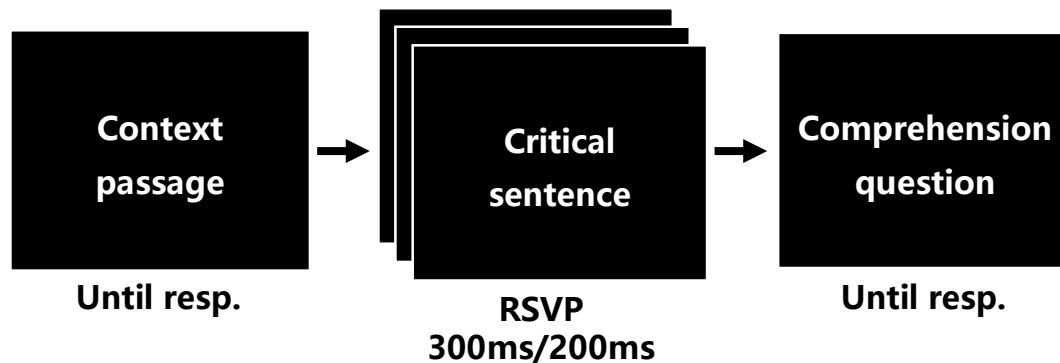
Change detection task

- To assess each individual's VWM capacity
- Set Size 4 & 8
- 60 trials for each set size
- Accuracy for each set size is converted into **K estimate**: $K = N \times (H - FA)$



Discourse comprehension

- 66 story triplets
- 22 stories for each condition (Unambiguous, 2-referent, 3-referent)
- Each story triplets consists of three parts:
 - Context passage
 - Critical sentence
 - Comprehension question



3-ref (English Ver.)

Context passage

Robert lounges on the couch to watch the TV show. Teddy, one of the roommates, listens to the heavy raindrops on the balcony that almost drown out the sound of the TV. Jack complains that the rain has continued for two days and ruins all the weekend plans. According to the weather forecast, the rain won't just let up soon. It seems that the good weather Teddy, Jack, and Robert wish for isn't in the cards for them.

Critical sentence

If it continues to rain, he thinks that Teddy and Jack will feel very upset at work tomorrow.

Comprehension question

$\frac{1}{2}$ → It has been raining (O) for over a day / (X) for just one day.

$\frac{1}{4}$ → The characters in the story needs to go to (O) work / (X) school tomorrow

$\frac{1}{4}$ → (O) Robert / (X) Teddy thinks that his roommates will be very upset if the rain continues tomorrow.

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↑Repeat and rotate these three names to equalize their saliency

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Critical sentence

If it continues to rain, he thinks that Teddy and Jack will feel very upset at work tomorrow.

↑A buffer to prevent the critical pronoun from being the first word presented

Comprehension question

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↑disambiguation

Comprehension question

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2-ref (English Ver.)

Context passage

Robert lounges on the couch to watch the TV show. Teddy, one of the roommates, listens to the heavy raindrops on the balcony that almost drown out the sound of the TV. Jack complains that the rain has continued for two days and ruins all the weekend plans. According to the weather forecast, the rain won't just let up soon. It seems that the good weather Teddy, Jack, and Robert wish for isn't in the cards for them.

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Unamb (English Ver.)

Context passage

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Critical sentence

If it continues to rain, he thinks that Teddy and Jack will feel very upset at work tomorrow.

Comprehension question

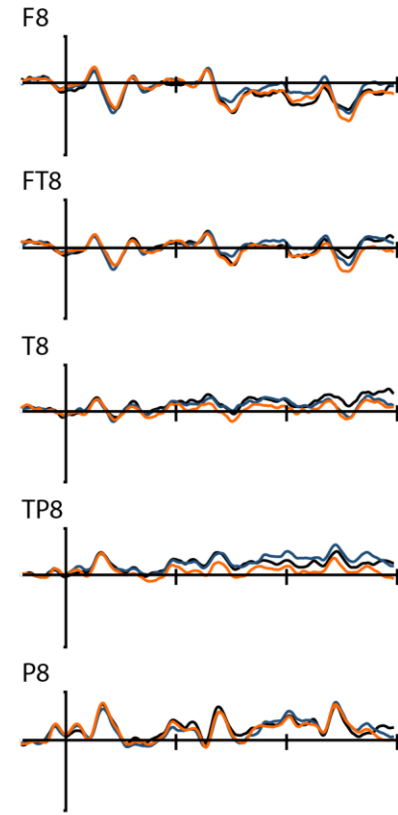
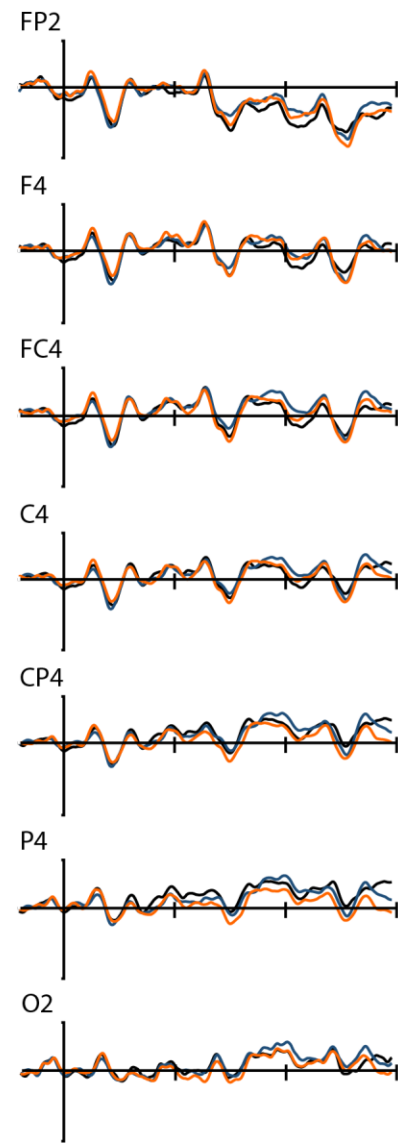
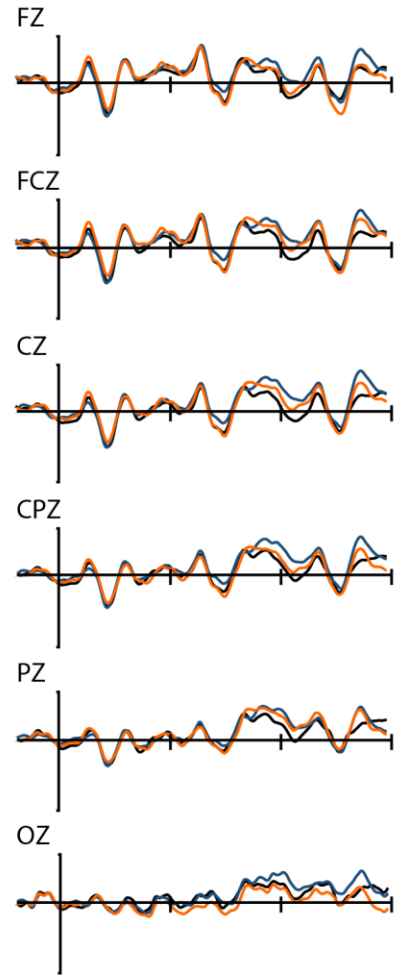
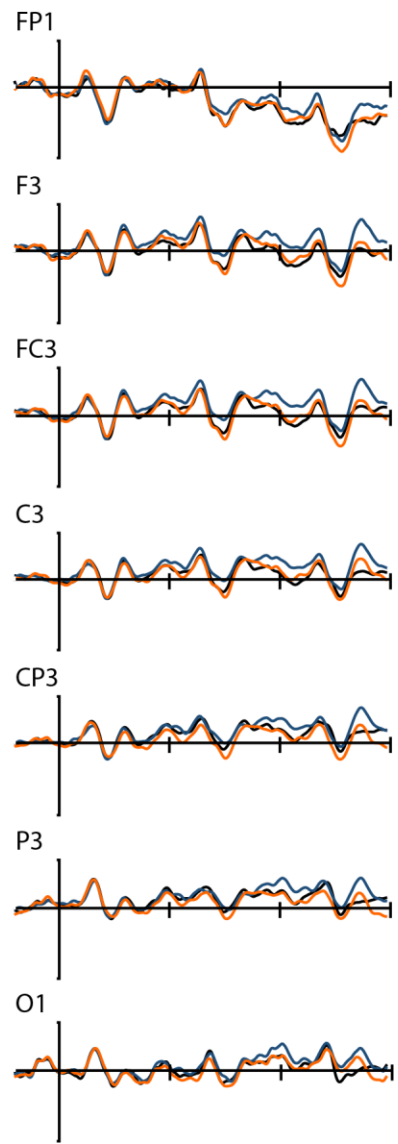
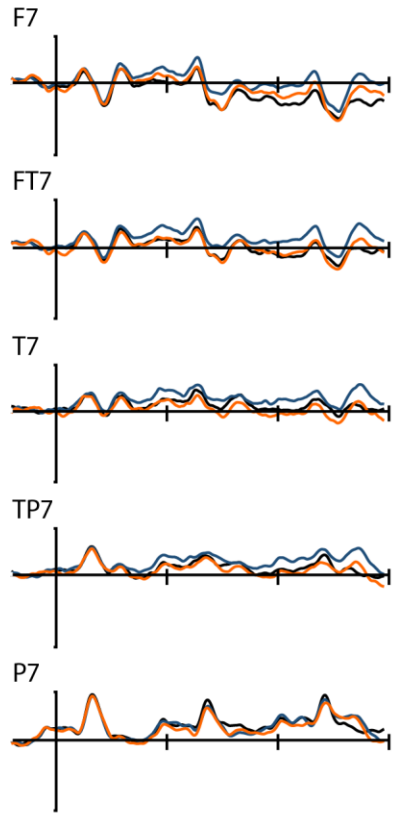
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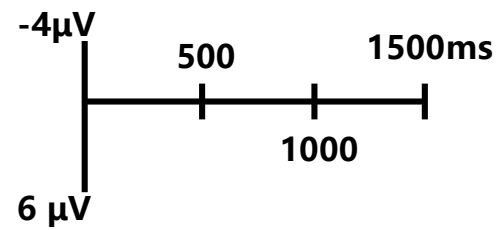
$\frac{1}{4}$ → (O) Robert / (X) Teddy thinks that his roommates will be very upset if the rain continues tomorrow.

Behavioral results

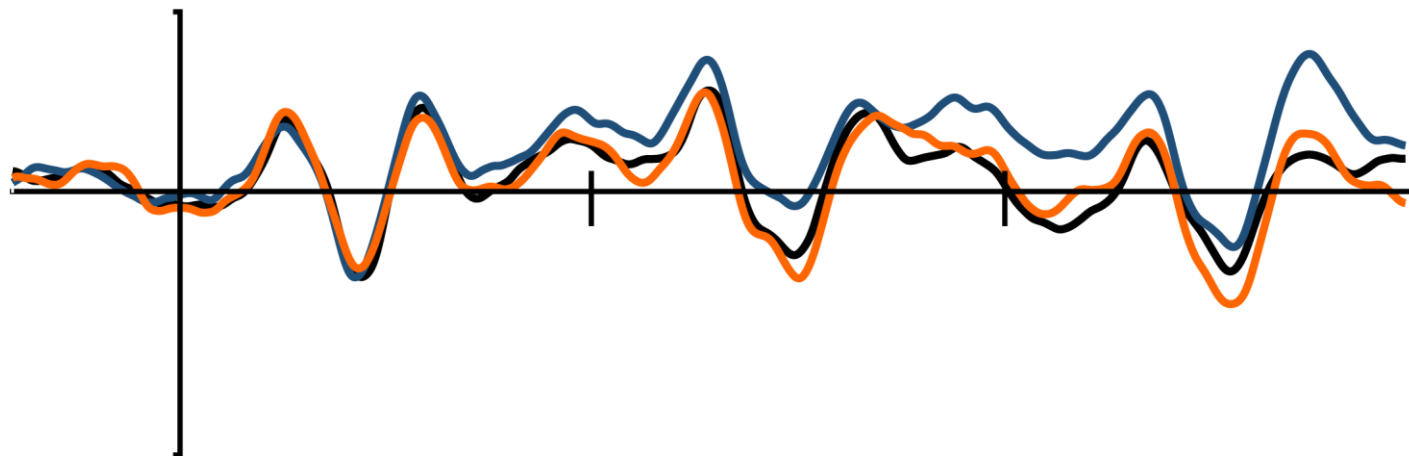
- **K estimate:**
 - **K4 score:** 2.77 (0.81)
 - **K8 score:** 2.41 (1.59)
 - **K score:** 2.59 (1.13)
- **Accuracy:** 0.88 (0.07)



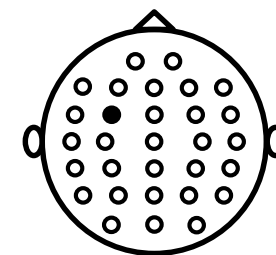
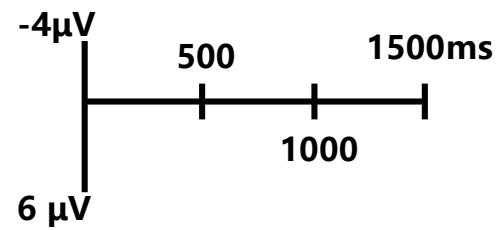
— Unamb
 — 2ref
 — 3ref



FC3



— Unamb
— 2ref
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3-ref (English Ver.)

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Critical sentence

If it continues to rain, he thinks that Teddy and Jack will feel very upset at work tomorrow.

↑ disambiguation

Comprehension question

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Critical sentence

↓ There are still two possible referents for the pronoun

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Critical sentence

↓ Fully disambiguated

If it continues to rain, he thinks that Teddy and Jack will feel very upset at work tomorrow.

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2-ref (English Ver.)

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Critical sentence

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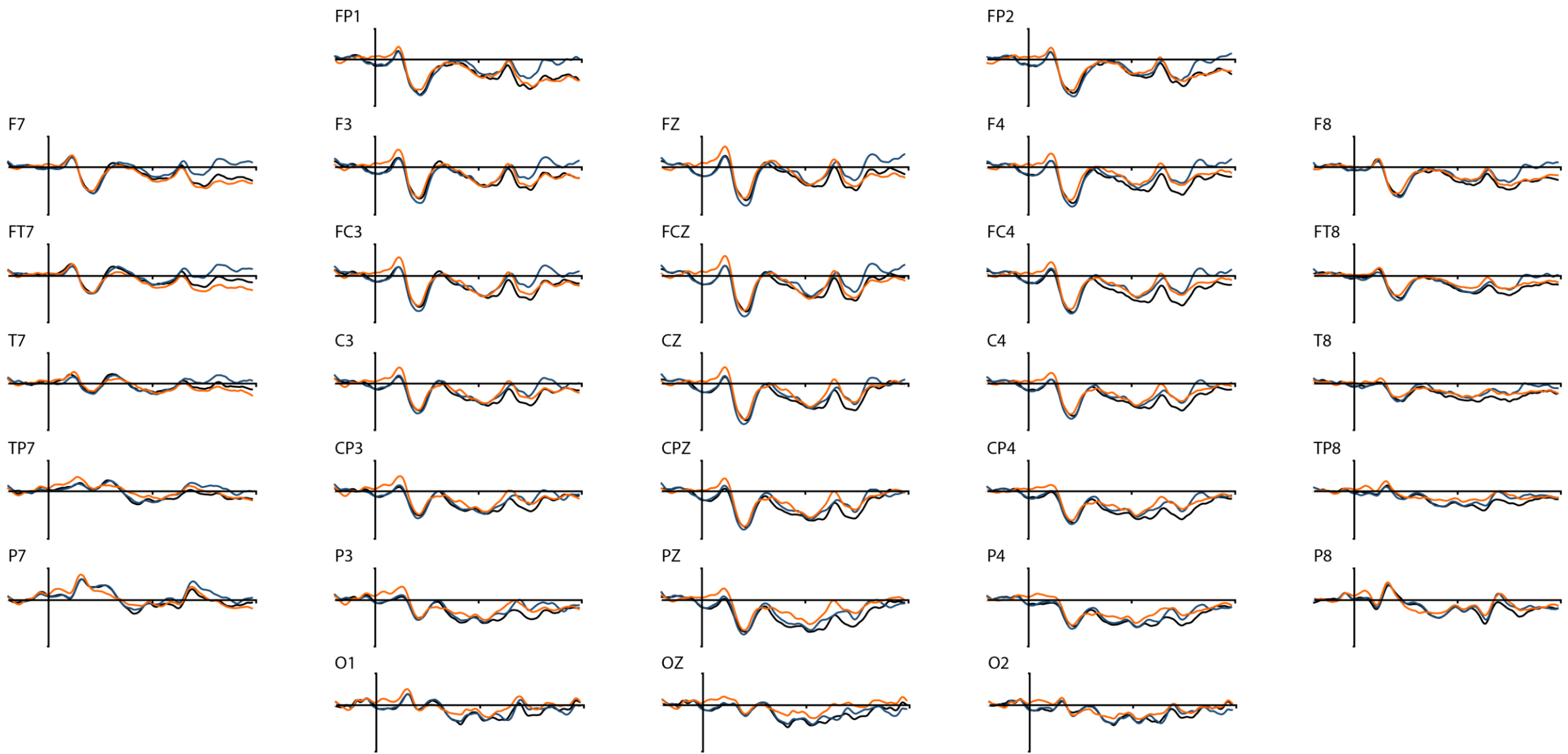
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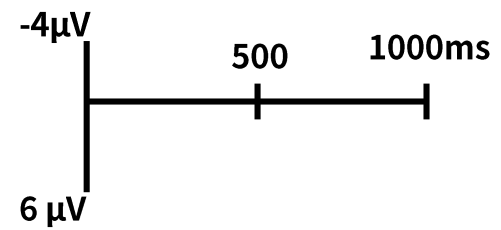
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— 2ref_disamb1
 — 3ref_disamb1
 — 3ref_disamb2



Correlations

VWM capacity was correlated with mean amplitude differences between:

- 2-ref & Unamb
- 3-ref & Unamb

in time windows of 300-600/600-1000/1000-1500ms

→ No correlations between any mean amplitude differences

Summary

- No graded Nref effect in target word
- An Nref effect in disambiguation word

- Our results demonstrated that the Nref effect is elicited even when the word is not an ambiguous referential expression, and thus disfavoring the **detection** hypothesis.
- Although there is no Nref effect for the 3-ref condition, our results showed that the Nref effect is elicited when two possible referents are available, which is more consistent with the **maintenance** hypothesis.