Introduction to ERP & Referential ambiguity project

語言所碩二　柯逸均

Overview

- What is EEG & ERP?
- ERP component: **Nref**
- Referential ambiguity project

What is EEG & ERP?

What is EEG?

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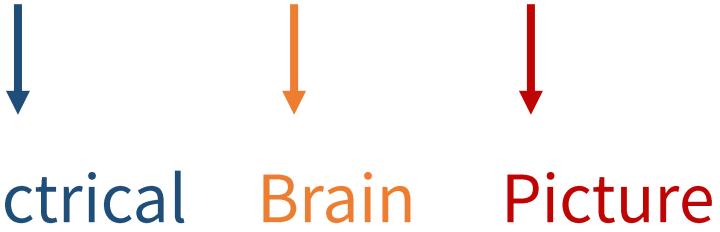

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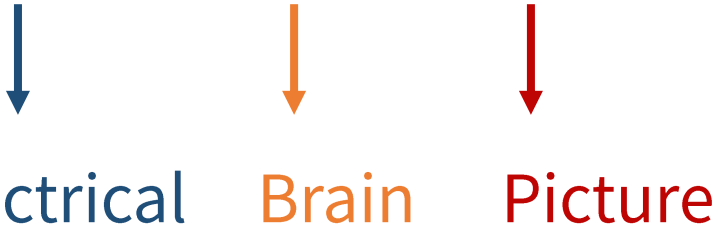
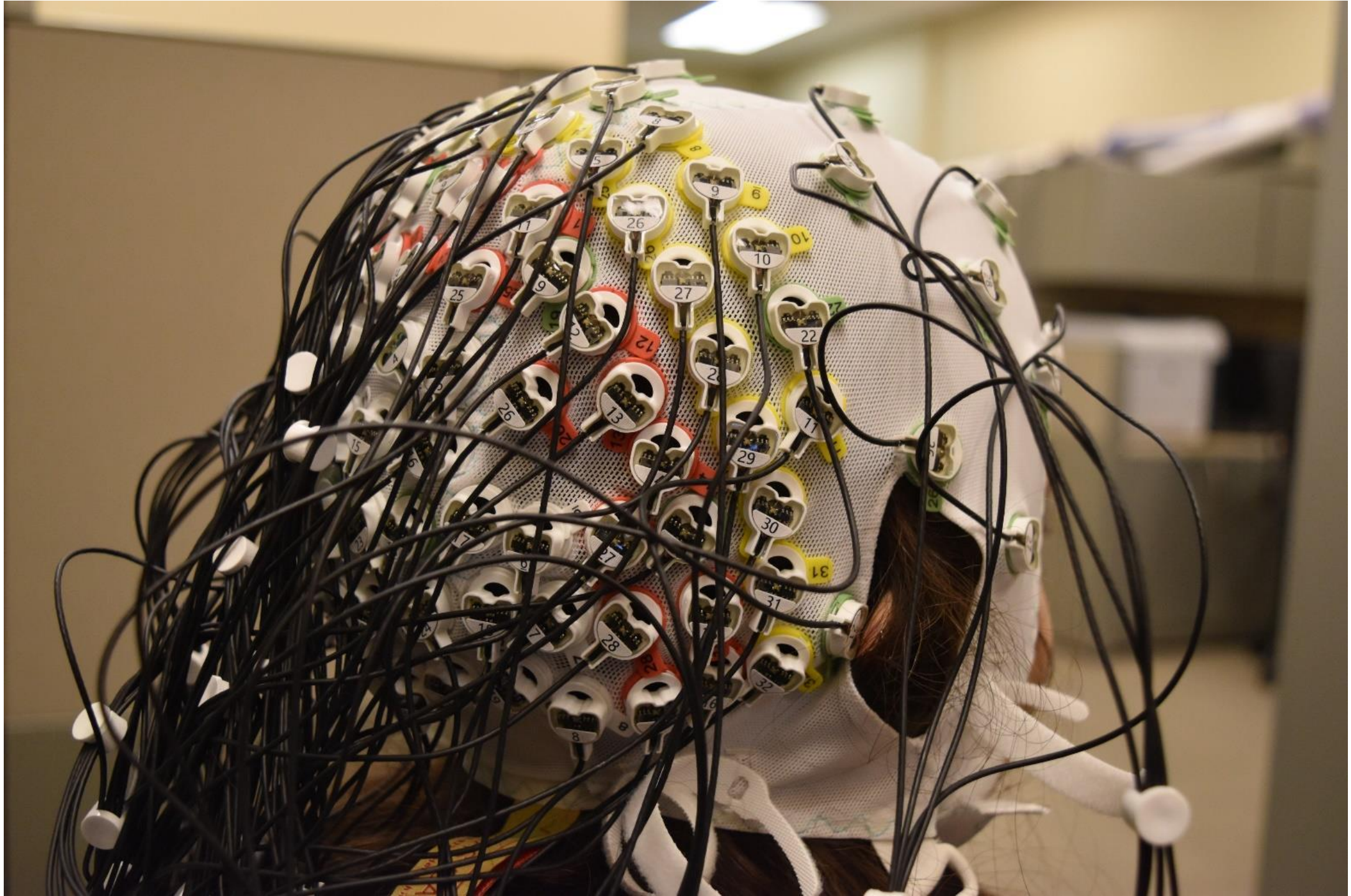


- A method to record electrical activity in the brain
- EEG signal is recorded by placing electrodes on the scalp
- Non-invasive



What is EEG?

- Raw EEG signals are very complicated
- It's the sum of everything our brain doing!
- ... and with some noise!

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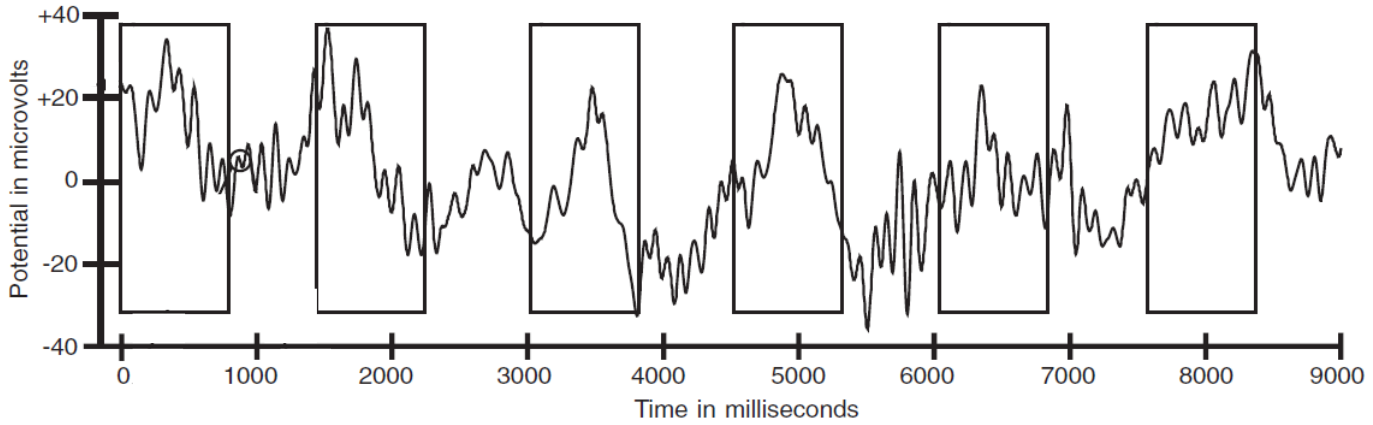

Adapted from Luck (2014)

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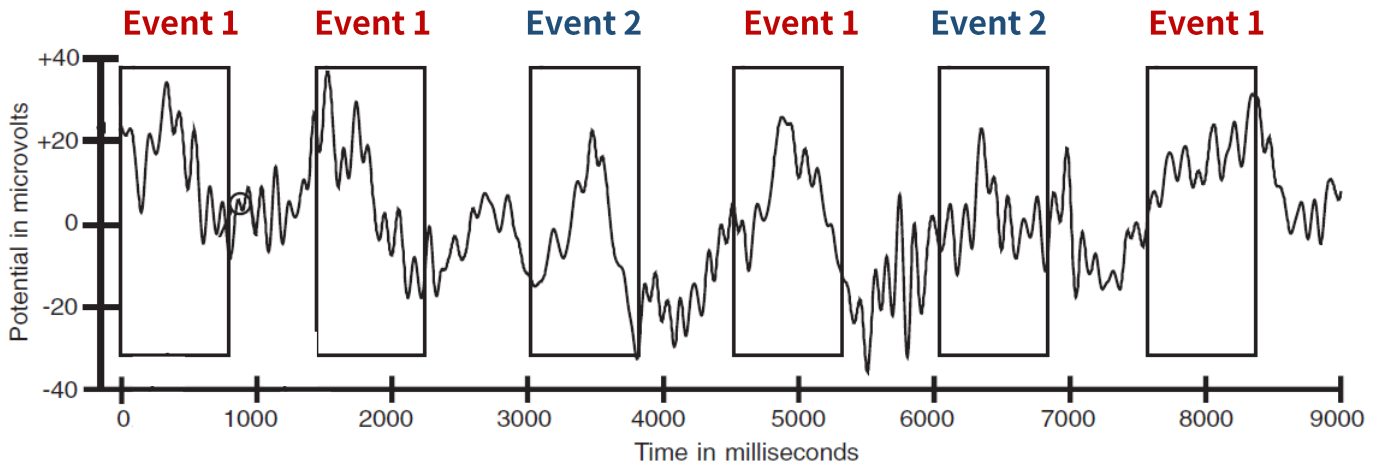

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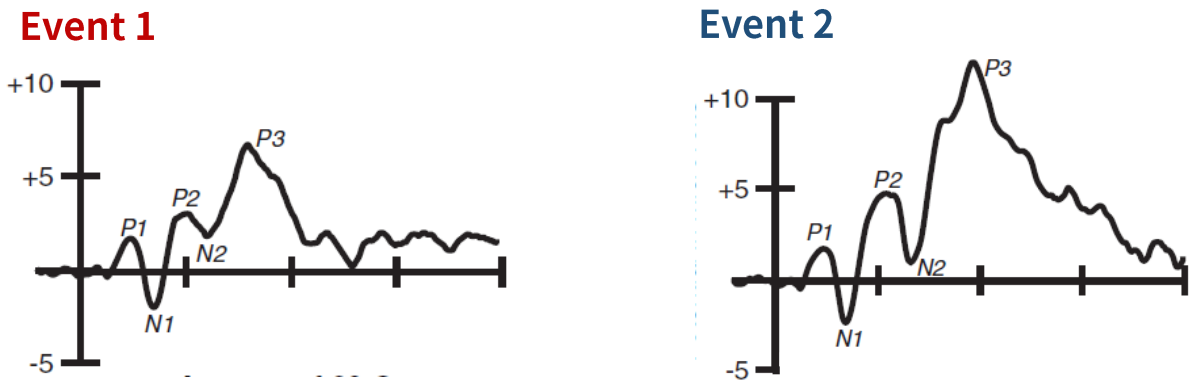

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- **But why?**
  - Noise is random, so it will **cancel out each other** after averaging
  - Signals that are elicited by that event will **remain** even after averaging

Example

- In one experiments, subjects read 200 sentences

- 100 sentences are ended with a grammatical word

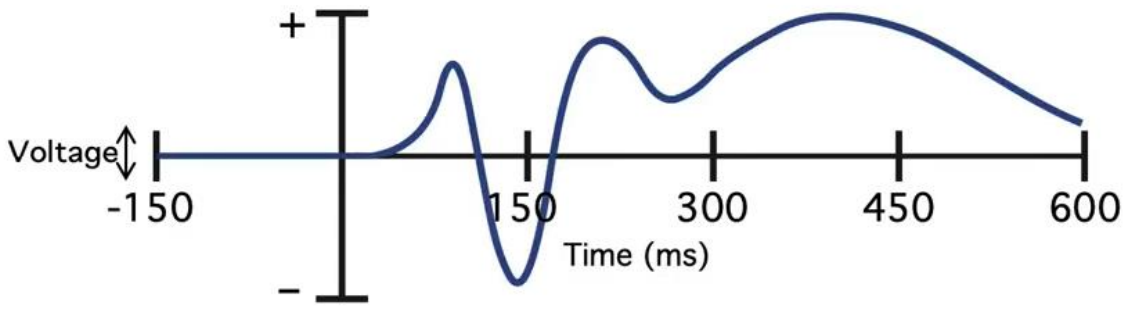
  “I take my coffee with cream and **sugar**”

- 100 sentences are ended with an ungrammatical word

  “I take my coffee with cream and **dog**”

Example

- If we cut the EEG signals of those **grammatical** words and then average these segments together, we will get an event-related potential like this:



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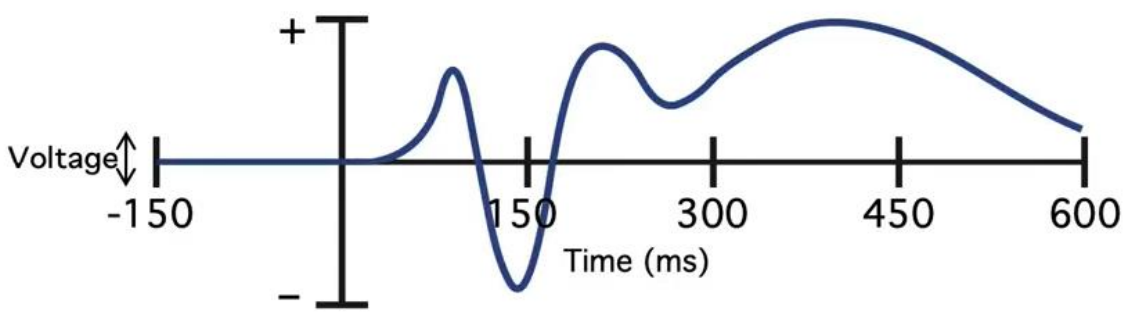

← signals that are related to the grammatical words

(the brain activity that our subjects elicit when they are processing the grammatical words)

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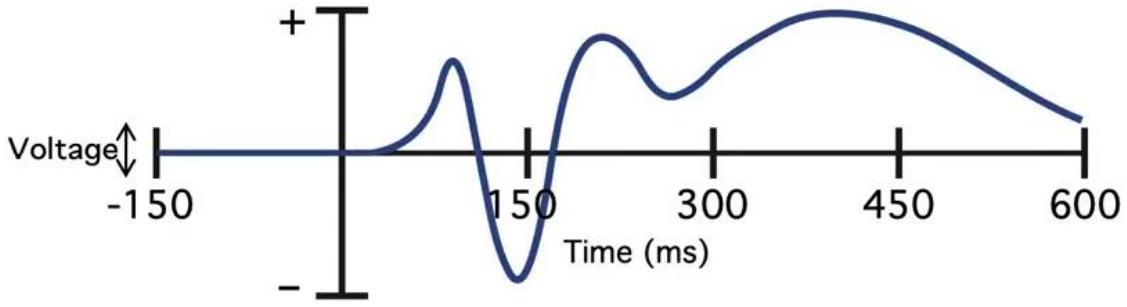
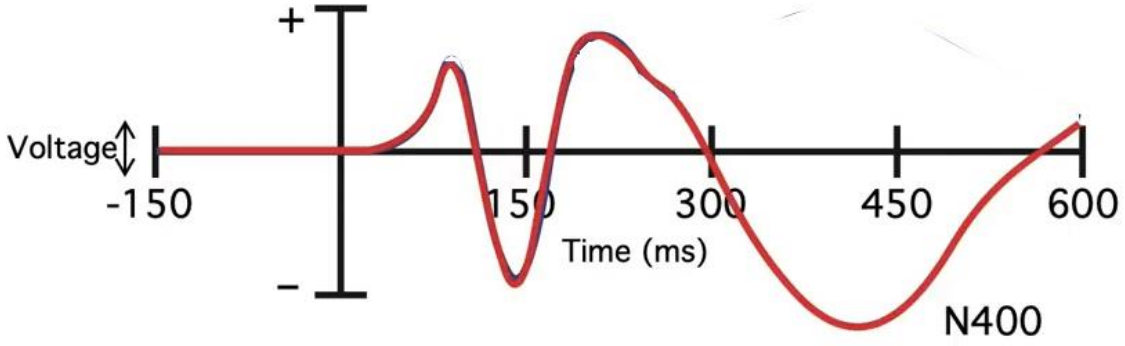
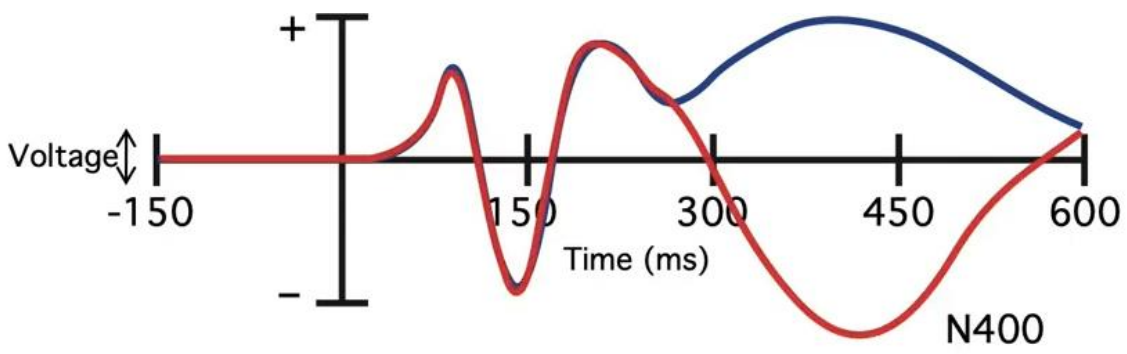




Example

- If we cut the EEG signals of those **grammatical** words and then average these segments together, we will get an event-related potential like this:
- Similarly, we can do the same thing to the **ungrammatical** words:
- If we overlap these two lines:



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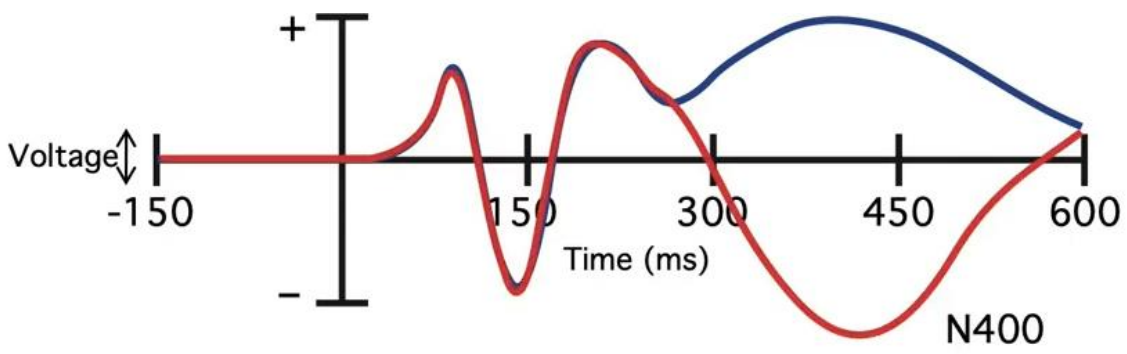
- The ERP waveform of **ungrammatical** words is more **negative** than that of **grammatical** words between 300ms and 600ms



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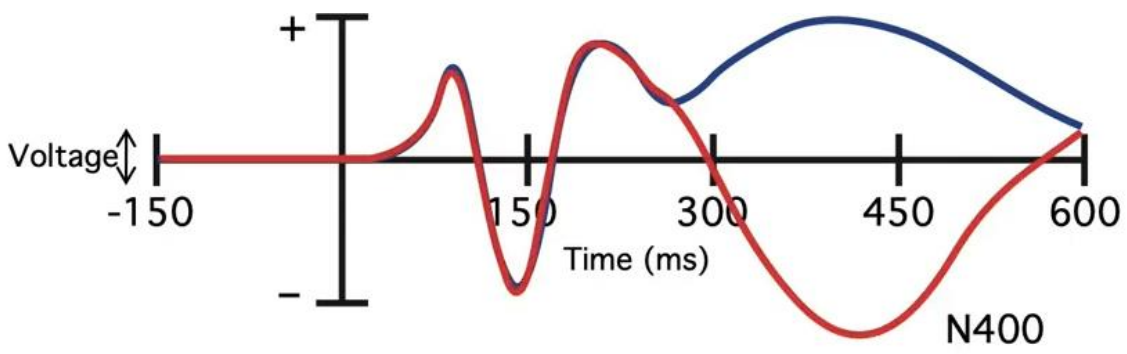

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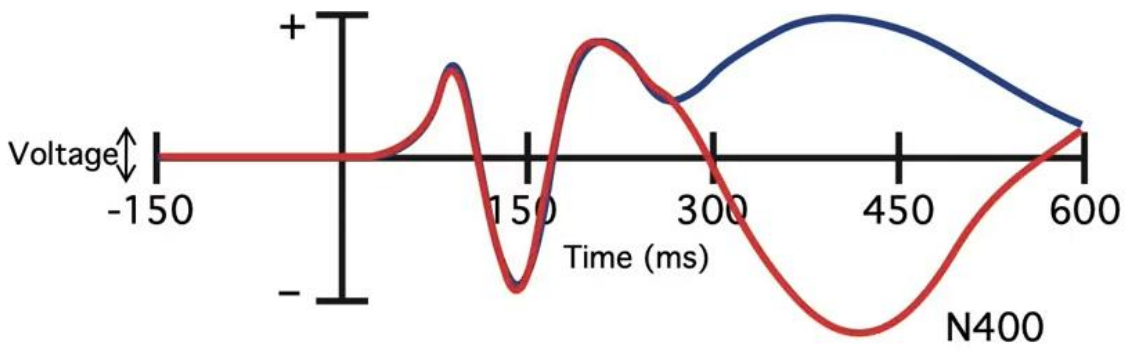
- This difference between waveforms suggests that our brain processes **grammatical** and **ungrammatical** words in a different way
- Our brain can detect the **ungrammaticality** within 300ms

  → pretty amazing, right?



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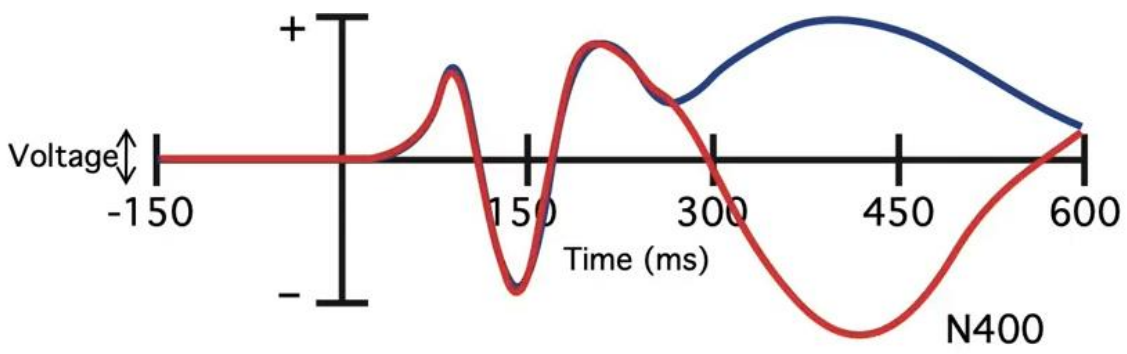
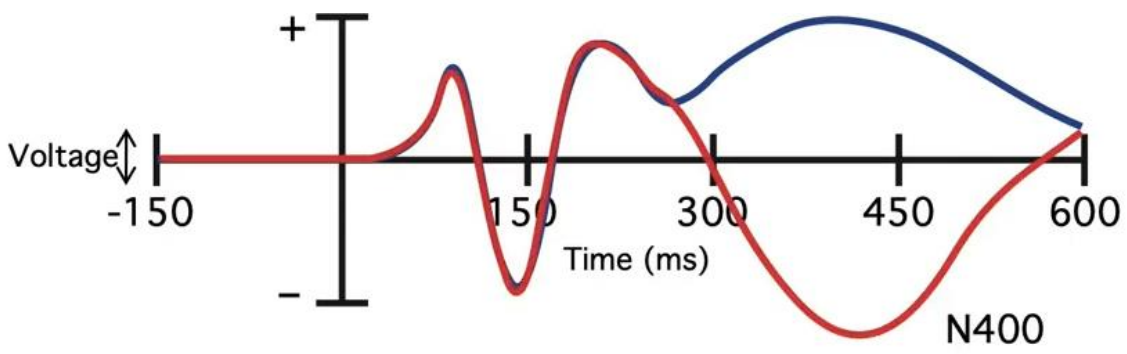


Example

- This difference is usually what we called an **ERP component**
- Note that it's just a simplified version

  → **Actually it's far more complicated than this**!



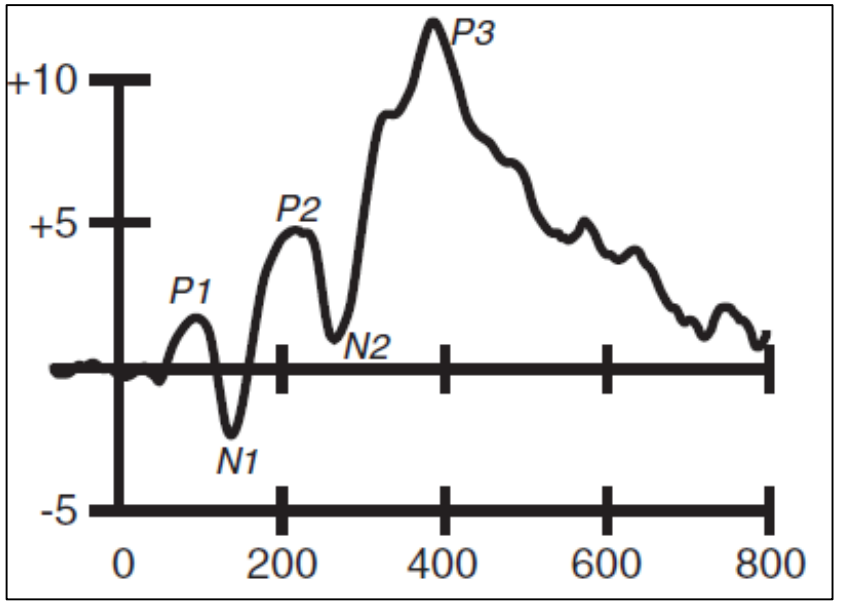
Tutorials

- Introduction to ERPs (by Steven Luck)
- ERP online courses (by Steven Luck)
- An introduction to the event-related potential technique (again, by Steven Luck)

ERP components

- There are numerous ERP components
  - Sensory
  - Working memory
  - Attention

- Naming convention
  - **P** = positive-going
  - **N** = negative-going
  - **Number** = ordinal number/latency of the peak



Adapted from Luck (2014)

Language-related ERP components

N400

- Kutas and Hillyard (1980)
- Typically seen in response to **semantic** violations

"He spread the warm bread with socks"

P600

- Hagoort, Brown, and Groothusen (1993)
- Typically seen in response to **syntactic** violations

"The spoiled child throw the toys on the floor"

Nref effect &
Referential ambiguity Project

Nref effect

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One-referents	Two-referents
David had told **the boy and the girl** to clean up their room before lunch time. But **the boy** had stayed in bed all morning, and **the girl** had been on the phone all the time David told the **girl** that had been phoning to hang up.	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 phoning to hang up.

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- The word "girl" in the two-referents condition is **temporally ambiguous**

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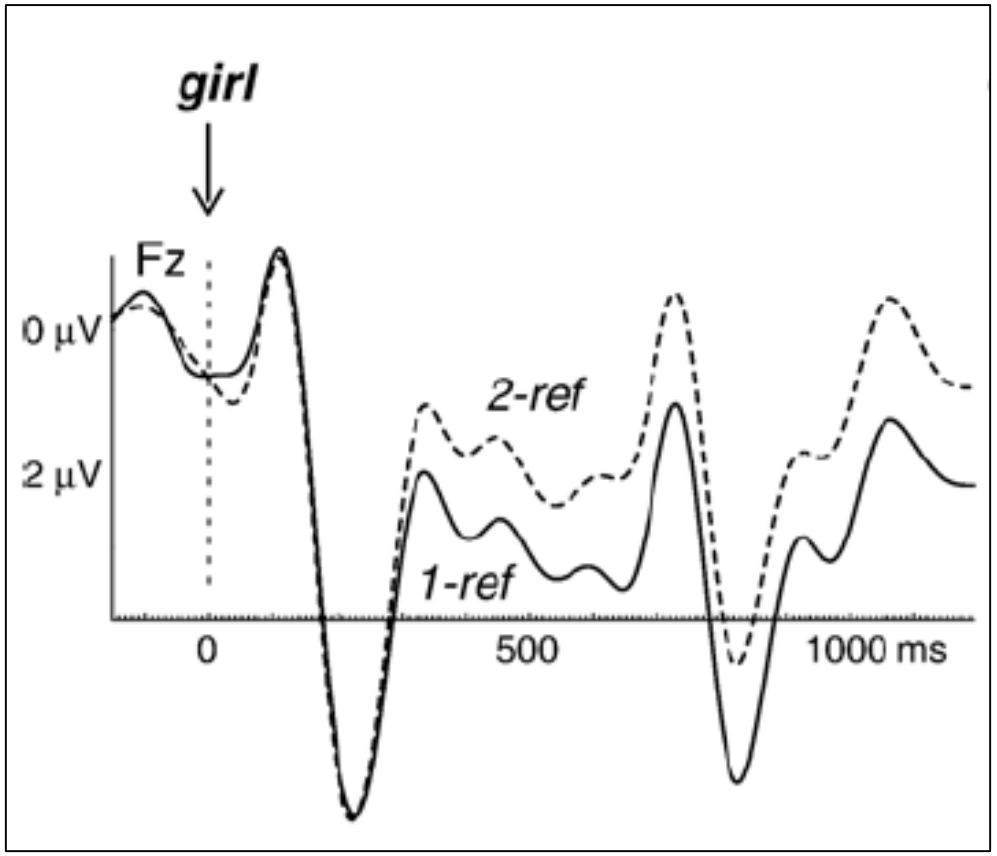

Nref effect

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So what?

What is the significance of Nref effect?

Why is it important?

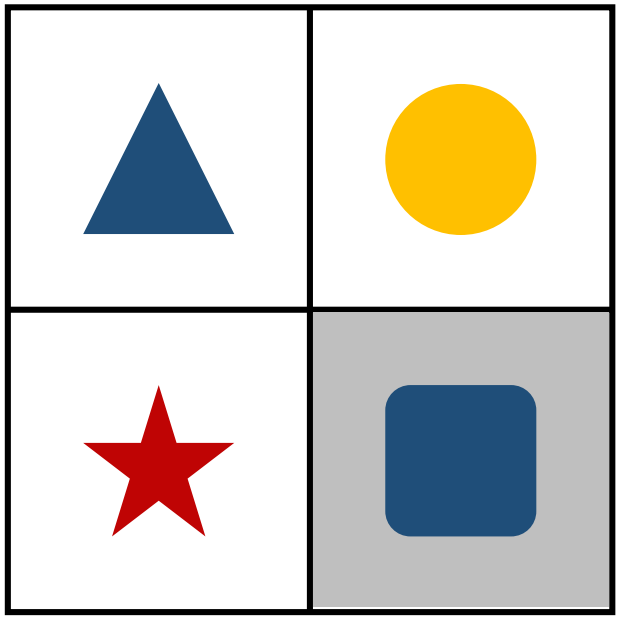
Nref effect

- We can use the Nref effect to investigate **perspective taking**

→ During a conversation, do we consider what others know from their perspective?

Example

- Subjects were told that they were talking to another person
- In each trial, they saw four boxes, each containing one item
- **One of the random boxes was gray**
  - White box = common ground (both people see the same items)
  - Gray box = privileged ground (the other person sees a different item)



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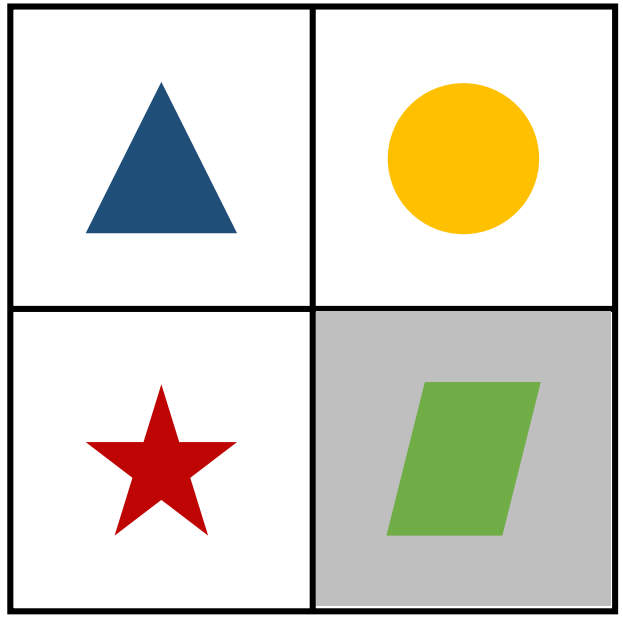

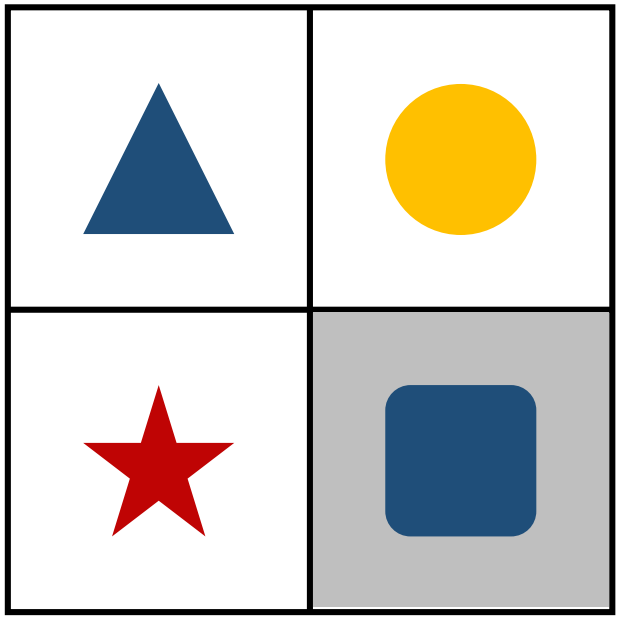

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Example

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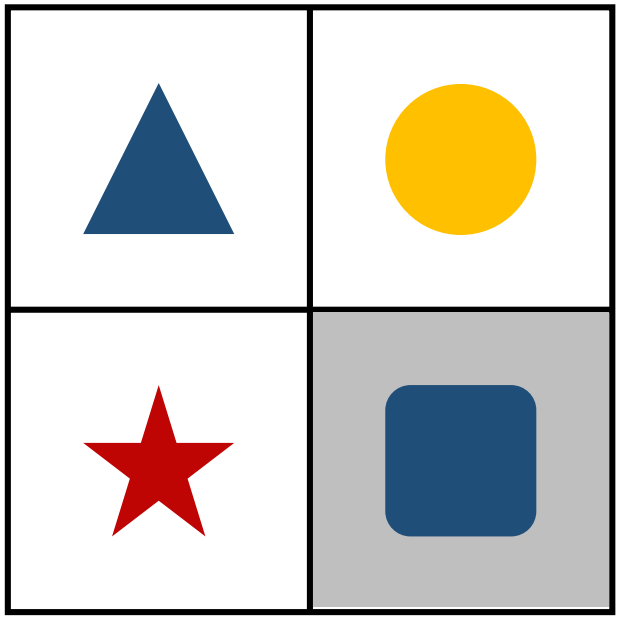

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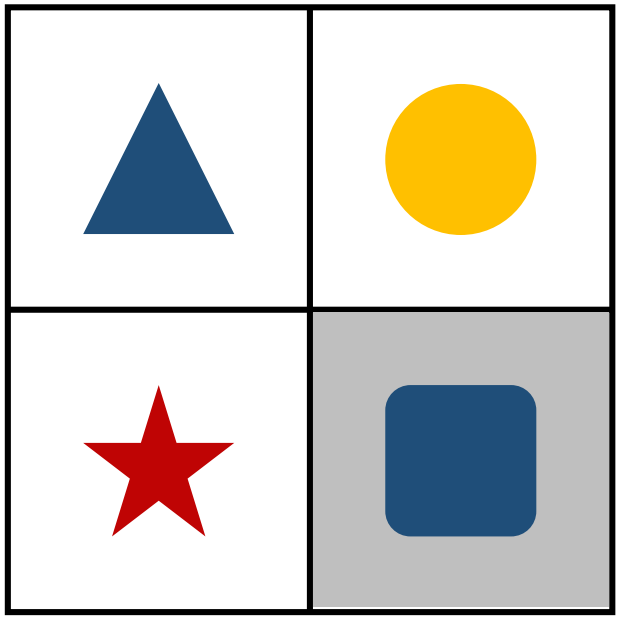

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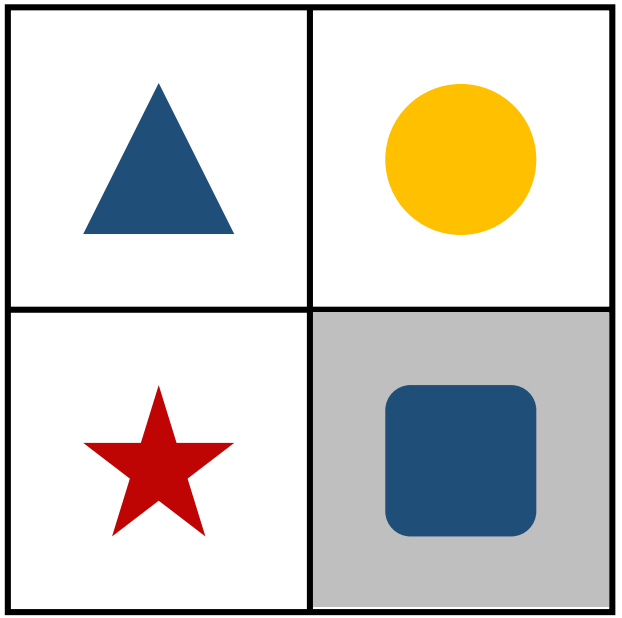

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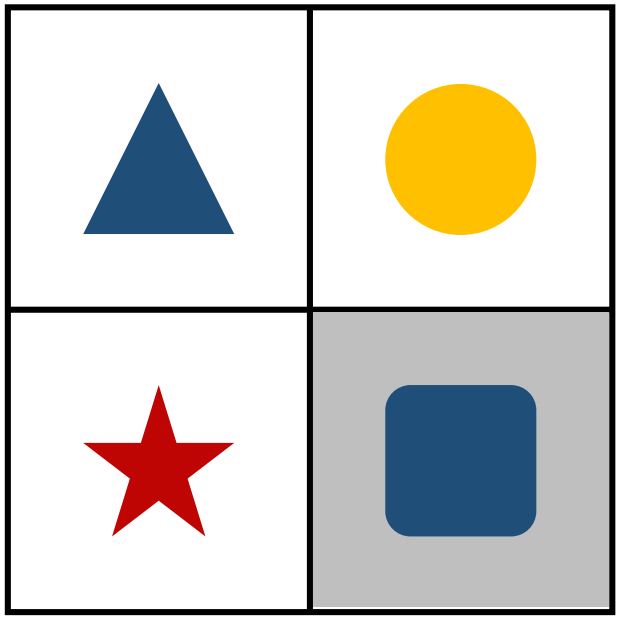
- If they don't, they will still consider the gray box

  → the word **blue** is ambiguous

  → and will thus elicit an Nref effect !



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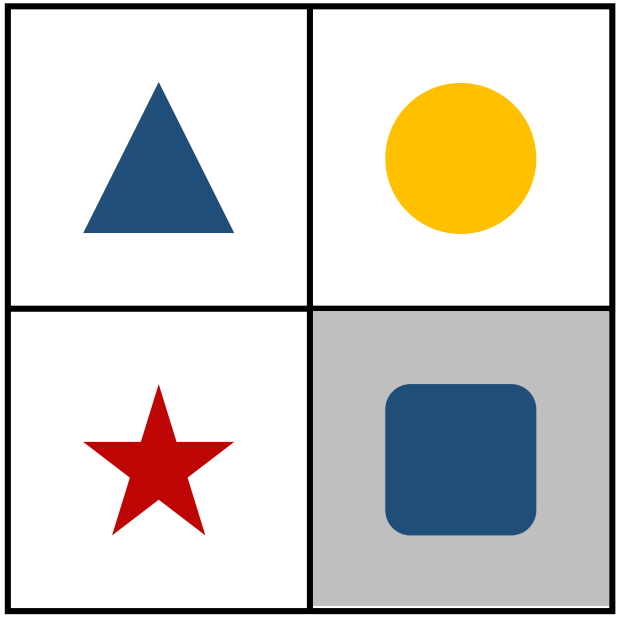

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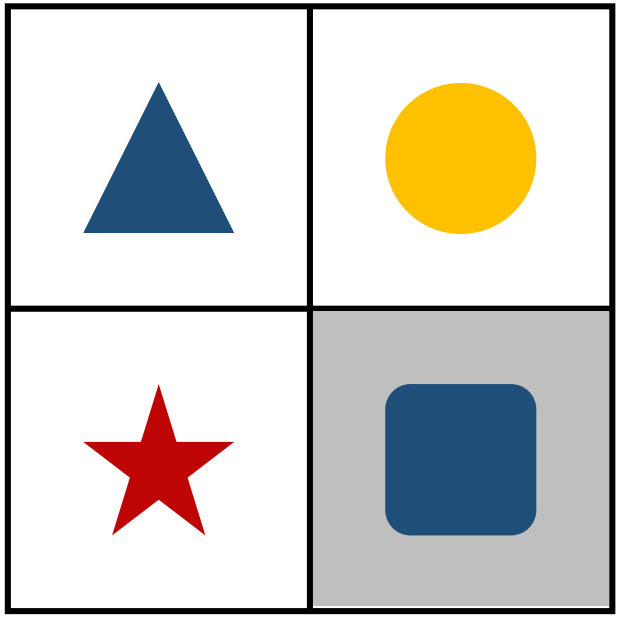

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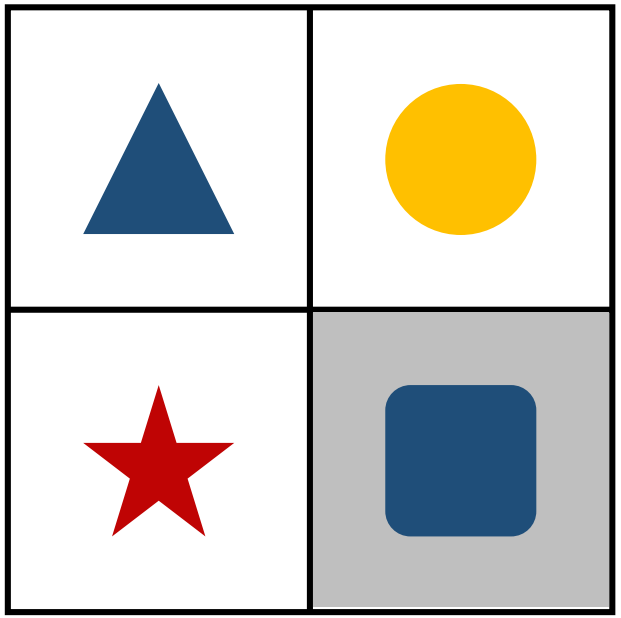

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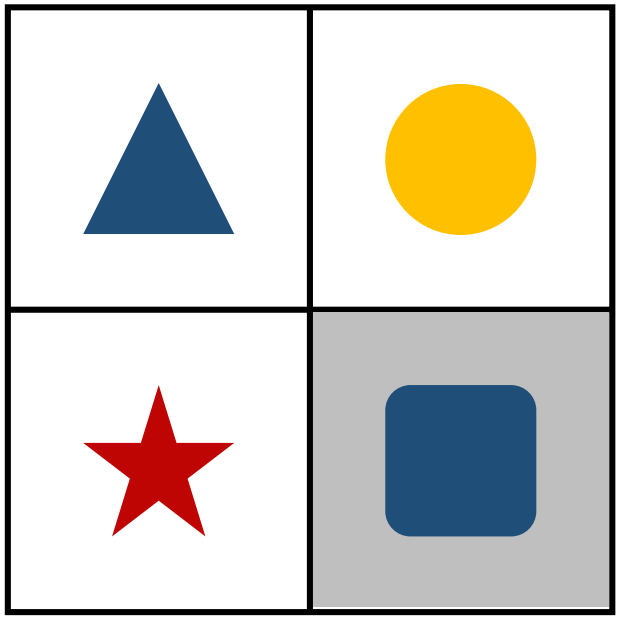

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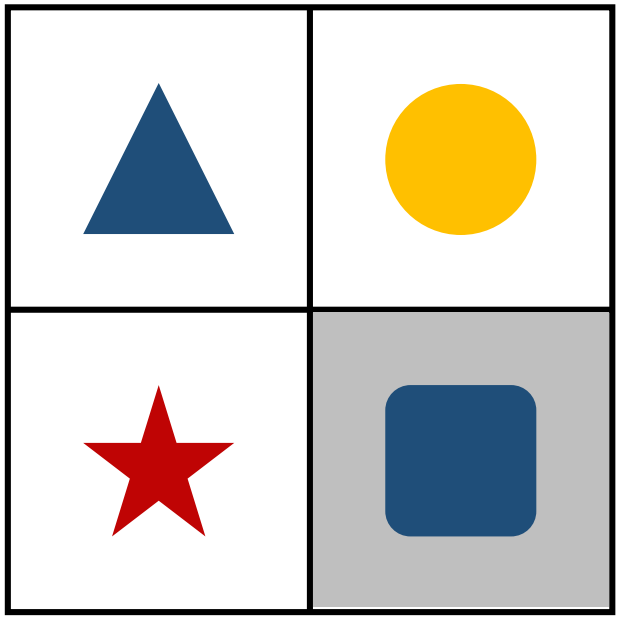

※The whole experiment is modified and simplified here

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Referential ambiguity project

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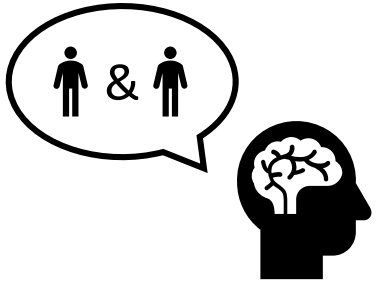

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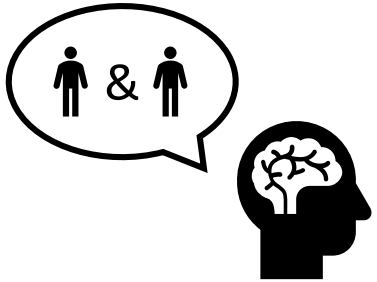
  → Why do we need to hold them in working memory?

  → We hold these items and wait for **disambiguating information**



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disambiguating information

Referential ambiguity project

- We only know that the Nref effect is elicited by **referential ambiguity**

→ But what kinds of processing does the Nref effect reflect?

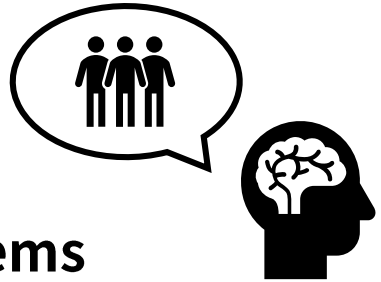
- One hypothesis is that the Nref effect reflects **"maintenance of possible referents"**
  - When there is referential ambiguity, it means both items are suitable referent
  - Maybe the Nref effect reflects processing of **holding these two items in our working memory**

  → Why do we need to hold them in working memory?

    → we hold these items and wait for **disambiguating information**

- If this hypothesis is true,

    → there should be a larger Nref effect **when there are more than two items**



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Research questions:

Does Nref amplitude increases when more "candidates" are available?

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Participants read 22 stories for each of the three conditions:

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Prediction:

Nref amplitude: **3-referent > 2-referent**

BLP lab

- **Brain & Language Processing lab**

  → http://blplab.linguistics.ntu.edu.tw/

- **Cognitive-neural basis of language processing**
  - Hemispheric asymmetry
  - Language and aging
  - Language learning
  - Interface b/t the verbal & non-verbal systems