ERP introduction & Statistical Learning project

語言所碩一　柯逸均

ERP introduction

脳電波 (EEG)

- EEG = Electroencephalogram

腦電波 (EEG)

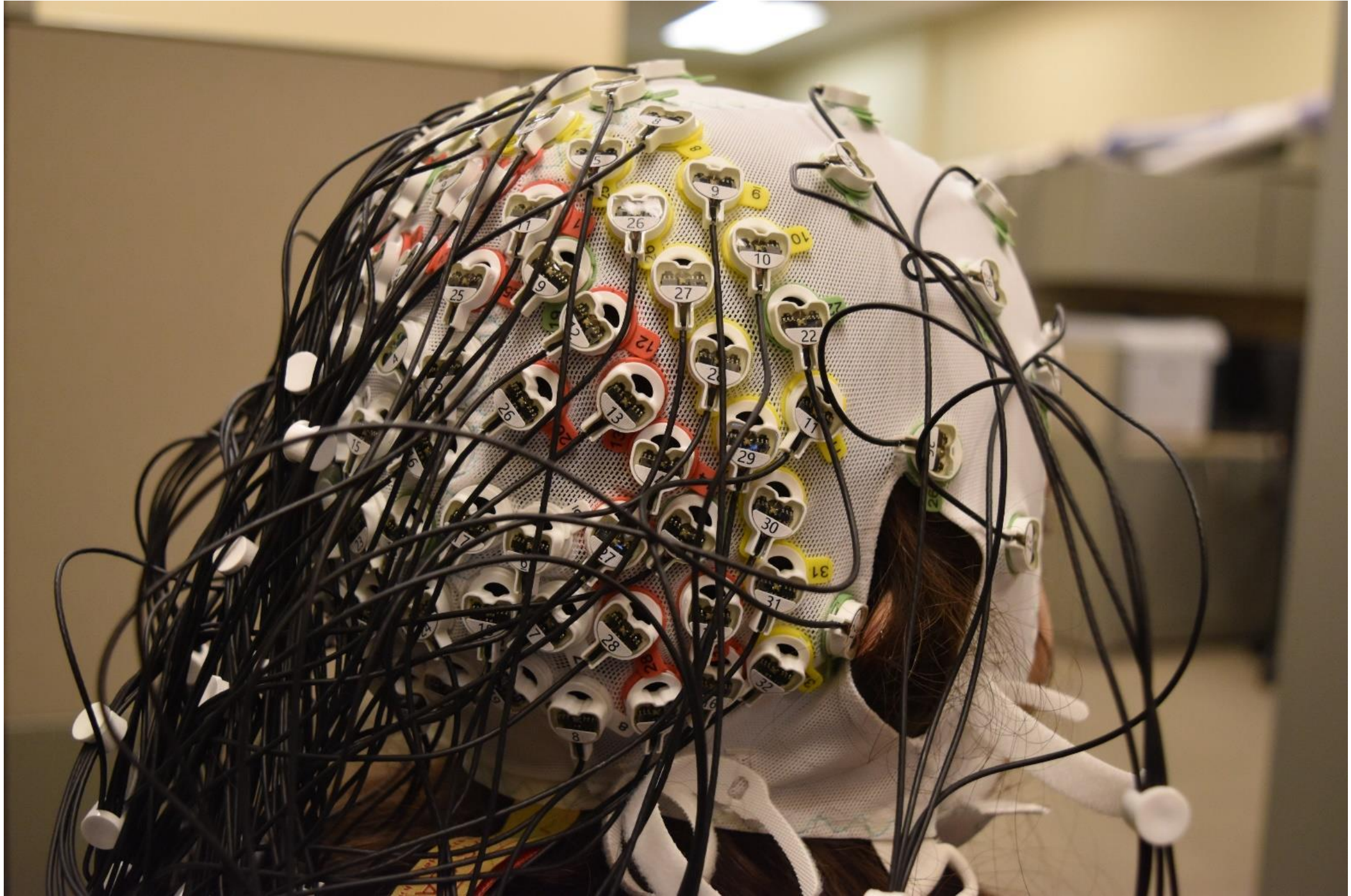
- EEG = Electroencephalogram

Electrical Brain Picture

腦電波 (EEG)

- EEG = Electroencephalogram

- Participants' electrical activity of brain are recorded using electrodes placed on the scalp



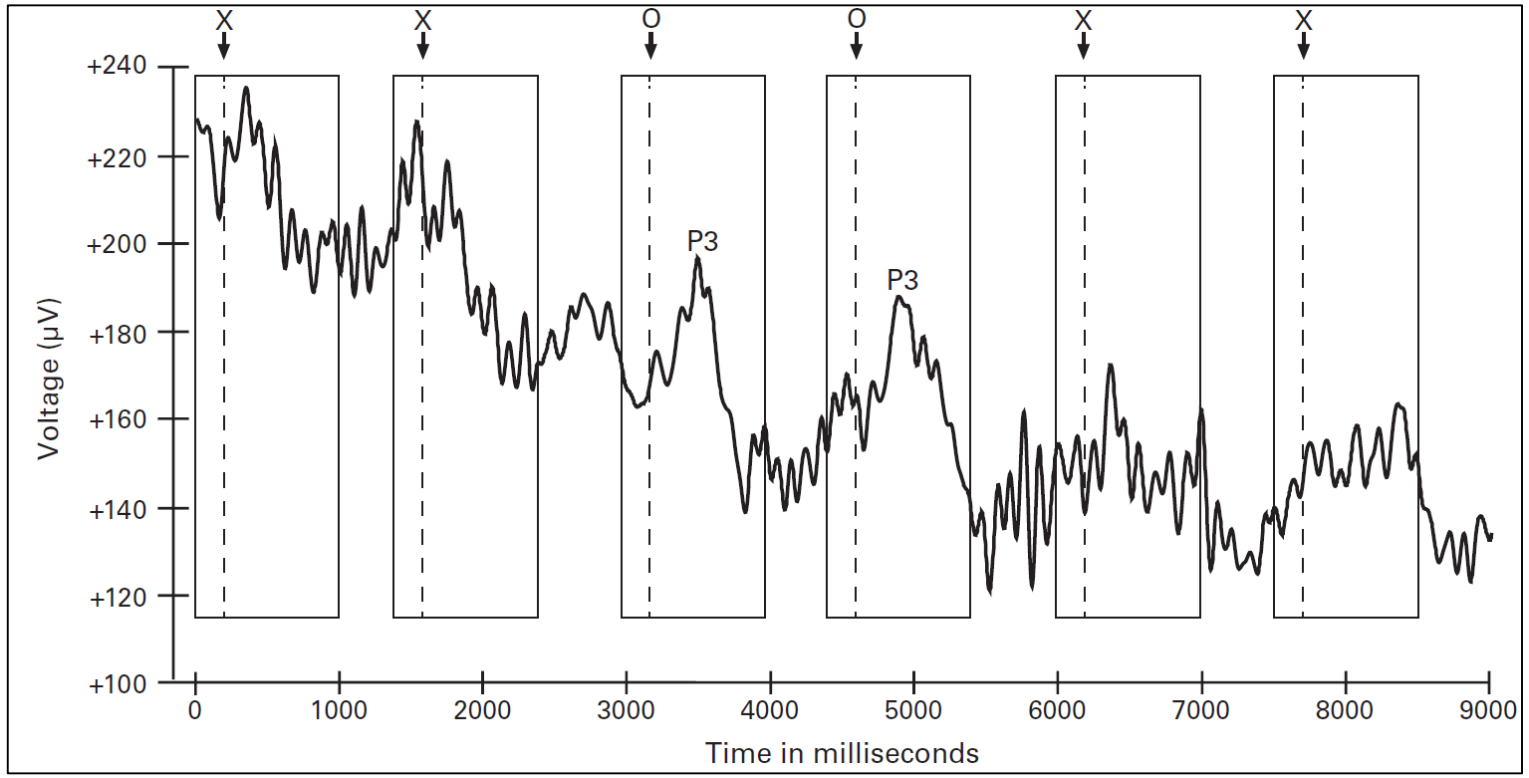
事件相關電位 (ERP)

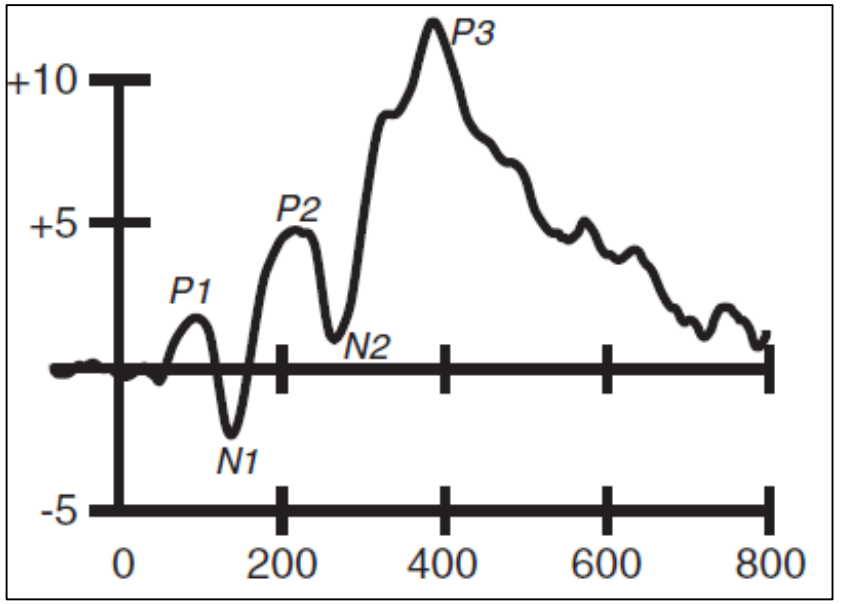
- ERP = event-related potentials
- Segments of EEG are averaged to create the “event-related potentials”

- Odd-ball experiment
  - X appears in 80% of trials
  - O appears in 20% of trials → “Odd-ball”

事件相關電位 (ERP)

Raw EEG data

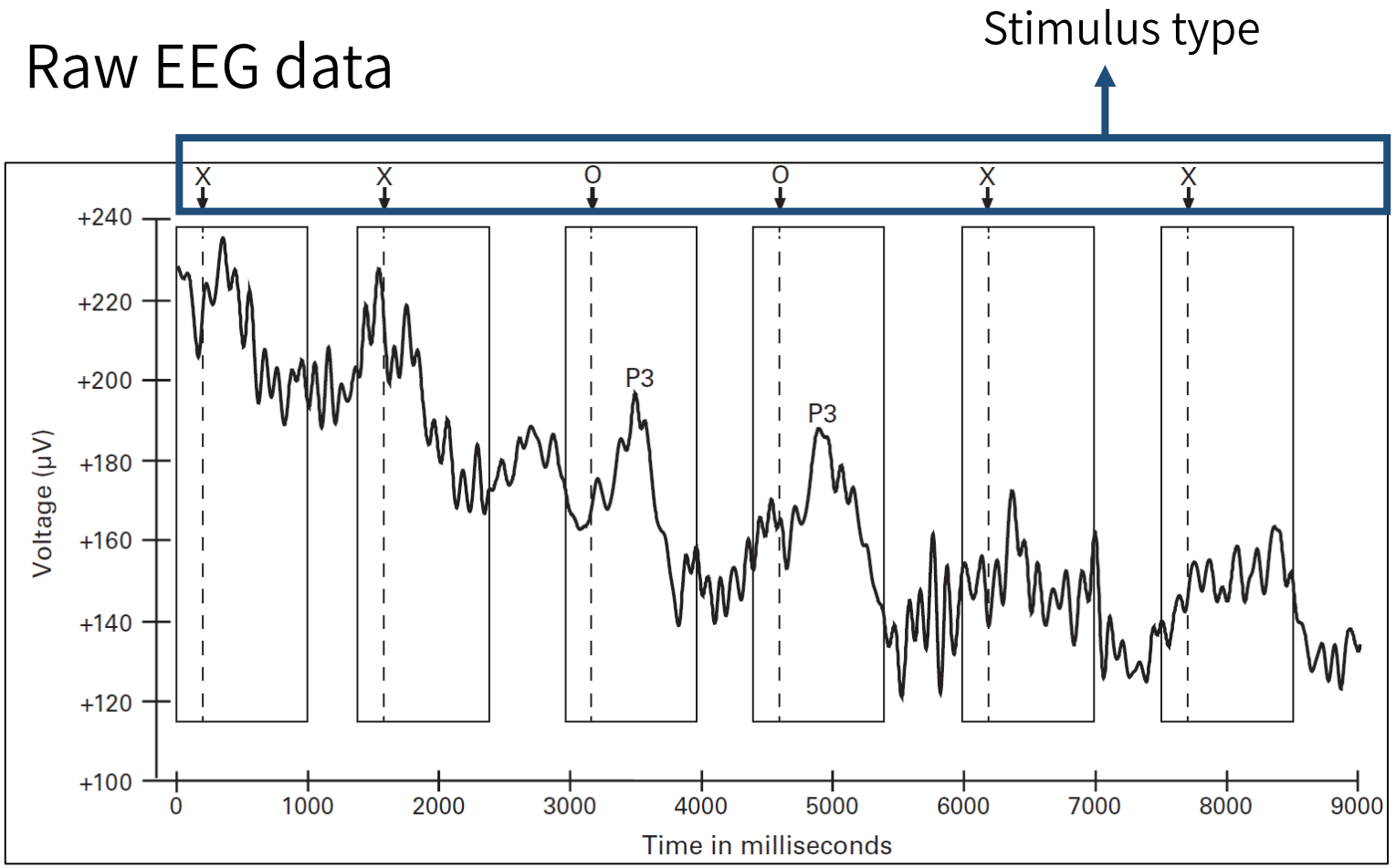


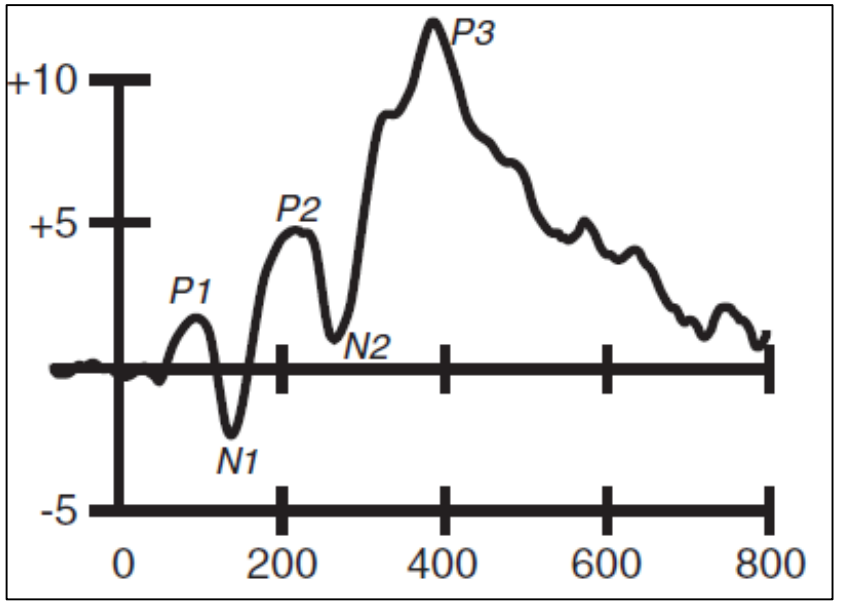


Adapted from Luck (2014)

事件相關電位 (ERP)

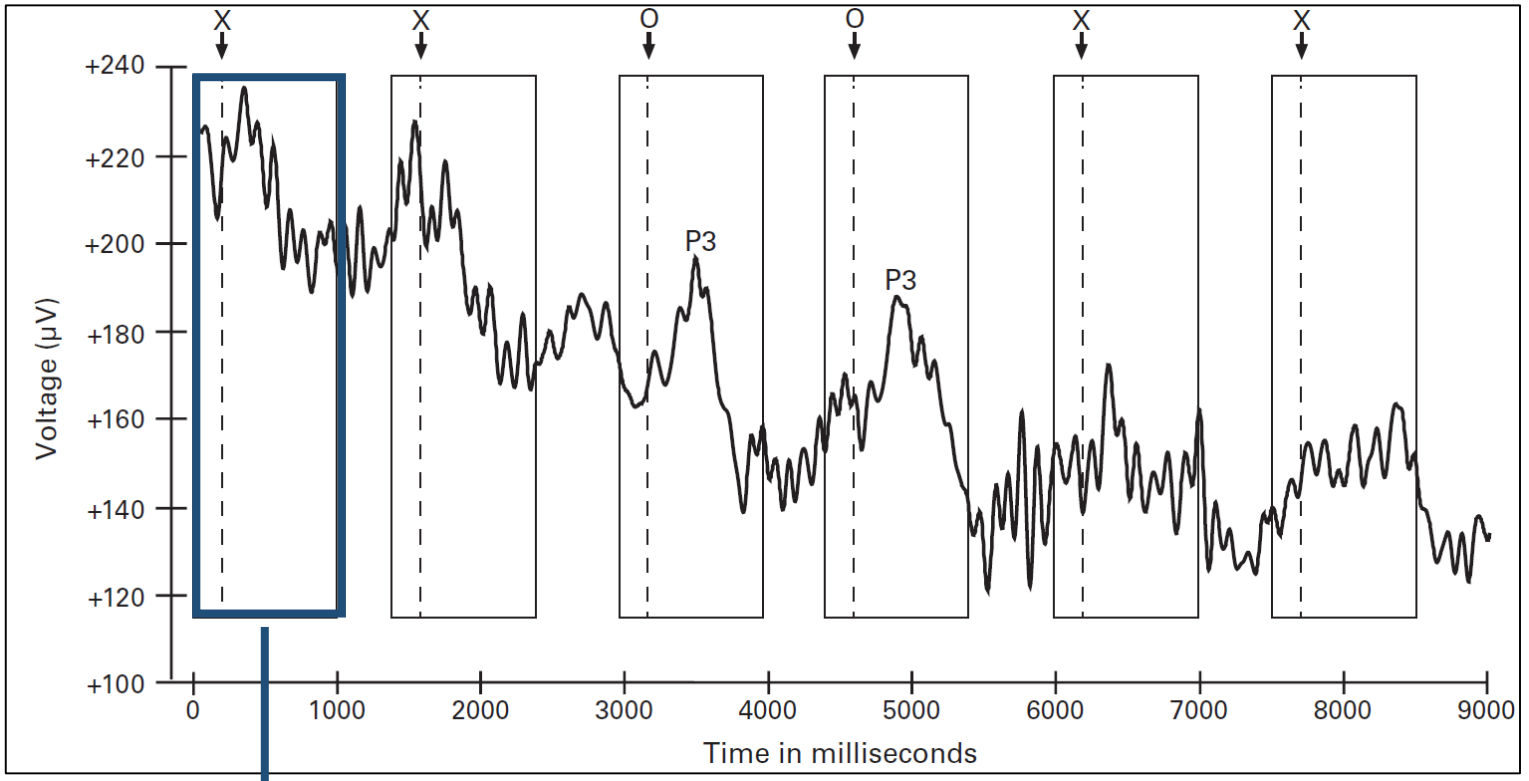
Raw EEG data



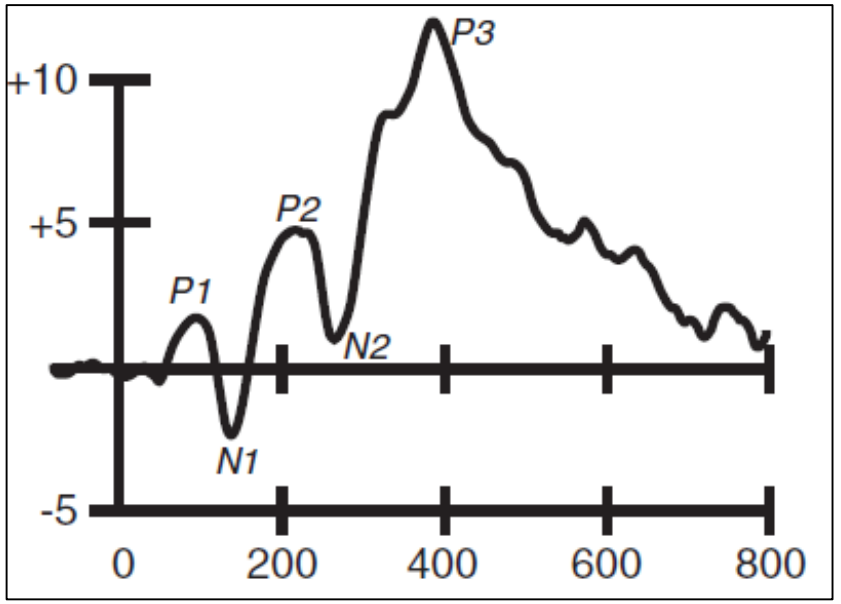


事件相關電位 (ERP)

Raw EEG data

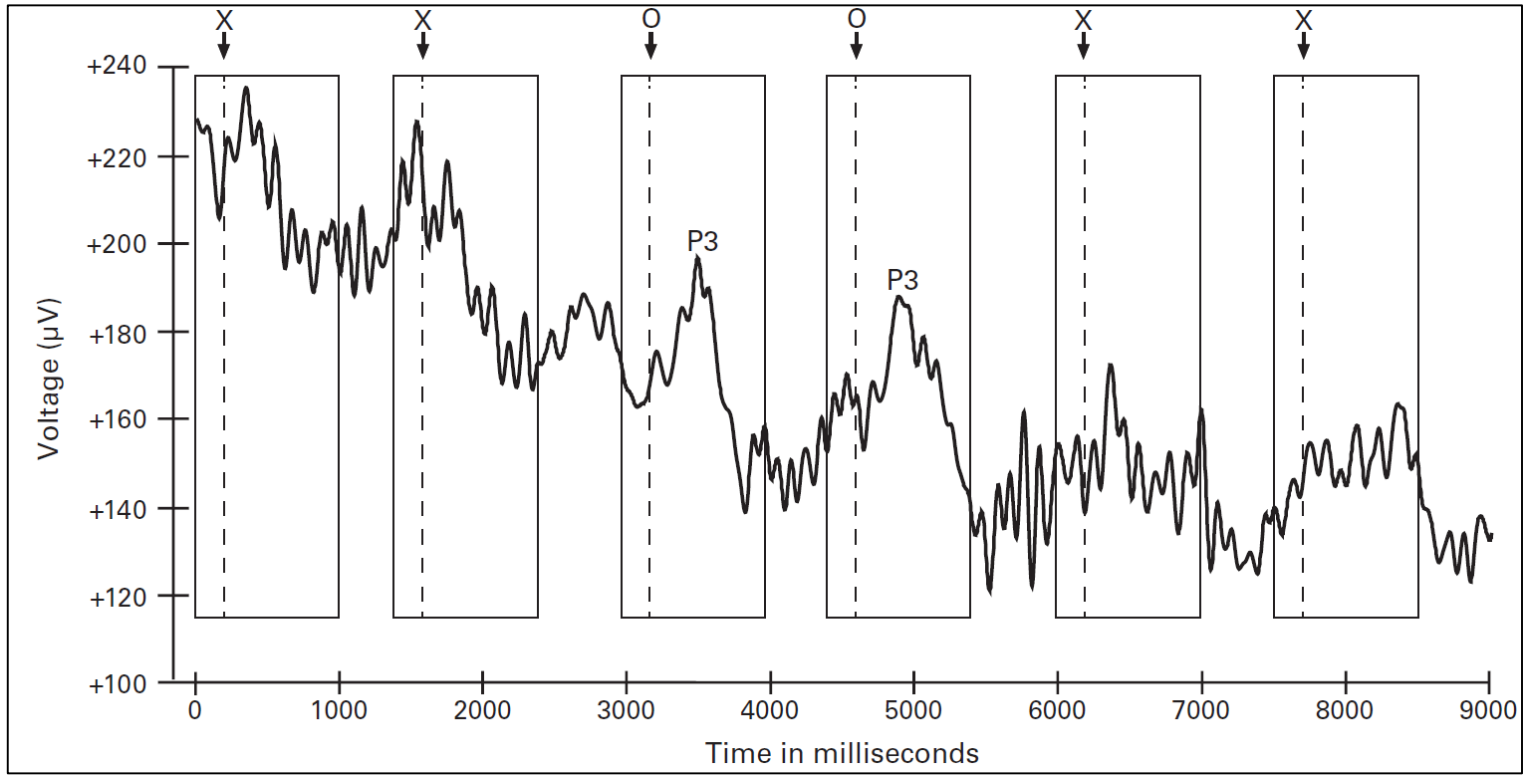


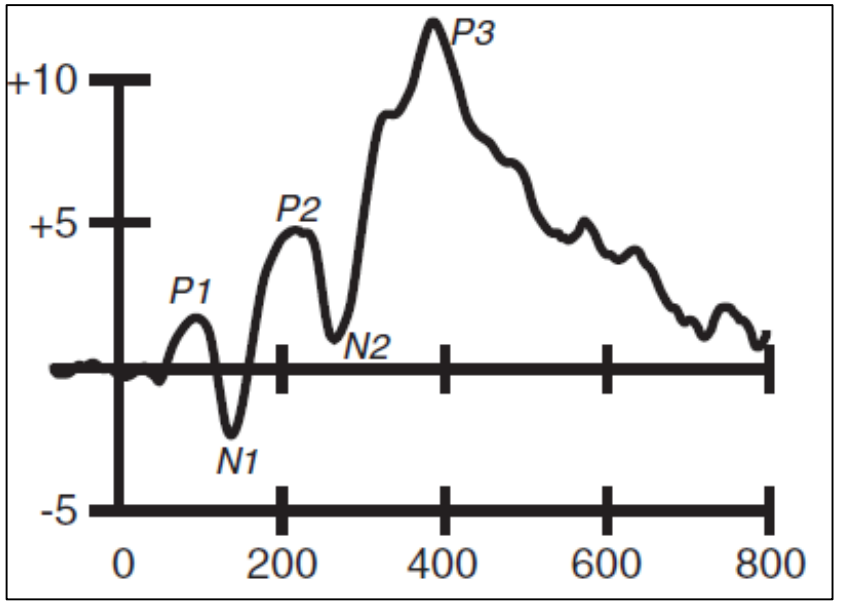
One trials



事件相關電位 (ERP)

Raw EEG data

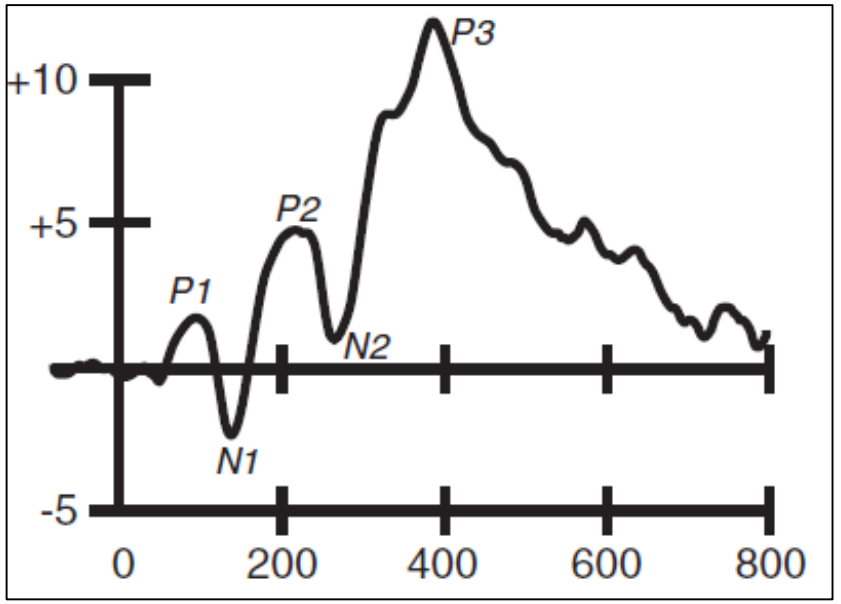




Noise is random, but signal is “event-related”

ERP components

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



Language-related ERP components

- N400
  - Kutas and Hillyard (1980)
  - Typically seen in response to semantics 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”

Event-related potentials (ERP)

Advantages

- Good temporal resolution
- Continuous measure of processing

  (not a “snapshot” like information)
- Do not require meta-linguistic task

Disadvantages

- Poor spatial resolution
- Expensive

  But much cheaper than MEG...
- Eye movements create artifacts
- Speech create artifacts
- Large number of trials

Statistical Learning Project

Hemispheric difference in syntactic processing

- Syntactic processing is strongly lateralized to the left hemisphere (LH). Especially for right-handers, syntactic anomalies were reliably observed when the errors were initially perceived by the LH. (Lee, & Federmeier, 2015; Gazzaniga & Hillyard, 1971; Humphries, Binder, Medler, & Liebenthal, 2006).

Hemispheric difference in syntactic processing

- Syntactic processing is strongly lateralized to the left hemisphere (LH). Especially for right-handers, syntactic anomalies were reliably observed when the errors were initially perceived by the LH. (Lee, & Federmeier, 2015; Gazzaniga & Hillyard, 1971; Humphries, Binder, Medler, & Liebenthal, 2006).

- Previous studies have suggested that the RH is able to process syntactic information :
  - Detecting word class errors in sentences (Arambel & Chiarello, 2006; Service et al., 2007; Weng, & Lee, 2020)
  - Processing grammatical number agreement (Kemmer, Coulson, & Kutas, 2014; Liu, Chiarello, & Quan, 1999; Zaidel, 1983)
  - Left-brain damaged patients sometimes might outperformed right-brain damaged patients when executing syntactic task. (De Vreese et al., 1996; Schneiderman & Saddy, 1988)

RH and poor performance

- In some cases, the RH response associates with poor language performance :
  - L2 learners (P.H. Chen et al.,2018)
  - Older adults (Leckey & Federmeier, 2017, Shafto & Tyler; 2014)

RH and poor performance

- In some cases, the RH response associates with poor language performance :
  - L2 learners (P.H. Chen et al.,2018)
  - Older adults (Leckey & Federmeier, 2017, Shafto & Tyler; 2014)

Assistance?

RH and poor performance

- In some cases, the RH response associates with poor language performance :
  - L2 learners (P.H. Chen et al.,2018)
  - Older adults (Leckey & Federmeier, 2017, Shafto & Tyler; 2014)

Assistance?

Interference?

Paradigm

Gómez (2002, 2005)

1) Statistical Learning
2) Artificial Language
3) Non-adjacent-dependency

Paradigm

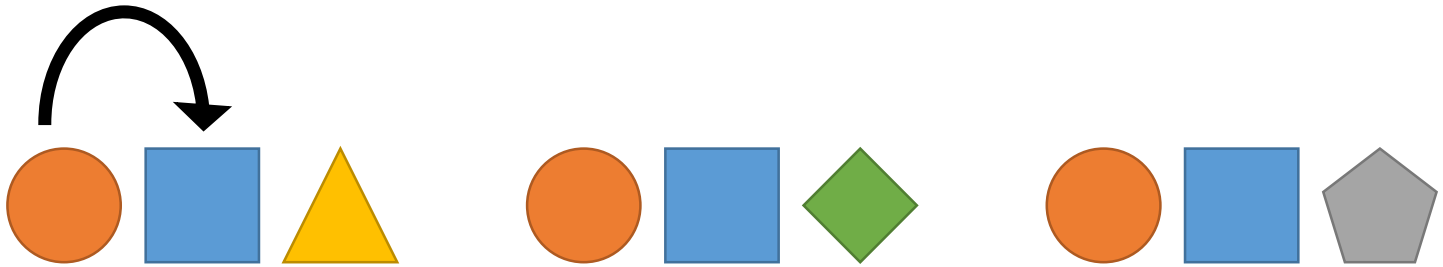
Gómez (2002, 2005)

1) Statistical Learning
2) Artificial Language
3) Non-adjacent-dependency

Paradigm

Gómez (2002, 2005)

1) Statistical Learning
2) Artificial Language
3) Non-adjacent-dependency



Adjacent dependency

Paradigm

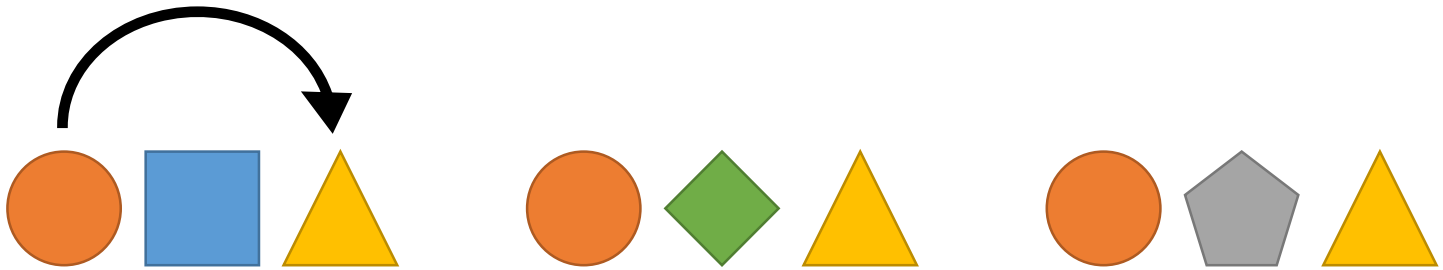
Gómez (2002, 2005)

1) Statistical Learning
2) Artificial Language
3) Non-adjacent-dependency

Paradigm

Gómez (2002, 2005)

1) Statistical Learning
2) Artificial Language
3) Non-adjacent-dependency

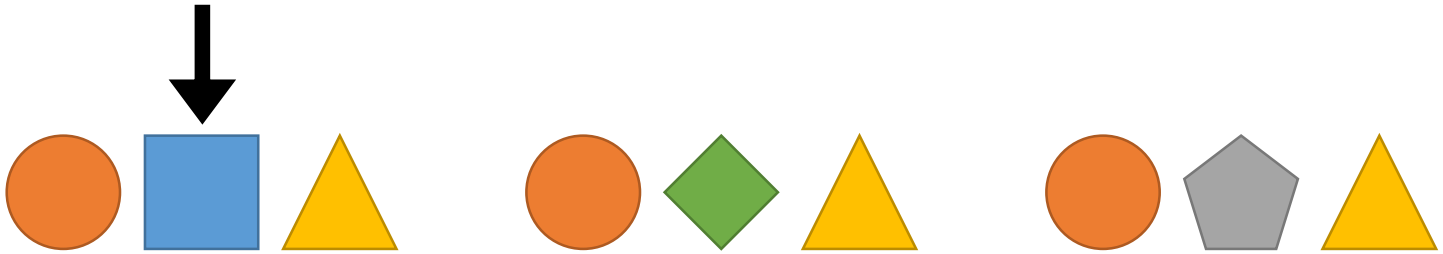


Non-adjacent dependency

Paradigm

Gómez (2002, 2005)

1) Statistical Learning
2) Artificial Language
3) Non-adjacent-dependency

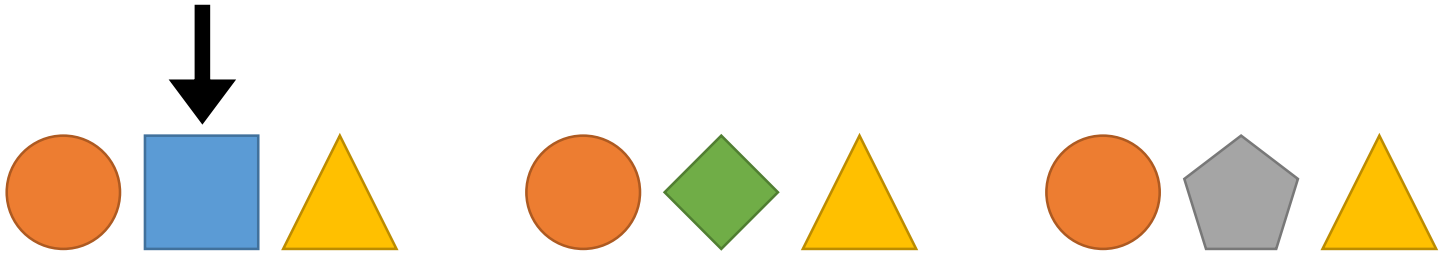


Set size : the number of items that occur in this place

Paradigm

Gómez (2002, 2005)

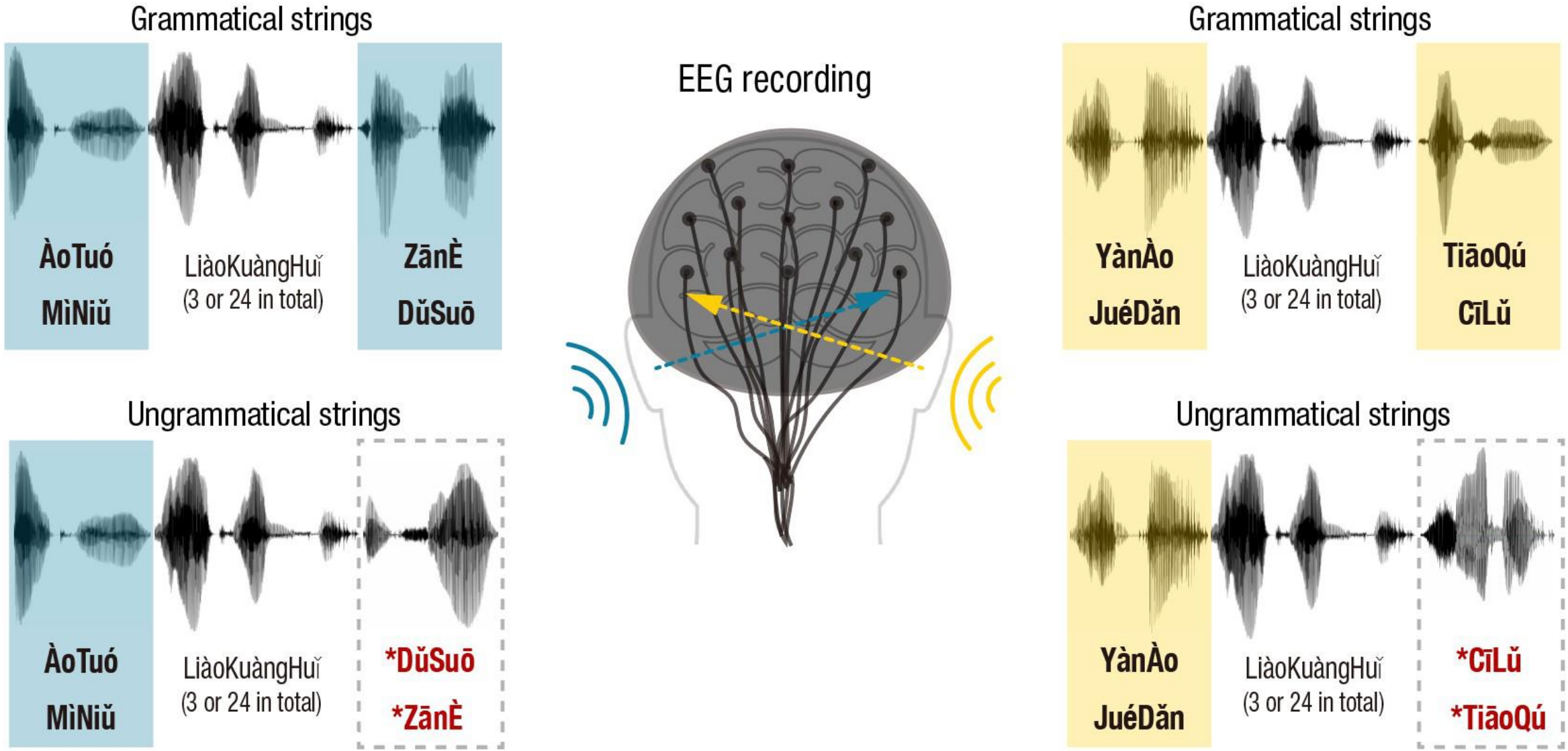
1) Statistical Learning
2) Artificial Language
3) Non-adjacent-dependency



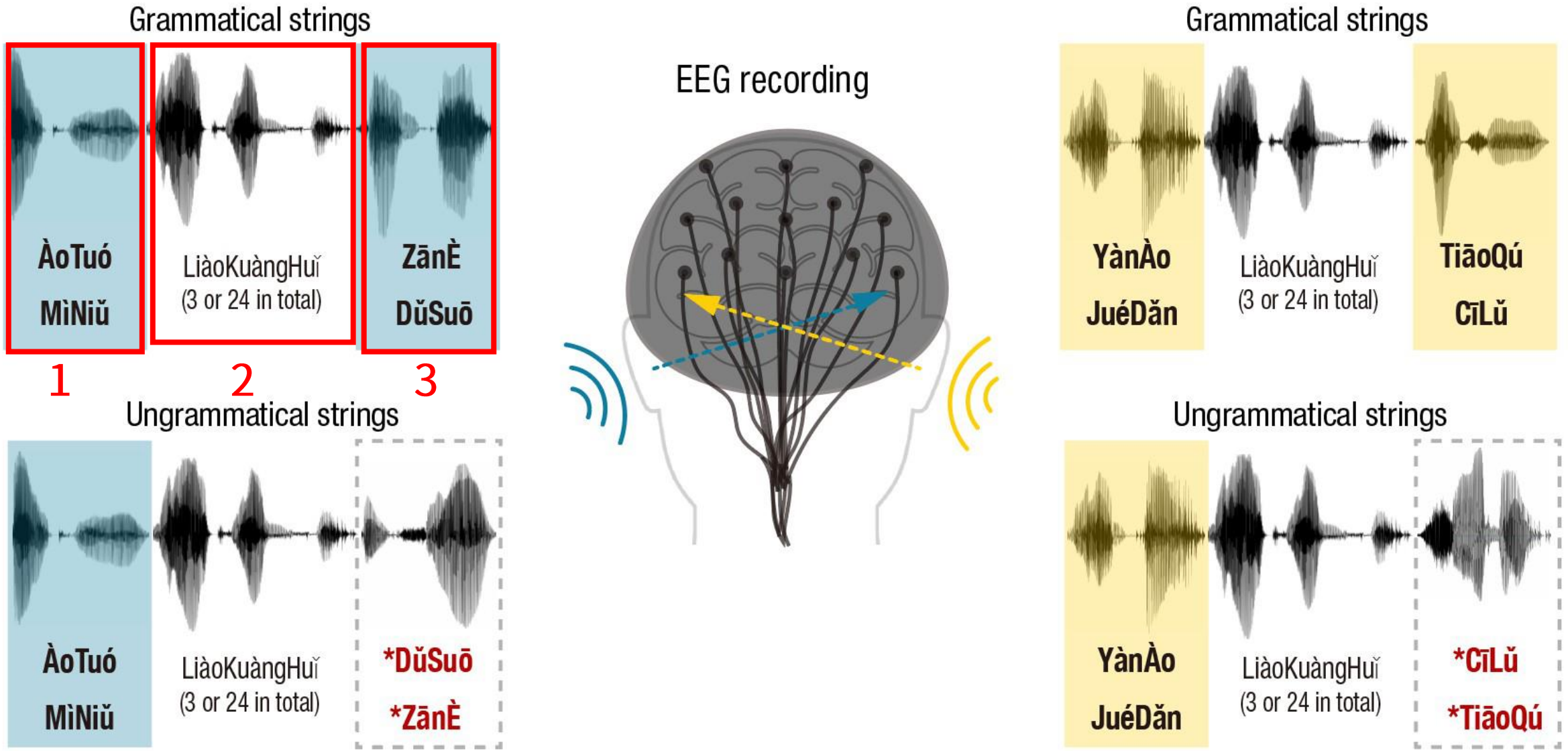
Set size : the number of items that occur in this place

Set size ↑ = difficulty ↓

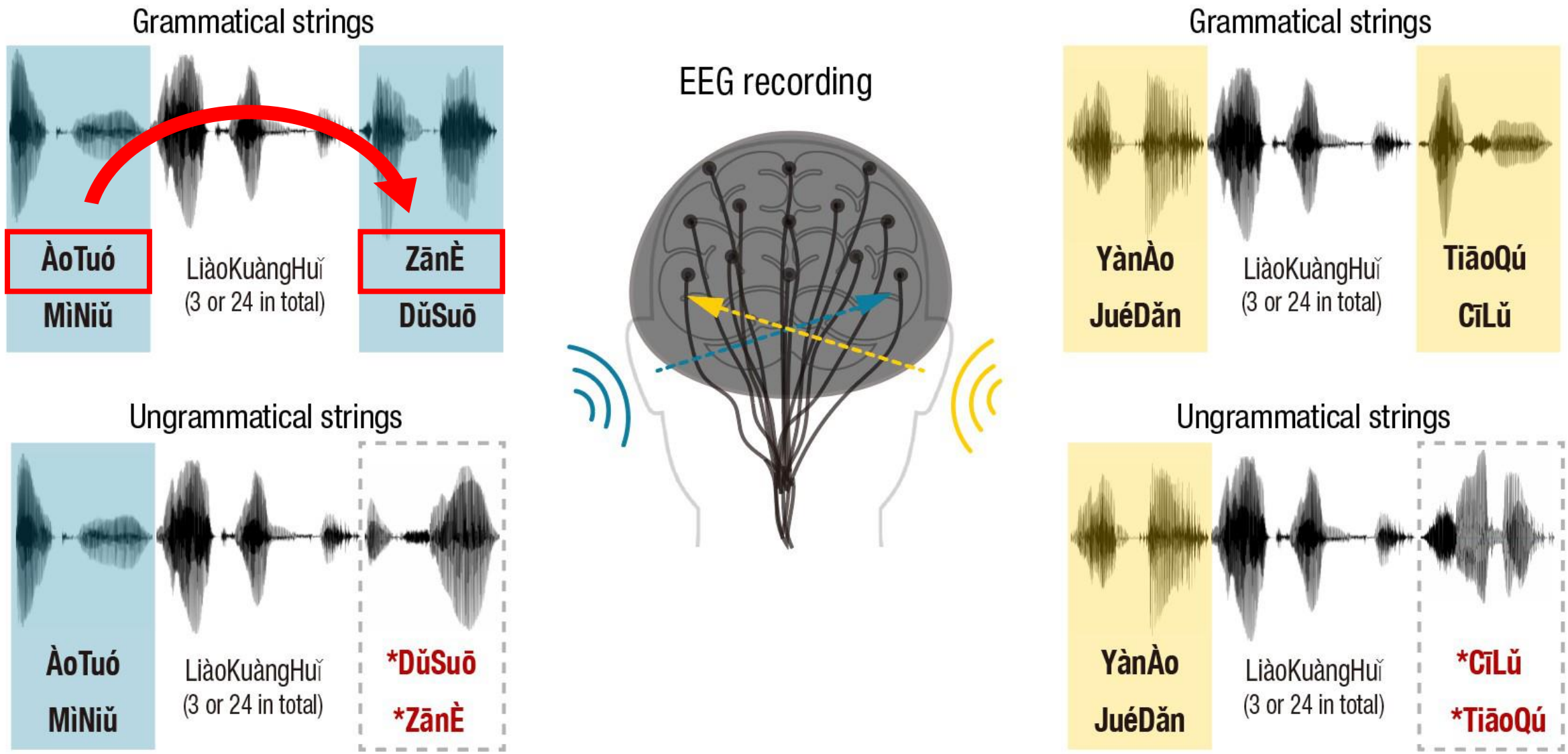
Artificial strings in monaral presentation



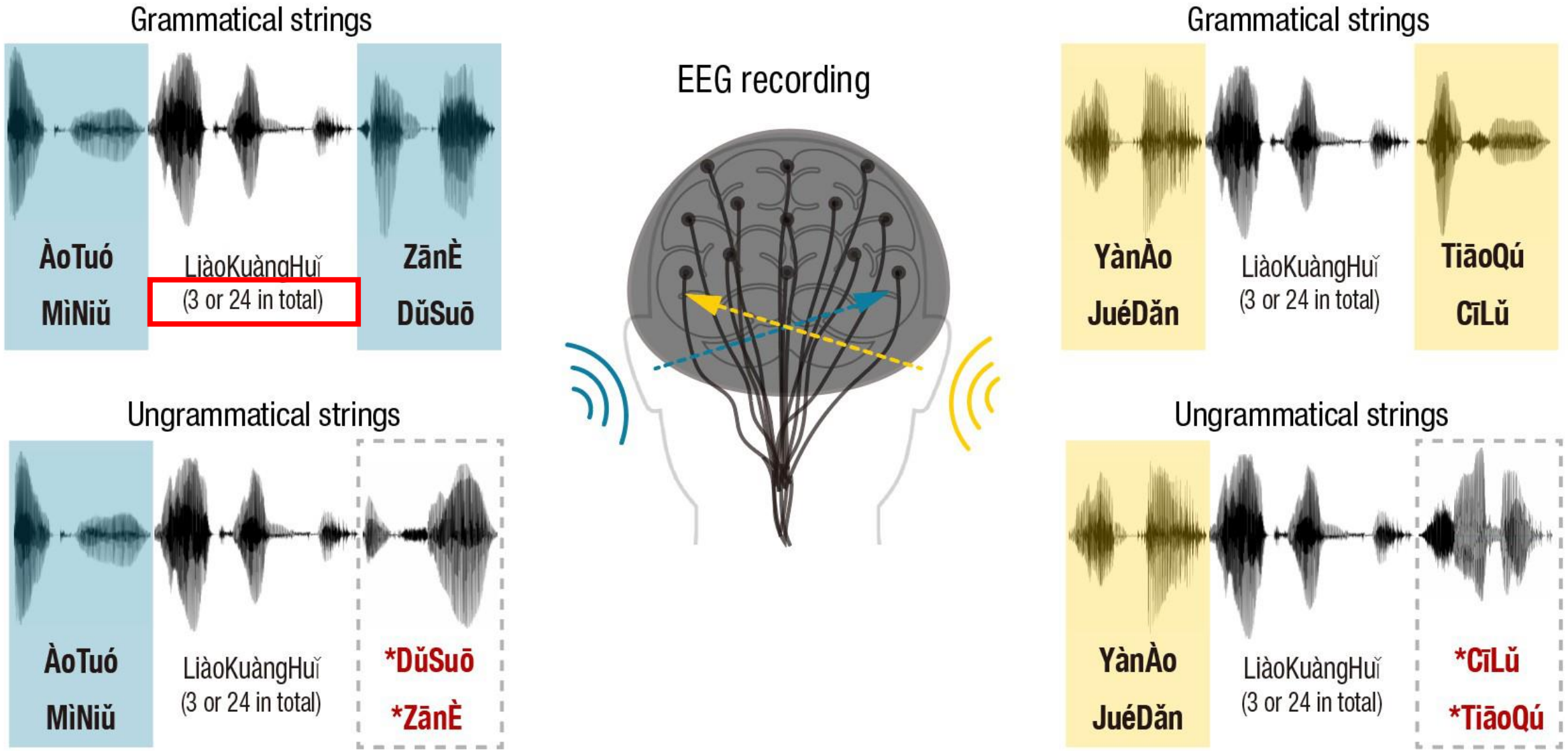
Artificial strings in monaral presentation



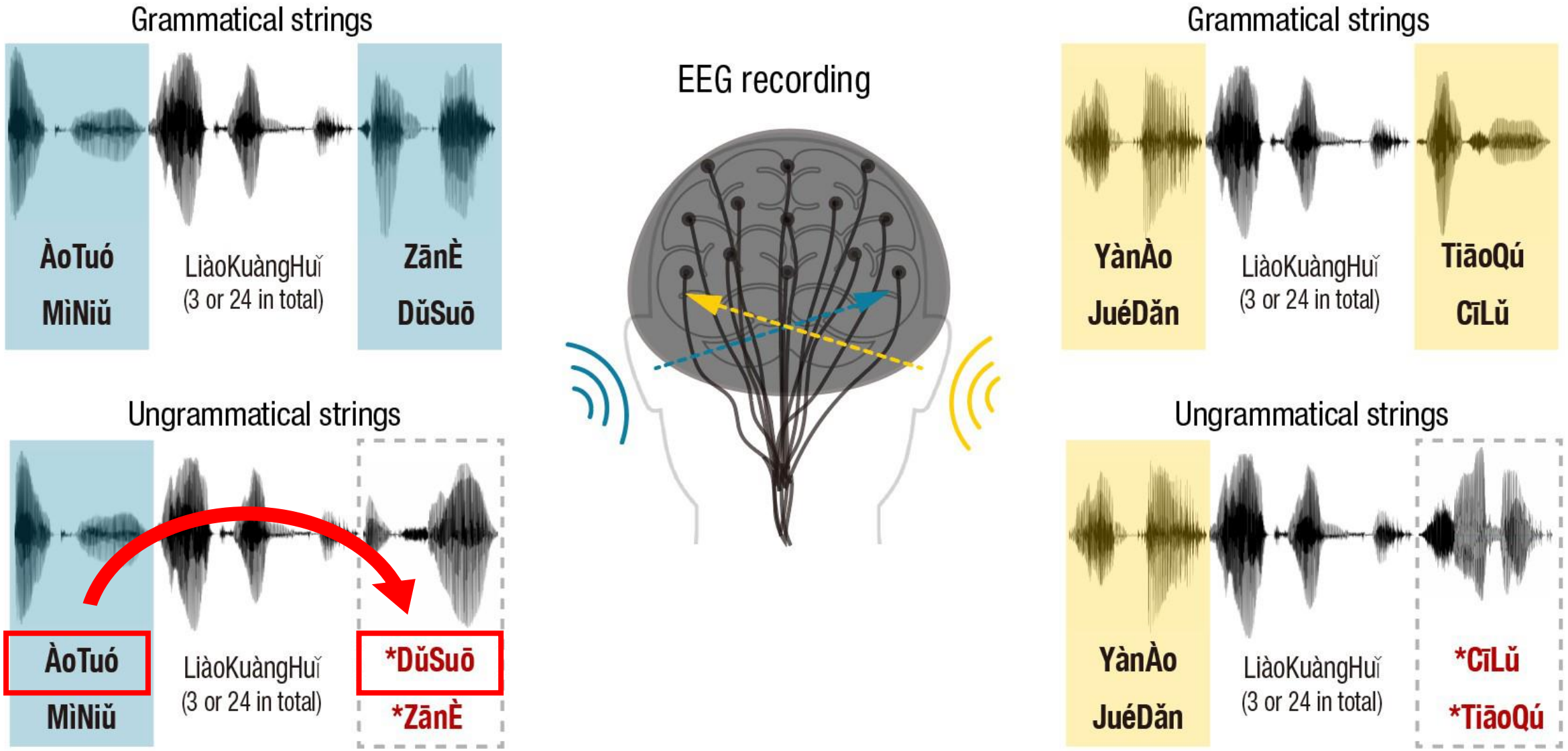
Artificial strings in monaral presentation



Artificial strings in monaral presentation



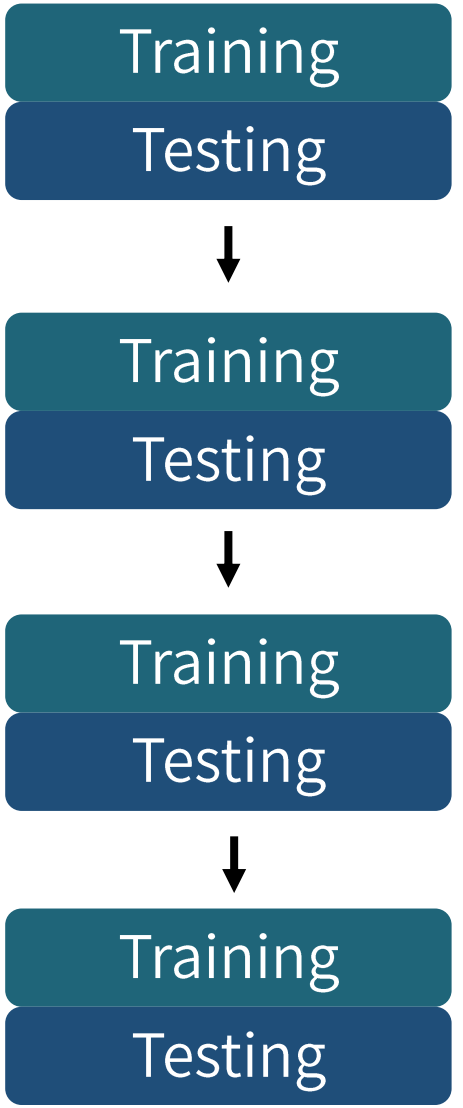
Artificial strings in monaral presentation



Procedure

- 48 trials in each training and testing sessions
- Four blocks of training and testing

→ to capture the learning trajectories of each subjects



Participants

- 63 right-handed FS- young adults.
  (29 M; mean age: 22.22; range: 20 – 26)
- Native speakers of Taiwan Mandarin with no exposure to other languages other than Taiwanese before age 5.
- No history of neurobiological or psychiatric disorders or brain damage.
- Additional tests to control the general cognitive abilities :
  - Non-word repetition test
  - WAIS-MR

Predictions

If RH is an assistance

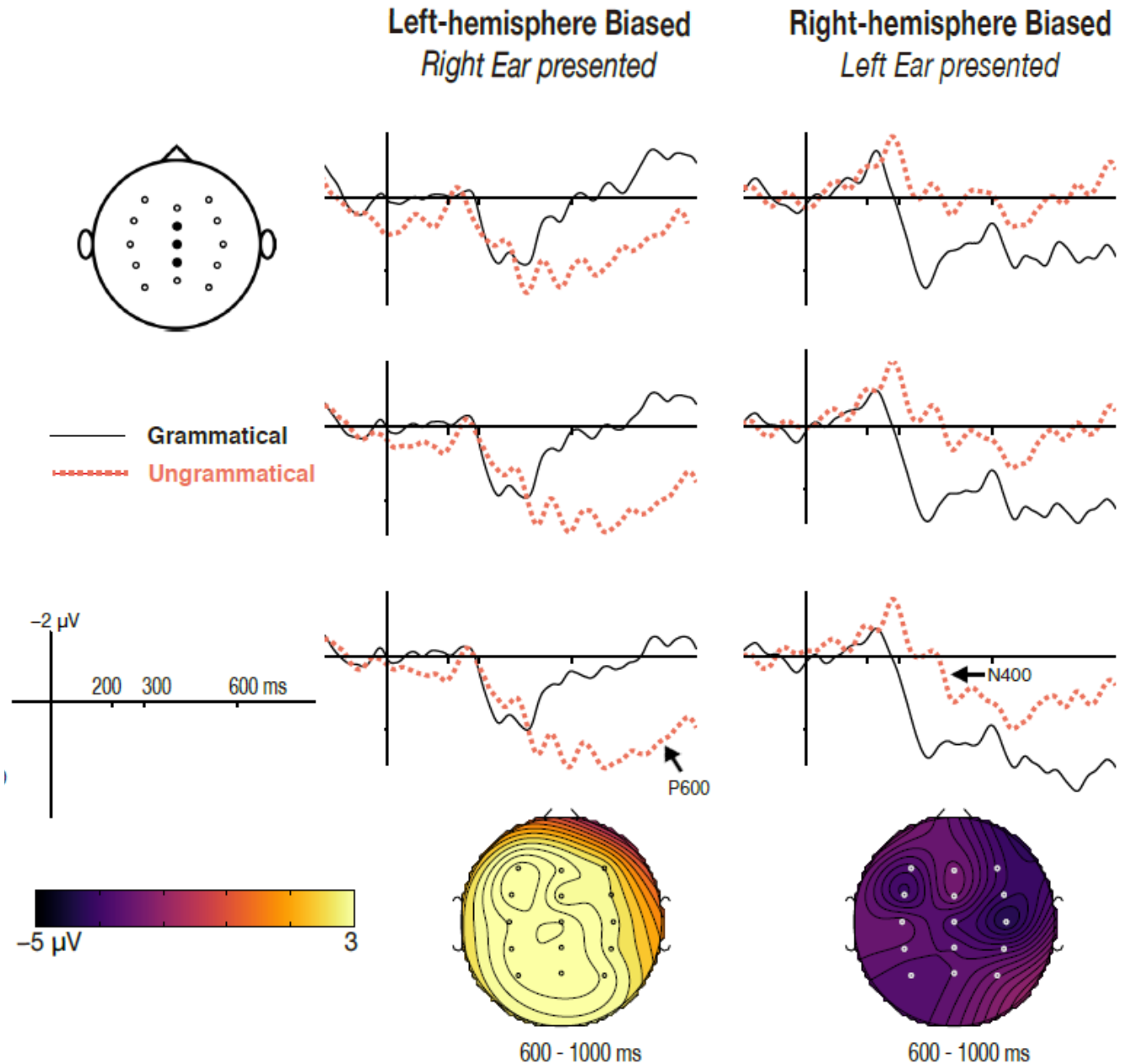
	Set Size = 3	Set Size = 24
Successful	O	

If RH is an interference

	Set Size = 3	Set Size = 24
Successful		

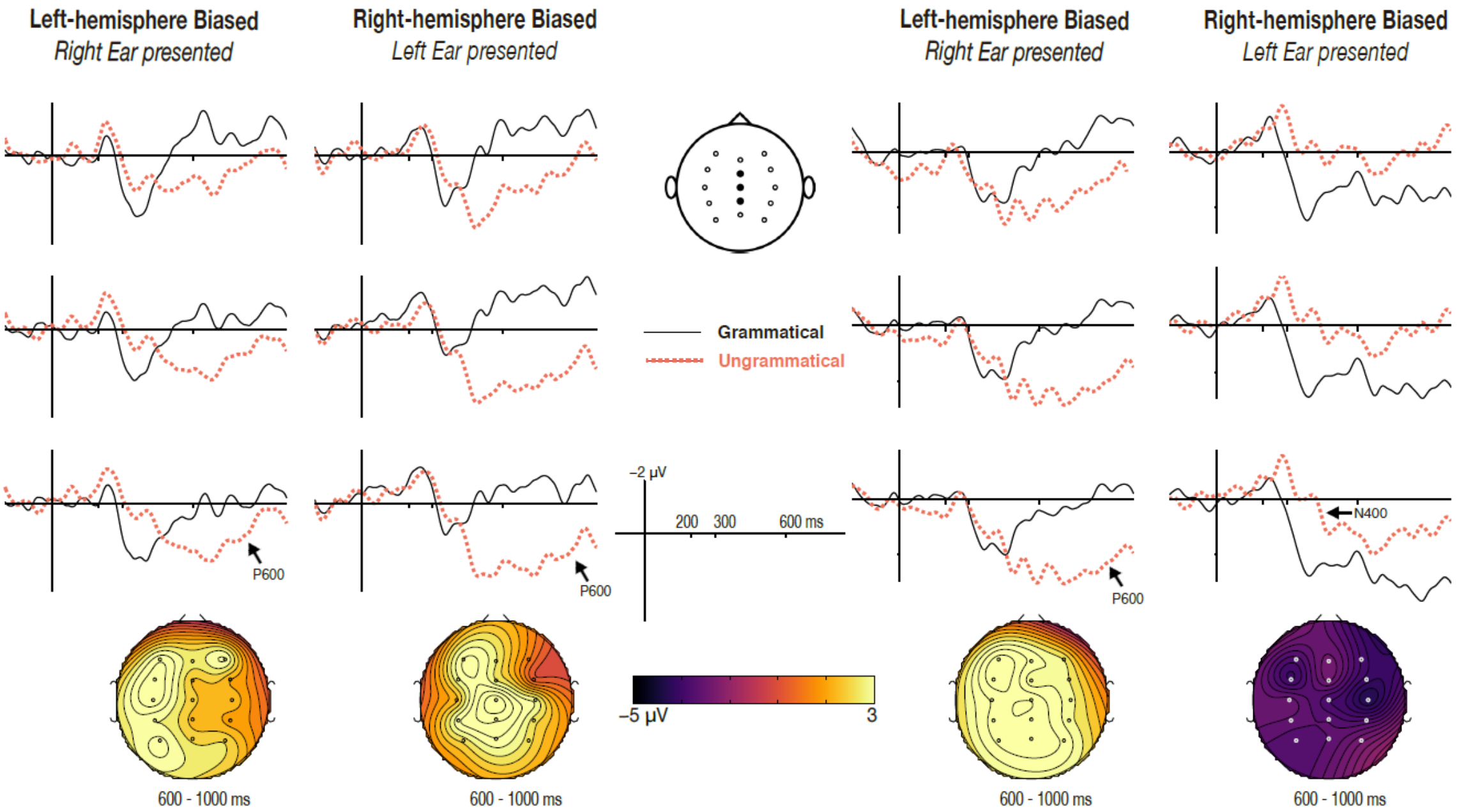
(O = RH P600)

Set Size = 24


Left-hemisphere Biased
Right Ear presented
Right-hemisphere Biased
Left Ear presented
Grammatical
Ungrammatical
−2 μV
200
300
600 ms
N400
P600
−5 μV
3
600 - 1000 ms
600 - 1000 ms

Set Size = 3

Set Size = 24



Back to Prediction

- RH P600 occur in challenging condition (set size = 3) but not in easy condition (set size = 24)

→ RH is likely an assistance

- RH P600 occur in behaviorally successful learner

→ RH is less possibly a hindrance