Both semantic and form representations are pre-activated during sentence comprehension: Evidence from EEG Representational Similarity Analysis

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Prediction at multiple levels of representation
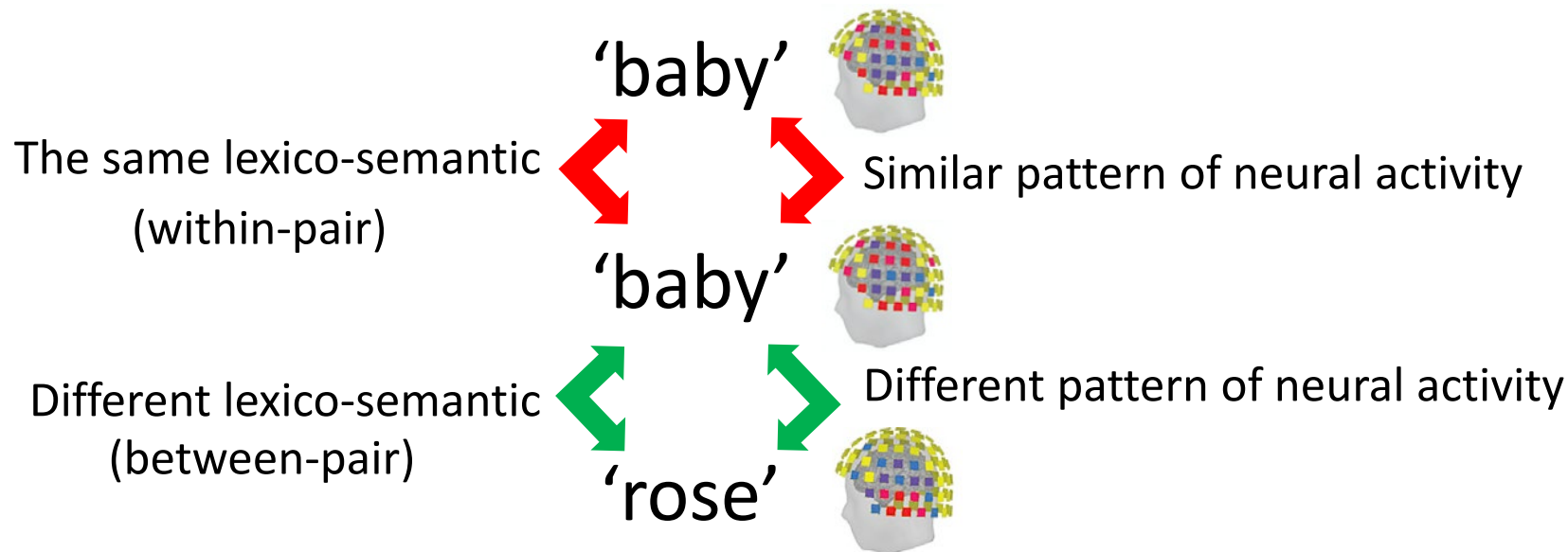
'In the crib, there is a sleeping ...' **baby**

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Semantic properties **?**
<animate>, <can breathe>, <small>

⬇

Word form **?**
'b-a-b-y' /ˈbeɪbi/

(Kuperberg & Jaeger, 2016)

■ The processing of incoming words is facilitated in proportion to their predictability.

- Is upcoming linguistic information pre-activated *before* new bottom-up input becomes available?

- Does the pre-activation occur at semantic and/or form levels?

Representational Similarity Analysis (RSA)

■ The representation of a unique word is associated with distinct *patterns* of neural activity.

'baby'

The same lexico-semantic (within-pair)

Similar pattern of neural activity

'baby'

Different lexico-semantic (between-pair)

Different pattern of neural activity

'rose'

■ Representationally similar items produce neural patterns that are more similar to each other than representationally distinct items.

■ RSA + EEG: examine neural similarity at each time point (Cichy et al. 2014)

- To determine when representationally specific information is activated prior to the onset of incoming word.
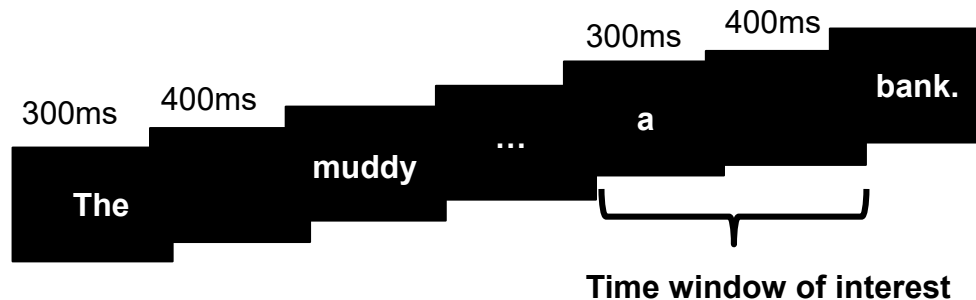
Homographs: to dissociate the time-course of form-based and meaning-based pre-activation

Form-related

Semantic-related

Form-related

Semantic-related

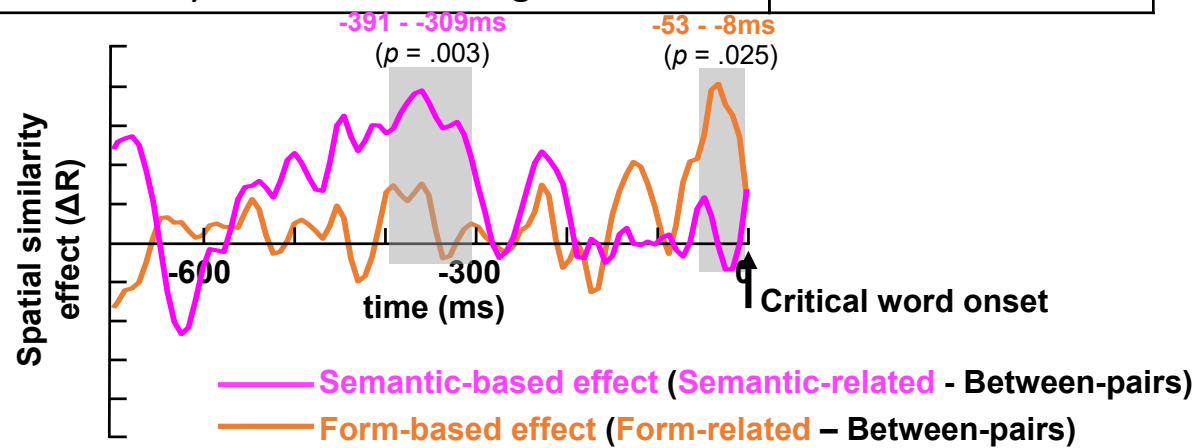|				Between-pairs
1a	The muddy sides of a river are called a <u>bank.</u>	Subordinate		
1b	James went to deposit the check at his <u>bank.</u>	Dominant		
1c	To pay for college the student took out a <u>loan.</u>	Dominant-related		
2a	There are twelve inches in a <u>foot.</u>	Subordinate		
2b	He put a shoe on his left <u>foot.</u>	Dominant		
2c	He had healthy nails on all his fingers and <u>toes.</u>	Dominant-related		

Methods:

- 84 triplets of high constraint sentences (cloze: mean $\pm$ SD = 88% $\pm$ 8%)

- 33 participants
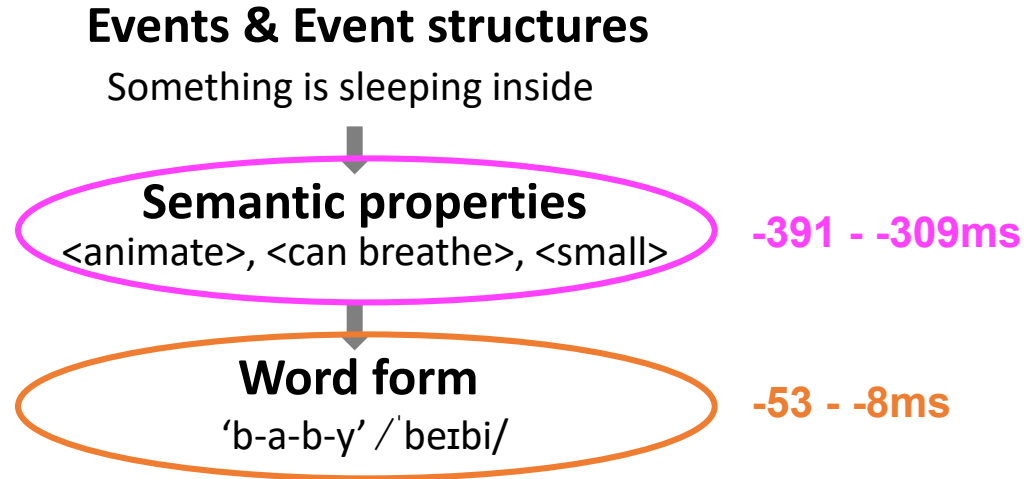
- 64-channel EEG

Procedure: word-by-word presentation

300ms   400ms   300ms   400ms

The   muddy   ...   a   bank.

Time window of interest

RSA Results

1a	The muddy sides of a river are called a <u>bank.</u>	Subordinate
1b	James went to deposit the check at his <u>bank.</u>	Dominant
1c	To pay for college the student took out a <u>loan.</u>	Dominant-related
2a	There are twelve inches in a <u>foot.</u>	Subordinate
2b	He put a shoe on his left <u>foot.</u>	Dominant
2c	He had healthy nails on all his fingers and <u>toes.</u>	Dominant-related

Form-related (1a–1b)
Semantic-relate (1b–1c)
Form-related (2a–2b)
Semantic-related (2b–2c)

Between-pairs

-391 - -309ms (*p* = .003)
-53 - -8ms (*p* = .025)

Spatial similarity effect (ΔR)

-600   -300   time (ms)   Critical word onset

—— **Semantic-based effect** (**Semantic-related** - Between-pairs)
—— **Form-based effect** (**Form-related** – Between-pairs)

- Increase in neural similarity when the predicted words shared semantic features.

  --- Pre-activation of semantic features.

- Increase in neural similarity when the predicted words had the same word form.

  --- Pre-activation of word form.

Discussion

'In the crib, there is a sleeping ...'

Events & Event structures

Something is sleeping inside

Semantic properties
<animate>, <can breathe>, <small>   **-391 - -309ms**

Word form
'b-a-b-y' /ˈbeɪbi/   **-53 - -8ms**

- Clear neural evidence for semantic and form pre-activation during the processing of predictable sentences.

- The earlier pre-activation of semantic than form information is consistent with a hierarchical generative framework, suggesting that top-down pre-activation is propagated from higher to successively lower levels of the linguistic hierarchy over time.

Thank you for your attention!