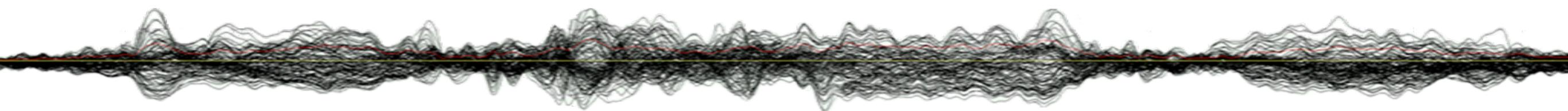


TAKING MORPHOLOGY SERIOUSLY: MEG STUDIES OF MORPHOLOGICAL REPRESENTATIONS



Laura Gwilliams & Alec Marantz

17th International Morphology Meeting | Vienna | February 18th 2016

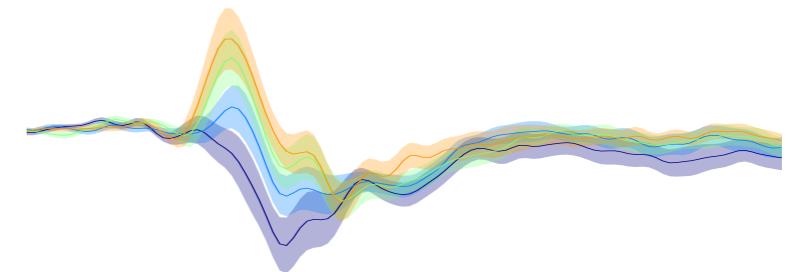
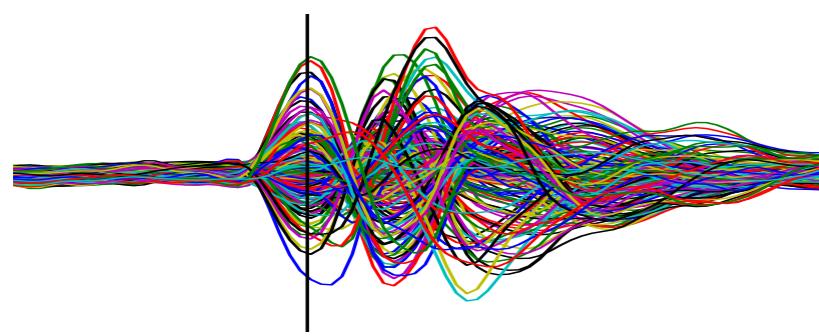
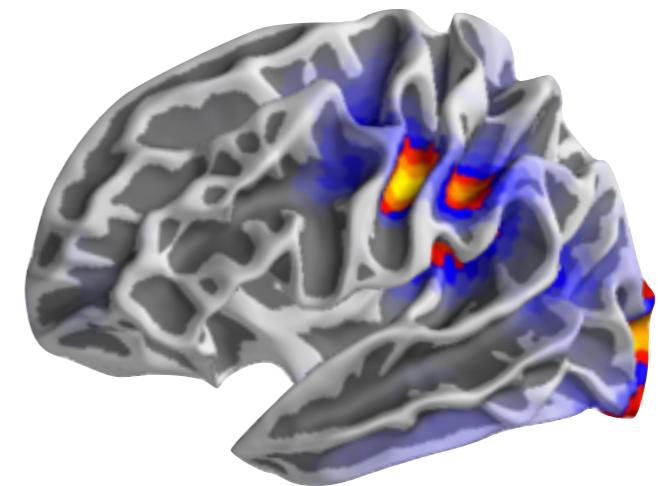
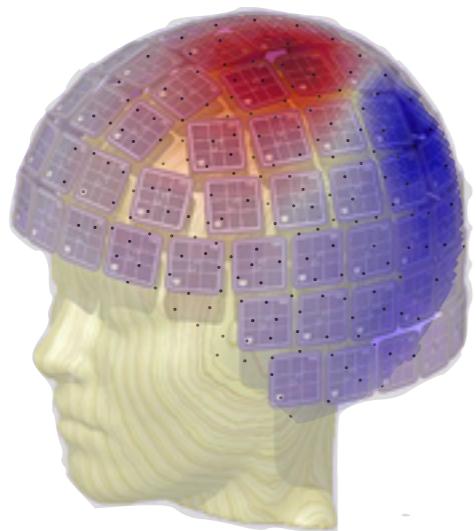
TODAY'S QUESTIONS

1. What is represented?
2. How are representations formed?
3. How are representations accessed?

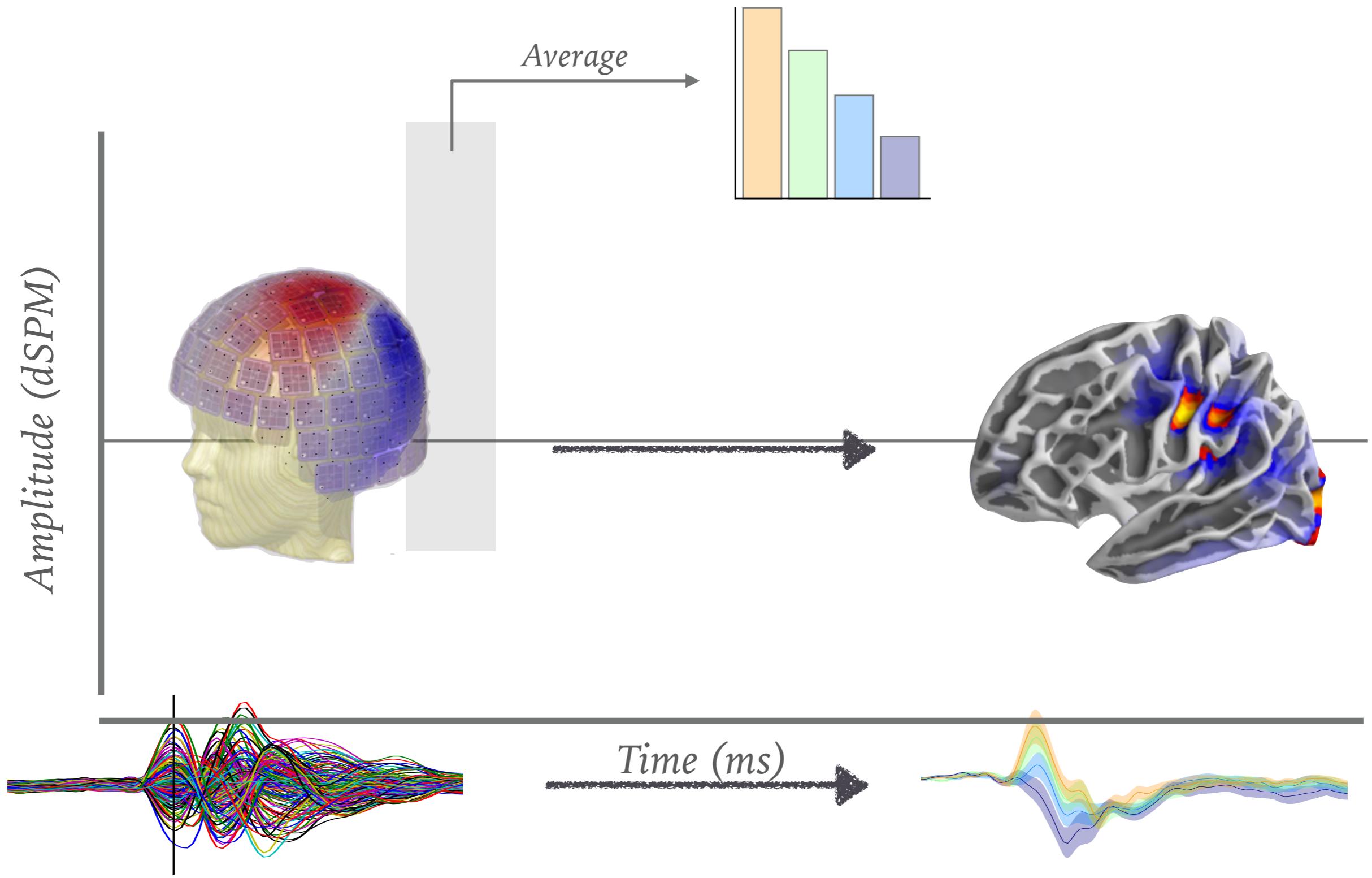
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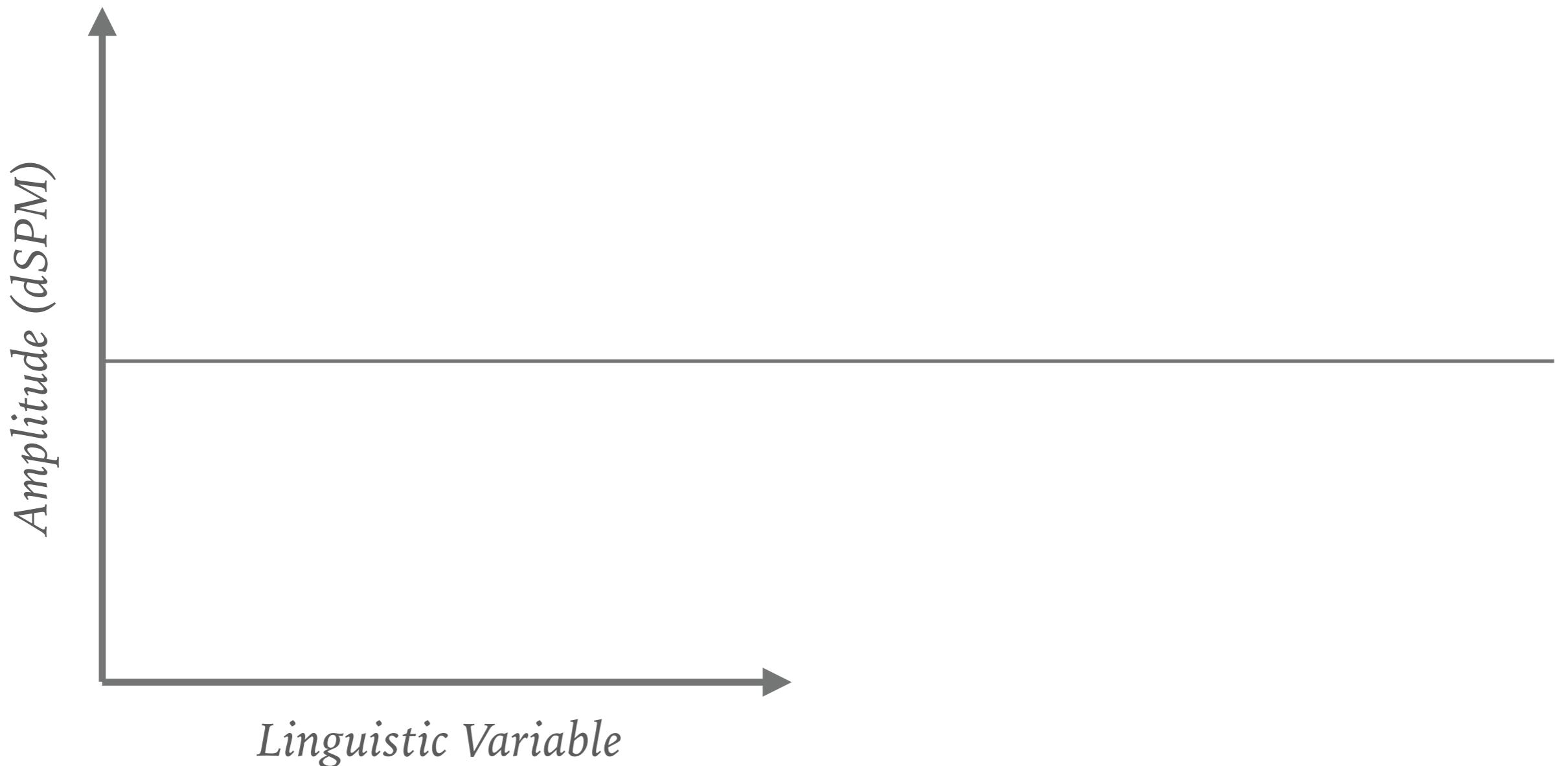
MAGNETOENCEPHALOGRAPHY (MEG)



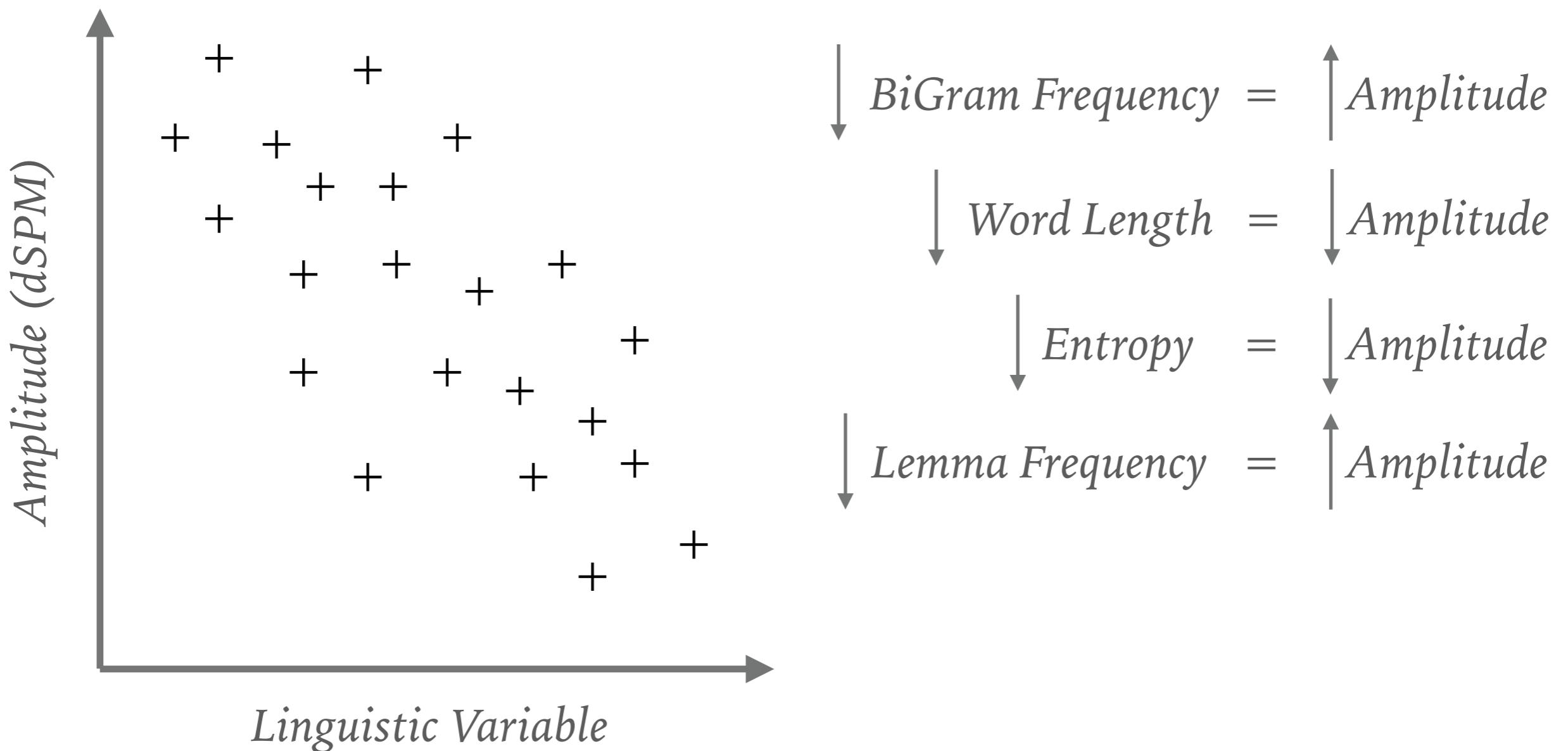
MAGNETOENCEPHALOGRAPHY (MEG)



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MAGNETOENCEPHALOGRAPHY (MEG)

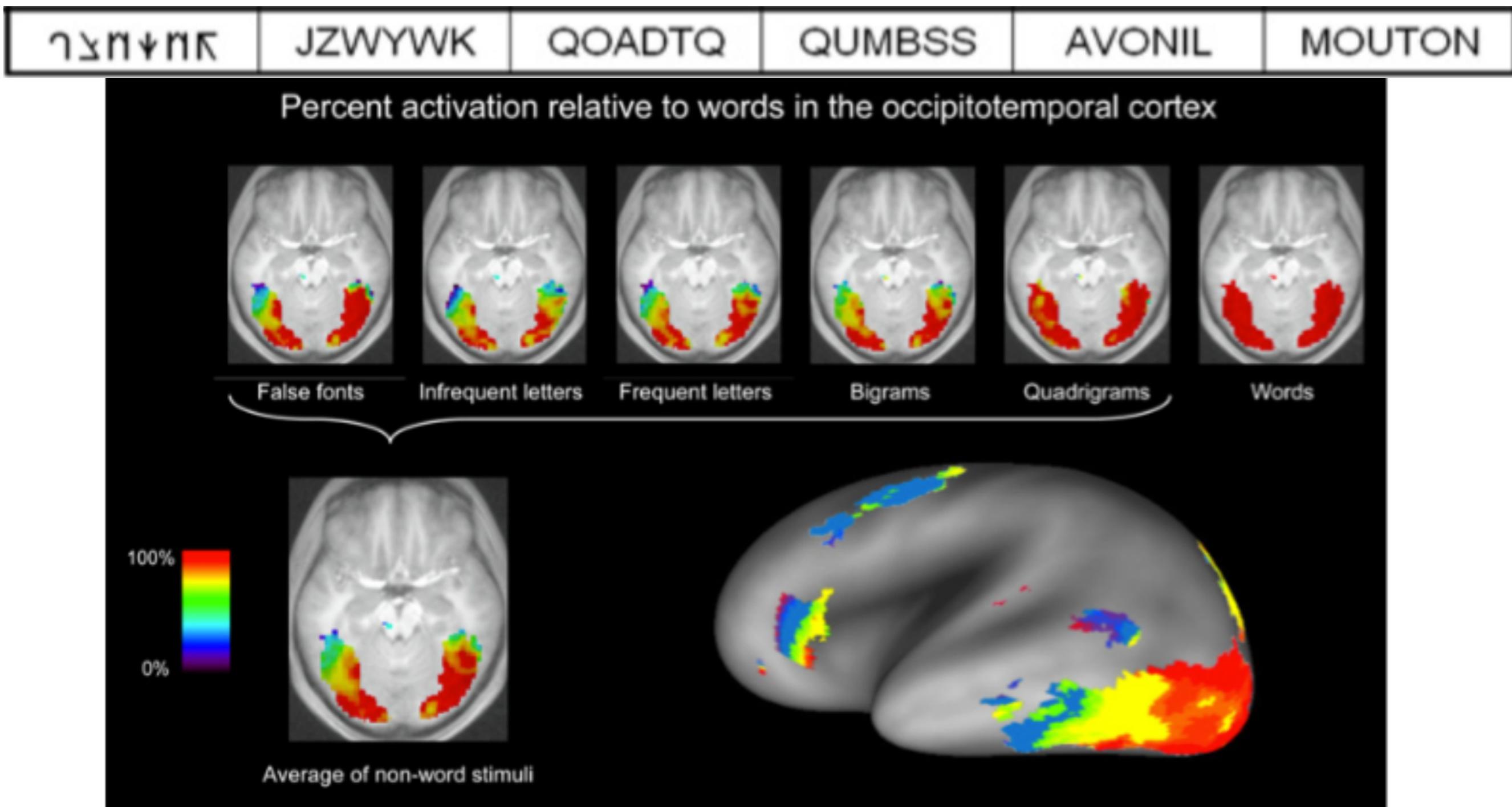


EXPERIMENT 1:

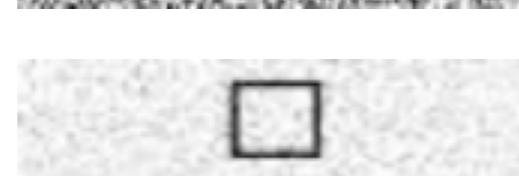
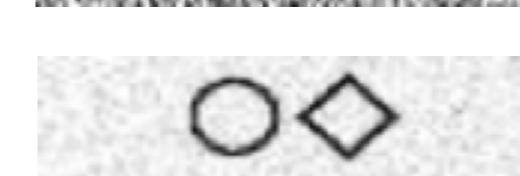
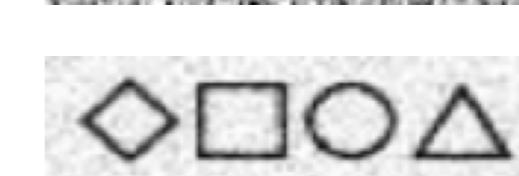
WHEN AND WHERE TO LOOK

EXPERIMENT 1 – WHEN AND WHERE TO LOOK

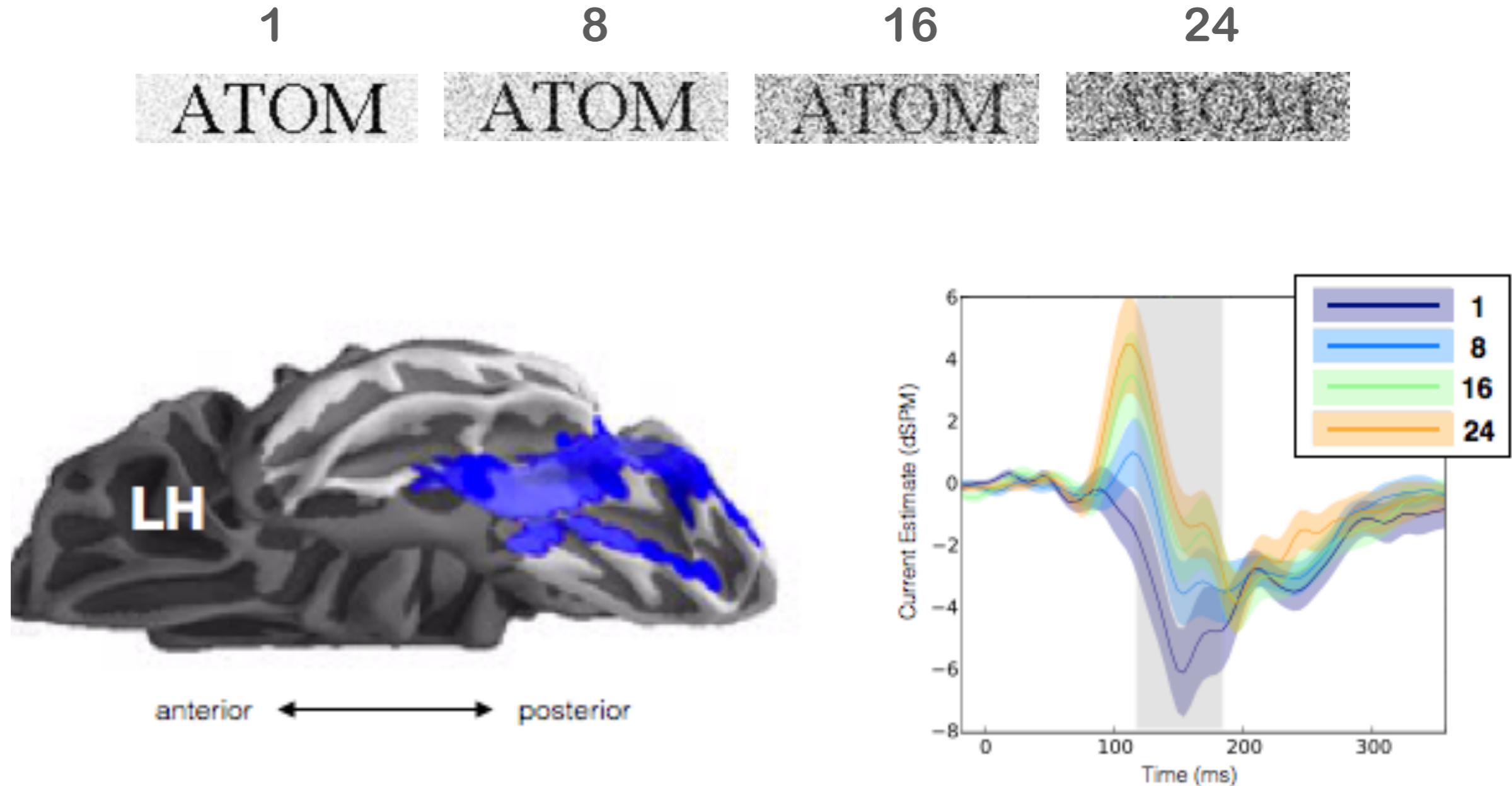
less wordlike ← → *more wordlike*



SETUP

i) Pure Noise	ii) One-element	iii) Two-element	iv) Four-element	
	B	GA	ATOM	1
	B	GA	ATOM	8
	B	GA	ATOM	16
				24
				Symbols

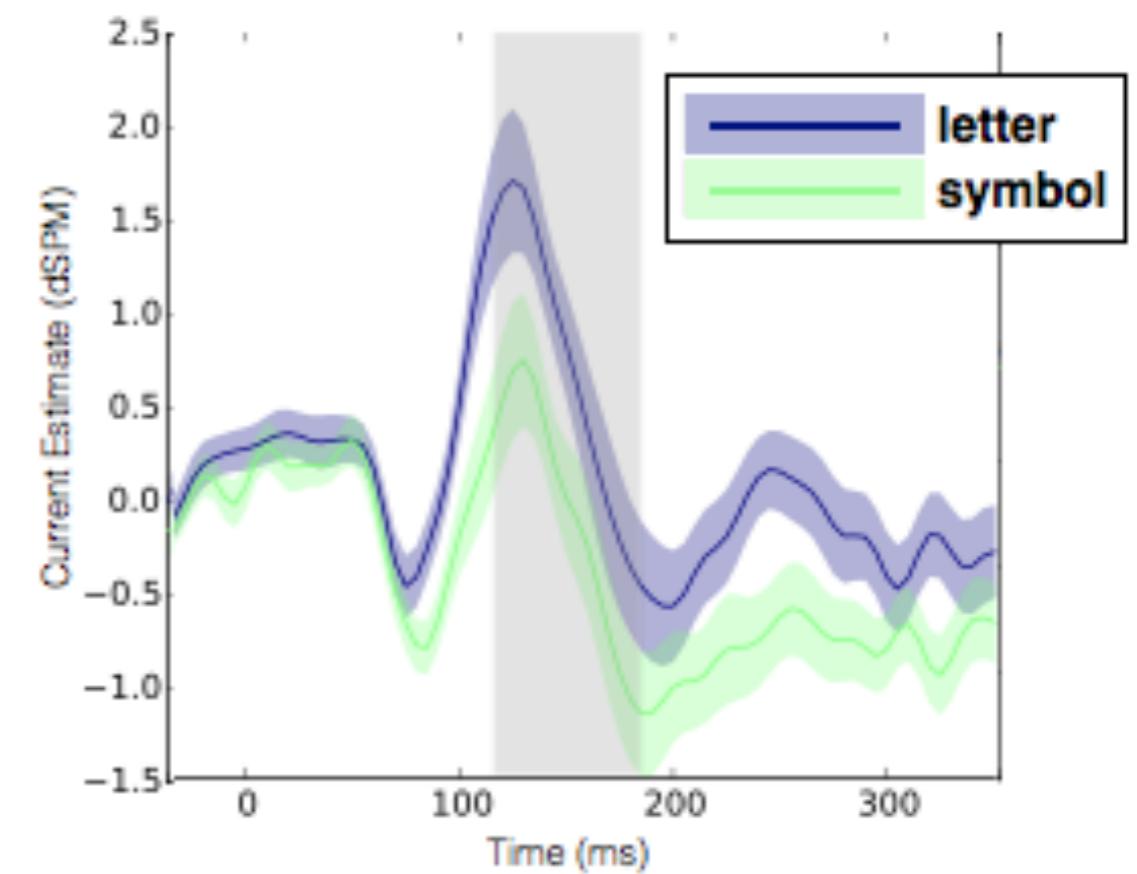
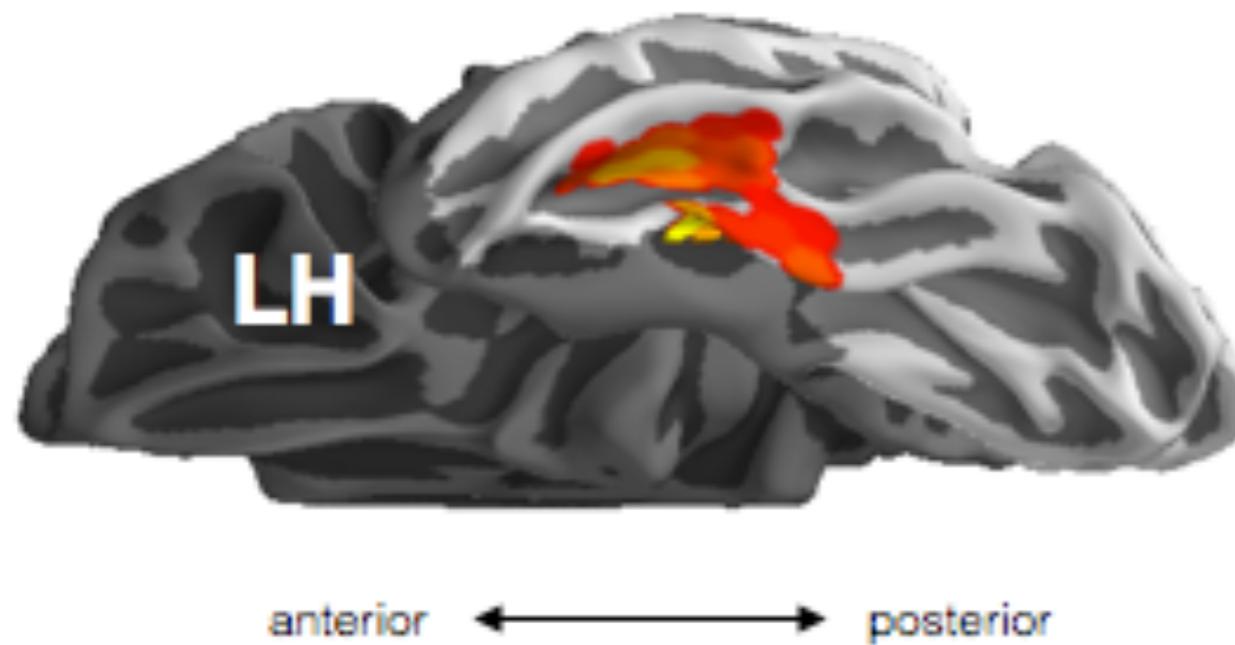
RESULTS



RESULTS

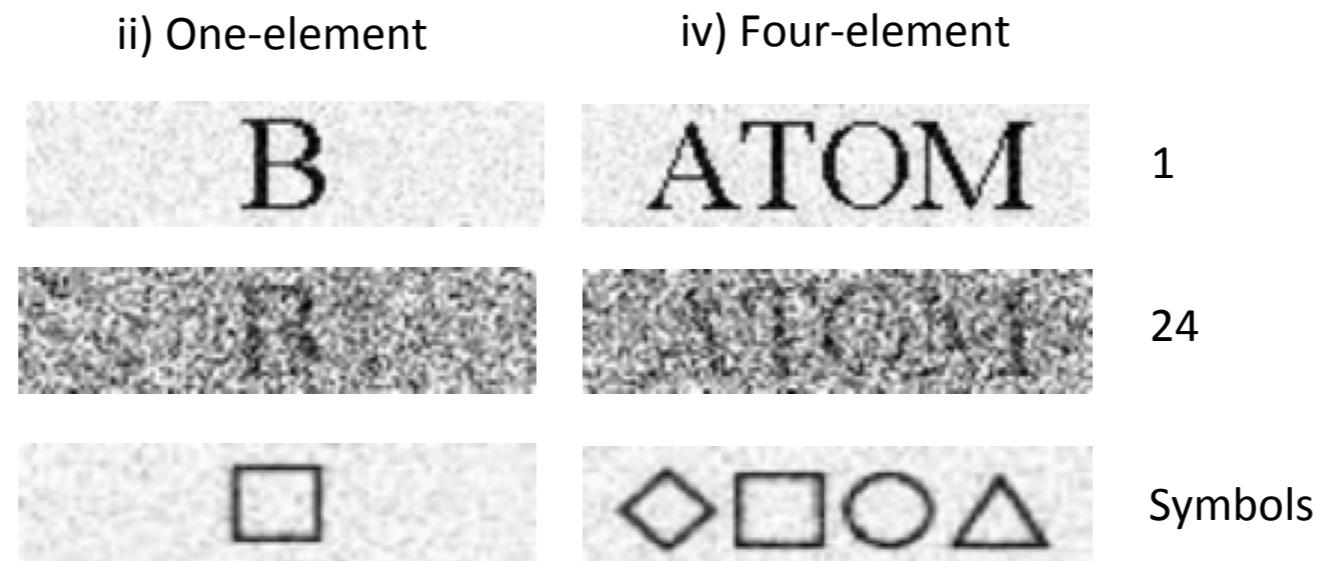
letter symbol

ATOM $\diamond \square \circ \triangle$

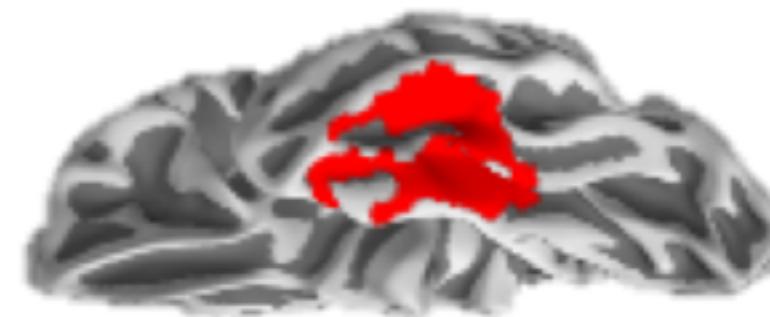
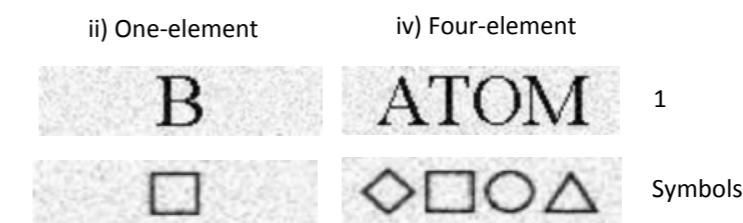
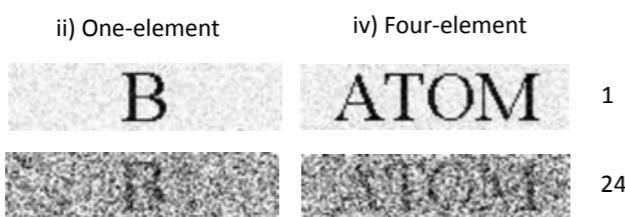


FUNCTIONAL LOCALISER

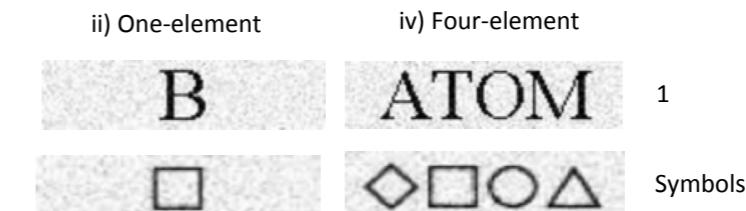
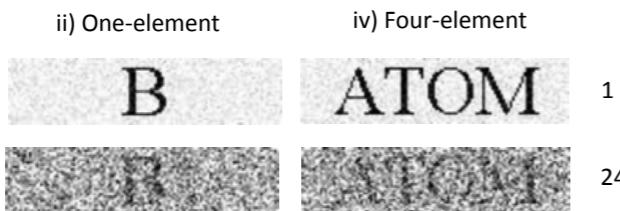
- Subset of stimulus materials
- Ran in same experimental session as experiment of interest
- ~6 minutes to complete



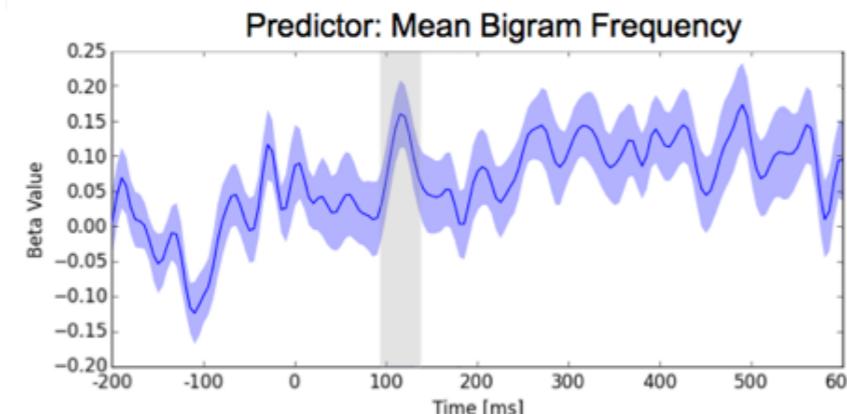
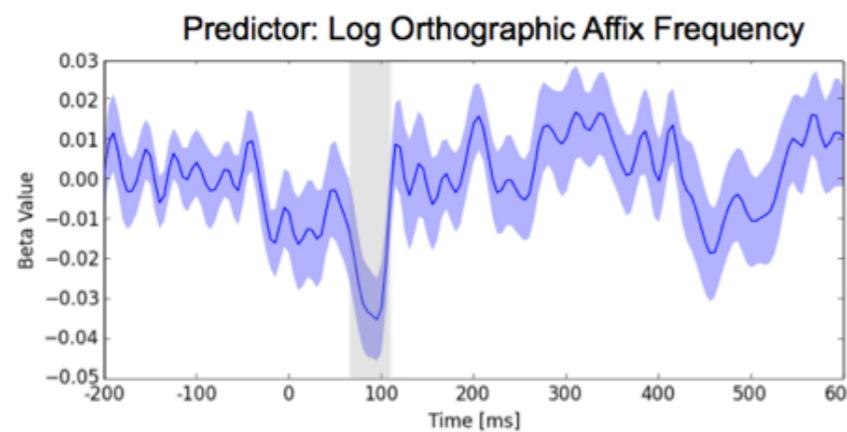
FUNCTIONAL LOCALISER



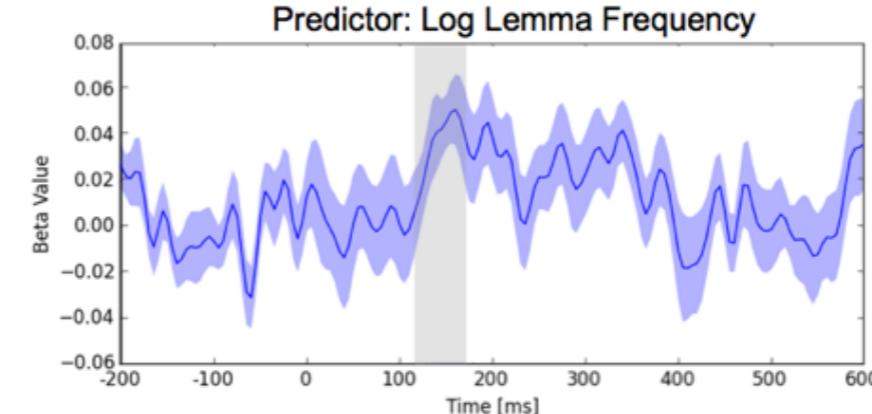
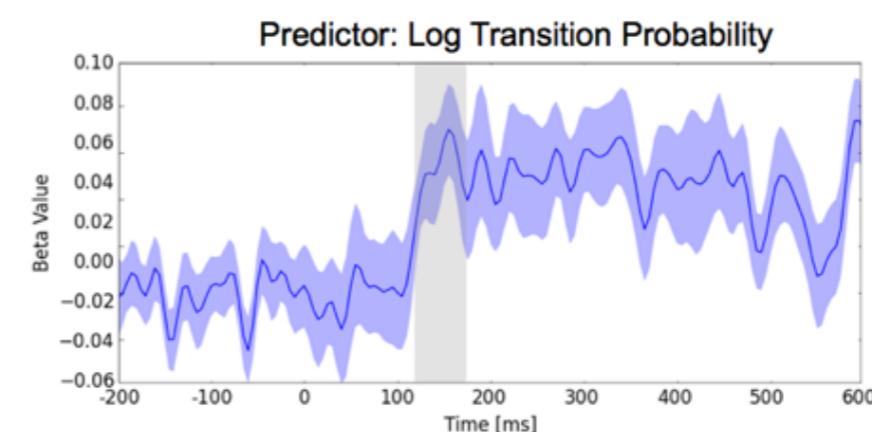
APPLYING FUNCTIONAL LOCALISER



Orthographic



Morphological



EXPERIMENT 1 - TAKE AWAY

- Orthography: 130 ms in the posterior temporal lobe
- Morphology: 170 ms in the anterior temporal lobe
- Successfully created a localiser for these two streams of processing

EXPERIMENT 2:

REPRESENTATIONS OF NON-EXISTENT STEMS

“

To be recognized as a [stem] morpheme, a form must either (1) occur as a free form, making up a complete word, or (2) occur, with the same meaning, in more than one word.

-R.M.W. Dixon

Making New Words, 2014: 3

BACKGROUND & QUESTION

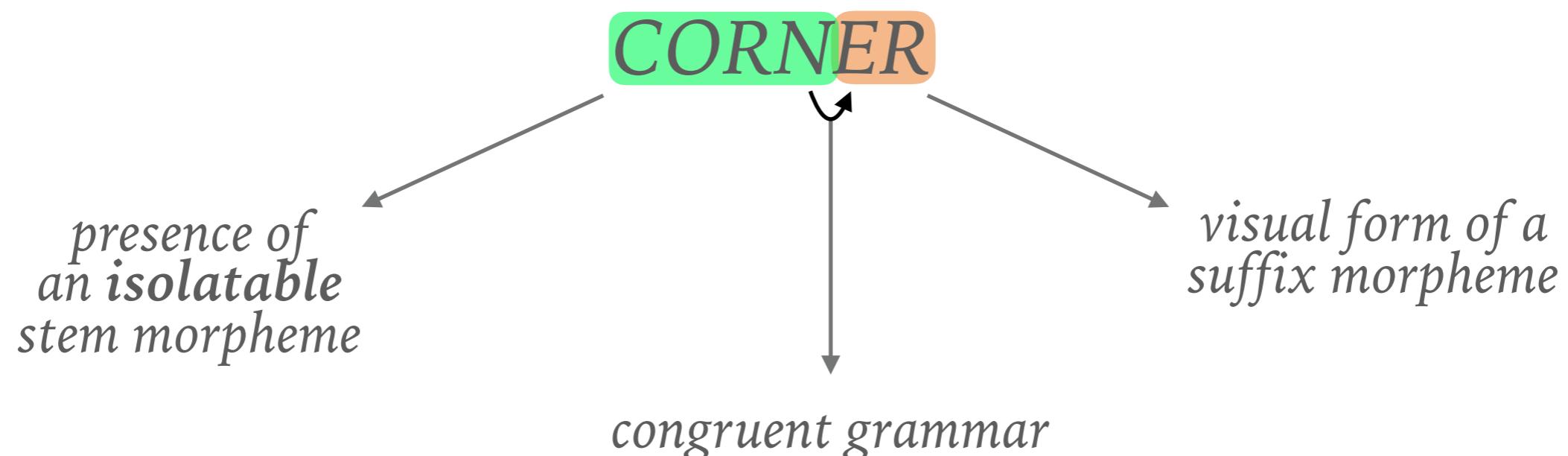
- Copious evidence that:

FARMER → *FARM* + *ER*

CORNER → *CORN* + *ER*

BROTHEL ≠ *BROTH* + *EL*

- What is driving this effect?



QUESTION

EXCURSION

- isolatable stem, + congruent grammar

“to explode”
“explosion”

“to excursion”
“excursion”

WINTER

- isolatable stem, - congruent grammar

“to bake”
“baker”

* “to wint”
“winter”

LEAKAGE

+ isolatable stem, + congruent grammar

BROTHER

+ isolatable stem, - congruent grammar

SETUP

- Lexical decision task
- Ran “morphology localiser” to select ROI
- 24 native English participants

53 items per condition



LEAKAGE

+ *isolatable stem, + congruent grammar*

EXCURSION

- *isolatable stem, + congruent grammar*

BROTHER

+ *isolatable stem, - congruent grammar*

WINTER

- *isolatable stem, - congruent grammar*

RESULTS

- Hypotheses:



CONDITION
leakage
brother
excursion
winter

RESULTS

➤ Analysis:

- Mixed effect regression model
- Ran in localised “morphology” region
- Coded as binary variables



CONDITION	suffix	isolatable stem	congruent grammar	combination 2 or 3
leakage	1	1	1	1
brother	1	1	0	1
excursion	1	0	1	1
winter	1	0	0	0

RESULTS

➤ Analysis:

- Mixed effect regression model
- Ran in localised “morphology” region
- Coded as binary variables

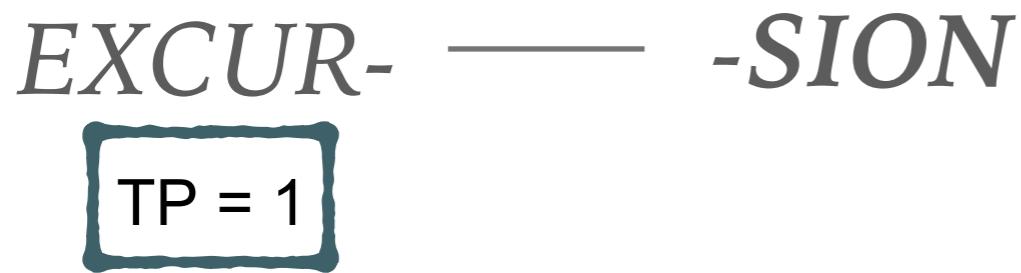
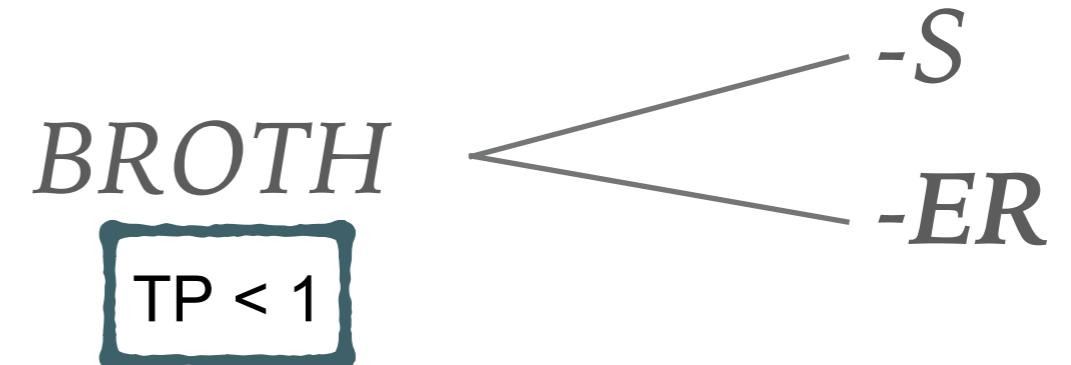
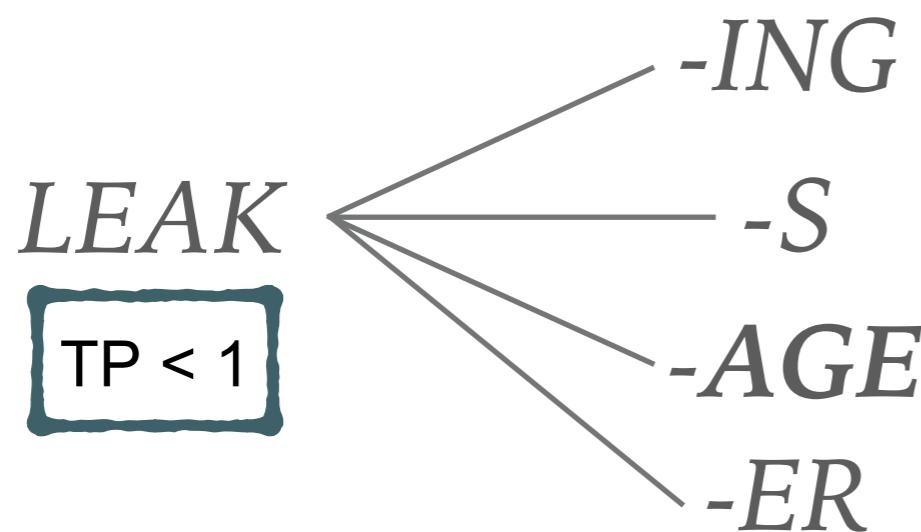


p > .5 **t = 1.06, p = .105** **t = 2.15, p = .03**

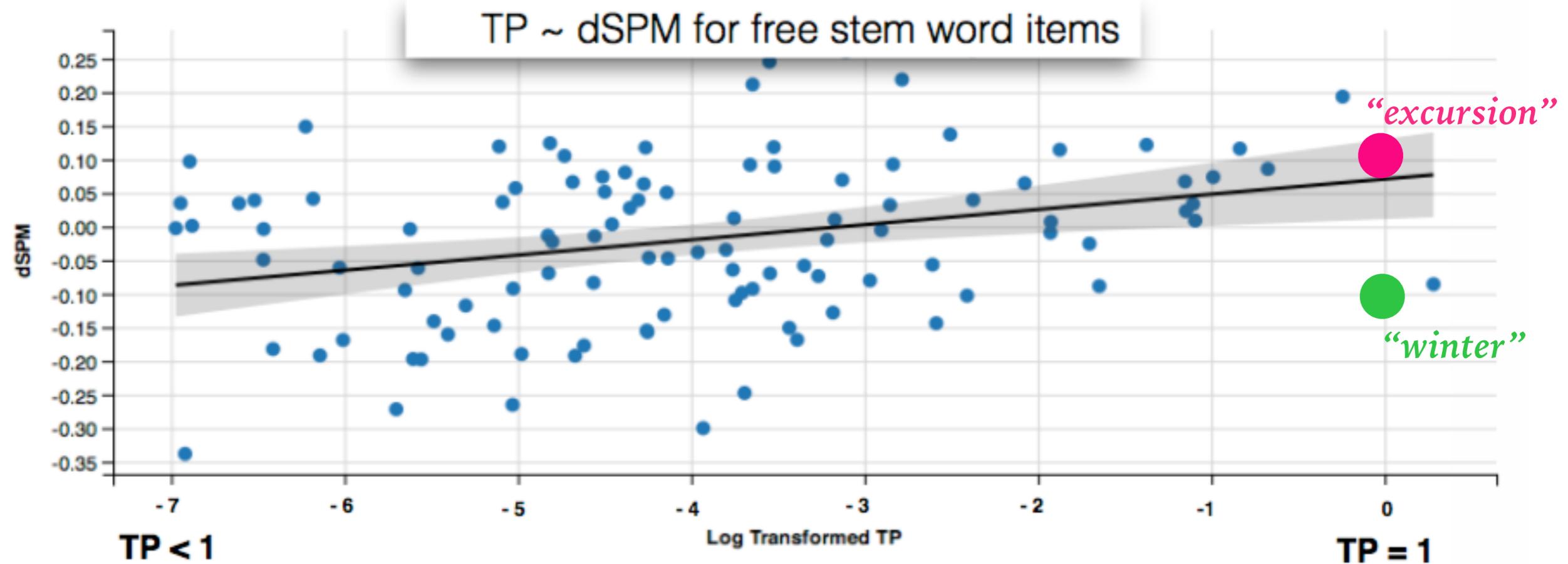
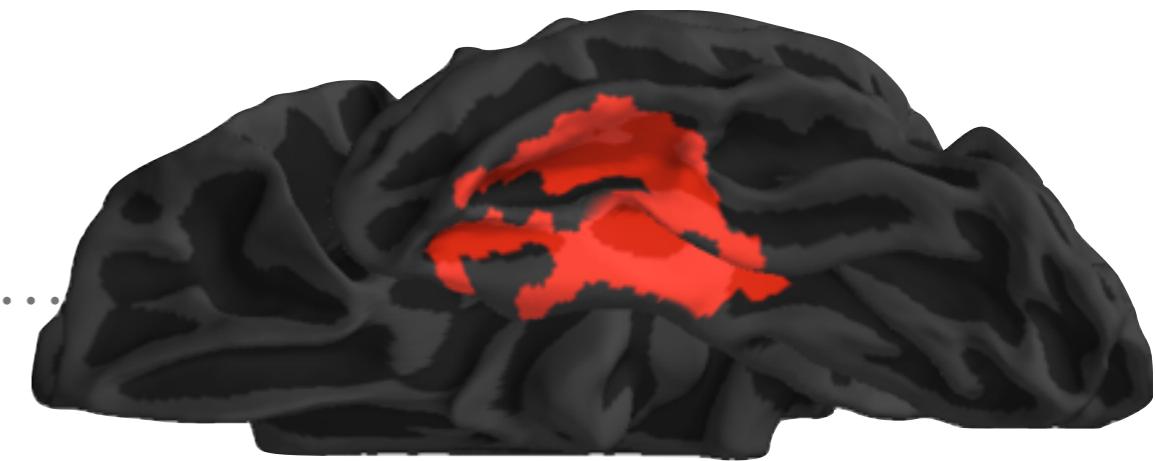
CONDITION	suffix	isolatable stem	congruent grammar	combination 2 or 3
leakage	1	1	1	1
brother	1	1	0	1
excursion	1	0	1	1
winter	1	0	0	0

RESULTS

- Transition probability (TP) as an index of decomposition:



RESULTS



EXPERIMENT 2 - TAKE AWAY

“

To be recognized as a [stem] morpheme, a form must either (1) occur as a free form, making up a complete word, or (2) occur, with the same meaning, in more than one word.

-R.M.W. Dixon
Making New Words, 2014: 3

EXPERIMENT 2 - TAKE AWAY

“

To be recognized as a [stem] morpheme, a form must either (1) occur as a free form, making up a complete word, or (2) ~~occur, with the same meaning, in more than one word.~~

-R.M.W. Dixon

Making New Words, 2014: 3

EXPERIMENT 2 - TAKE AWAY

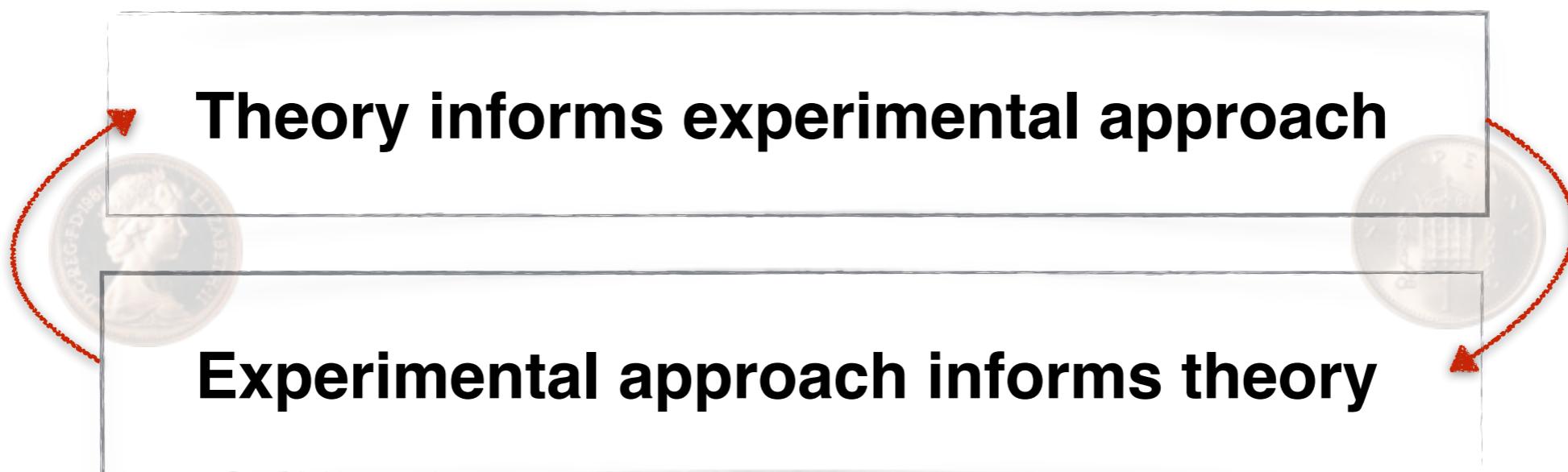
“

To be recognized as a [stem] morpheme, a form must either (1) occur as a free form, making up a complete word, or (2) occur [within a complex word with grammatical wellformedness].

-R.M.W. Dixon
Making New Words, 2014: 3

EXPERIMENT 2 - TAKE AWAY

- Data from neurophysiological techniques allow us to inform and adjudicate between different theoretical models

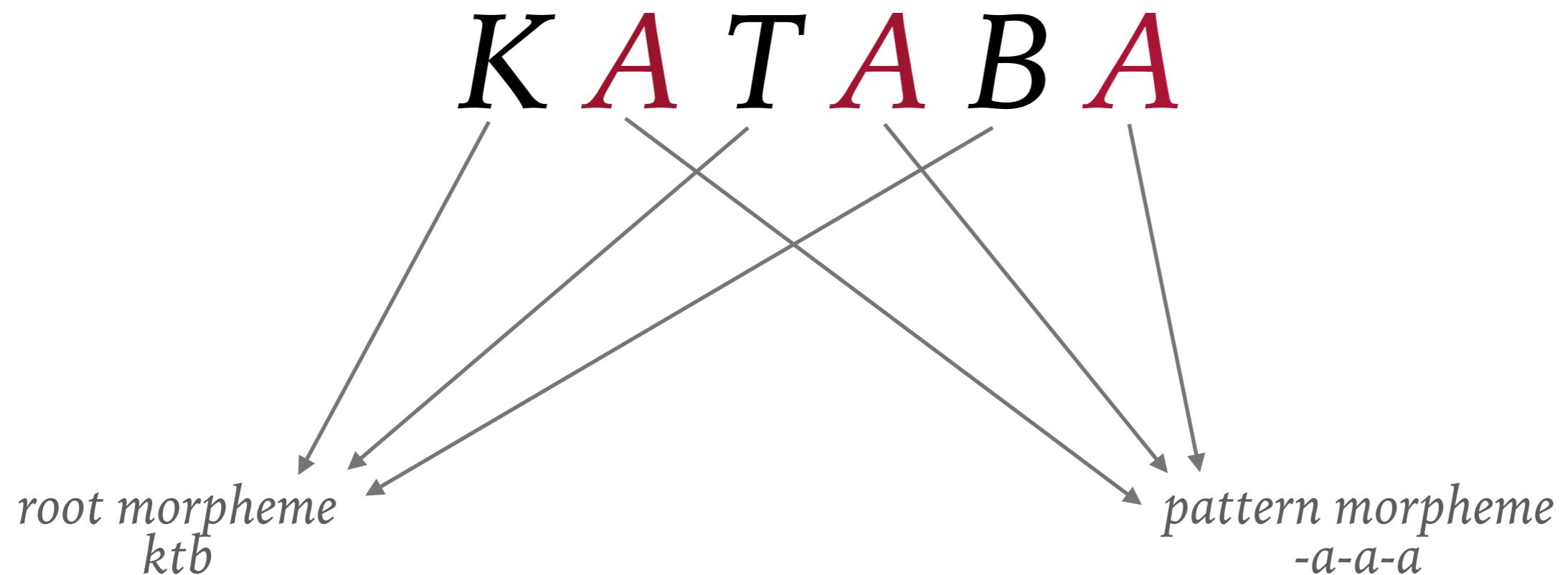


EXPERIMENT 3:

REPRESENTATIONS OF NON-LINEAR ROOTS

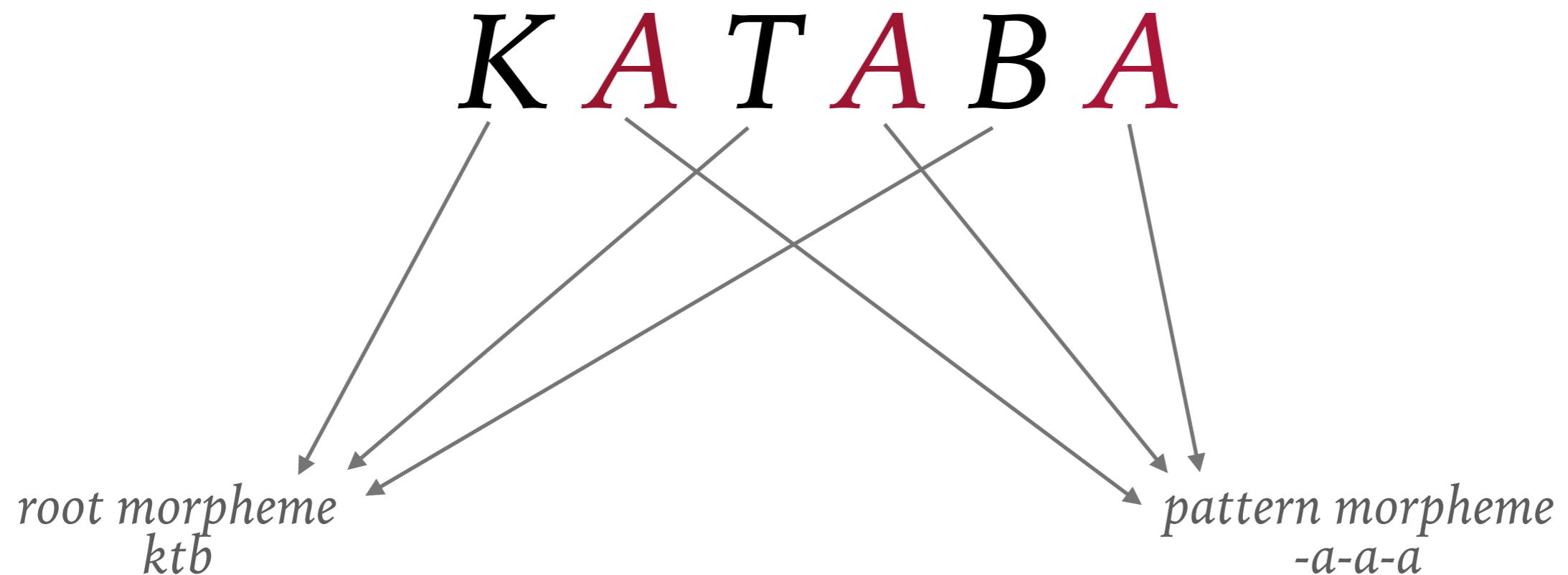
BACKGROUND

- In semitic languages such as Arabic and Hebrew, morphemes are arranged in an interleaved manner:



QUESTION

- Are Arabic words processed through their constituent morphemes, or as un-analysed wholes?



QUESTION

- The superior temporal gyrus is sensitive to how expected it is for a sound to occur within a word
- We utilised this sensitivity to determine what morphological constituents are activated during processing

$K A T A B A$ $p(B | KATA)$

$K T B$ $p(B | KT)$

QUESTION

- The superior temporal gyrus is sensitive to how expected it is for a sound to occur within a word
- We utilised this sensitivity to determine what morphological constituents are activated during processing

K A T A B A

$$\frac{\text{frequency}(KATAB)}{\text{frequency}(KATA)}$$

K T B

$$\frac{\text{frequency}(KTB)}{\text{frequency}(KT)}$$

QUESTION

- The superior temporal gyrus is sensitive to how expected it is for a sound to occur within a word
- We utilised this sensitivity to determine what morphological constituents are activated during processing

K A T A B A

$$\text{linear surprisal} = -\log(p(B \mid KATA))$$

K T B

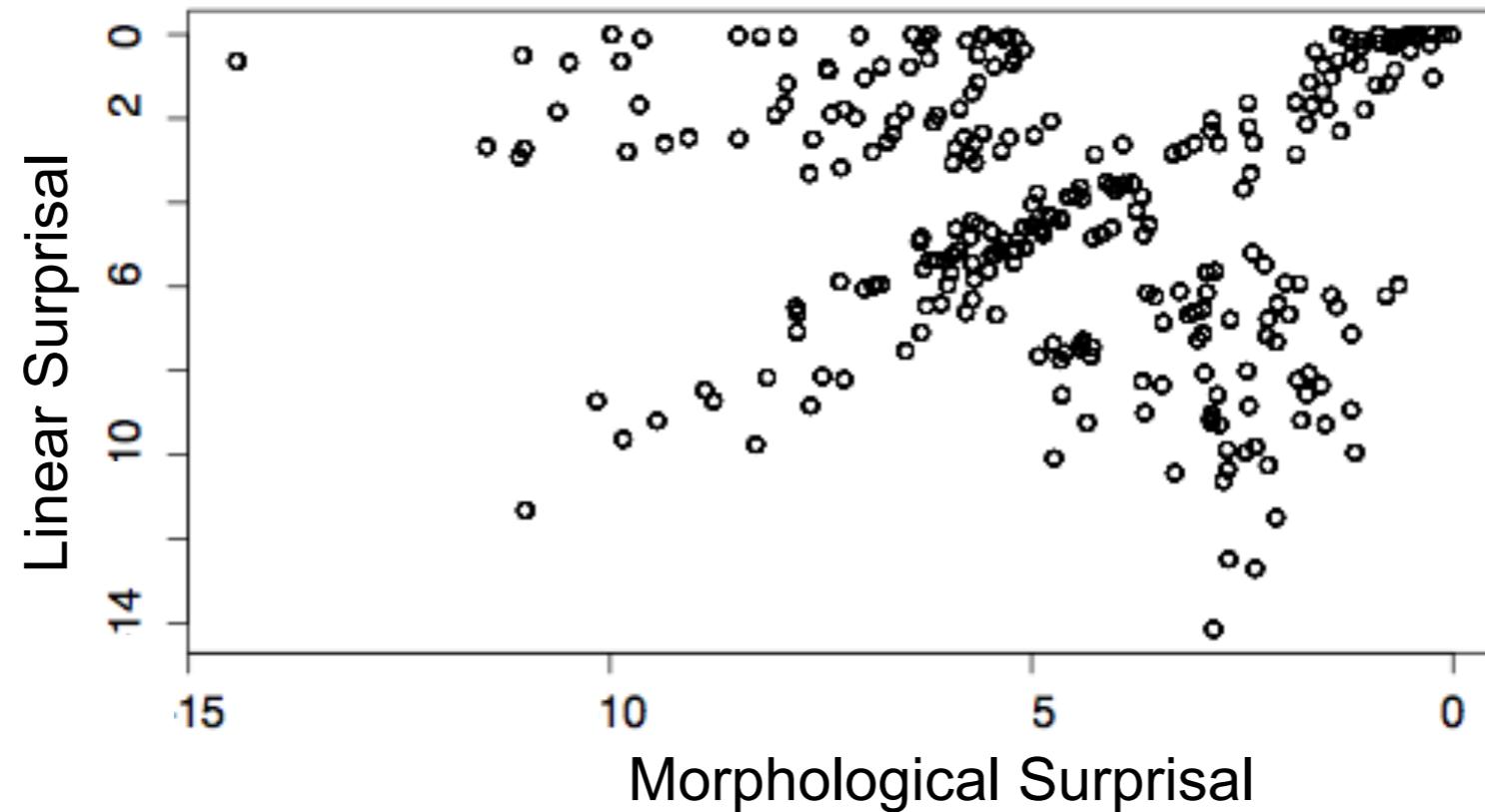
$$\text{morphological surprisal} = -\log(p(B \mid KT))$$

MATERIALS

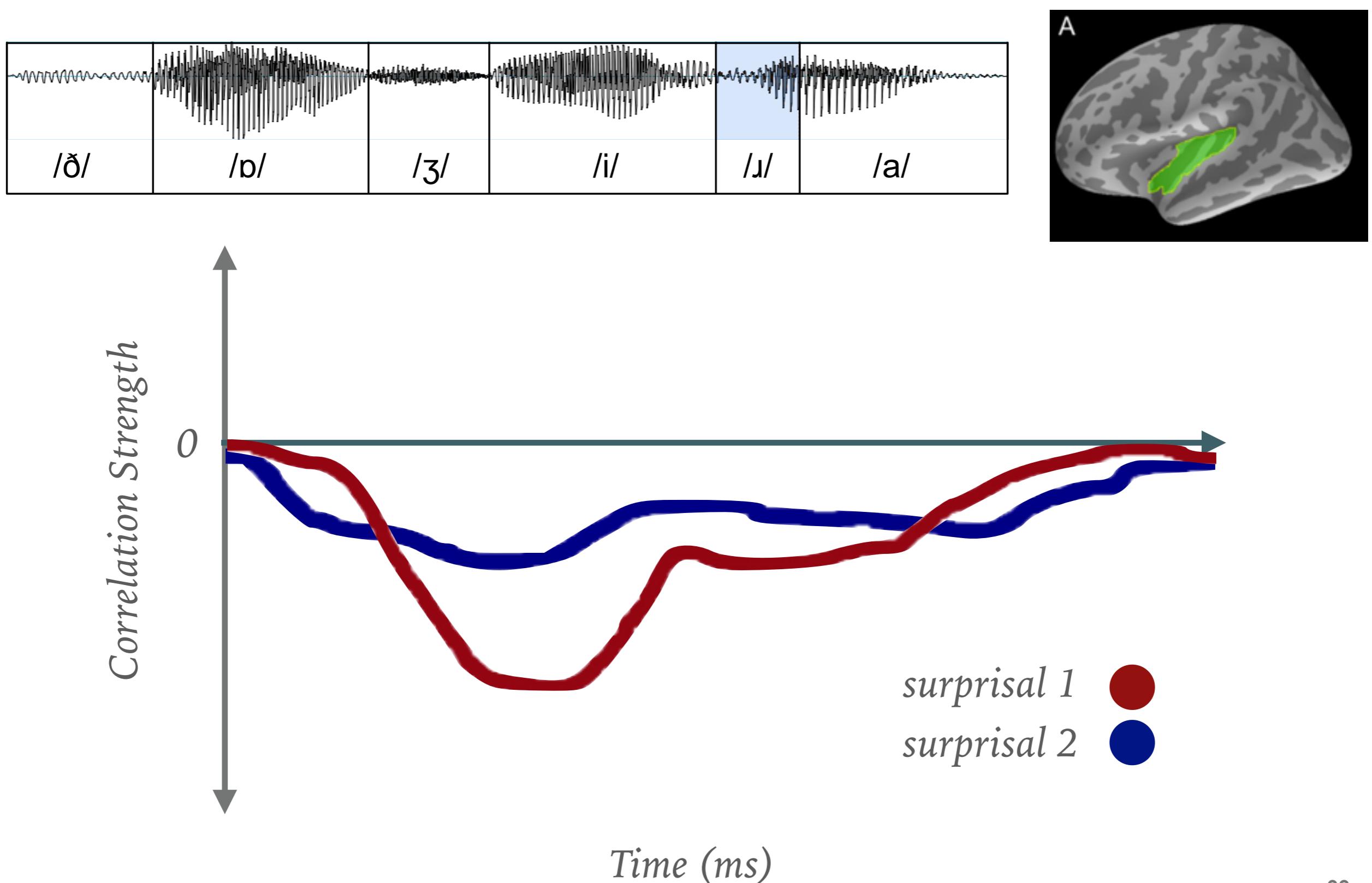
- 280 words with a CVCVCV structure

$$\text{linear surprisal} = -\log(p(B \mid KATA))$$

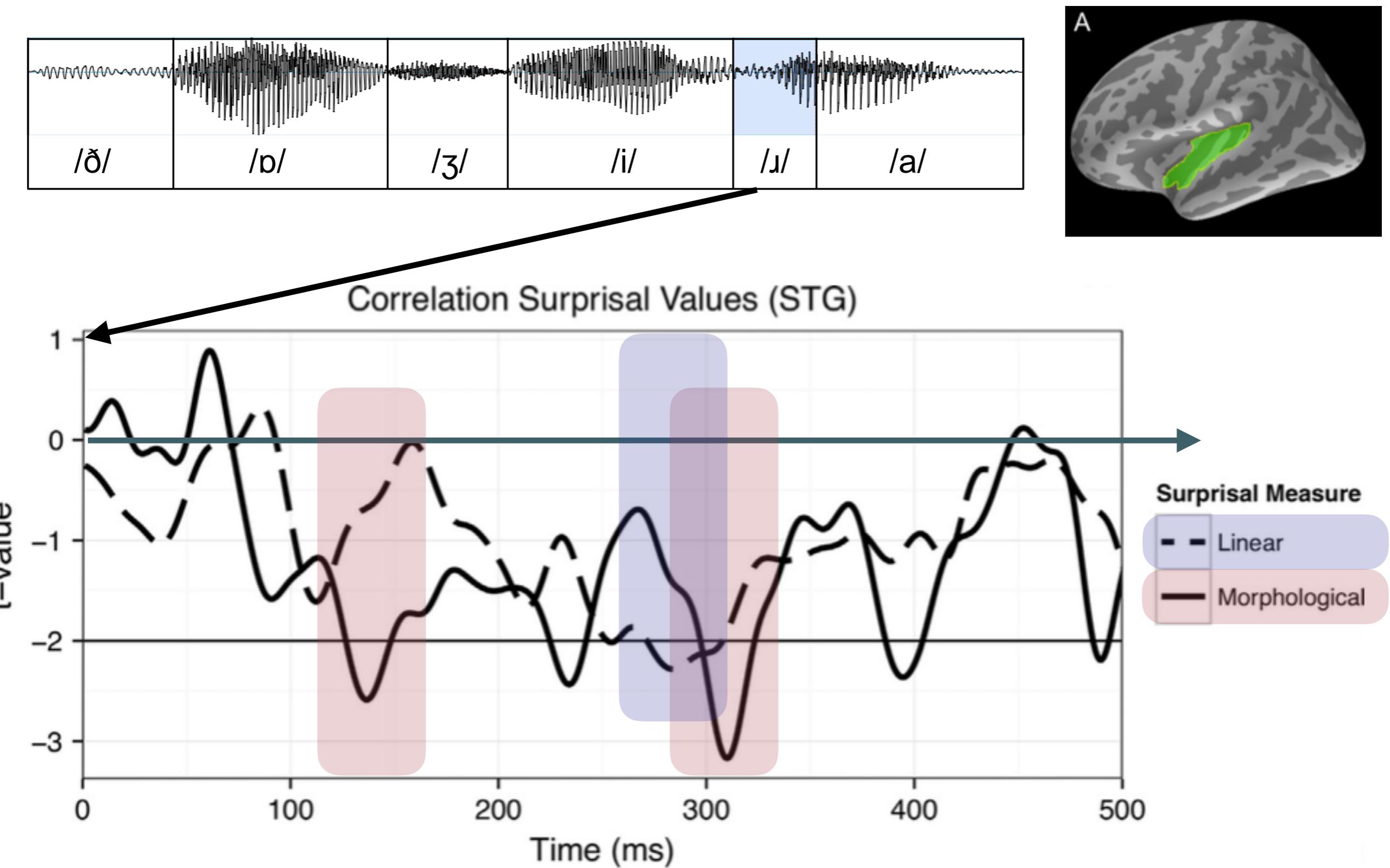
$$\text{morphological surprisal} = -\log(p(B \mid KT))$$



QUESTION



RESULTS



EXPERIMENT 3 – TAKE AWAY

- Spoken word processing in an understudied language such as Arabic also shows morpheme specific processing
- Supports a morphological-driven theory of spoken word comprehension rather than a model that assumes linear processing of phonemes (e.g., the cohort model)

TODAY'S QUESTIONS

1. What is represented?

Root and stem morphemes.

2. How are representations formed?

Dependant upon grammatical wellformedness

3. How are representations accessed?

Through the recognition of a represented stem across both visual and auditory modalities.

THANK YOU, DANKE!

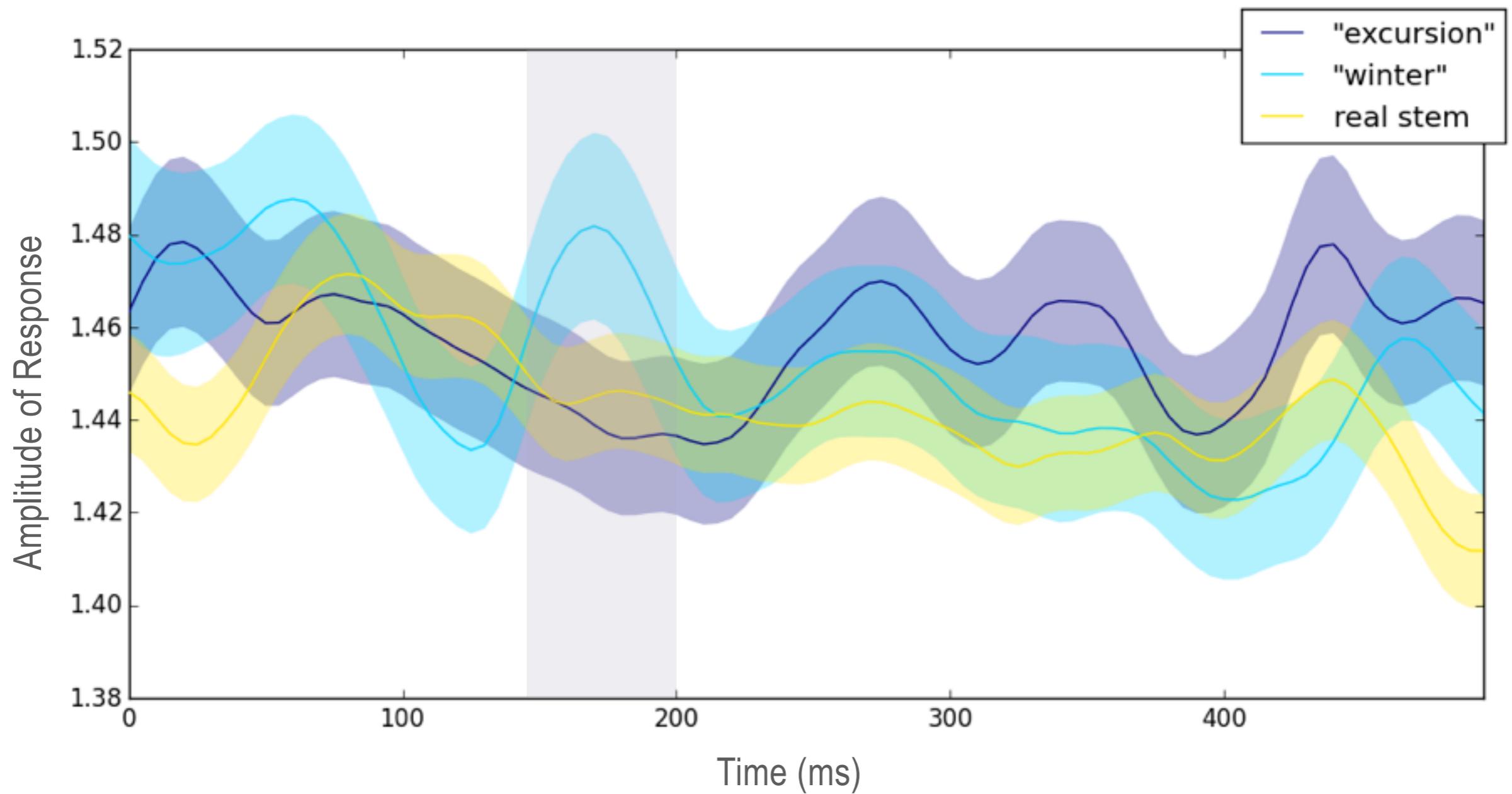
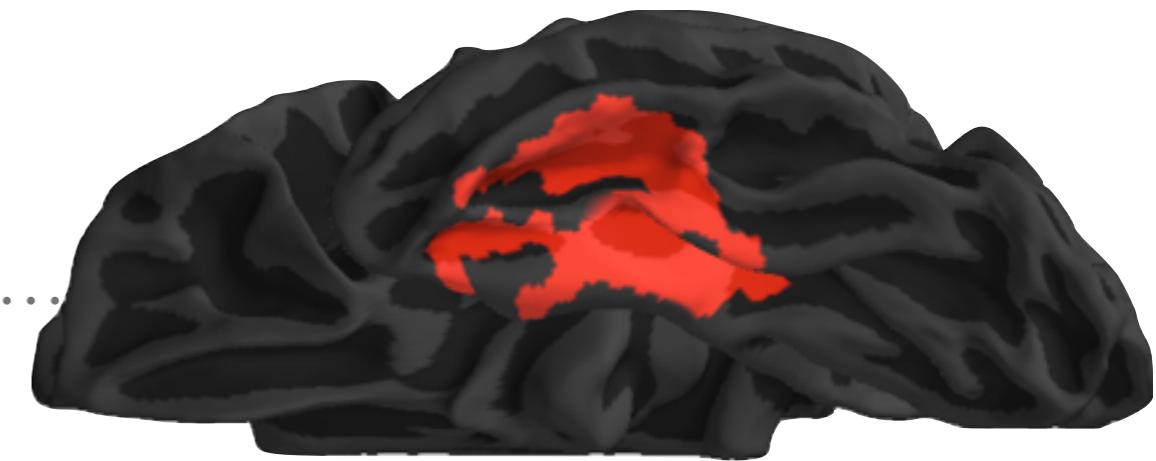
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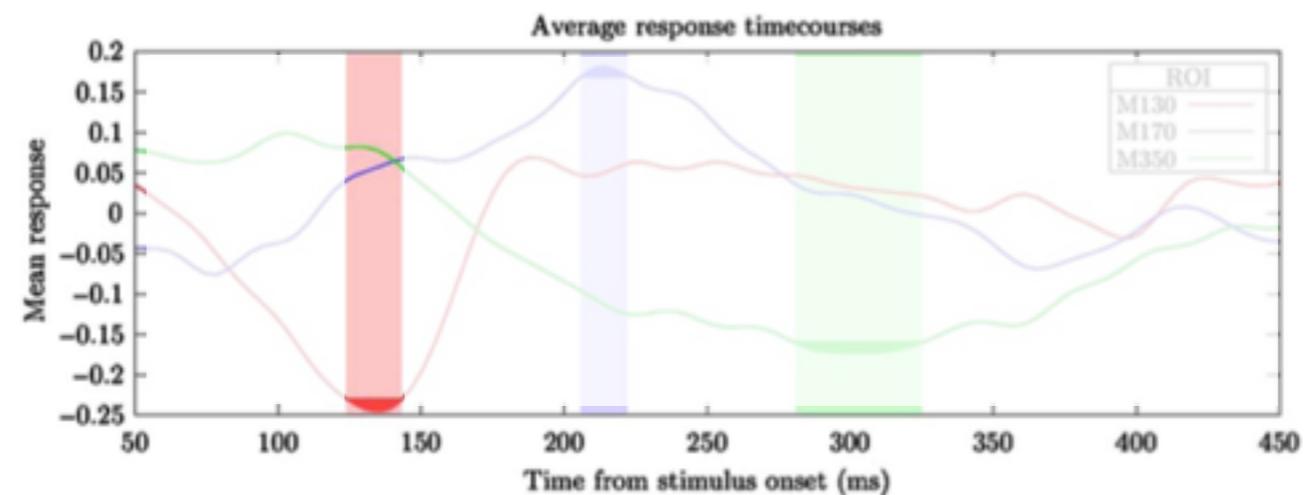
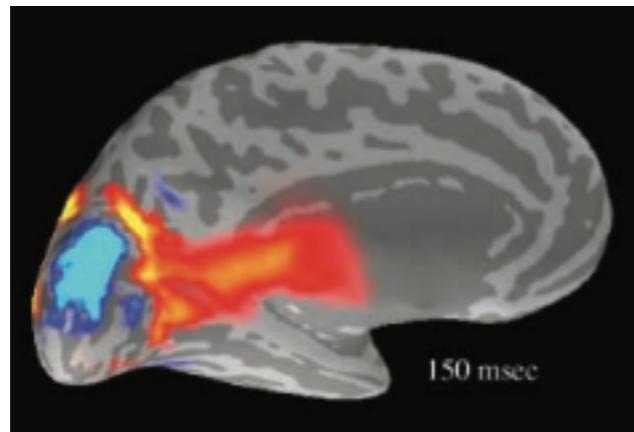
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RESULTS

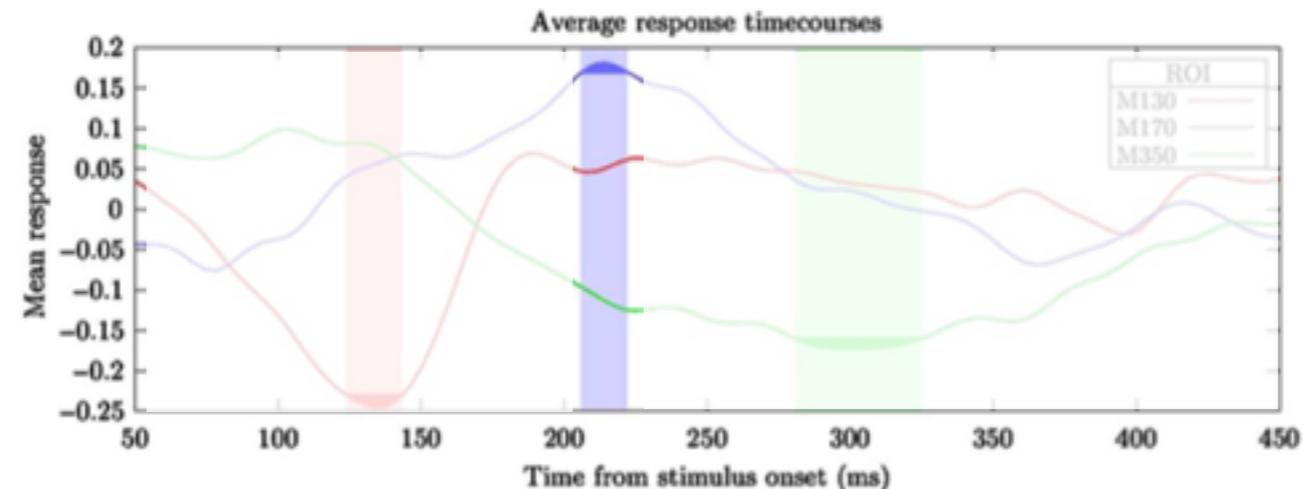
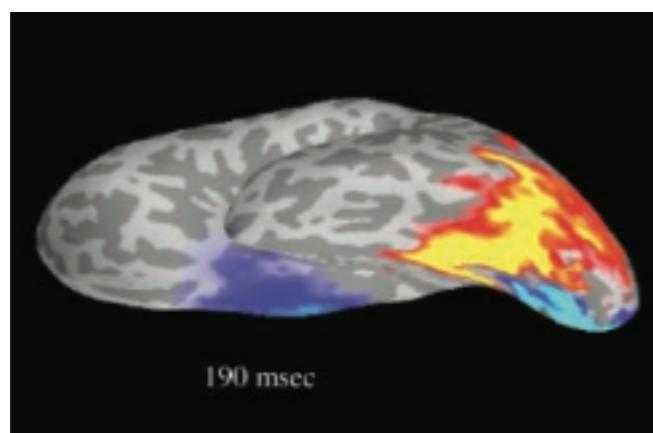


EXPERIMENT 1 – WHEN AND WHERE TO LOOK

- Orthographic processing
 - Correlates with bigram frequency, orthographic affix frequency



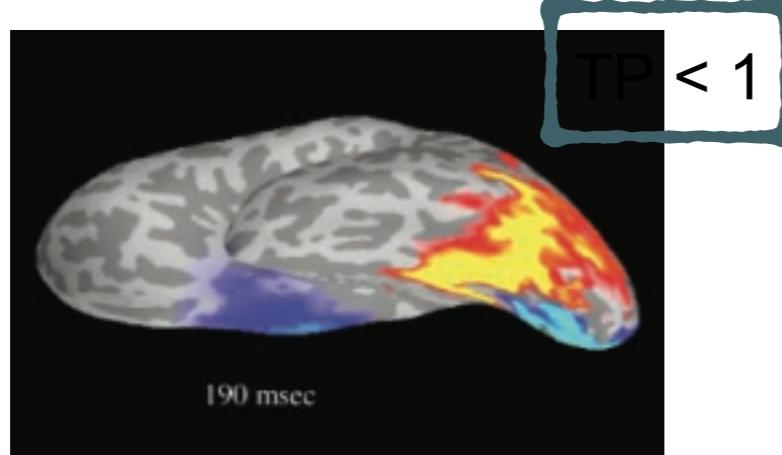
- Morphological processing
 - Correlates with lemma frequency, stem frequency, transition probability



EXPERIMENT 1 - WHEN AND WHERE TO LOOK

- Morphological processing

- Correlates with lemma frequency, stem frequency, transition probability

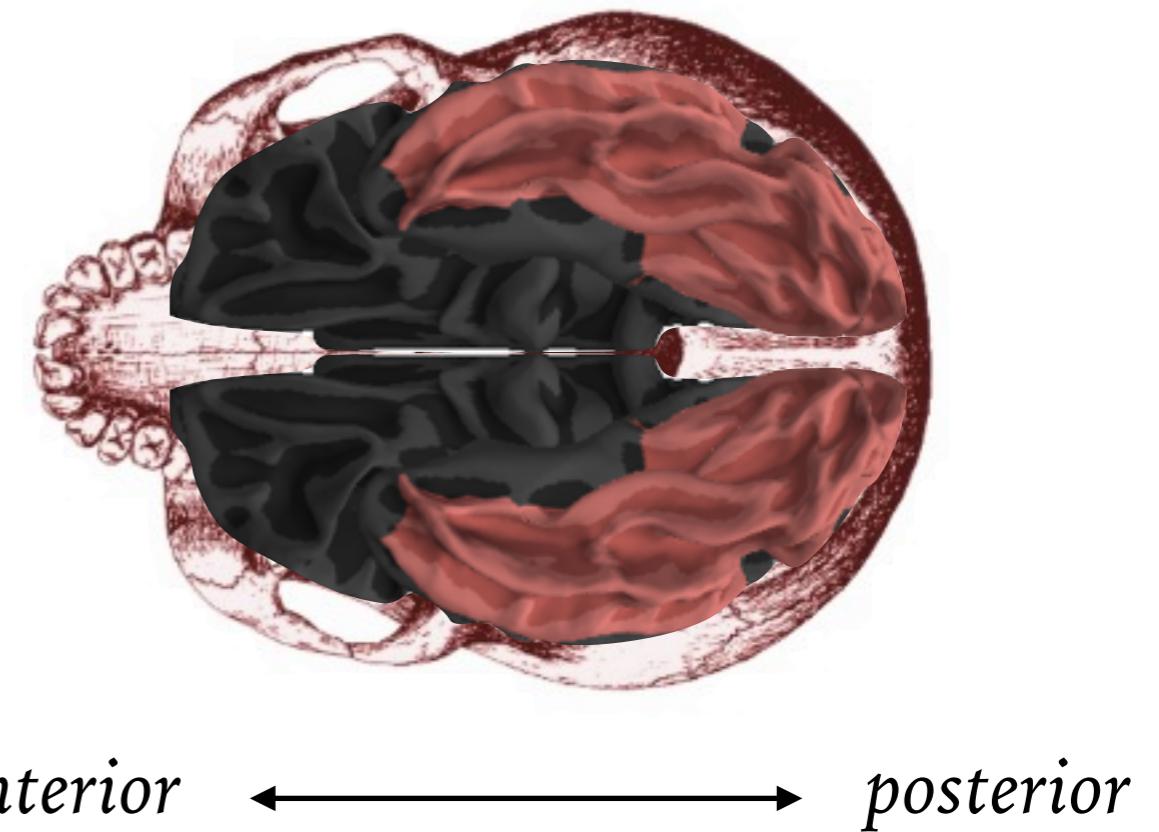
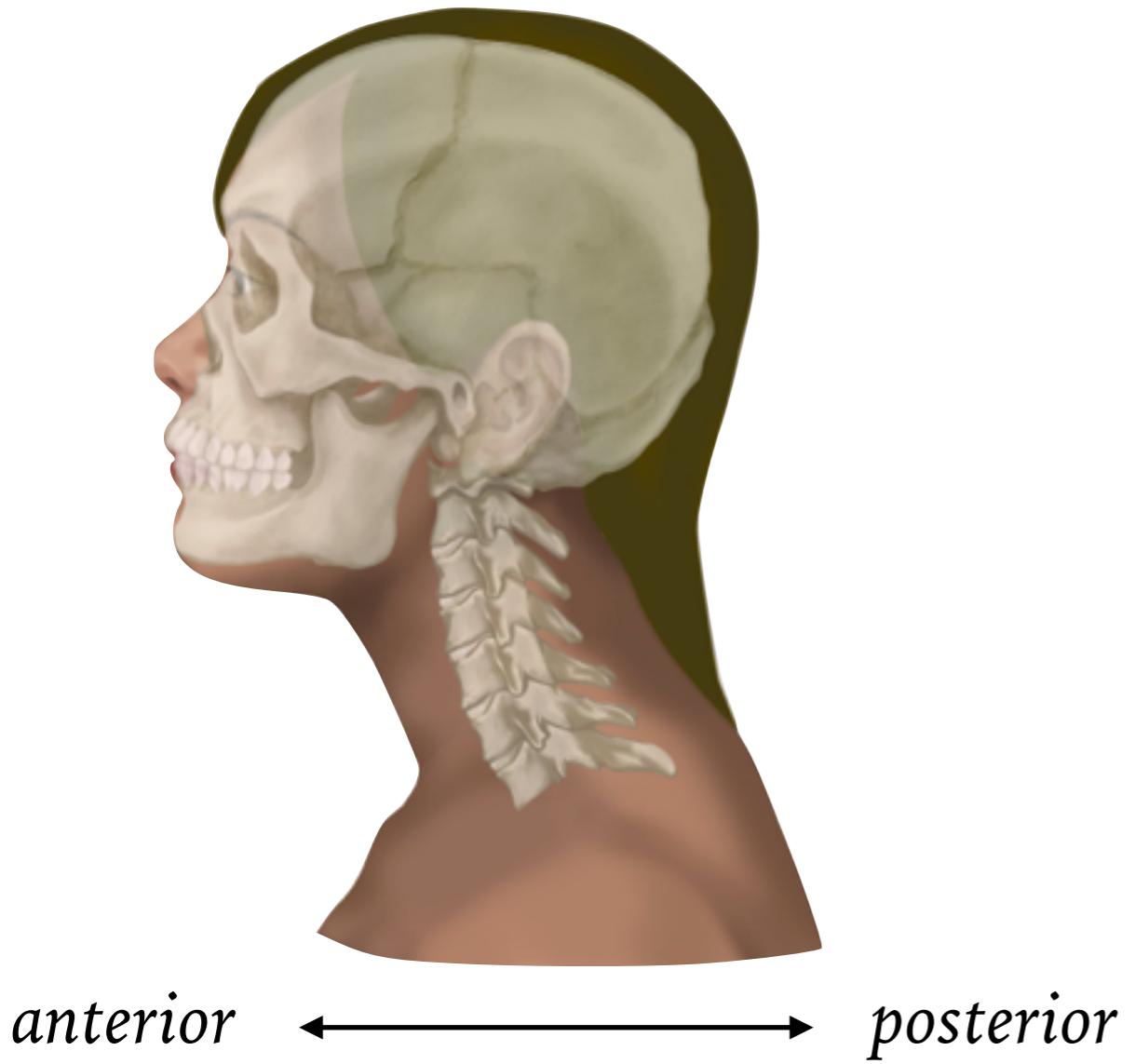


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EXPERIMENT 1 – WHEN AND WHERE TO LOOK



RESULTS

