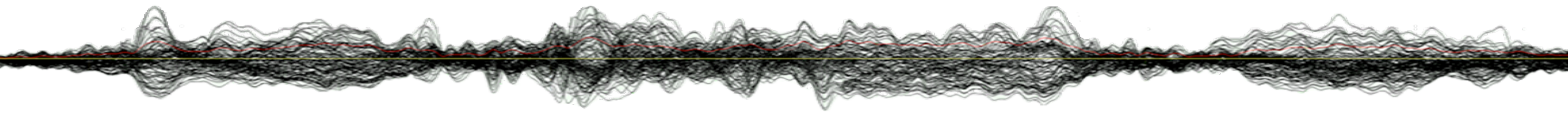
NEW YORK UNIVERSITY

TAKING MORPHOLOGY SERIOUSLY: MEG STUDIES OF MORPHOLOGICAL REPRESENTATIONS



Laura Gwilliams & Alec Marantz

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

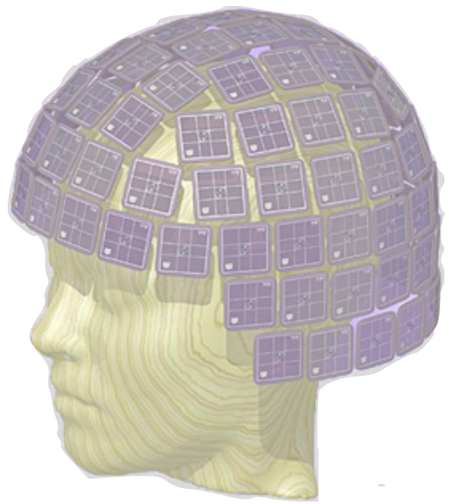
TODAY'S QUESTIONS

1. What is represented?

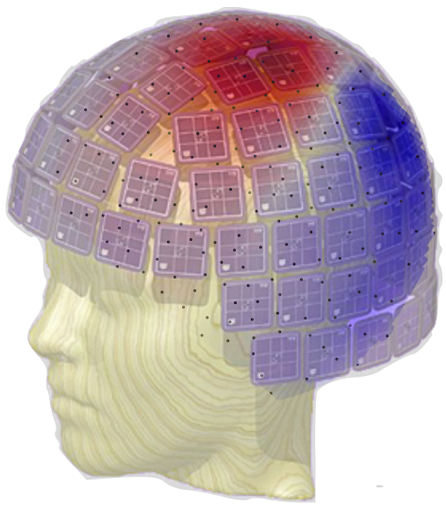
2. How are representations formed?

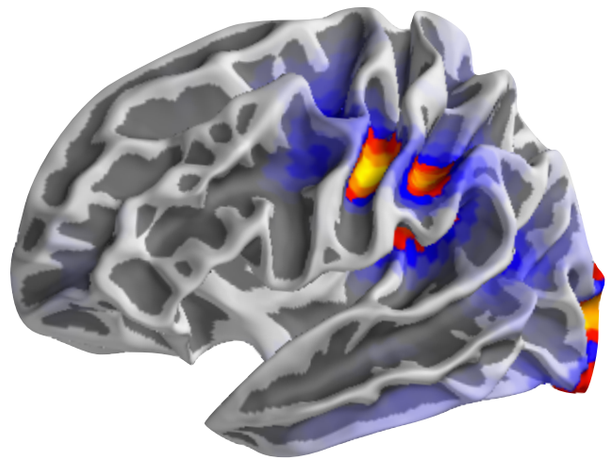
3. How are representations accessed?

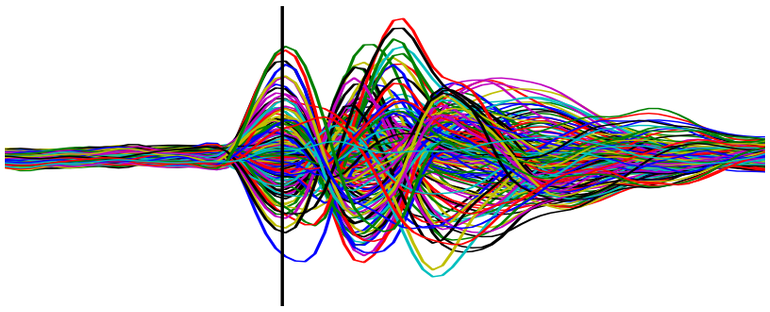
MAGNETOENCEPHALOGRAPHY (MEG)

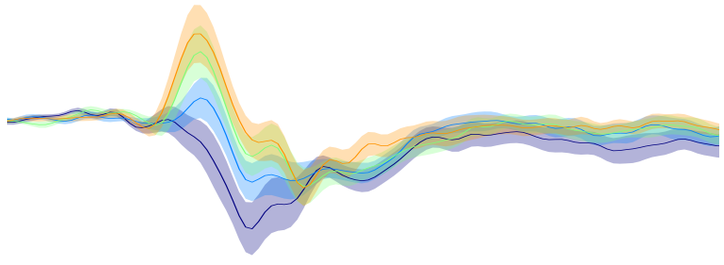


MAGNETOENCEPHALOGRAPHY (MEG)









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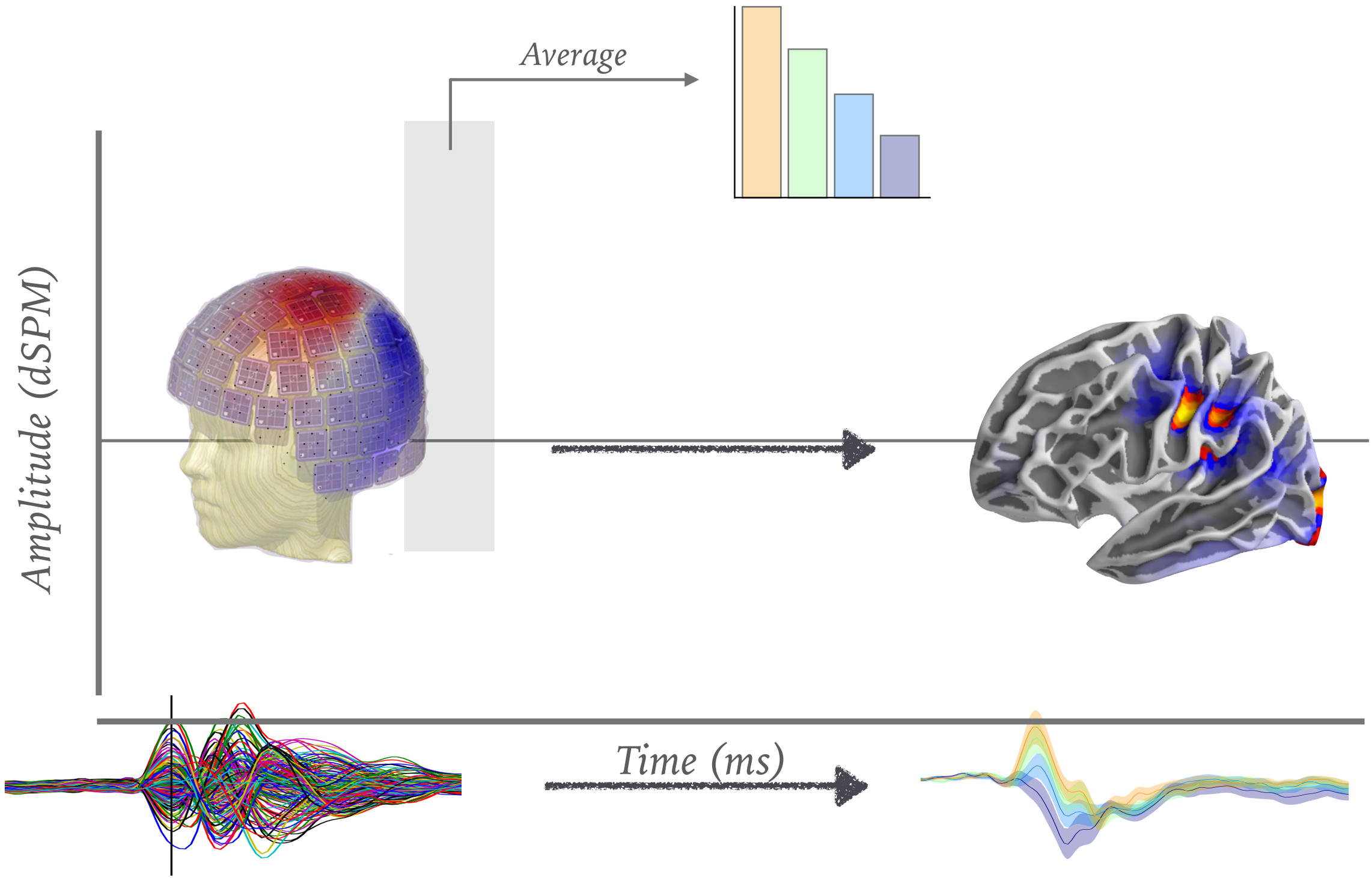
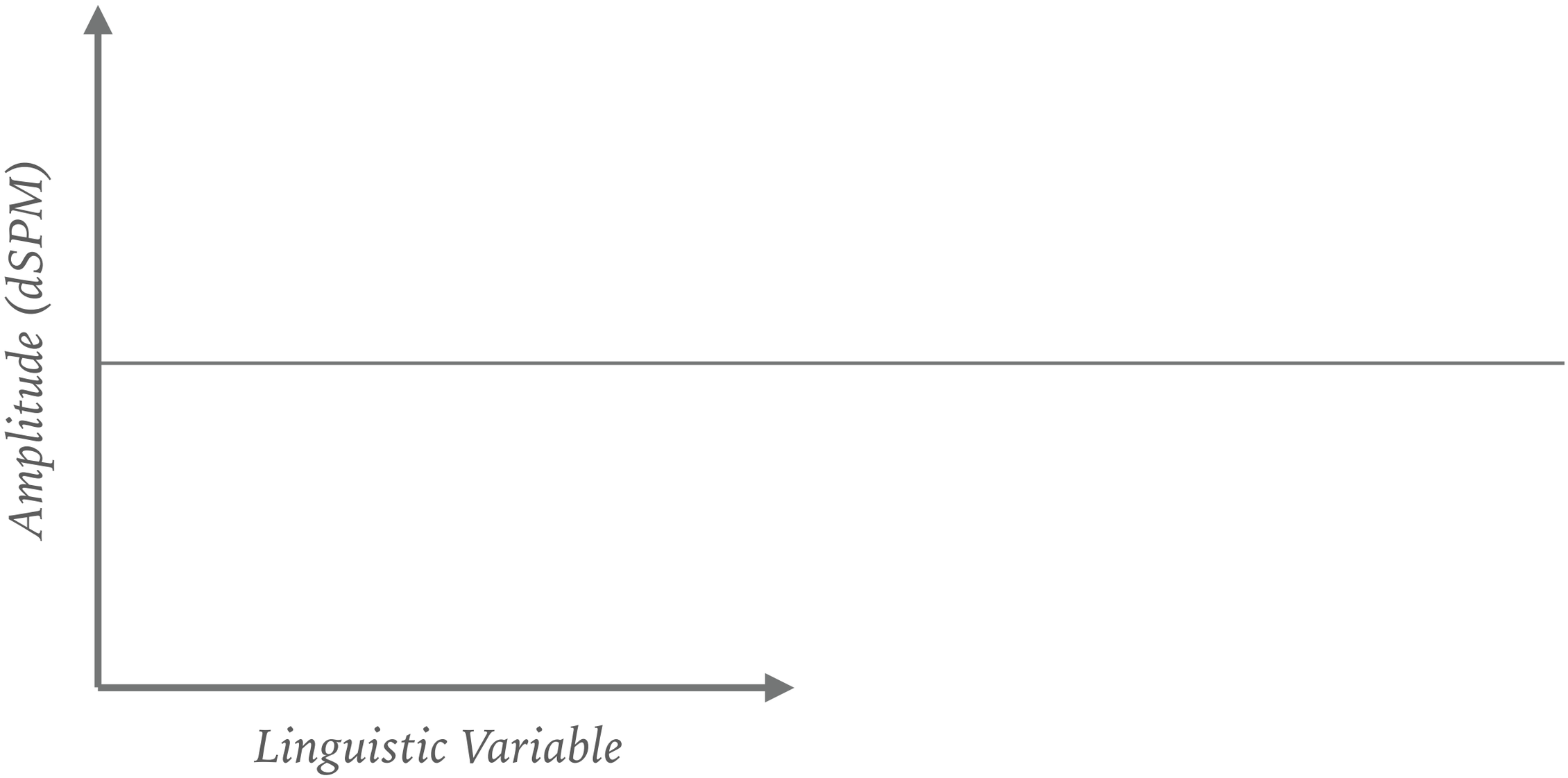
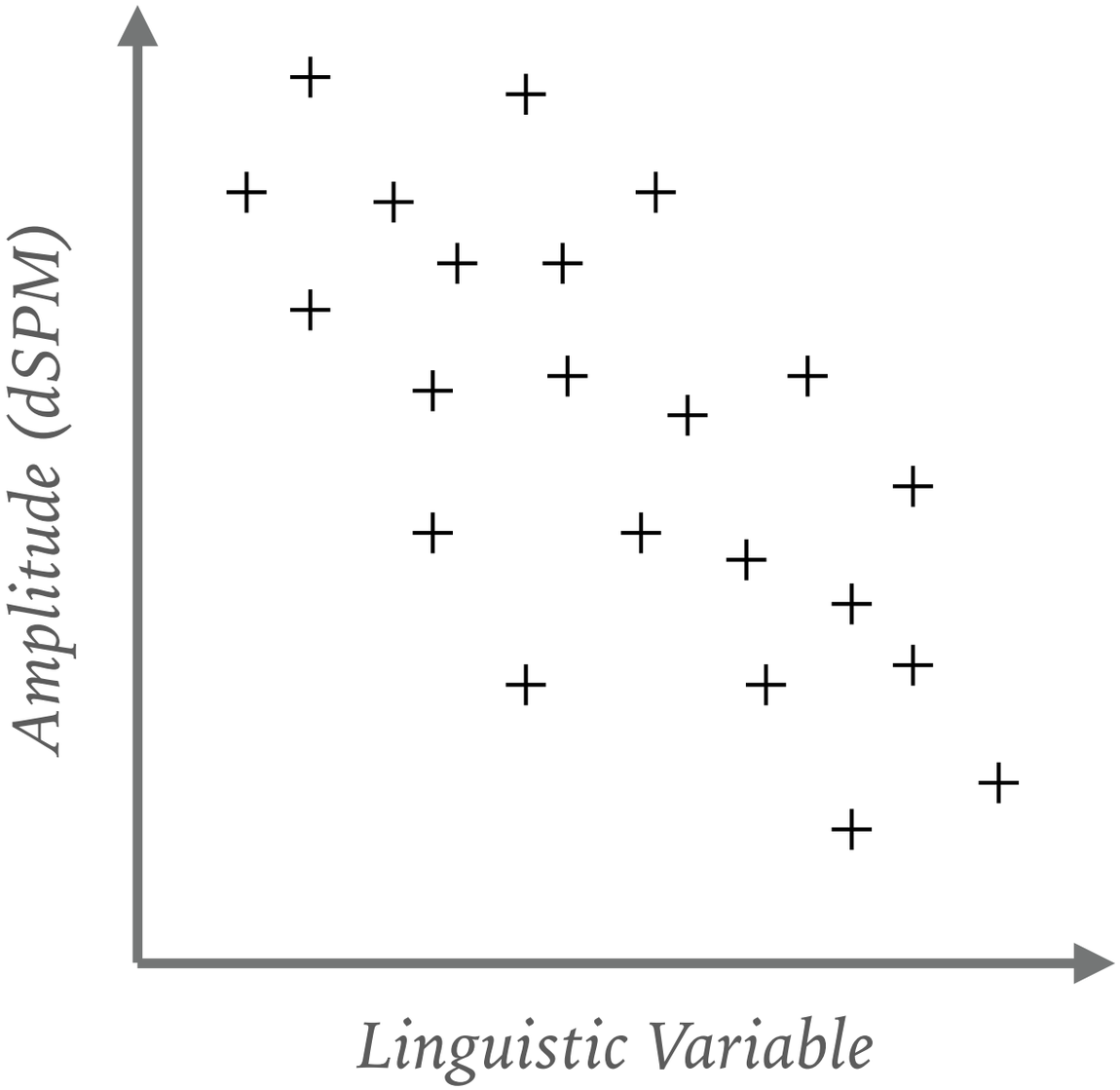


MAGNETOENCEPHALOGRAPHY (MEG)



MAGNETOENCEPHALOGRAPHY (MEG)



EXPERIMENT 1:

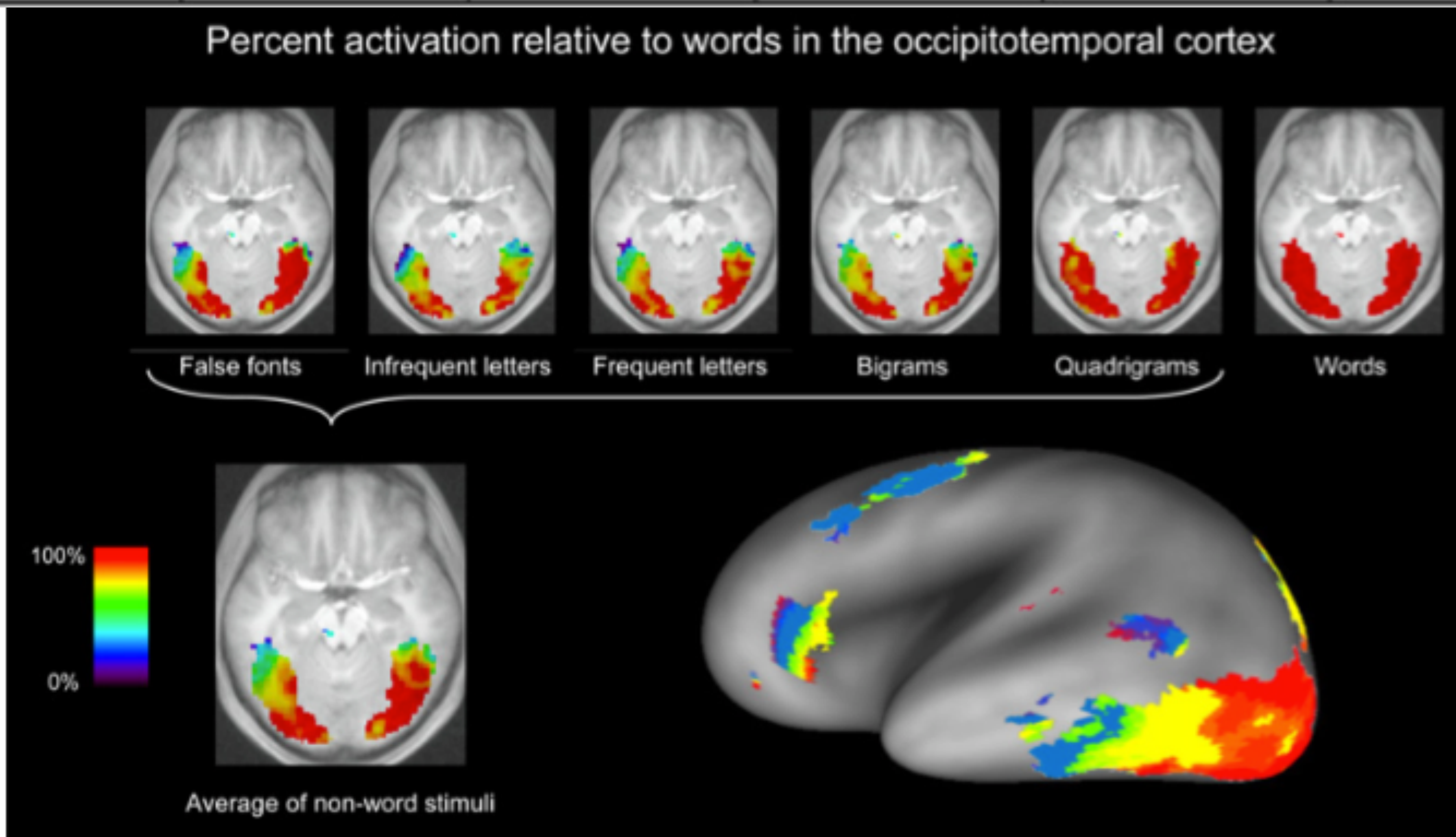
WHEN AND WHERE TO LOOK

Gwilliams, Lewis & Marantz (In Press)

EXPERIMENT 1 – WHEN AND WHERE TO LOOK

less wordlike ⟷ *more wordlike*

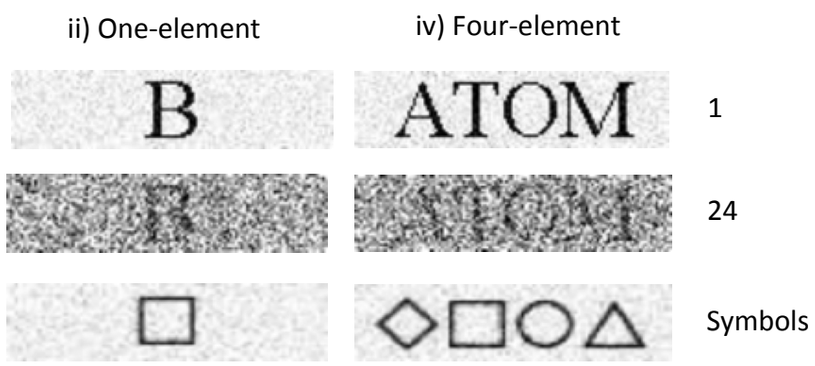
	JZWYWK	**QOADTQ**	**QUMBSS**	**AVONIL**	**GRAVEL**



Vinckier et al., 2007

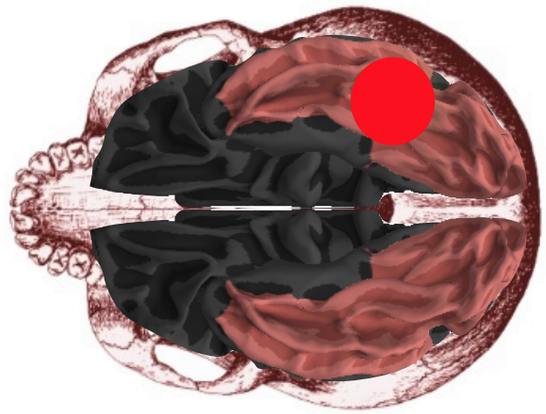
FUNCTIONAL LOCALISER

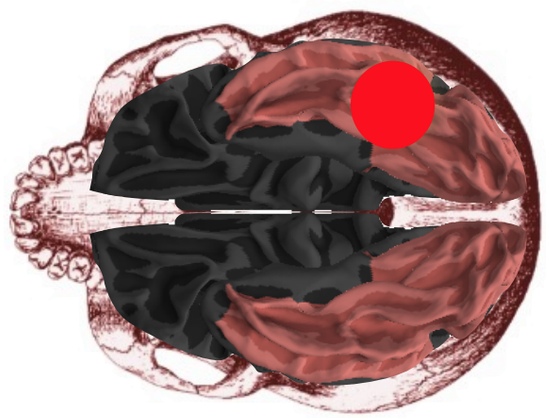
Mini-Experiment



"Real" Experiment

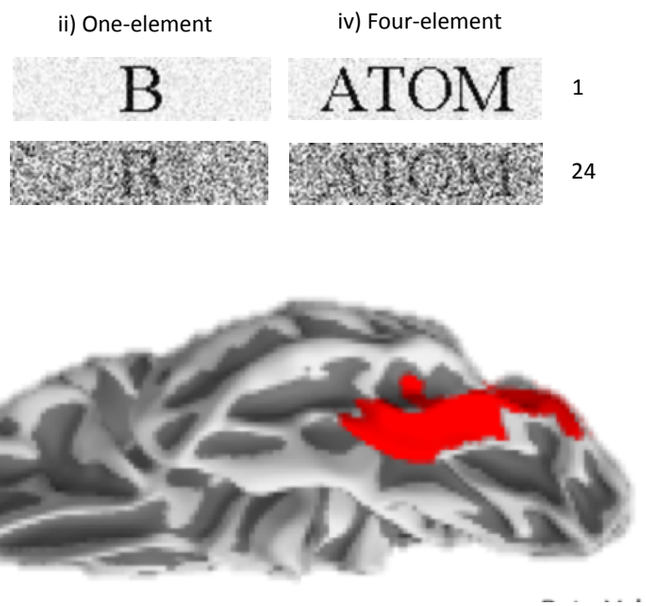
free stem	bound stem
bookable	durable
perishable	equable
predictable	hospitable
printable	numerable

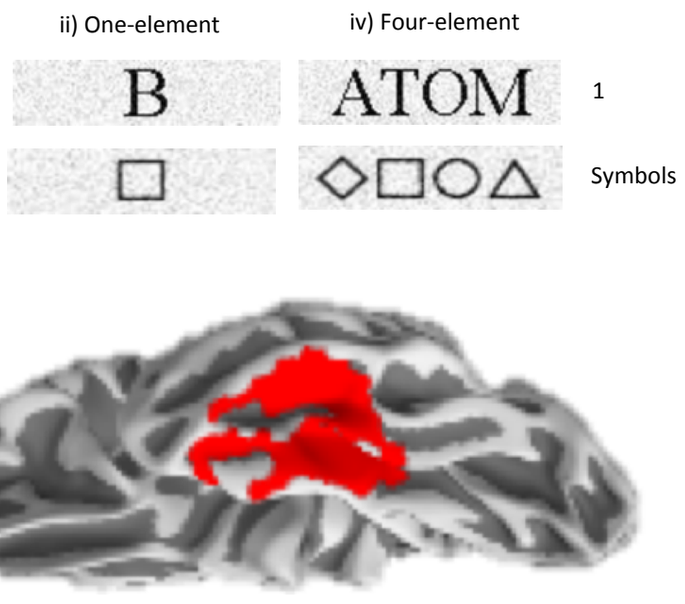




Gwilliams, Lewis & Marantz (In Press)

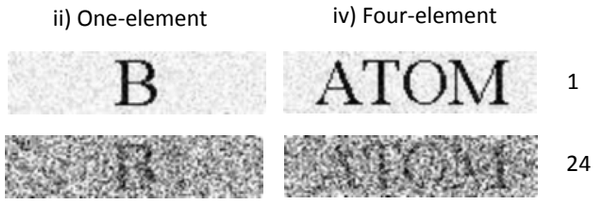
FUNCTIONAL LOCALISER



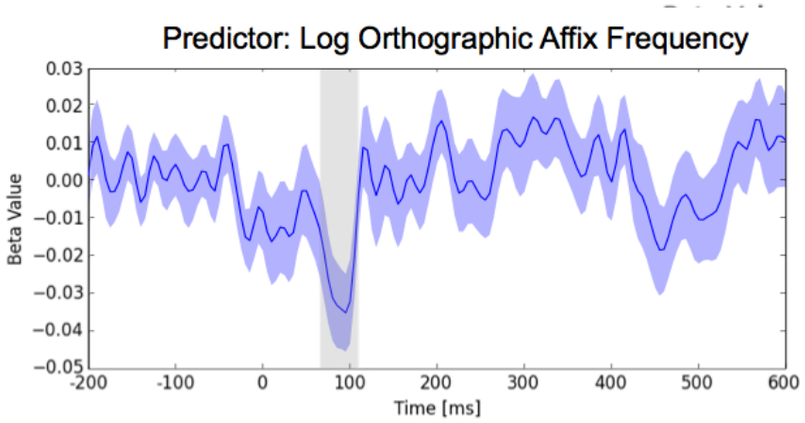


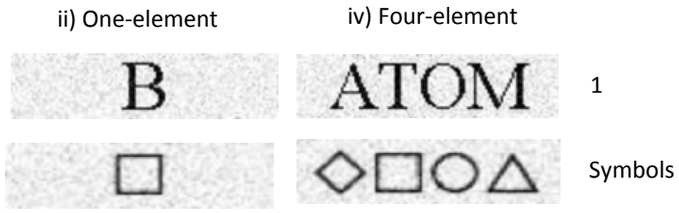
Gwilliams, Lewis & Marantz (In Press)

APPLYING FUNCTIONAL LOCALISER

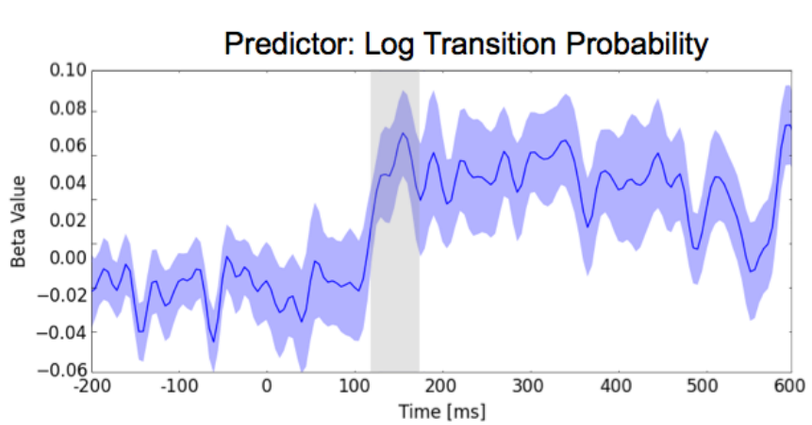


Orthographic





Morphological



Gwilliams, Lewis & Marantz (In Press)

EXPERIMENT 1 – TAKE AWAY

- Orthography: ~140 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

Gwilliams & Marantz (In Prep.)

“

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

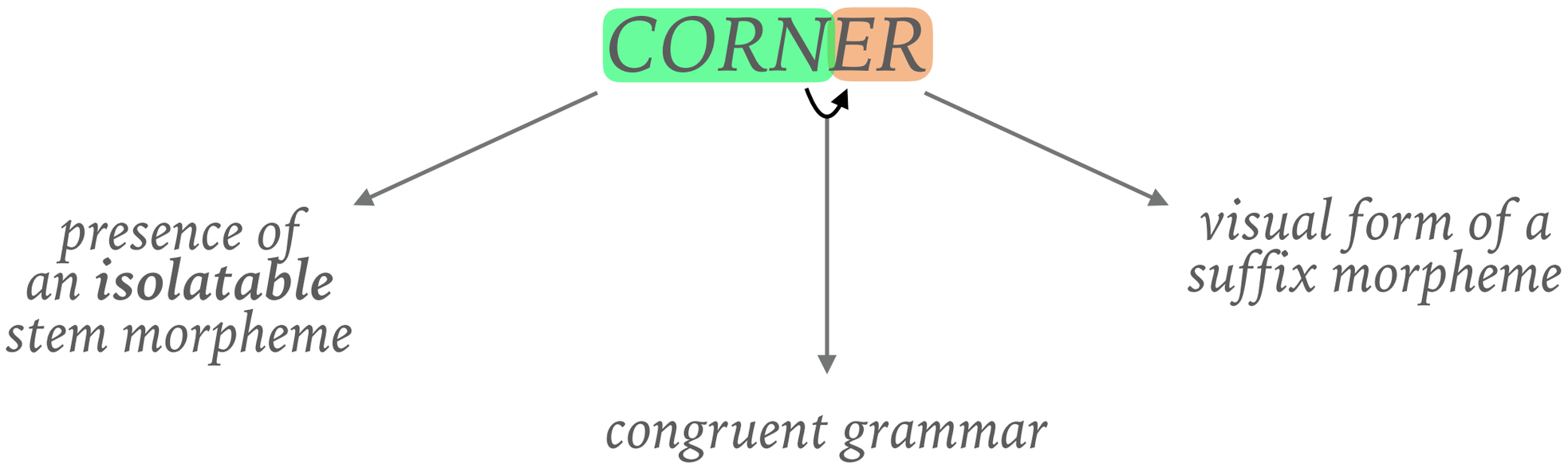
Making New Words, 2014: 3

BACKGROUND & QUESTION

- Copious evidence that:

$$FARMER \longrightarrow FARM + ER$$
$$CORNER \longrightarrow CORN + ER$$
$$BROTHEL \neq BROTH + EL$$

- What is driving this effect?



see Rastle & Davis, 2008 for a review

QUESTION

EXCURSION

- isolatable stem, + congruent grammar

“to explode”
“explosion”

“to excurse”
“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

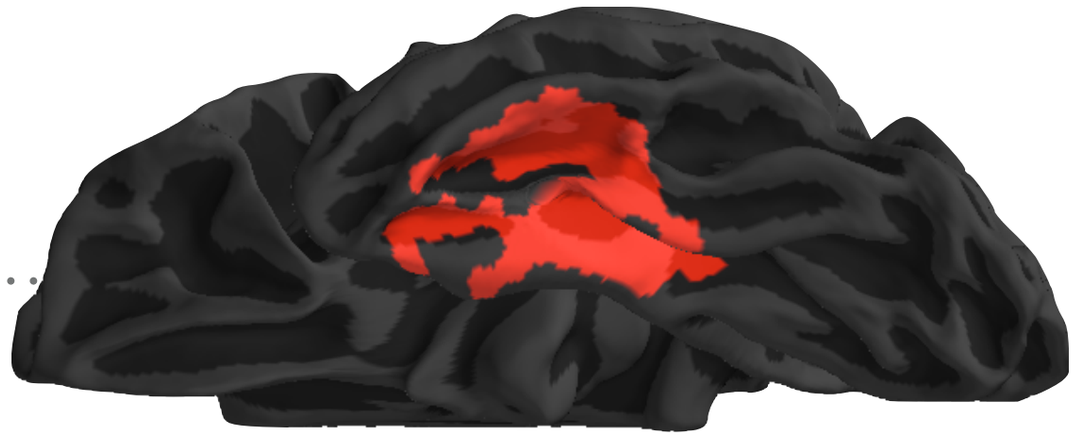
LEAKAGE
+ isolatable stem, + congruent grammar

EXCURSION
- isolatable stem, + congruent grammar

BROTHER
+ isolatable stem, - congruent grammar

WINTER
- isolatable stem, - congruent grammar

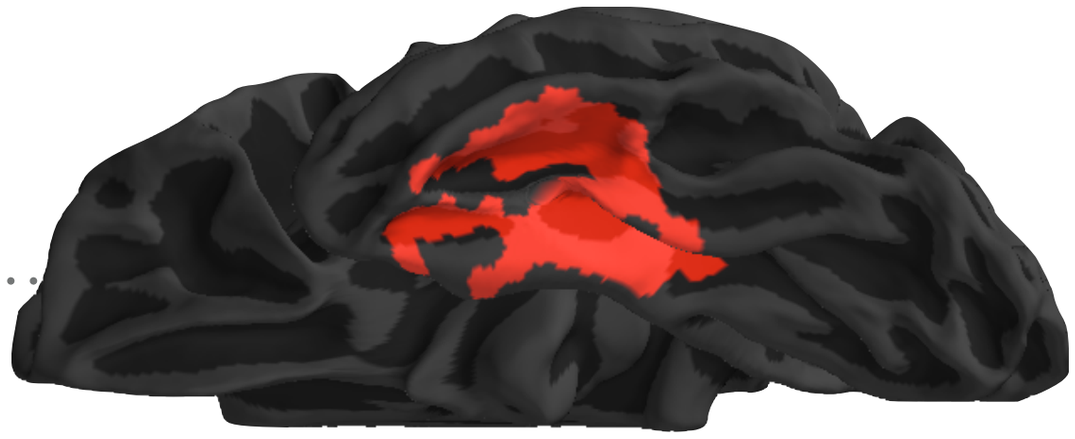
RESULTS



- Hypotheses:

CONDITION
leakage
brother
excursion
winter

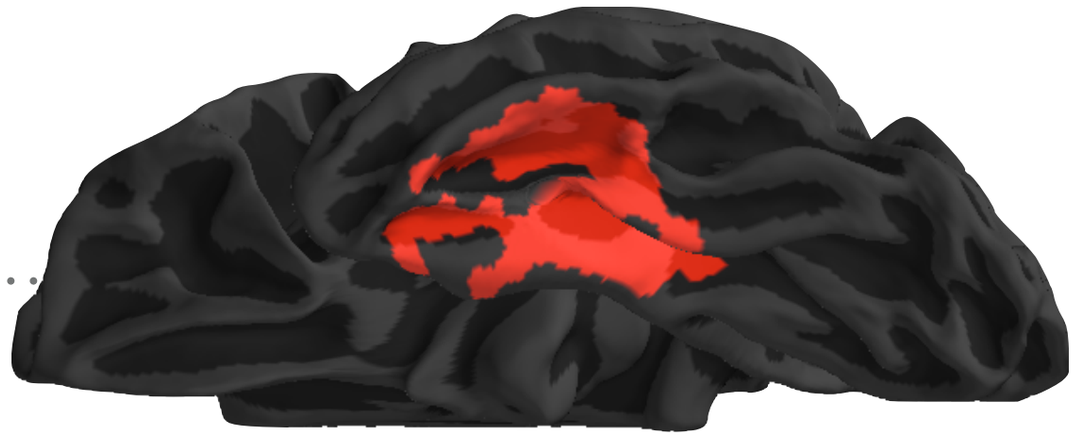
RESULTS



- Analysis:
  - Mixed effects 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

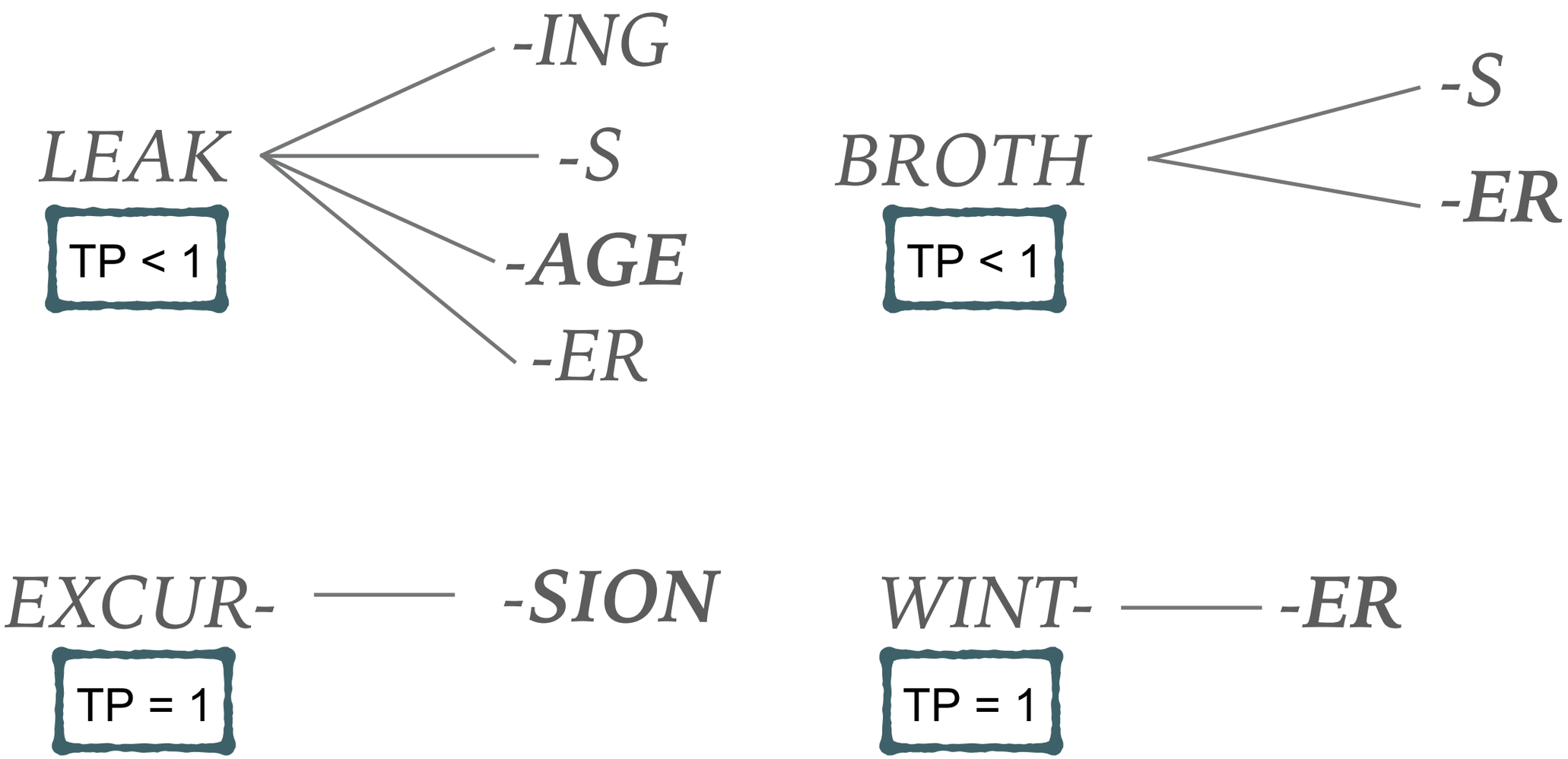


- Analysis:
  - Mixed effects regression model
  - Ran in localised “morphology” region
  - Coded as binary variables

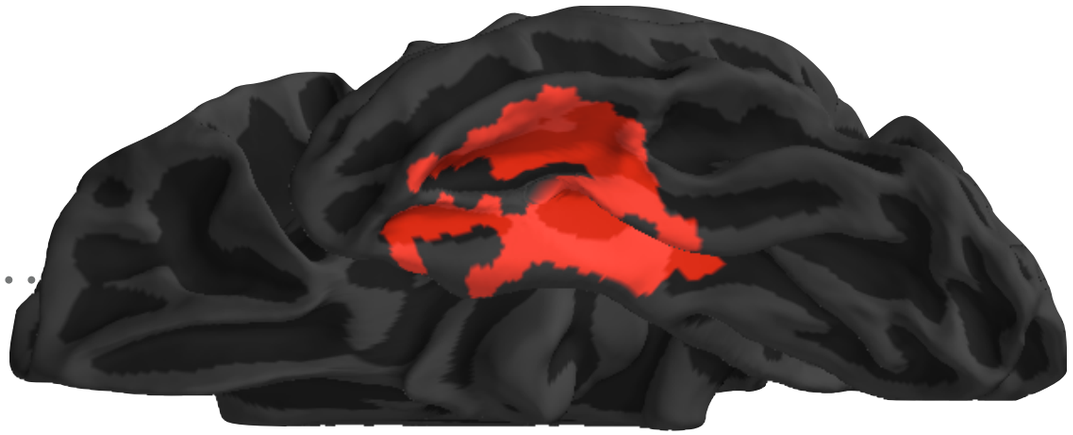
	not significant	approaching significance	significant
	p > .5	t = 1.06, p = .105	t = 2.15, p = .03
CONDITION	suffix	isolatable stem	congruent grammar	combination 2 or 3
leakage	1	1	1	1
brother	1	1	0	1
excursion	1	0	1	1
winter	1	0	0	0

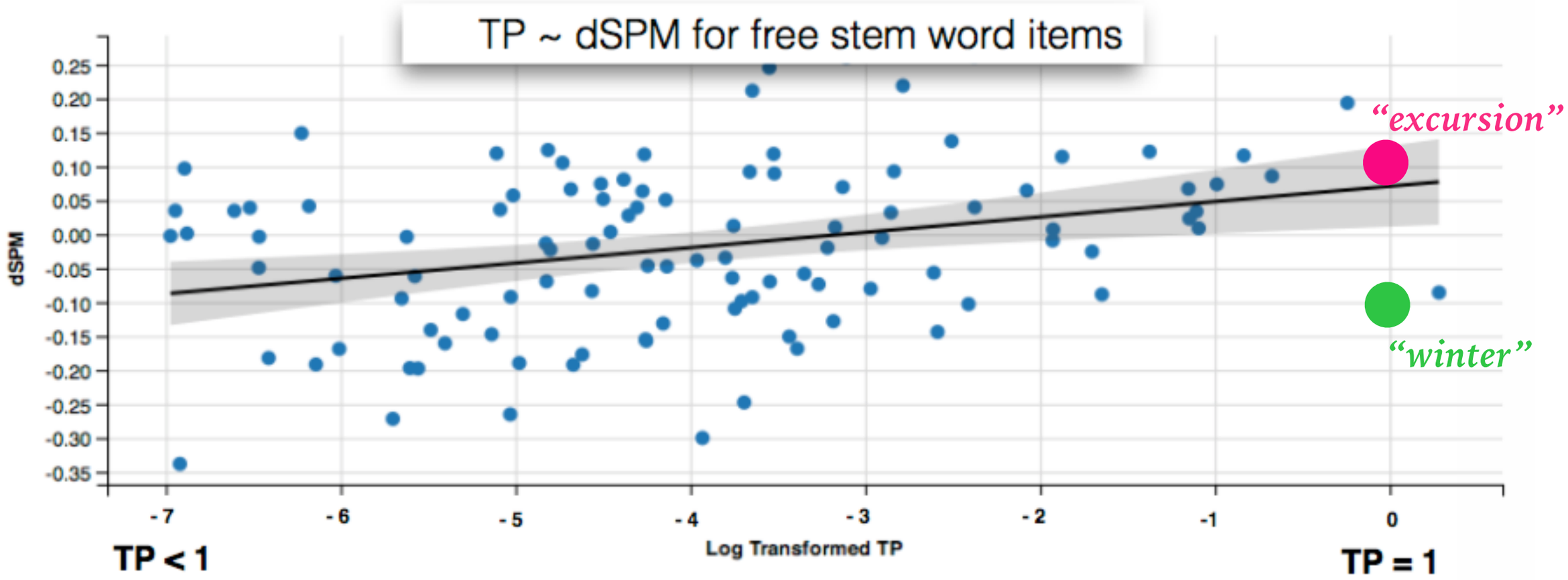
RESULTS

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



RESULTS




TP ~ dSPM for free stem word items
0.25
0.20
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15
-0.20
-0.25
-0.30
-0.35
dSPM
-7
-6
-5
-4
-3
-2
-1
0
Log Transformed TP
TP < 1
TP = 1
"excursion"
"winter"

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 3:

REPRESENTATIONS OF NON-LINEAR ROOTS

Gwilliams & Marantz (2015)

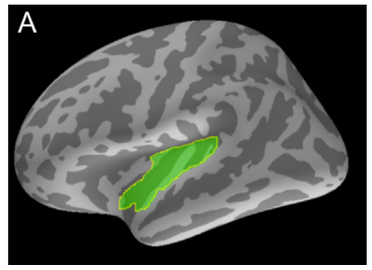
BACKGROUND

- 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

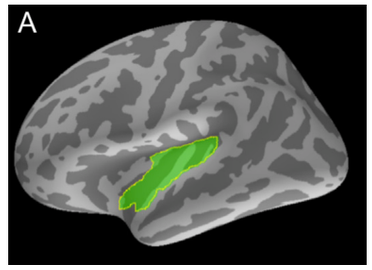


- The superior temporal gyrus is sensitive to how expected it is for a sound to occur within a word
- We utilised this sensitivity to determine what morphological constituents are activated during processing

$$K\,A\,T\,A\,B\,A \qquad p(B \mid KATA)$$

$$K\,T\,B \qquad p(B \mid KT)$$

QUESTION

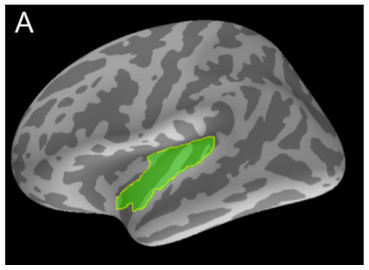


- The superior temporal gyrus is sensitive to how expected it is for a sound to occur within a word
- We utilised this sensitivity to determine what morphological constituents are activated during processing

$$K\,A\,T\,A\,B\,A \qquad \frac{frequency(KATAB)}{frequency(KATA)}$$

$$K\,T\,B \qquad \frac{frequency(KTB)}{frequency(KT)}$$

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

$$K\,A\,T\,A\,B\,A$$

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

$$K\,T\,B$$

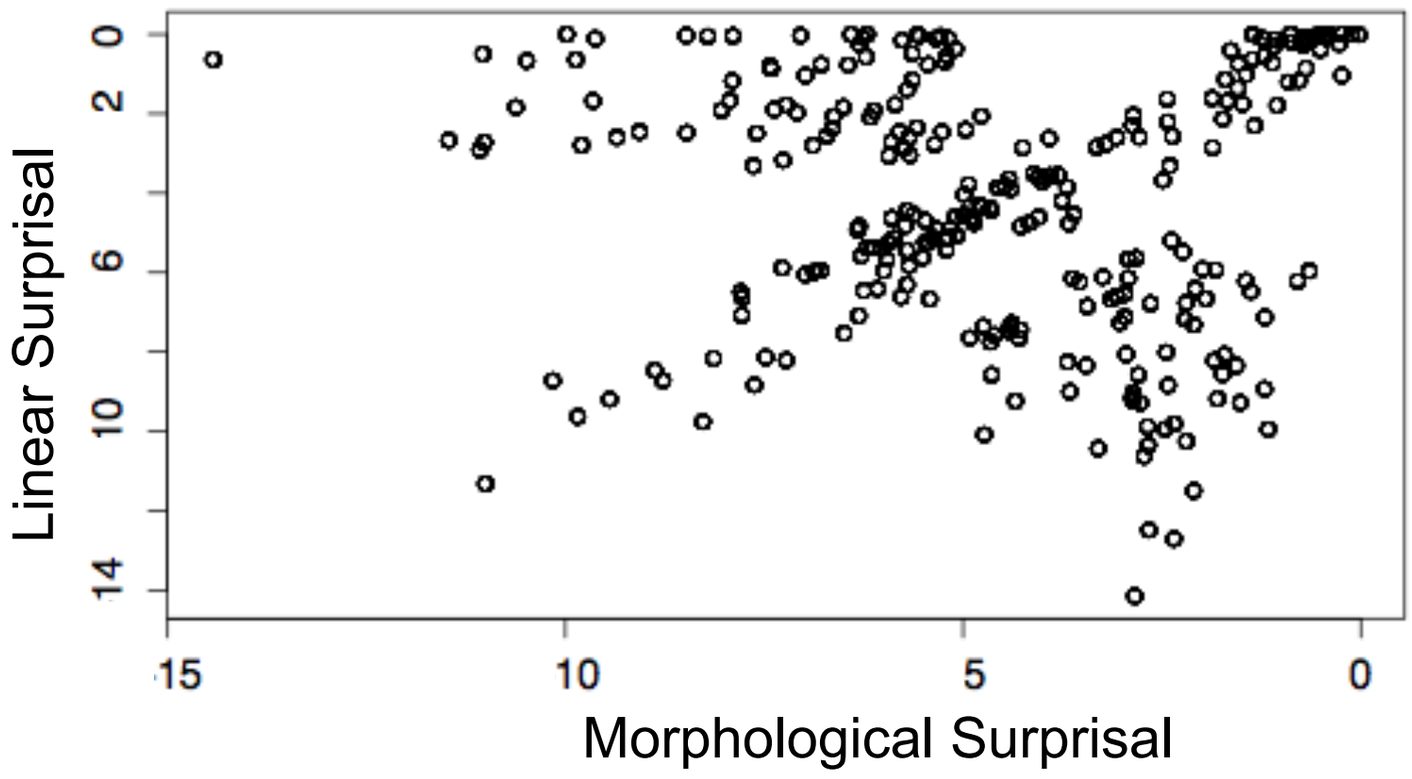
$$\textit{morphological surprisal} = -\log(p(B \mid KT))$$

MATERIALS

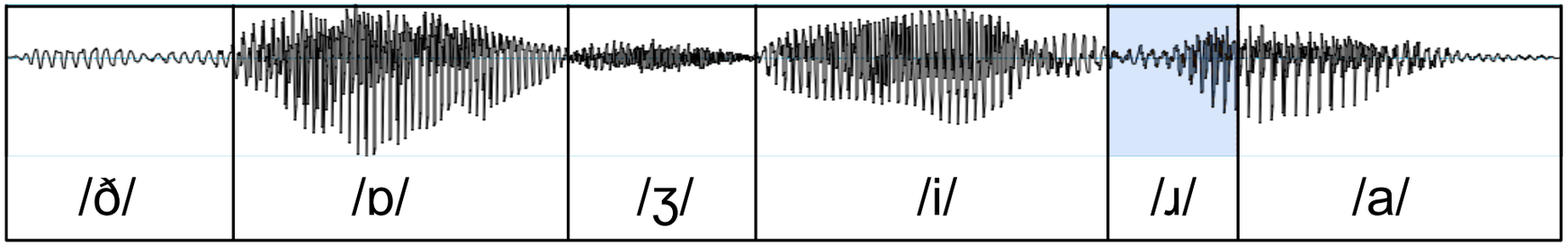
- 280 words with a CVCVCV structure

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

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



QUESTION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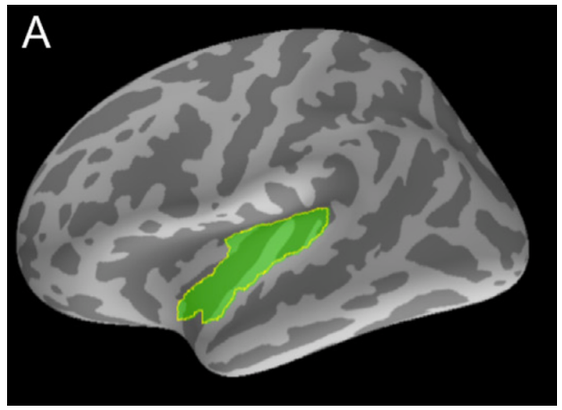
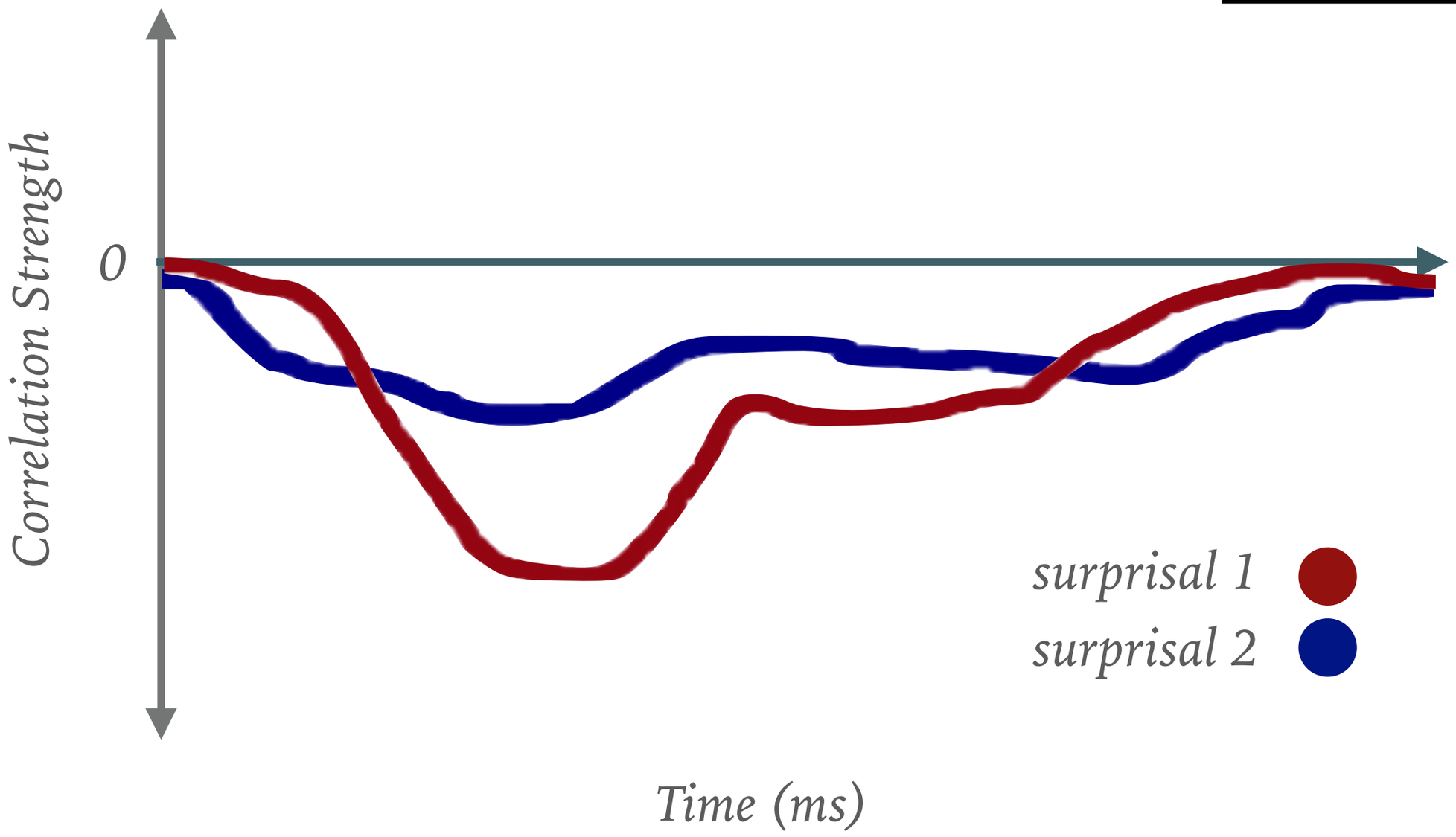
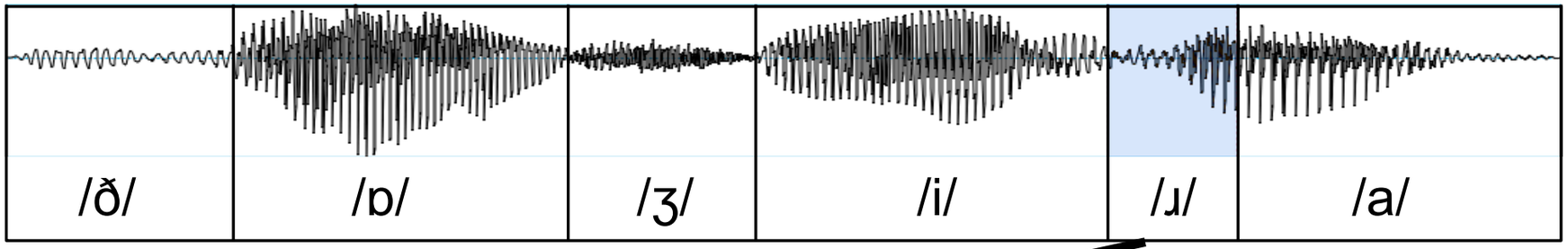

A


Correlation Strength
0
surprisal 1
surprisal 2
Time (ms)

RESULTS


/ð/
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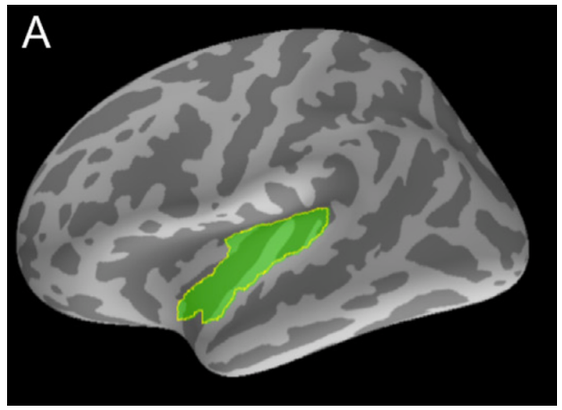
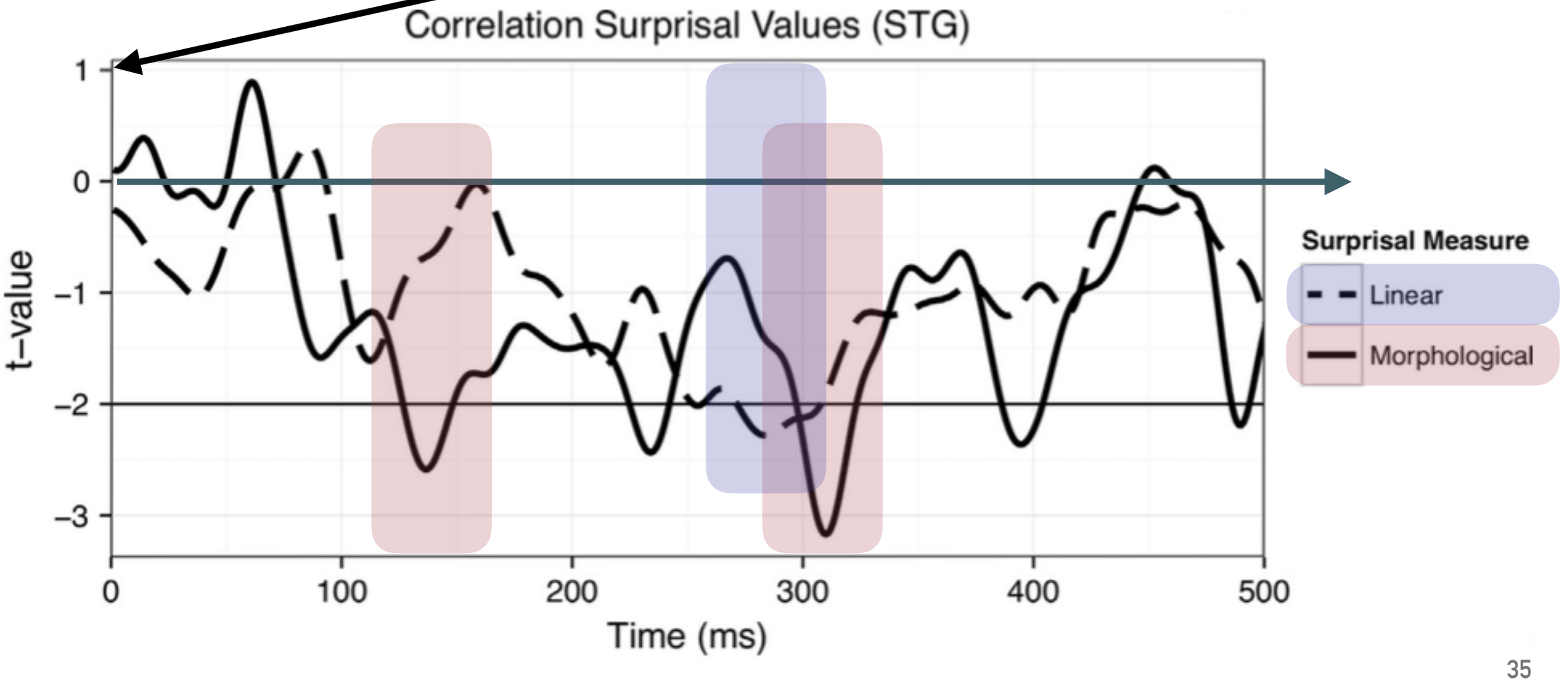
/i/
/ɹ/
/a/


A


Correlation Surprisal Values (STG)
1
0
−1
−2
−3
t−value
0
100
200
300
400
500
Time (ms)
Surprisal Measure
Linear
Morphological

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 ANSWERS

1. What is represented?

Root and stem morphemes.

2. How are representations formed?

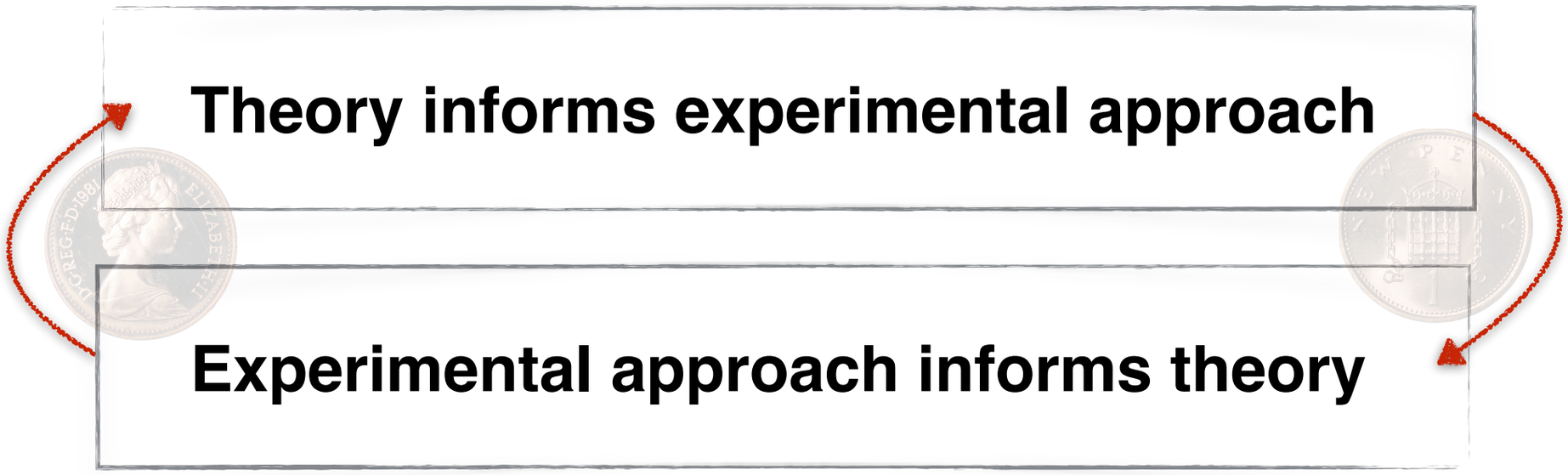
Dependant upon grammatical wellformedness

3. How are representations accessed?

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

TODAY'S ANSWERS

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



THANK YOU, DANKE!

References:

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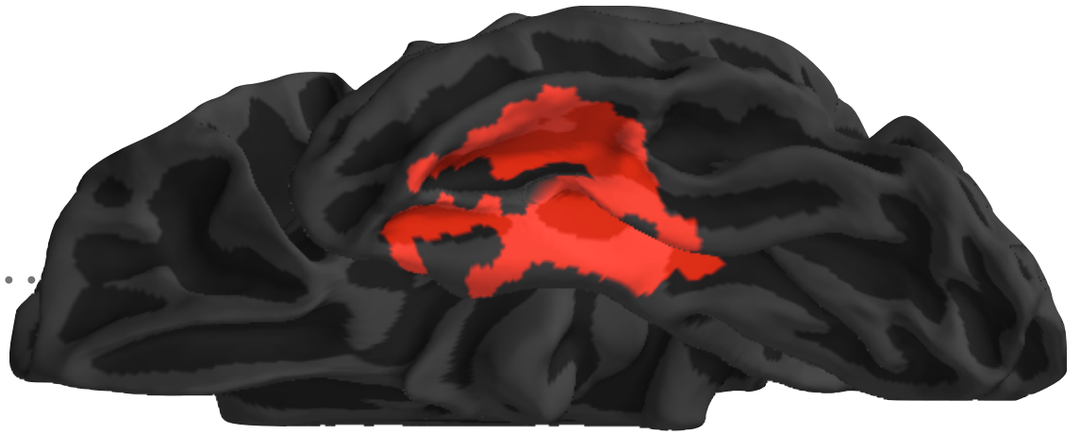
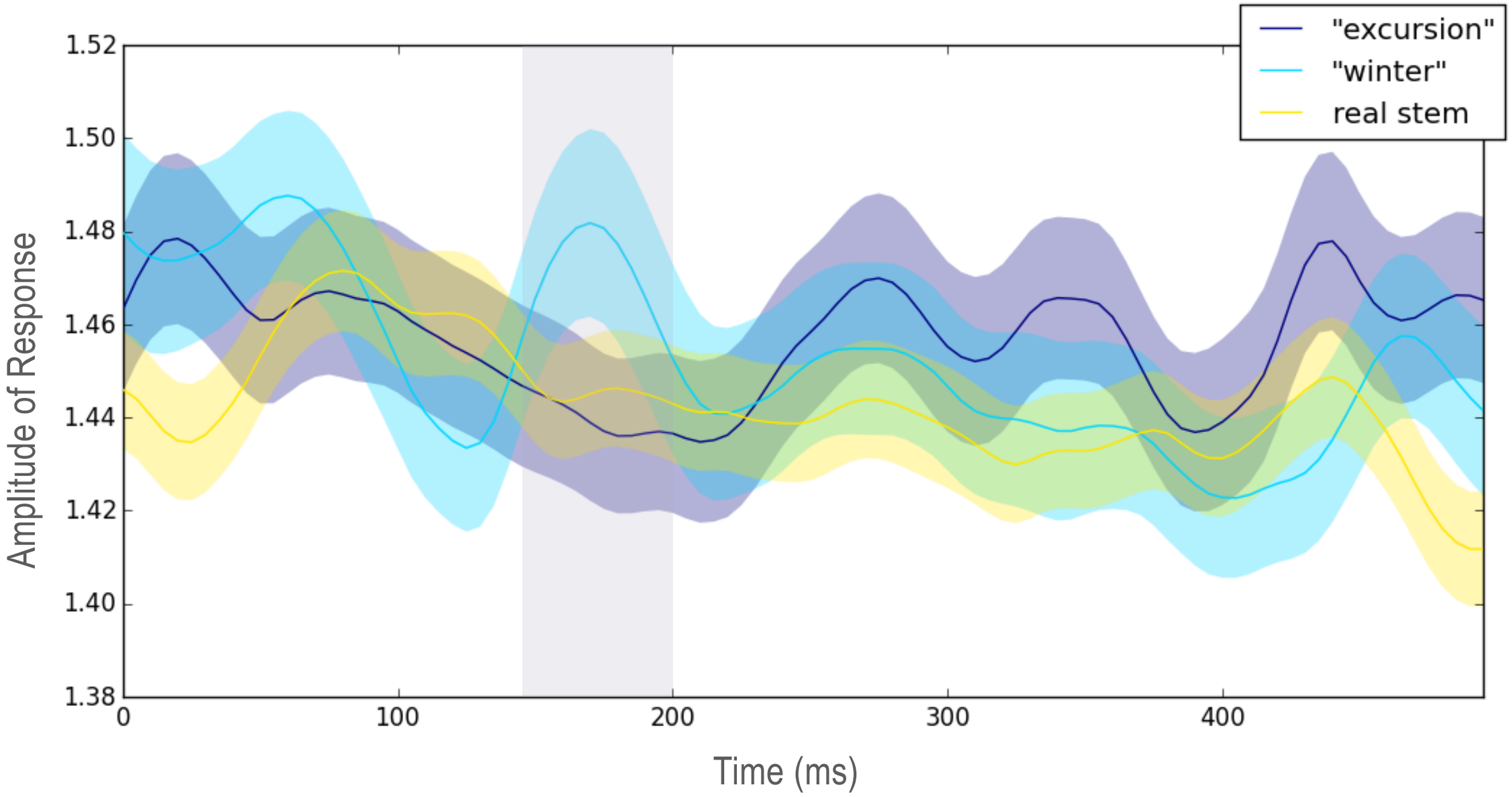
RESULTS




"excursion"
"winter"
real stem
1.52
1.50
1.48
1.46
1.44
1.42
1.40
1.38
Amplitude of Response
0
100
200
300
400
Time (ms)