TODAY’S QUESTIONS

1. What is represented?

2. How are representations formed?

3. How are representations accessed?
MAGNETOENCEPHALOGRAPHY (MEG)
MAGNETOENCEPHALOGRAPHY (MEG)
MAGNETOENCEPHALOGRAPHY (MEG)

Amplitude (dSPM)

Average

Time (ms)
MAGNETOENCEPHALOGRAPHY (MEG)
MAGNETOENCEPHALOGRAPHY (MEG)

Amplitude (dSPM) vs. Linguistic Variable
EXPERIMENT 1:
WHEN AND WHERE TO LOOK
EXPERIMENT 1 – WHEN AND WHERE TO LOOK

less wordlike  

more wordlike

<table>
<thead>
<tr>
<th></th>
<th>JZWyWK</th>
<th>QOADTQ</th>
<th>QUMBSS</th>
<th>AVONIL</th>
<th>GRAVEL</th>
</tr>
</thead>
</table>

Percent activation relative to words in the occipitotemporal cortex

False fonts  
Infrequent letters  
Frequent letters  
Bigrams  
Quadrigrams  
Words

Average of non-word stimuli

Vinckier et al., 2007
FUNCTIONAL LOCALISER

**Mini-Experiment**

ii) One-element

<table>
<thead>
<tr>
<th>Symbols</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
</tr>
<tr>
<td>ATOM</td>
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</table>

iv) Four-element

<table>
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<th>Symbols</th>
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<tr>
<td>□</td>
</tr>
<tr>
<td>◇</td>
</tr>
<tr>
<td>□</td>
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<tr>
<td>△</td>
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</table>

**Symbols**

1

24

**“Real” Experiment**

<table>
<thead>
<tr>
<th>free stem</th>
<th>bound stem</th>
</tr>
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<tbody>
<tr>
<td>bookable</td>
<td>durable</td>
</tr>
<tr>
<td>perishable</td>
<td>equable</td>
</tr>
<tr>
<td>predictable</td>
<td>hospitable</td>
</tr>
<tr>
<td>printable</td>
<td>numerable</td>
</tr>
</tbody>
</table>
FUNCTIONAL LOCALISER

ii) One-element

iv) Four-element

B
ATOM

B
ATOM

1
24

Symbols

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
Copious evidence that:

\[
\begin{align*}
FARMER & \rightarrow FARM + ER \\
CORNER & \rightarrow CORN + ER \\
BROTHEL & \neq BROTH + EL
\end{align*}
\]

What is driving this effect?

- presence of an isolatable stem morpheme
- visual form of a suffix morpheme
- congruent grammar

see Rastle & Davis, 2008 for a review
**EXCURSION**
- isolatable stem, + congruent grammar

**WINTER**
- isolatable stem, - congruent grammar

**LEAKAGE**
+ isolatable stem, + congruent grammar

**BROTHER**
+ isolatable stem, - congruent grammar
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:

<table>
<thead>
<tr>
<th>CONDITION</th>
<th>leakage</th>
<th>brother</th>
<th>excursion</th>
<th>winter</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>1</td>
<td>1</td>
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RESULTS

➤ Analysis:

➤ Mixed effects regression model
➤ Ran in localised “morphology” region
➤ Coded as binary variables

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<tr>
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<th>congruent grammar</th>
<th>combination 2 or 3</th>
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<td>0</td>
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![not significant](p > .5) ![approaching significance](t = 1.06, p = .105) ![significant](t = 2.15, p = .03)
➤ Transition probability (TP) as an index of decomposition:

- LEAK
  - TP < 1
  - TP = 1

- BROTH
  - TP < 1

- EXCUR-
  - TP = 1

- SION

- WINT-
  - TP = 1

- ER
  - ING
  - S
  - AGE
  - ER
  - S
  - ER
RESULTS

TP ~ dSPM for free stem word items

“excursion”

“winter”
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
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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
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
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?
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.

$p(B \mid KATA)$

$p(B \mid KT)$
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.
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.

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

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

Morphological surprisal = $-\log(p(B \mid KT))$
**Correlation Strength**

<table>
<thead>
<tr>
<th>Time (ms)</th>
<th>/ð/</th>
<th>/ɒ/</th>
<th>/ʒ/</th>
<th>/ɨ/</th>
<th>/ʉ/</th>
<th>/a/</th>
</tr>
</thead>
</table>

- **surprisal 1**
- **surprisal 2**
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)
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.
Data from neurophysiological techniques allow us to inform and adjudicate between different theoretical models.
 References:


 contact: laura.gwilliams@nyu.edu
RESULTS

![Graph of Amplitude of Response over Time](image)

- "excursion"
- "winter"
- real stem