Individual variability in the timecourse of predictions

Kate Stone and Sol Lago
People predict upcoming words

“Klicke auf den…”
People predict upcoming words

“Klicke auf den…”
Existing methods
Existing methods

- Was there a prediction?
- In what time window was the predictive effect significant?

* e.g. Barr et al, 2014; Seedorff et al, 2017
When do we first see evidence of a predictive effect?
Goals for this talk

- Present a bootstrapping method that allows us to identify when a predictive effect began.
- Apply the method to study prediction speed in native and non-native German speakers.
Structure of the talk

1. Provide background on gender predictions in non-native speakers
2. Apply the bootstrapping method to groups of native and non-native speakers
3. Show how the method can be applied at an individual subject level
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1. Provide background on gender predictions in non-native speakers
   - What do we know about non-native gender predictions
   - Our experiment

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Native speakers use syntactic gender to predict

"Der Hase frisst den… "

*The rabbit eats the*.MASC...

Dussias et al., 2013; Grüter et al., 2012; Hopp, 2013; Hopp & Lemmerth, 2018; Lemmerth & Hopp, 2018
Non-native speakers are not as good at predicting

Encuentra la pelota

*Find the fem ball*

<table>
<thead>
<tr>
<th>Same gender</th>
<th>Different gender</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="soccer-ball.png" alt="soccer ball" /> <img src="cookie.png" alt="cookie" /></td>
<td><img src="soccer-ball.png" alt="soccer ball" /> <img src="shoe.png" alt="shoe" /></td>
</tr>
<tr>
<td>“la galleta”</td>
<td>“el zapato”</td>
</tr>
</tbody>
</table>

*Grüter et al., 2012*
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Grüter et al., 2012
Non-native speakers are not as good at predicting

Wo ist der/die/das gelbe…?
Where is the masc/fem/neut yellow…?

Hopp, 2013
Key point: L2 predictive ability is variable

- What determines predictive ability?
  - Accurate gender representations (vocabulary knowledge)
  - Familiarity with a gender system in the L1?

- Having a way to quantify prediction speed at the group and individual level would help us decide which factors are important!
How much slower are non-native than native predictions?

How much does non-native speakers’ L1 impact prediction speed?
Structure of the talk

1. Provide background on gender predictions in L2
   
   ○ What do we know about L2 gender predictions
   
   ○ Our experiment

2. Introduce the bootstrapping method at a group level

3. Show how the method can be applied at an individual subject level
Syntactic gender predictions
A visual world experiment
Martin and Sarah have to clean up the house before their parents get home.

Syntactic gender predictions
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Martin and Sarah have to clean up the house before their parents get home.
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“Klicke auf seinen blauen Knopf”
Martin and Sarah have to clean up the house before their parents get home.

"Klicke auf seinen blauen Knopf"
Martin and Sarah have to clean up the house before their parents get home.

“Klicke auf seinen blauen Knopf”

Critical window

die Flasche.fem
COMPETITOR

der Knopf.masc
TARGET
Three speaker groups:

74 German native speakers

63 Spanish learners of German (L1 with gender)

66 English learners of German (L1 without gender)
Three speaker groups:

74 German native speakers

63 Spanish learners of German (L1 with gender)

66 English learners of German (L1 without gender)
Results
Results

- Native speakers predicted the noun
Results

• Native speakers predicted the noun

• Non-native speakers also predicted
Results

- Native speakers predicted the noun
- Non-native speakers also predicted
- Slower predictions in non-native speakers
Structure of the talk

1. Provide background on morphosyntactic gender predictions in L2

2. Introduce the bootstrapping method to participant groups

3. Show how the method can be applied at an individual subject level
A bootstrapping approach

Adapted from Sheridan & Reingold 2012; Reingold & Sheridan, 2014

Steps:

Stone, Lago & Schad (under review)
A bootstrapping approach
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Steps:

1. Test between curves at each timepoint

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2. Find the **first** significant test statistic in a run of five

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A bootstrapping approach
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Steps:

1. Test between curves at each timepoint

2. Find the first significant test statistic in a run of five

3. Resample the data, repeat 2000 times

Stone, Lago & Schad (under review)
Proportion of Looks

Time from possessive onset (ms)

L1 German:
- 616 [580, 640] ms

L1 Spanish:
- 821 [760, 920] ms

L1 English:
- 747 [700, 800] ms
L1 vs. L2:
94 [60, 140] ms
p < 0.05
L1 vs. L2: 94 [60, 140] ms
p < 0.05
L1 vs. L2: 94 [60, 140] ms, p < 0.05

Spanish vs. English: 51 [-40, 160] ms, p > 0.05
Structure of the talk

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Individual variability

a) Can we detect prediction onsets in individual datasets?

b) Can we link individual prediction speed to individual factors like:
   - Proficiency?
   - Age of acquisition?
   - How often a speaker uses German?
   - Object naming accuracy?
Problem: Individual data is really noisy
Solution: Stricter criteria

Adapted from Reingold & Sheridan, 2014
Solution: Stricter criteria

- Lots of items

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- Exclude participants did not pick up on the cue in the auditory instruction

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- Stricter criteria for defining the onset

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Solution: Stricter criteria

- Lots of items
- Exclude participants did not pick up on the cue in the auditory instruction
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- Stricter criteria for defining the onset

~50% of data excluded

Remaining participants:
73 L1 German
19 L1 Spanish
51 L1 English

Adapted from Reingold & Sheridan, 2014
Individual prediction onsets

- Group mean onset
- Mean of individual onsets
Individual prediction onsets

Group mean onset

Mean of individual onsets
Individual variability

By-subject onset (ms)

- Proficiency (SD)
- Age of acquisition (SD)
- Proportion of time using German (SD)
- Naming accuracy (SD)
Summary

- Using estimates of the onset of a predictive effect:
  - Non-native speakers were ~100 ms slower to predict than native speakers
  - But having an L1 with gender (Spanish) did not appear to be an advantage
  - We found no link between individual prediction speed and demographic factors
Discussion

- Why were Spanish speakers no faster than English speakers?
  - Interference from mismatching Spanish gender? (but only very few items)
  - Perhaps having two gender representations for each lexical item results in a global lexical access slow-down?
Discussion

● Why were Spanish speakers no faster than English speakers?
  ○ Interference from mismatching Spanish gender? (but only very few items)
  ○ Perhaps having two gender representations for each lexical item results in a global lexical access slow-down?

● Why did none of the individual factors predict onset time?
  ○ Perhaps cognitive factors are more predictive, e.g. lexical access speed, object naming speed rather than accuracy
  ○ Or perhaps person-specific rather than language-specific factors, e.g. processing speed or attentional factors
Future directions

- Does L1 gender really predict L2 gender performance? If so, how?

- Is individual L2 predictive variability better explained by cognitive factors?

- Link L2 prediction speed directly to L2 processing accounts:
  - E.g. General slowing in L2 due to capacity limitations (Dekydtspotter & Renaud, 2014; Hopp, 2013; McDonald, 2006), or variable speed in different operations (Claansen & Felser, 2018; Cunnings, 2017)

- Provide parameters for future computational models of L2 processing
Thank you!

Projekt:
Kongruenz in Erst- und Zweitsprachverarbeitung

Sol Lago

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