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Language Brain & Behaviour

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*Te Whare Wānanga o Waitaha*
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# Word-order maintains OCP-Place effects across word boundaries in Māori

Yoon Mi OH, Clay BECKNER, Jen HAY, Jeanette KING
NZILBB, University of Canterbury

MARSDEN FUND
TE PŪTEA RANGAHAU A MARSDEN

ICL20
July 2, 2018

# Background



## What is OCP-Place effect?

### (Obligatory Contour Principle for Place of Articulation)

- Gradient dispreference for homorganic consonant sequences (i.e. using the same place of articulation, e.g. /p/ & /b/) in adjacent syllables within a word
- This phonotactic constraint of similarity avoidance is due to language processing difficulty. Processing a sequence of similar sounds is more difficult than processing a sequence of dissimilar sounds.
- For example, in CVCV patterns in Māori, a sequence of non-identical labial consonants [mVfV] (Freq=9) is less preferred than a sequence of non-homorganic consonants [mVtV] (Freq=21285).

# Research question

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- The OCP-Place effects have been found within words, in particular, within verbal roots or across morpheme boundaries (McCarthy, 1986), and regarded as a feature of words. In this study, we examine **the statistical patterns of OCP-Place effects within words and across word boundaries** in Japanese and Māori.
- If we can find the OCP-Place effects across word boundaries, how can we explain the underlying mechanism which maintains these effects beyond words?
- We further explore the relationship between word order and OCP-Place effects across word boundaries.

# Data



To study the OCP-place effects across word boundaries, the following running speech corpora are used.

**Japanese**

- the corpus of spontaneous Japanese (CSJ) (NINJAL, 2011)

**Māori**

- the Māori and New Zealand English corpus (MAONZE) (King et al., 2011)
- the Māori Broadcast Corpus (MBC) (Boyce, 2006)

Contrary to previous studies, we do not look at long-distance consonant avoidance (e.g. C̲VCVC̲V) but only C̲VC̲V patterns.

# Language description

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## Māori

- **Phonological system:** 10 vowels and 10 consonants
- **Syllable structure**: (C)V(V), simple

### Māori consonants

| | Labial | Alveolar | Velar | Glottal |
|---|---|---|---|---|
| Plosive | p | t | k | |
| Fricative | f ← **wh** | | | h |
| Nasal | m | n | ŋ ← **ng** | |
| Tap | | r | | |
| Approximant | w | | | |

# Language description

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## Japanese

- **Phonological system:** 10 vowels and 19 consonants
- **Syllable structure**: (C)(C)V(ː)(C), moderately complex

### Japanese consonants

| | Labial | Alveolar | Palato-alveolar | Palatal | Velar | Uvular | Glottal |
|---|---|---|---|---|---|---|---|
| Plosive | p b | t d | | | k g | | |
| Affricate | | (t͡s) | (tʃ) (dʒ) | | | | |
| Fricative | (f) | s z | | | | | h |
| Nasal | m | n | | | | N | |
| Tap | | r | | | | | |
| Approximant | w | | | j | | | |

# Methodology

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- The **position-dependent ratio of observed probability over expected probability** (**O over E** or **O/E**) for each pair of adjacent consonants in CVCV patterns (Pierrehumbert, 1993) is used to measure the degree of underrepresentation and overrepresentation of co-occurrence.

probability of a consonant pair "xy"

- O/E of a consonant pair "*xy*" = observed probability/ expected probability

probability of a consonant x
× probability of a consonant y

- O/E=1

**O/E <1**
**Underrepresentation**

**1<O/E**
**Overrepresentation**

# Methodology

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- Simple linear regression models are used to test for the statistical significance of OCP-Place effects.
- For example, lm(O/E ~ labial + coronal + velar)

```
Coefficients:
                 Estimate Std. Error t value Pr(>|t|)
(Intercept)       1.03889    0.05345  19.437   <2e-16 ***
labialIdentical  -0.47536    0.23144  -2.054   0.0428 *
labialSame       -0.27974    0.14057  -1.990   0.0495 *
velarIdentical   -0.30249    0.32292  -0.937   0.3513
velarSame         0.43655    0.32292   1.352   0.1797
coronalIdentical -0.22739    0.26546  -0.857   0.3939
coronalSame       0.05293    0.19148   0.276   0.7828
```

Significant underrepresentation of non-identical labials = **OCP-Place effects of labials**!

# Results - Within words

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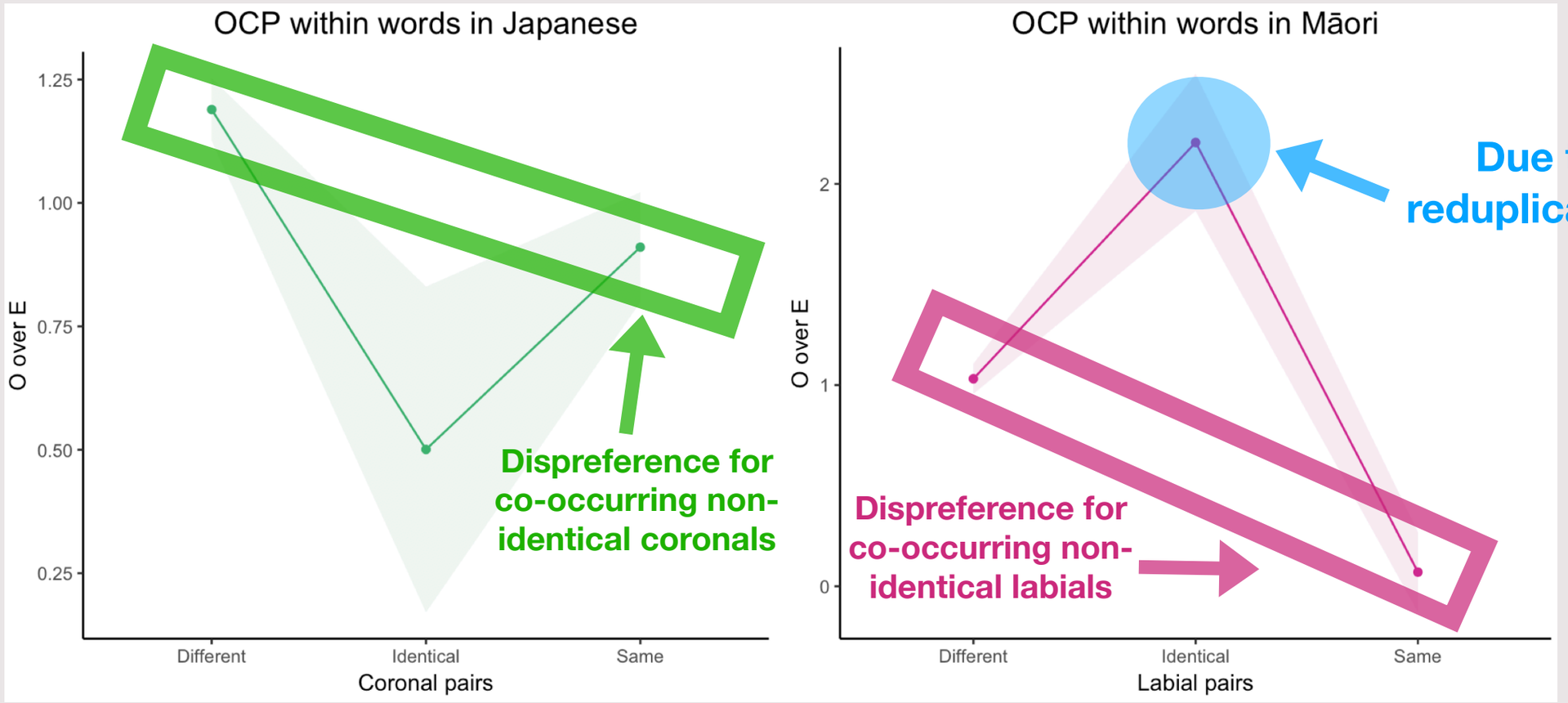
## OCP-Place effects within words (CVCV sequences) in Japanese & Māori




- Japanese displays significant OCP-Place effects of non-identical coronals within words while Māori shows significant OCP-Place effects of non-identical labials within words.

# Results - Word boundaries

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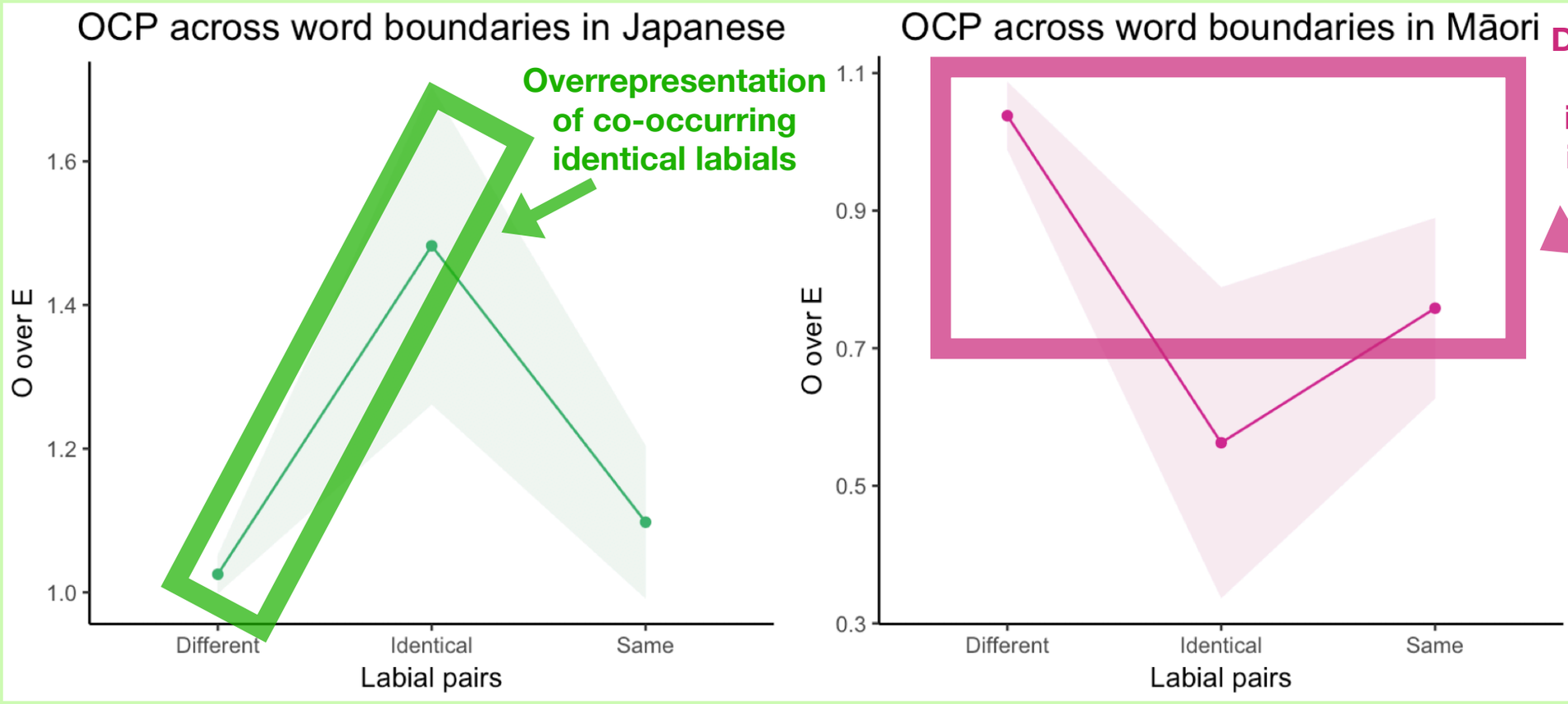
## OCP-Place effects across word boundaries in Japanese & Māori




- Only Māori shows significant OCP-Place effects of non-identical labials across word boundaries.

# Brief overview



- We have observed that the OCP-Place effects are present within words in Japanese and Māori and that **those effects are also present across word boundaries in Māori**.
- How can we explain the mechanism which maintains these effects beyond words?
  - Frequency of word pairs
  - Word order
  - POS (part of speech) of word pairs & POS phonotactics

# Results - Frequency

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OCP-Place effect and frequency of word pairs

- No significant difference between the OCP-Place effects of labials across high-frequency vs. low-frequency word pairs

- The effects of OCP-Place across word boundaries are not driven by highly frequent collocations.

# Results - Word order

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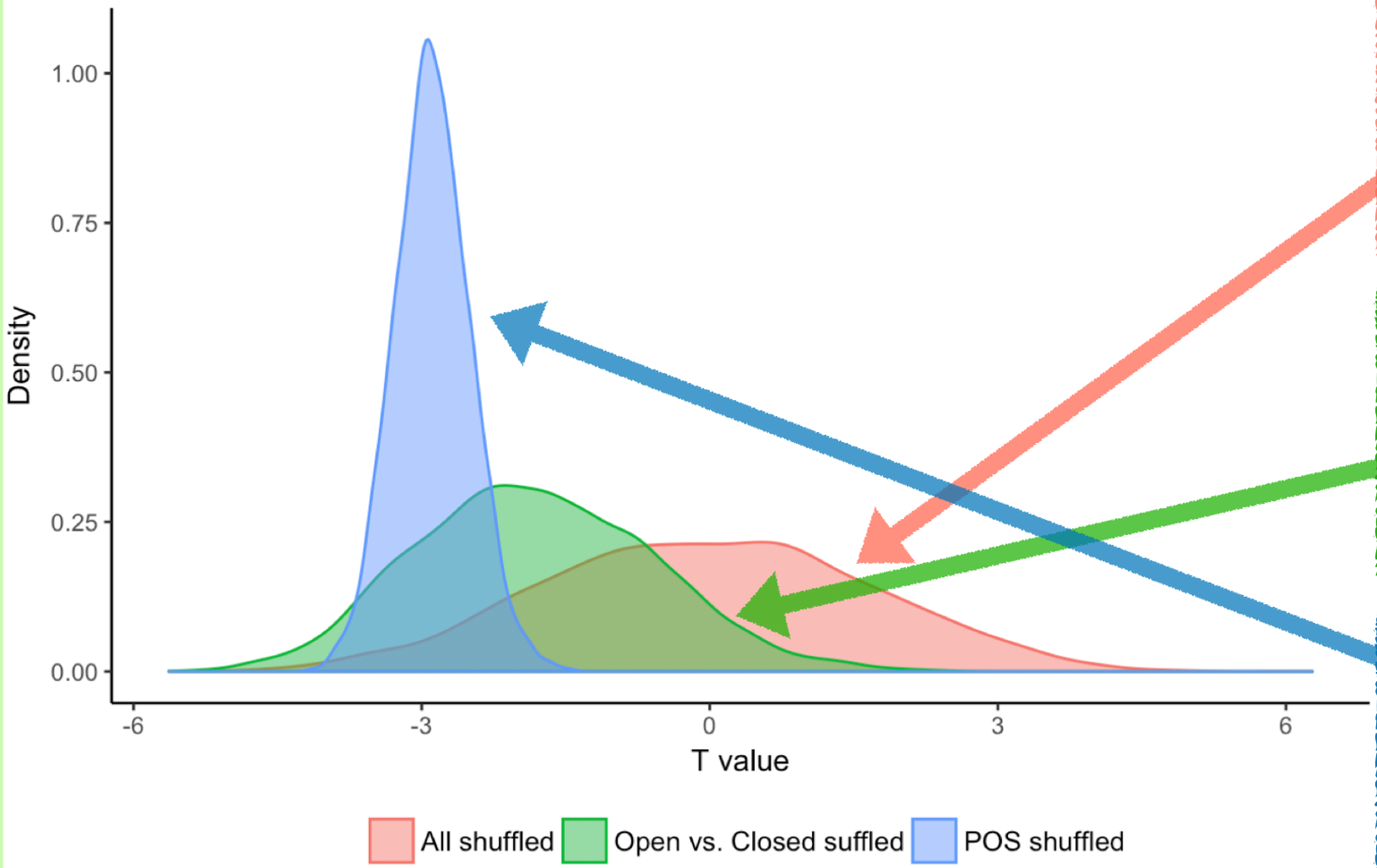
## Word order and OCP-Place effects

What happens if we randomize the order of words?




When all words are randomly shuffled (n=5k), it is unlikely to observe significant OCP-Place effect across word boundaries.

When words within open and closed classes are shuffled (n=5k), OCP-Place effects begin to emerge.

When words within the same POS are shuffled (n=5k), OCP-Place effects are maintained.

# Results - POS word pairs

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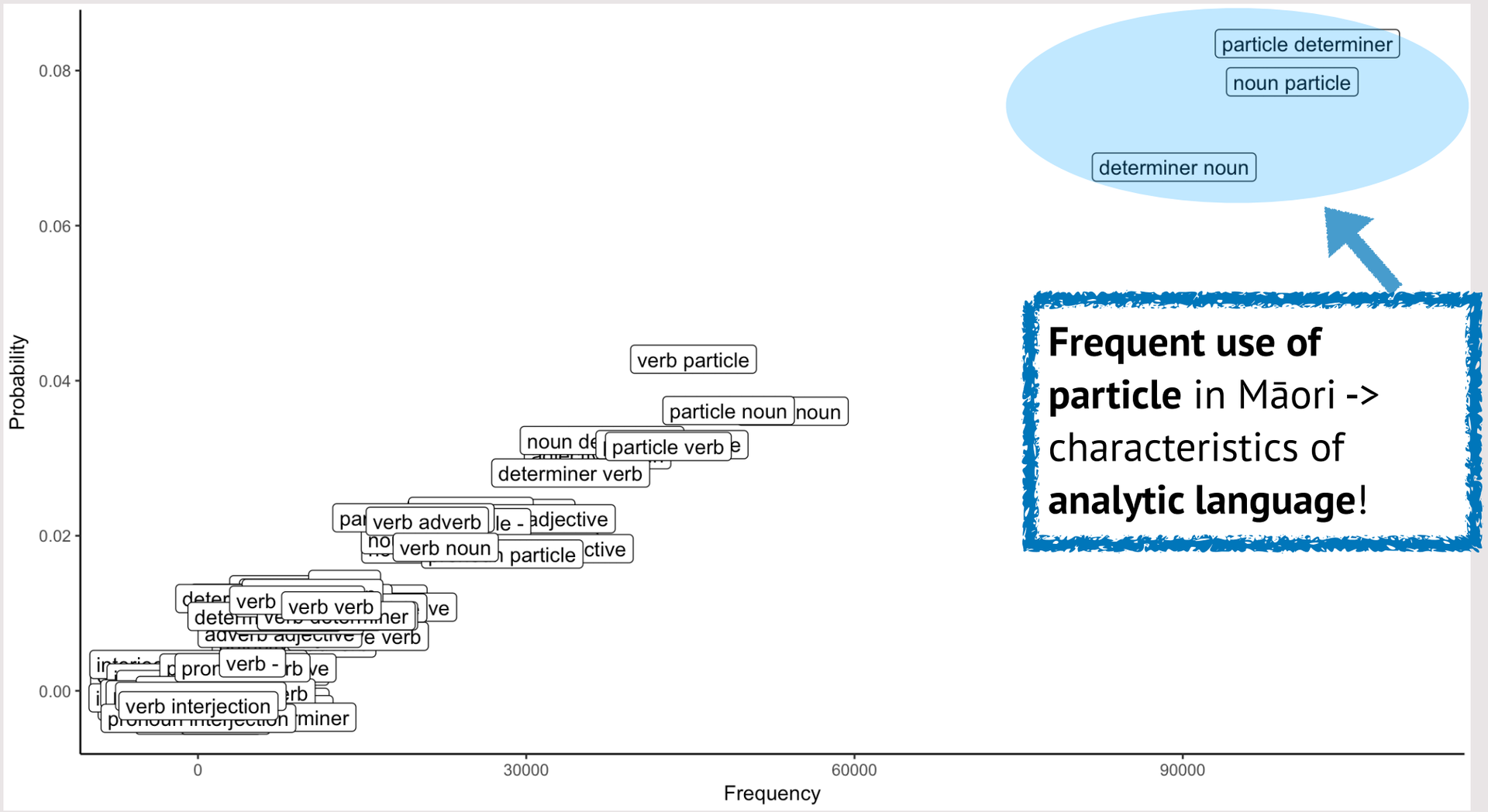
## Relative frequency of word pairs by POS




**Frequent use of particle** in Māori -> characteristics of **analytic language**!

# Results - POS phonotactics

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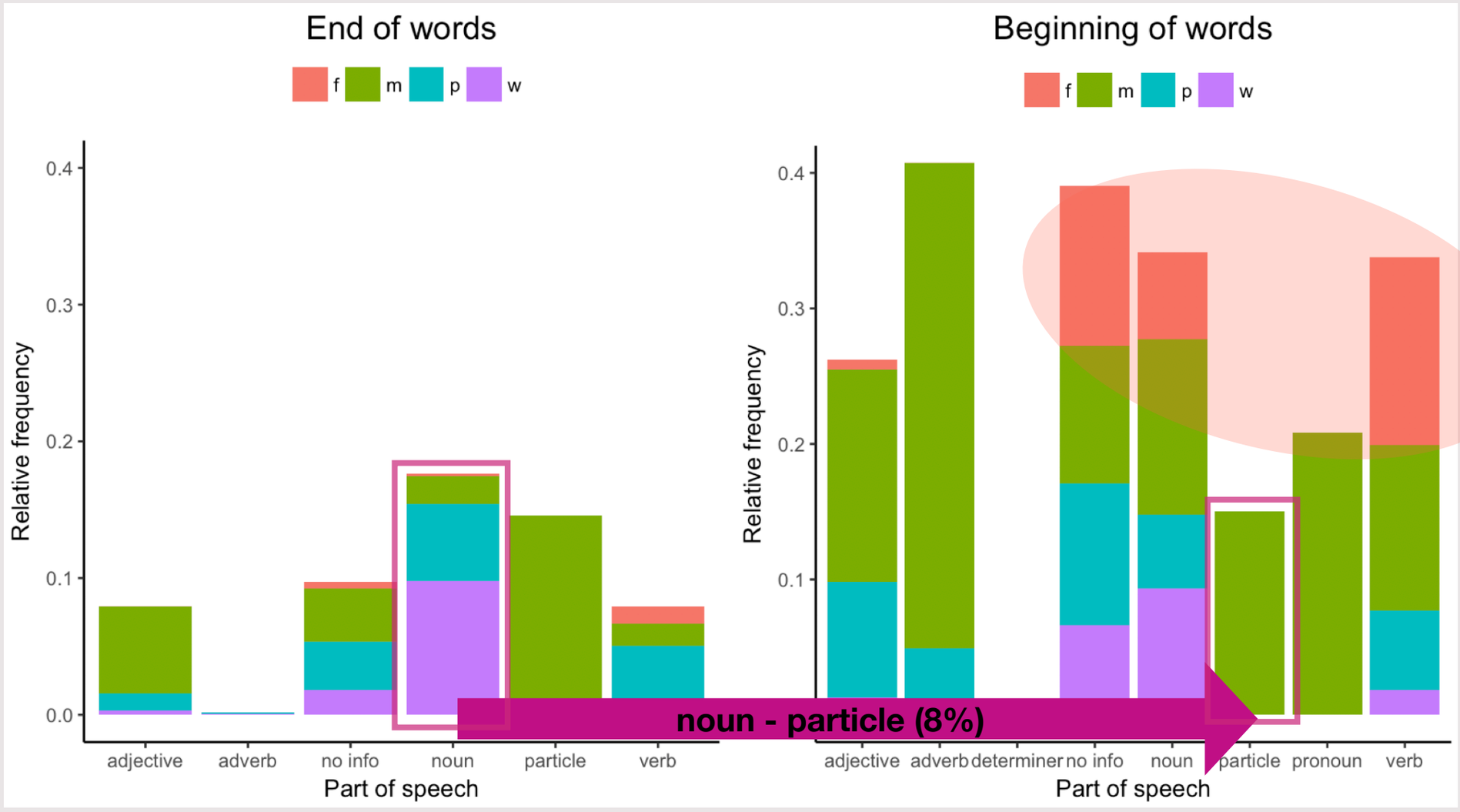
## Position-sensitive relative frequency of labials by POS



# Conclusion

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- The results of this study show that both Māori and Japanese display the OCP-Place effects within words.
- The OCP-Place effects are also present across word boundaries in Māori, but not in Japanese.
- In Māori, these effects are maintained by word order and are not driven by highly frequent word pairs .
- In Māori, these effects seem to be driven by some particular word orders (e.g. noun - particle).

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# Ngā mihi nui ki a koutou!

# Thank you! Any questions?