

# What is a perceptual category in L2? On the nature of sound representations in late learners of a second language with a smaller L1 phonological inventory

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## Dealing with bigger L2 inventories

1. While Spanish only has 5 monophthong vowels, English has a much larger vowel inventory (actual number will depend on regional variation).
2. L2 speakers of English whose L1 is Spanish need to learn how to cope with perception of new contrastive sounds.

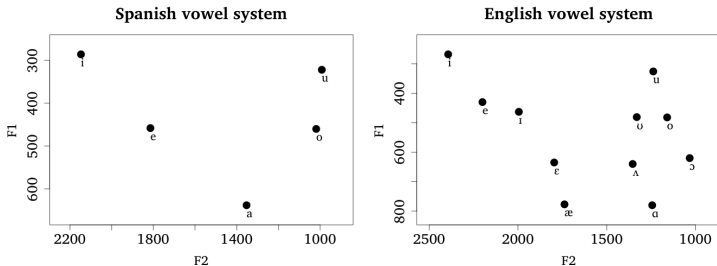


Figure 1 : English and Spanish vowel systems (data from Bradlow, 1995).

# L2 speech perception

1. The **what**: L2 speakers do not only perceive sounds individually but also as contrasts.
  - The PAM model (Best, 1995). *Single-Category* (SC) assimilation occurs when two non-native sounds assimilate to the same native category but are equal in terms of category goodness.
  - Discrimination here is expected to be poor.
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2. The **how**: Optimal L2 perception is *optimal native-like perception of the target language* (Escudero, 2005). L2 learners must carry out two tasks:
  - A *representational task*: creating perceptual representations of the new L2 sounds.
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  - A *representational task*: creating perceptual representations of the new L2 sounds.
  - A *perceptual task*: learning the correct mapping from the acoustic input to the linguistic representations (cue-weighting).
3. The **outcome**: L2 learners (especially those who learned at a late age) do not learn phonemes, but *phonetic categories* (Flege, 1995)

# The /a-ʌ/ distinction in Spanish speakers of L2 English

1. SC Assimilation type in its initial state: tokens of both sounds are mapped onto the L1 category /a/.
2. Perceptual cues available for vowels:
  - In the L1: F1, F2
  - In the TL: F1, F2, duration
  - L2 speakers need to bootstrap themselves out of the warping effect of the L1 category in order to perceive the /a-ʌ/ contrast.

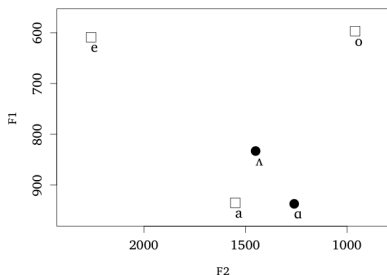


Figure 2 : Vowels in the perceptual space.

# The nature of the new perceptual representations

**Question:** How is the new learning encoded in the grammar? Possible answers:

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2. As **subsets**: L2 learners perceive the difference in a non-contrastive manner, just encoded as a phonetic difference.
3. As **homophony**: No learning takes place, and L2 speakers have access to the correct UR by lexical context.
4. As **different phonemes**: the L2 sounds are encoded in the grammar in a native-like manner.

# Categorical perception

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5. CP is particularly powerful for these purposes as it encompasses a) a test of the linguistic representations of the sounds; b) a test of the phonetic sensitivity of the speakers; and c) a relation between these two aspects.

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5. CP is particularly powerful for these purposes as it encompasses a) a test of the linguistic representations of the sounds; b) a test of the phonetic sensitivity of the speakers; and c) a relation between these two aspects.
6. CP is not usually considered to be a test of L2 perception.



# Method

## 1. Subjects:

- 7 native speakers of American English (NS)
- 9 native speakers of Spanish with advanced knowledge of English and time spent living abroad in an L2 speaking country (NNS-A)
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## 2. Stimuli:

- Three 5-step continua were created: /ɑ-ʌ/, /ɑ-ɛ/, and /ʌ-ɛ/.
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## 3. Tasks:

- Labelling of tokens with L2-like labels (pictures of the words "bed", "cup", and "pot")
- 1-step and 2-step discrimination between two tokens of the same continuum (AX, ISI = 1s)
- Labelling of tokens with L1-like labels (pictures of the words "pan", "ron", and "red")

# Results: Categorical perception, L2 labelling

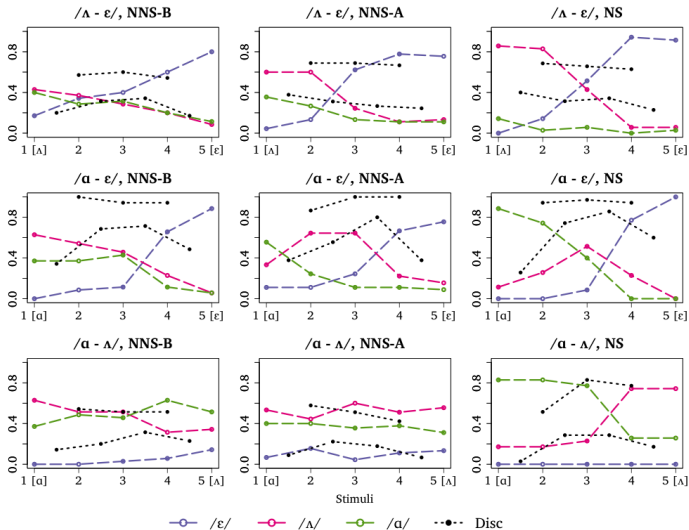
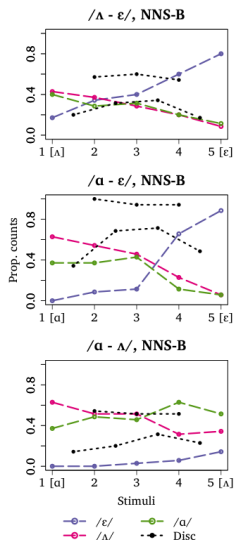


Figure 3 : Categorical perception with L2 labelling

# Results: CP with L2 labels, beginners

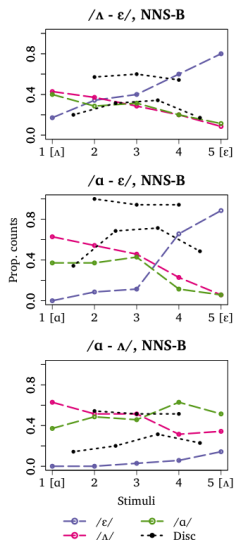


## 1. /ʌ-ε/ continuum

- Tokens 1-3 = /ɑ-ʌ-ε/
- Tokens 4-5 = /ε/.
- Peak at 3-4.

Figure 4 : L2 CP, NNS-B

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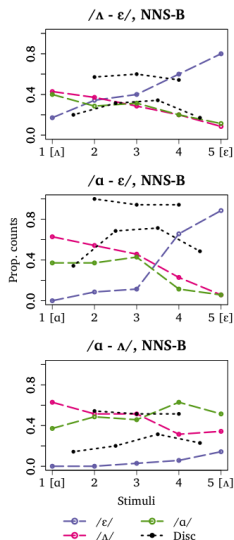
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## 2. /ɑ-ε/ continuum

- Tokens 1-3 = /ɑ-ʌ/.
- Clear boundary between tokens 3 and 4.
- Discrimination raises at boundary in 1-step, reaches ceiling in 2-step.

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## 1. /Λ-ε/ continuum

- Tokens 1-3 = /α-Λ-ε/
- Tokens 4-5 = /ε/.
- Peak at 3-4.

## 2. /α-ε/ continuum

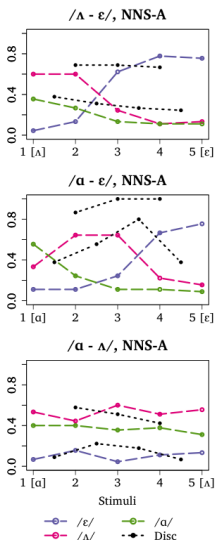
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- Clear boundary between tokens 3 and 4.
- Discrimination raises at boundary in 1-step, reaches ceiling in 2-step.

## 3. /α-Λ/ continuum

- Tokens 1-5 = /α-Λ/
- Poor discrimination in 1-step, chance level in 2-step.

Figure 4 : L2 CP, NNS-B

# Results: CP with L2 labels, advanced



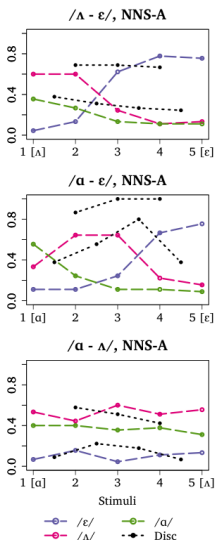
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- X pattern, though with /α/ label also triggered by /Λ/.
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- Flat discrimination (both 1- and 2-step).

Figure 5 : L2 CP, NNS-A



# Results: CP with L2 labels, advanced



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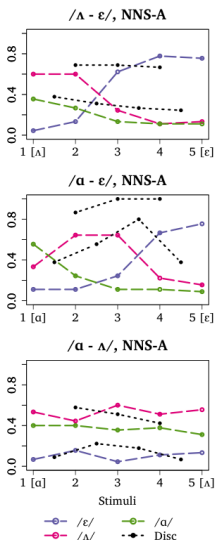
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## 2. Advanced L2 speakers are also able to perceive the /α-ε/ contrast as two different categories.

- Tokens 2-3 = /Λ/.
- Boundary between tokens 3 and 4.
- 2-step discrimination hits ceiling, but 1-step peaks at the boundary.

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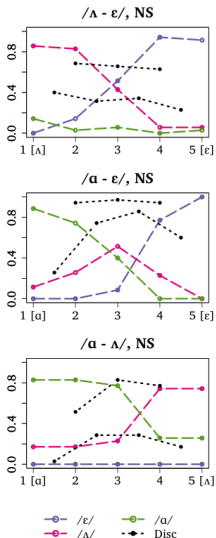
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3. /α-Λ/ continuum
  - Tokens 1-5 = /α-Λ/
  - Discrimination is either below chance (1-step) or at chance level (2-step).

Figure 5 : L2 CP, NNS-A

# Results: native CP

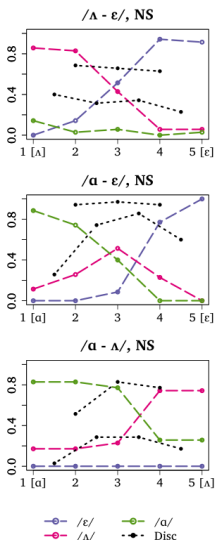


## 1. /Λ-ε/ continuum

- Perfectly clear X pattern.
- Boundary on token 3.
- No peaks in discrimination.

Figure 6 : NS CP

# Results: native CP



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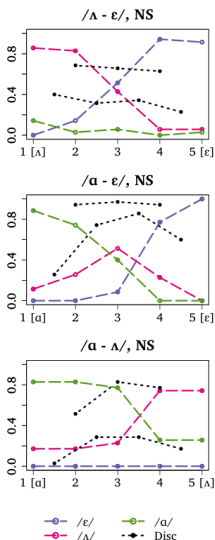
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- /Λ/ triggered on token 3, due to its position in the perceptual space (between /α-ε/).
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## 3. /α-Λ/ continuum

- Clear boundary between tokens 3 and 4.
- 2-step discrimination improves at end of continuum. 1-step is overall poor with peak before and at the boundary.

Figure 6 : NS CP

# Results: 1-step AX discrimination

- Overall, all three groups behaved similarly.

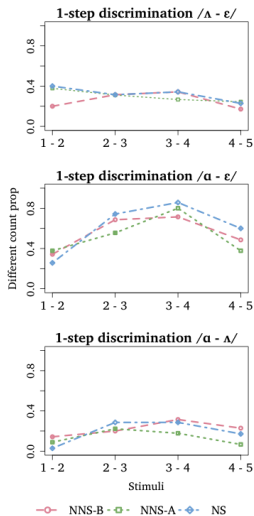


Figure 7 : 1-step discrimination

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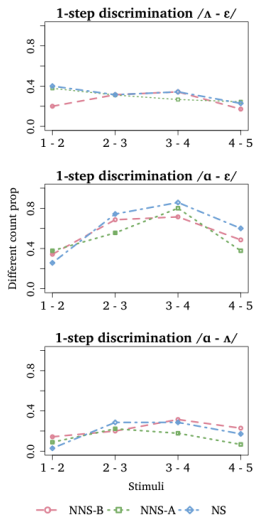


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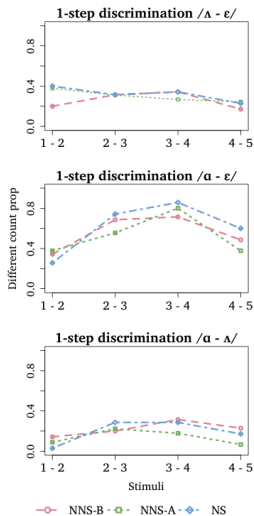


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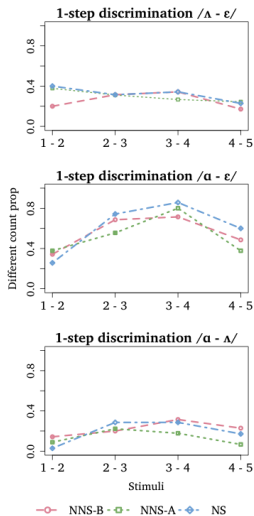


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5. Low *different* counts can be explained by the very small acoustic difference between immediately adjacent tokens ( $F1\Delta = 104$  Hz)

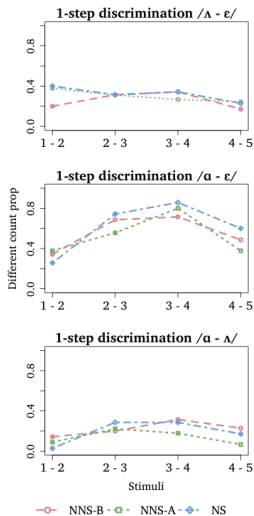


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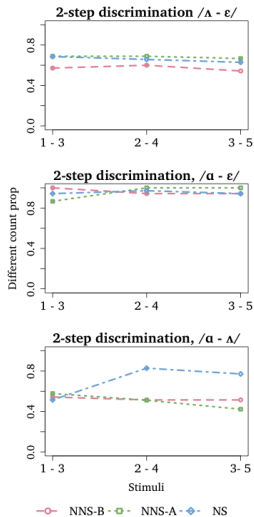


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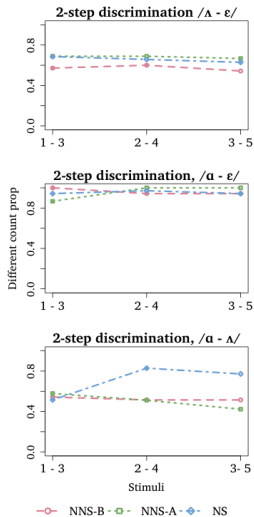


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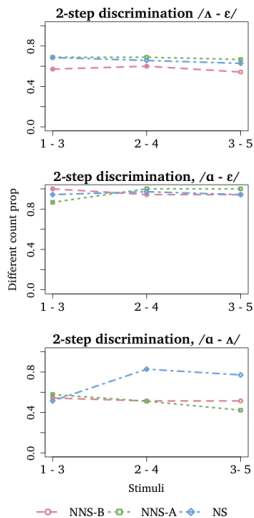


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4.  $/\alpha$ - $\lambda$ / showed higher discrimination, with NS showing a notorious peak when comparing tokens 2 - 4, and 3 - 5. NNS were unable to discriminate, performing at chance level.

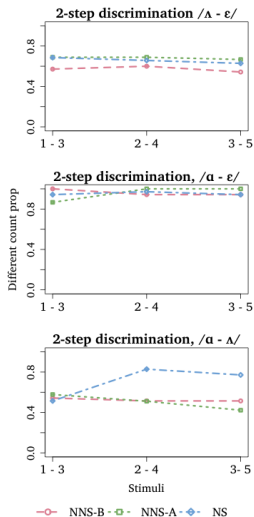
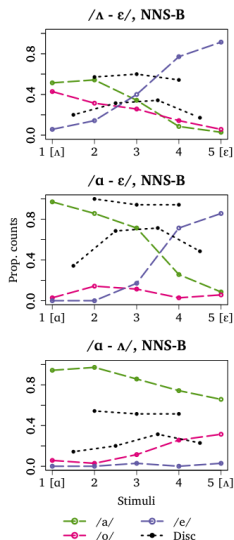


Figure 8 : 2-step discrimination

# Results: L1 CP, beginners

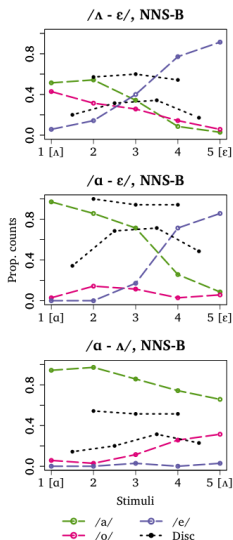


## 1. /Λ-ε/ continuum

- Tokens 1-2 = /a - o/. Tokens 4-5 = /e/.
- Discrimination shows slight peak at 3-4. Flat pattern in 2-step.

Figure 9 : L1 CP, NNS-B

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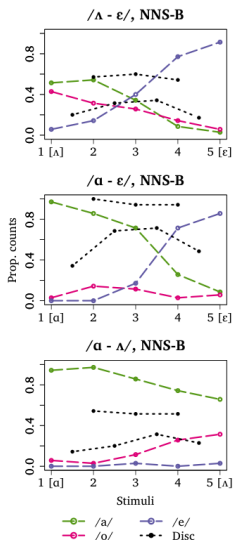
## 2. /a-ε/ continuum

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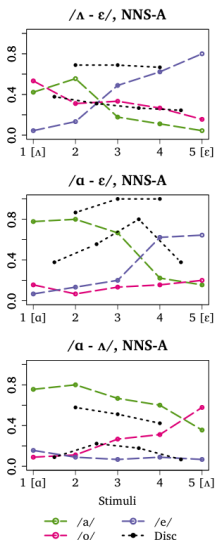
- Clear X pattern, with a boundary between tokens 3 and 4.
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## 3. /ɑ-Λ/continuum

- Clear preference for /a/.
- /o/ stands out as alternative for /Λ/.
- Low 1-step discrimination, peak between tokens 3-4. 2-step discrimination is flat and at chance level.

Figure 9 : L1 CP, NNS-B

# Results: L1 CP, advanced

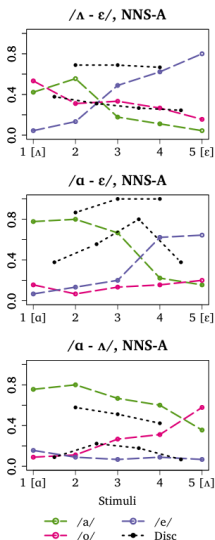


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Figure 10 : L1 CP, NNS-A

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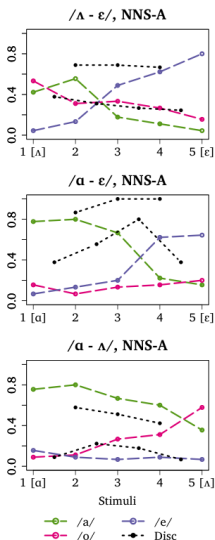
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- X pattern between /a/ and /e/, also with a boundary between tokens 3 and 4.
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### 2. /ɑ-ε/ continuum

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### 3. /ɑ-ʌ/ continuum

- Preference for /a/ along the first four tokens and then declines at /ʌ/. The /o/ category reached 50% by the end of the continuum.
- 2-step discrimination decreases at end of continuum; low 1-step discrimination with mild peak between 2-3.

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  - Discrimination does not change.
2. How is this learning similar/different to NSs?

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    - Probabilistic labelling: a /ʌ/ sound is perceived as /o/ with a 60% of certainty in NNS-A vs. the 30% of NNS-B.
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  - The contrast is encoded in L1 labels. L2 learners seem to be unaware of the existence of a different set of vowels in the L2.

# Conclusions

1. Is there any learning taking place at all?
  - L2 labelling is chiefly the same in NNS-B and NNS-A.
    - NNS are unaware of the existence of different vowel systems.
  - L1 labelling is different: NNS-B mainly categorize the stimuli as /a/, but NNS-A perceives /ʌ/ as /o/.
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2. How is this learning similar/different to NSs?
  - The contrast is encoded in L1 labels. L2 learners seem to be unaware of the existence of a different set of vowels in the L2.
  - Discrimination is different between NNS and NS iff the number of steps between the stimuli is large enough for NS to perceive a difference.

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3. L2 categories that are originally mapped onto the same L1 category are unlikely to be parsed by NNS-A with L2 labels
  - English labels seem to be meaningless to NNS
  - Instead, NNS-A rely on L1 labelling in order to encode the contrast.

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  - The /a/ category recedes and takes a [+low] specification, whereas /o/ lowers its boundaries and takes higher F1 values coming from [-front] vowels, thus welcoming near-open values.

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