

How categorical is categorical perception in L2? Discrimination and identification along continua in 1-to-1 and 1-to-2 mappings

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Perception of vowels by L2 speakers with a smaller L1 inventory

- ▶ **Perceptual Assimilation Model (PAM)**¹: Naive L2 speakers will perceptually assimilate L2 categories to L1 categories, mapping two L2 sounds into either two (1-to-1) or one different perceptual categories (2-to-1).
- ▶ Two-category assimilation (TC type): two non-native segments fall into two different L1 categories (1-to-1). Predicted discrimination: excellent.
- ▶ Single-category assimilation (SC type): two L2 segments fall into one L1 category (1-to-2). Predicted discrimination: poor.
- ▶ **Speech Learning Model (SLM)**³: L2 speakers may create new *phonetic categories* along their lifespan
- ▶ **Native Language Magnet**⁴: Native speech categories warp the perceptual space.

Experimental approaches for perceptual category testing

- ▶ Categorical Perception (CP)⁵: A labelling task along a continuum between two perceptual categories should predict discrimination between adjacent tokens of that continuum (spike in discrimination at label changing point).
- ▶ CP is better attested when creating continua between stop consonants (with manipulated VOT) than with vowels.⁶

Research questions

- ▶ Does CP occur in continua built between two vowel categories, both in native and nonnative speakers who have fewer vowel categories?
- ▶ Will the different types of perceptual assimilation in L2 speakers affect CP results?
- ▶ Can nonnative speakers learn CP after exposure to the language?

Methodology

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)
- ▶ 7 native speakers of Spanish with low/intermediate knowledge of English and no living abroad experience (NNS-B)

Stimuli

- ▶ Tokens of 5-step acoustic continua (F1 and F2 orthogonal manipulation of real vowels with Praat²): /a-ʌ/ (SC type), /a-ε/ (TC type) and /ʌ-ε/ (TC type). Endpoint values taken from recordings of a native speaker of American English (CVC words in carrier sentence).

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 = 700msec)
- ▶ Labelling of tokens with L1-like labels (pictures of the words "pan", "ron", and "red")

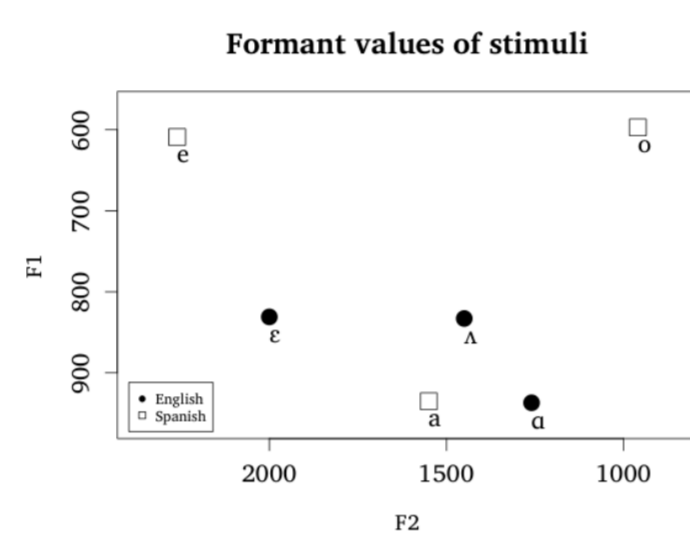


Figure 1: Formant values of endpoint stimuli

Results 1: L2 labelling

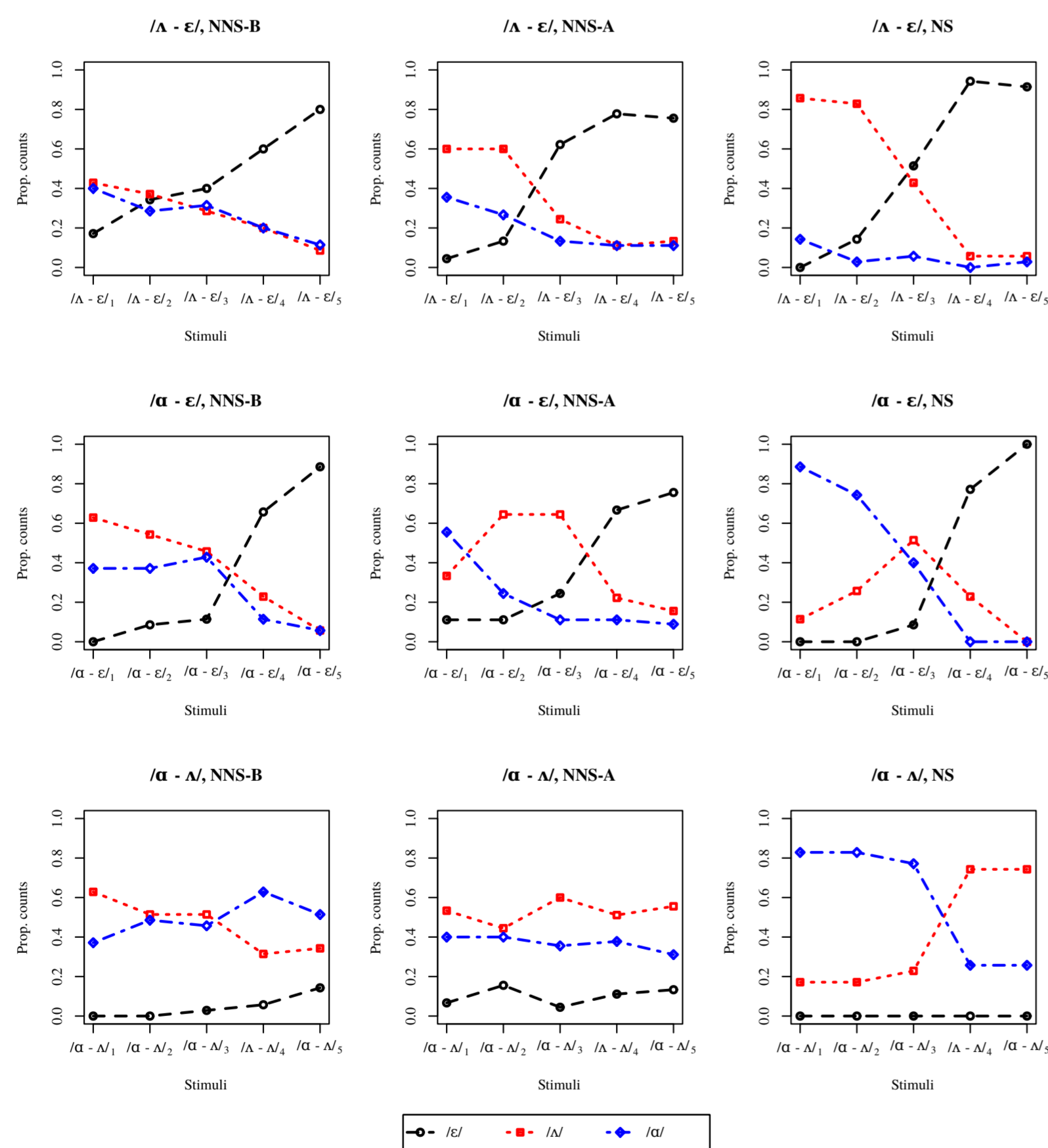


Figure 2: Results of L2 labelling task

- ▶ NNS-B show a clear merger of the /a-ʌ/ categories in all continua: distribution curves of both categories overlap. Distribution curves for /ε/ stand out in labelling of /a-ε/ and /ʌ-ε/ (TC type), and is close to zero in the /a-ʌ/ continuum.
- ▶ NNS-A show similar distribution curves for /ε/. Labelling pattern of /a-ʌ/ does not differ much from that of NNS-B, and /ʌ/ is triggered even by stimuli from /a-ε/ continuum.
- ▶ NS show clear CP patterns in all cases. However, the /ʌ/ category was also triggered by tokens 2-4 in the /a-ε/ continuum, given its position in the acoustic space (between /a-ε/).

References

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- [2] Paul Boersma and David Weenink. Praat: doing phonetics by computer (version 5.3.10) [computer program]. retrieved from <http://www.praat.org/>, 2012.
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- [5] Alvin Liberman, Katherine Harris, Howard Hoffman, and Belver Griffith. The discrimination of speech sounds within and across phoneme boundaries. *Journal of Experimental Psychology*, 54(5):358–368, 1957.
- [6] Bert Schouten, Ellen Gerrits, and Arjan van Hesse. The end of categorical perception as we know it. *Speech Communication*, 41:71–80, 2003.

Results 2: 1-step and 2-step discrimination

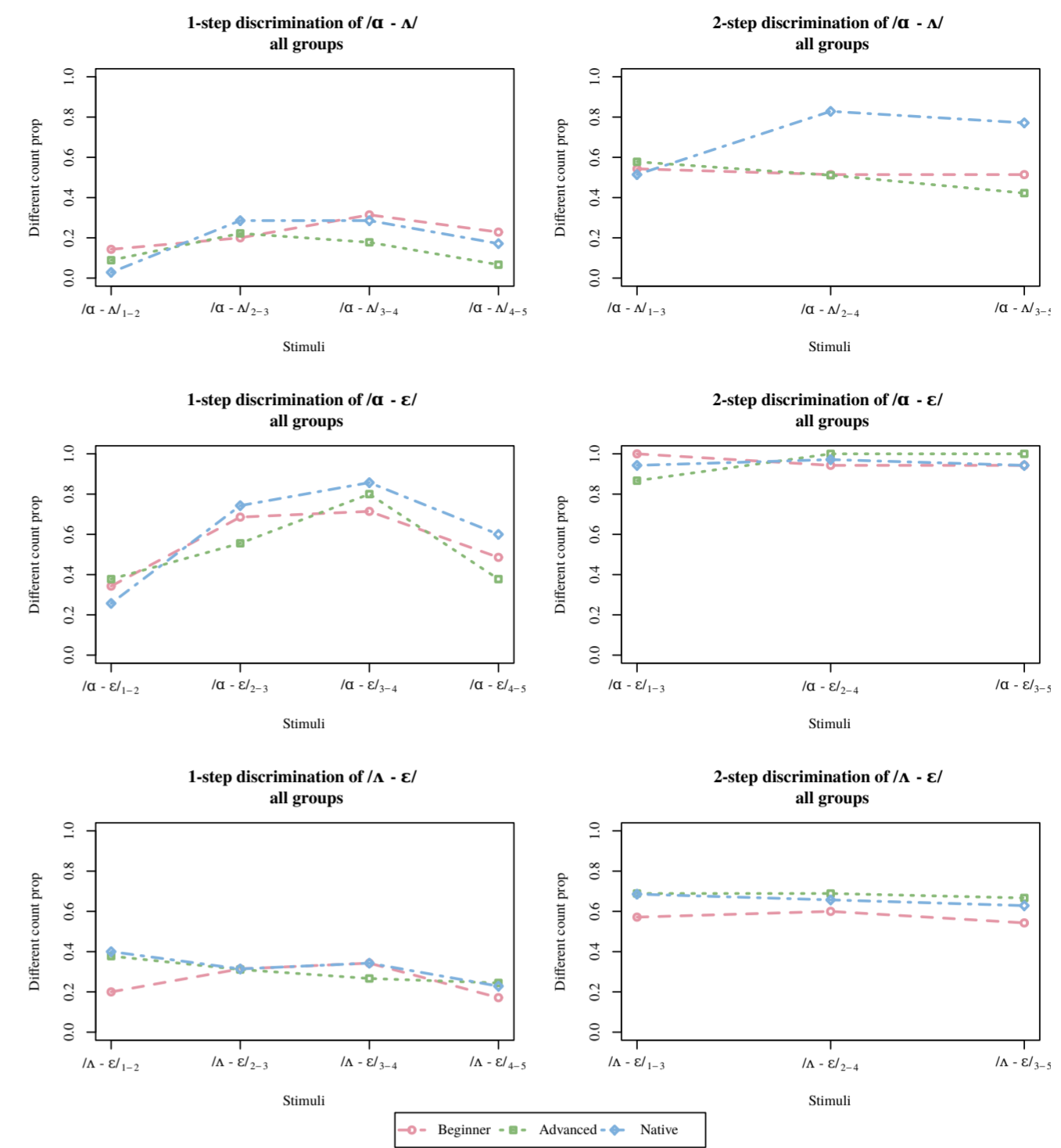


Figure 3: Results of discrimination test, 1-step and 2-step.

- ▶ Both 1-step and 2-step discrimination showed similar responses among groups, with the exception of /a-ʌ/ continuum: the 2-step task triggered a peak only in NS. The 1-step task did not yield any above-chance results in any of the groups.
- ▶ /a-ε/ continuum shows ceiling effect for all groups in the 2-step task. The 1-step task showed perfect CP-like discrimination in all groups, with a sensitivity peak in the boundary zone between tokens 3 and 4.
- ▶ /ʌ-ε/ continuum showed below-chance discrimination in all groups for the 1-step task along the entire continuum, and above chance (60% - 70%) for the 2-step task.

Results 3: L1 labelling

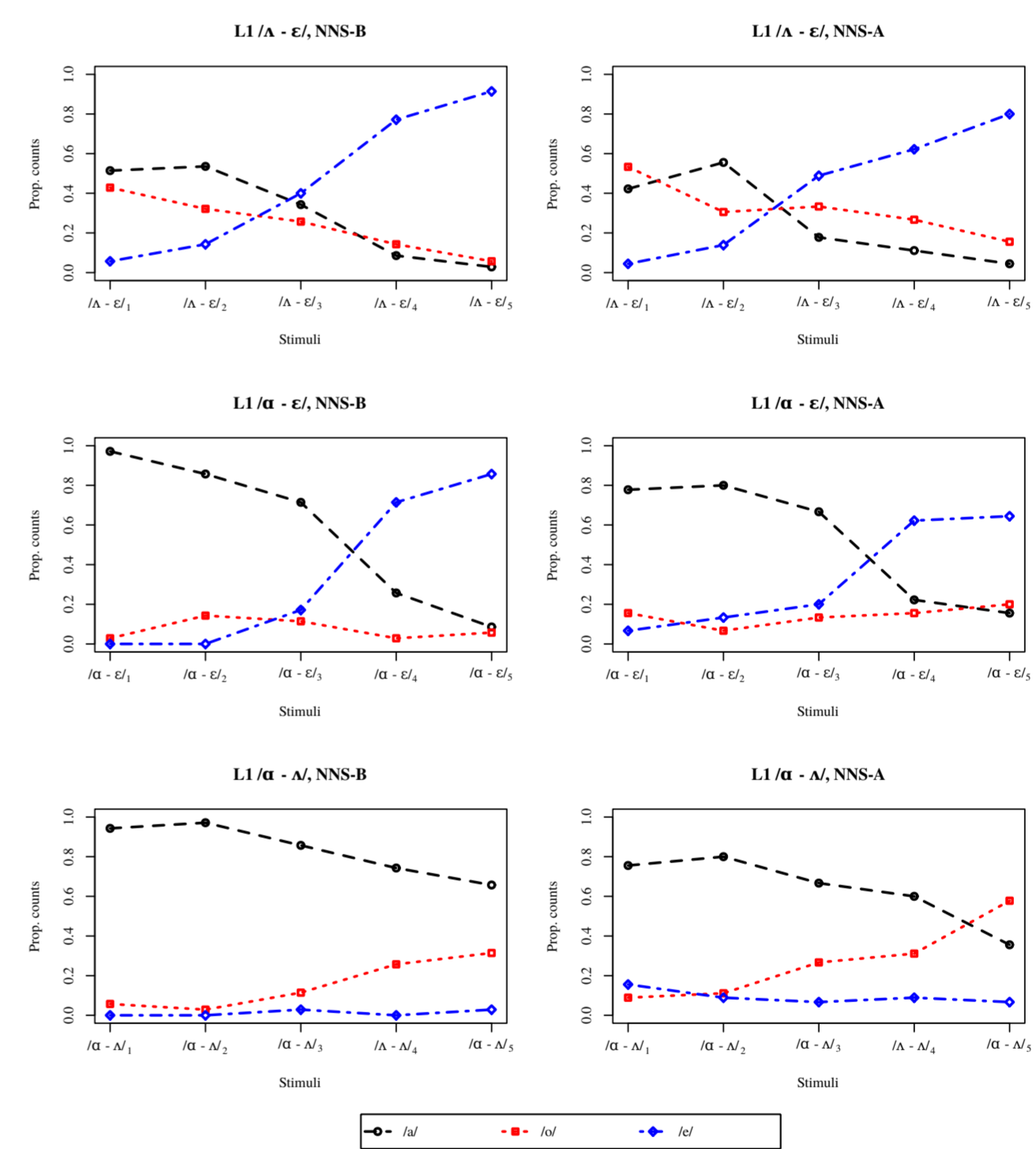


Figure 4: Results of L1 labelling task

- ▶ NNS-B and NNS-A show very similar labelling patterns. All cases show a clear mapping of /ε/ onto /ε/, /a/ is mapped mostly onto /a/, and /ʌ/ is mapped mostly onto /a/ but also /o/.
- ▶ However, NNS-A showed a different pattern in the /a-ʌ/ continuum, with a slight preference for an /o/ mapping of /ʌ/. Nevertheless, this preference is not enough to support a remapping hypothesis (where /ʌ/ is mapped onto the second closest native category in the perceptual space (i.e. /o/)).

Conclusions

- ▶ CP does not occur in vowel continua neither in NS nor NNS, as discrimination results seem to be bound to phonetic and not phonological factors. Labelling itself is a better method for assessing the presence of phoneme-like perceptual categories.
- ▶ Different types of perceptual assimilation do not affect discrimination; however, labelling patterns are clearly different between NS and NNS.
- ▶ Similar perceptual patterns in L2 labelling shows that NNS-A do not learn native-like perception, and do not create L2 categories when perceptin is affected by SC type of perceptual assimilation.
- ▶ Discrimination among adjacent tokens of a vowel continuum trigger similar responses in all groups, regardless of their experience in the language. However, it is enhanced when Euclidean distance between categories is short and perceptual categories are already present (i.e. in NS).
- ▶ Labelling does not seem to have any relation with discrimination: while labelling patterns were different along a given continuum by group, discrimination results were in most cases exactly the same. Euclidean distances are better predictors of discrimination, but it has no effect in labelling.