

# Perceptual Asymmetries in Learning

## Vowel Nasalization

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# Learning biases

- Previous research compared the learnability of different phonological patterns with artificial languages.
  - Are certain patterns learned more easily than others? Why?
  - testing learning behaviour and generalization behaviour
  - hypothesis: natural patterns are easier to learn than unnatural ones

- what it means to be natural – substance
  - physically definable acoustic, articulatory or auditory properties of speech (Crystal, 2008)
  - grounded in phonetics

- bias – cognitive predisposition toward certain patterns; e.g. toward patterns that are phonetically natural (Wilson, 2006)
- Phonological patterns that facilitate production or perception are learned more readily and easily than those that
  - do not (Becker et al., 2011; Baer-Henney & van de Vijver, 2012; White, 2014; van de Vijver & Baer-Henney, 2014; Baer-Henney et al., 2015).
  - do so to a lesser extent (Wilson, 2006; Finley, 2012; Baer-Henney et al., submitted).

# The nature of the substantive bias

- The present study wants to contribute to the debate about the nature of the bias.
  - What happens when the predictions for substance differ, because the effects of production and perception differ?
  - training and test with artificial language learning paradigm
  - a pattern which is new for the learners
  - compares learning of vowel nasalization in relation to vowel height

# 2

## Vowel nasalization

# Why vowel nasalization?

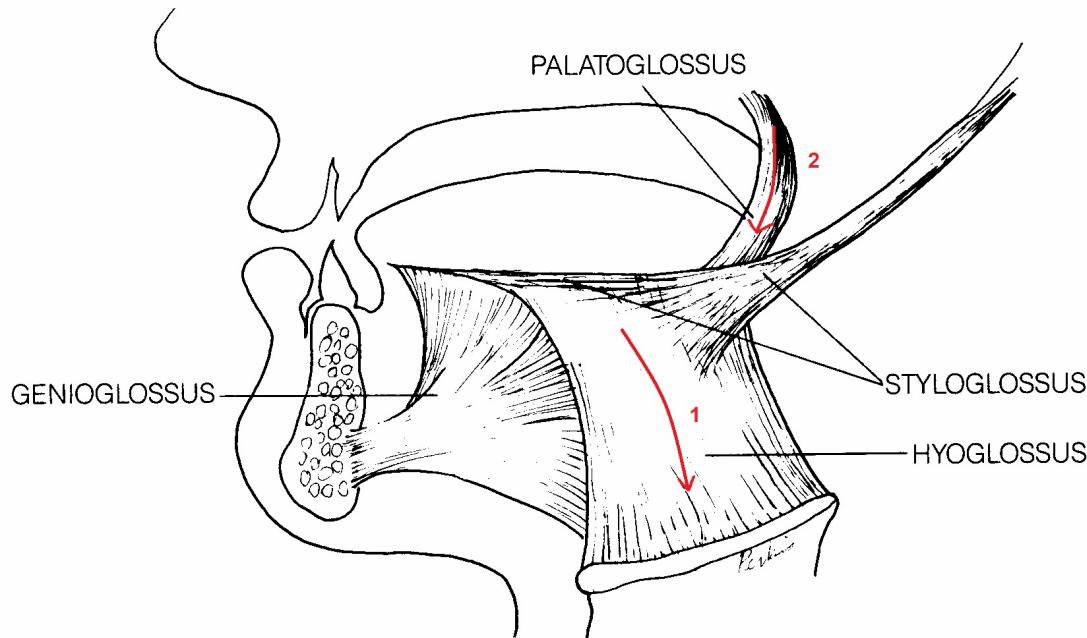
- for vowel nasalization there are two different predictions
  - production prefers low vowel nasalization
  - perception prefers high vowel nasalization

- left: oral vowel [e], right: nasalized vowel [ẽ] (Zsiga, 2013)



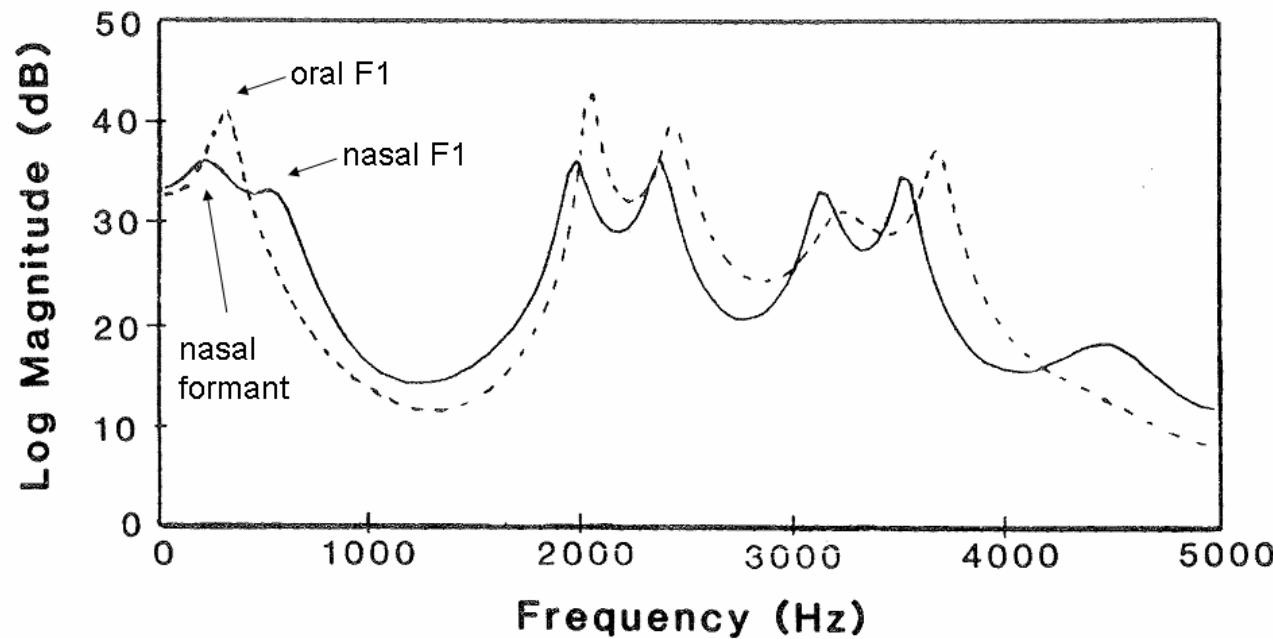
# Ease of production

- muscles for nasalization of the vowel (*palatoglossus*) and lowering the vowel (*hyoglossus*) are anatomically connected



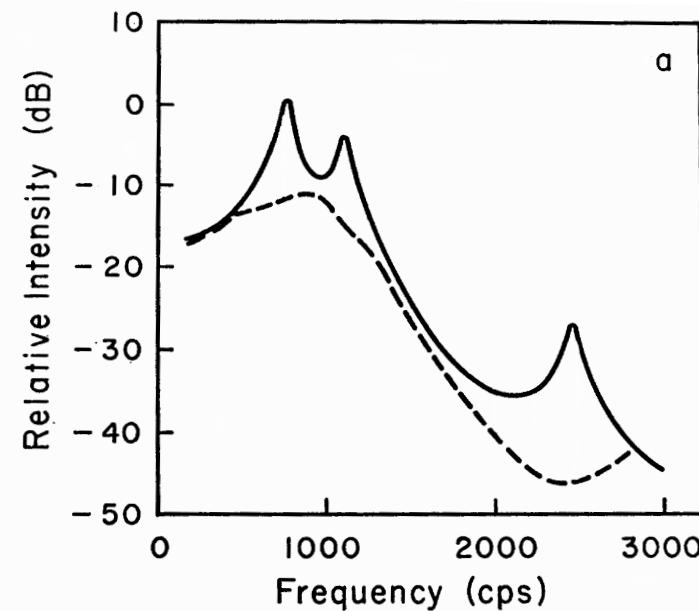
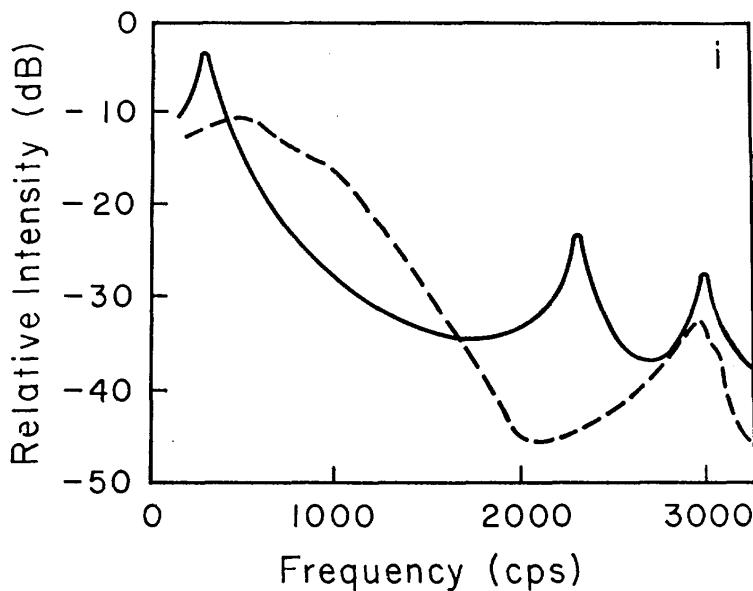
Hoole (2015)

- broken line: oral vowel [e], continuous line: nasalized vowel [ɛ] (Beddor, 1984)



# Ease of perception

- high oral and nasalized vowels are perceptually more distinct from each other than low oral and nasalized vowels (Schwartz, 1968)



- continuous line: oral vowel, broken line: nasalized vowel

- some languages prefer low vowel nasalization
  - e.g. many Chinese dialects, some Eastern Algonquian languages, Thai, Amuzgo, ... (Hajek & Maeda, 2000)
- some languages prefer high vowel nasalization
  - e.g. Chamorro, Picard, Panamanian Spanish, Chatino, ... (Hajek & Maeda, 2000)

# Asymmetry: previous research

- studies using natural stimuli (e.g. Lintz & Sherman, 1961; Bream, 1968):
  - preference for low vowel nasalization
- studies using synthetic stimuli (e.g. Hawkins & Stevens, 1985; Maeda, 1993):
  - preference for high vowel nasalization
- nasalized vowels were part of the phoneme inventory of the participants' native languages
  - only natural stimuli evoked association with the own articulation

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# Experiment

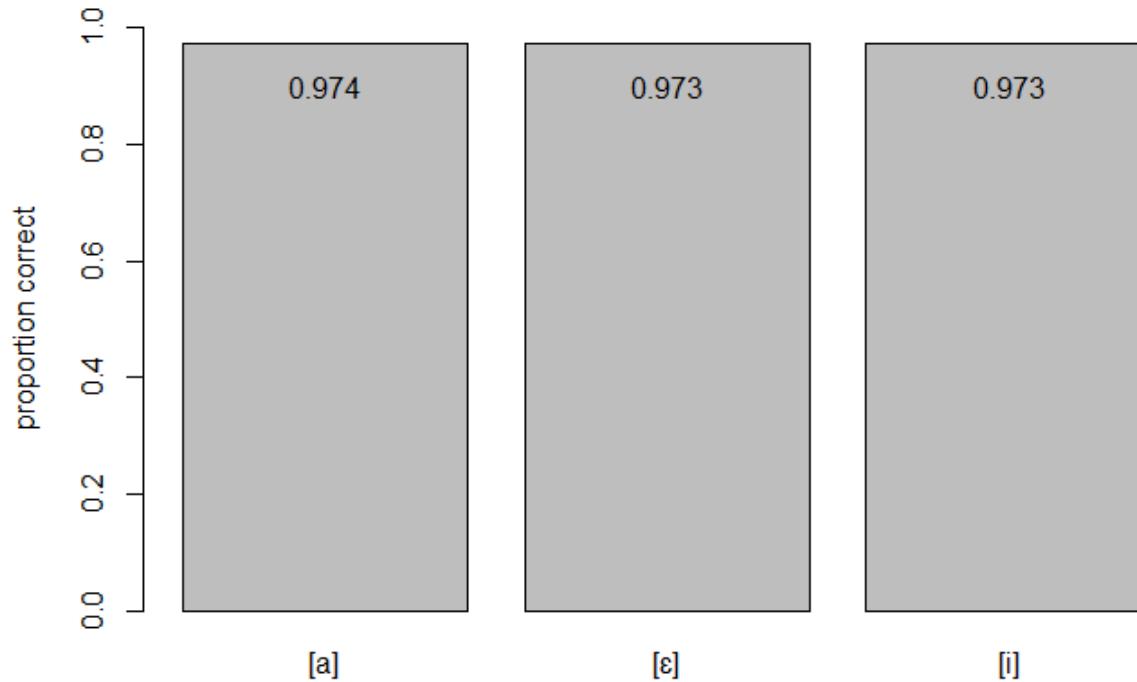
- In our experiment adult native speakers of German learned a new vowel nasalization pattern.
  - vowels are nasalized before nasals: /V/ → [Ṽ] /\_ [m]
  - nasalization of high vowel [i], mid vowel [ɛ] or low vowel [a]

predictions		
no substantive bias	substantive bias	
	ease of perception	ease of production
low = high	high > low	low > high

- Can German native speakers perceive the difference between nasalized and oral vowels although nasalized vowels are not part of their phoneme inventory?
- experiment with 75 native speakers of German
  - same-different-task
  - 2 x 60 stimulus pairs (oral vs. oral, nasalized vs. nasalized, oral vs. nasalized)
  - CV-syllables

C	V
[p t k]	[a ε i ɔ u / ã ë ï õ û]

- no significant difference between vowels



- German native speakers can perceive the difference between all oral and nasalized vowels.

- artificial language: singular, plural and diminutive forms
- subset of German and Portuguese phoneme inventory
- recorded by a native speaker of Portuguese

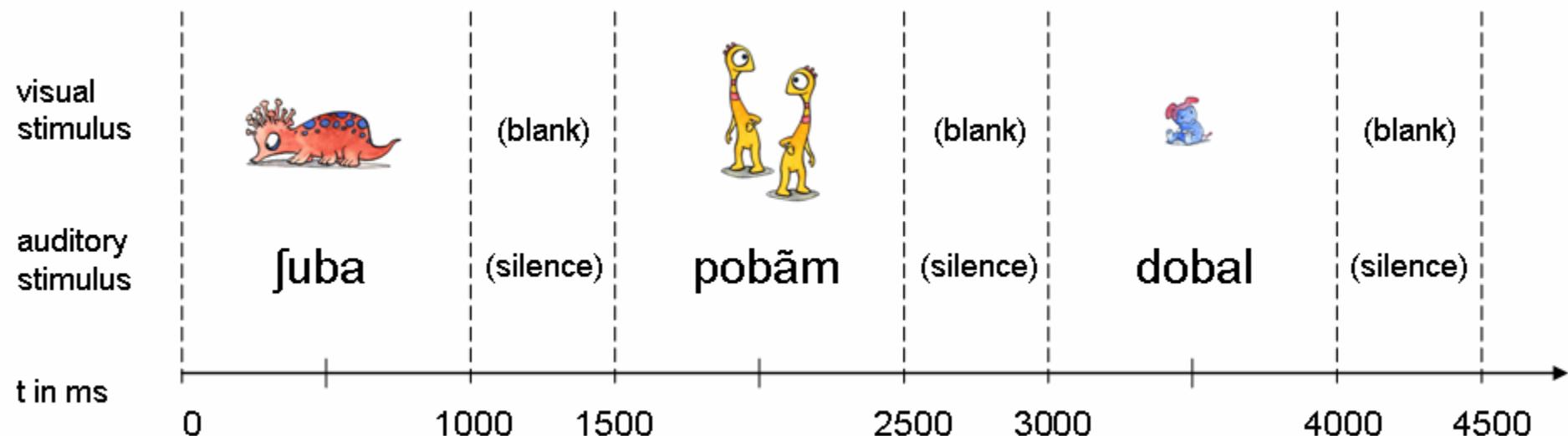
	$C_1$	$V_1$	$C_2$	$V_2$	suffix
singular	[p d k ſ v]	[o u]	[b t g f z]	[a ε i]	Ø
plural	[p d k ſ v]	[o u]	[b t g f z]	[ã ē ì]	[m]
diminutive	[p d k ſ v]	[o u]	[b t g f z]	[a ε i]	[l]



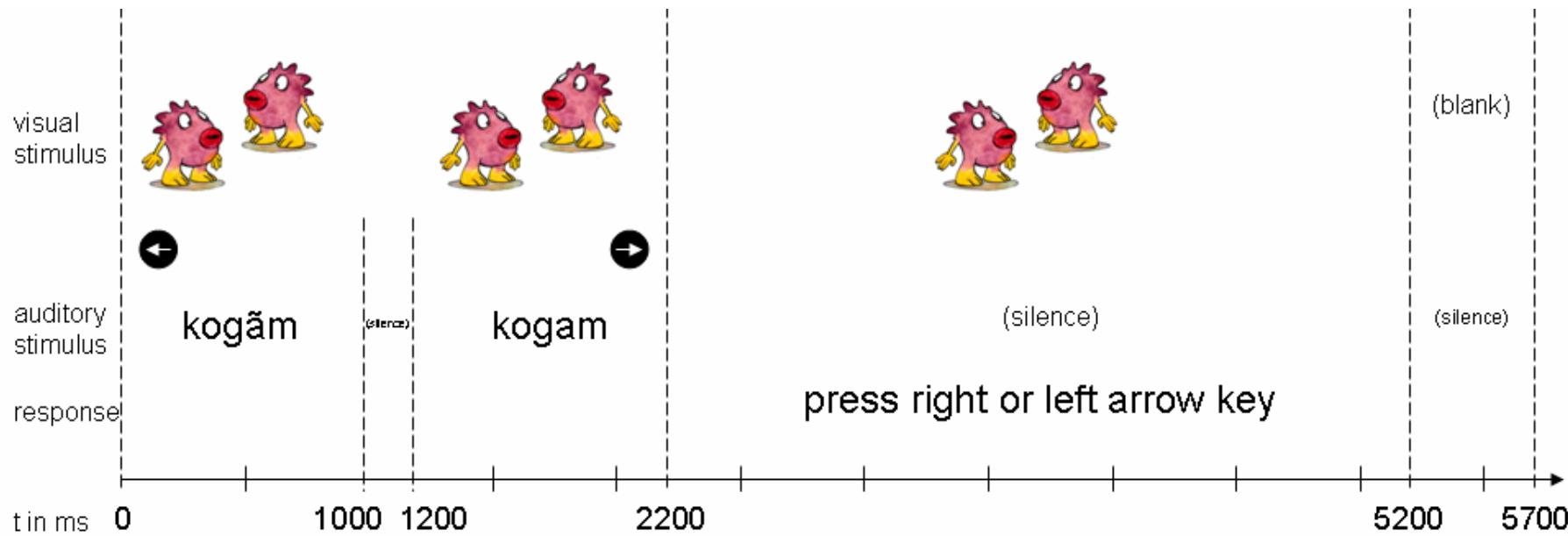
- *Poverty of the Stimulus Method* (Wilson, 2006) with three experimental groups

participants	training	test
n = 20	high	high, mid, low
n = 20	mid	high, mid, low
n = 20	low	high, mid, low

- 2 x 48 stimuli (16 singulars, 16 plurals, 16 diminutives) in randomized order



- *forced choice task*
  - correct vs. incorrect form; oral vs. nasalized vowel
- 48 stimulus pairs (24 plurals, 24 diminutives)
  - 16 pairs with high, mid and low vowels

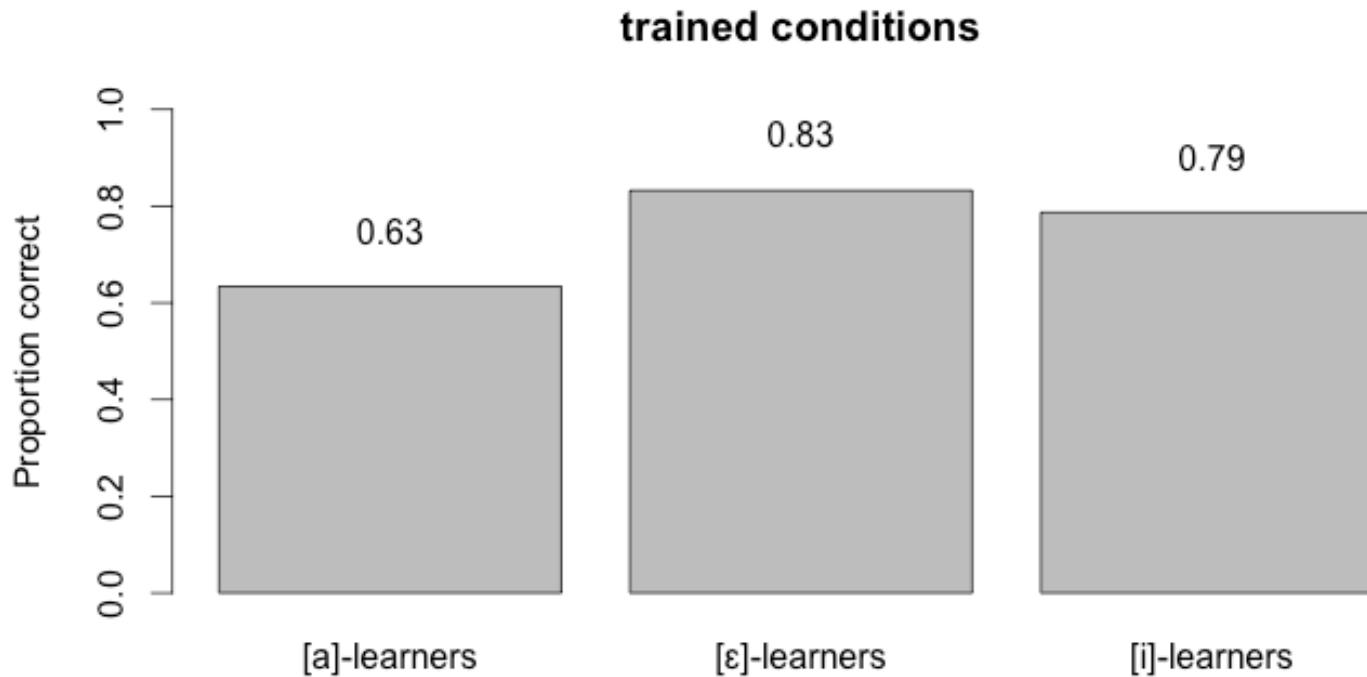


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# Results

# Plural formation: learning

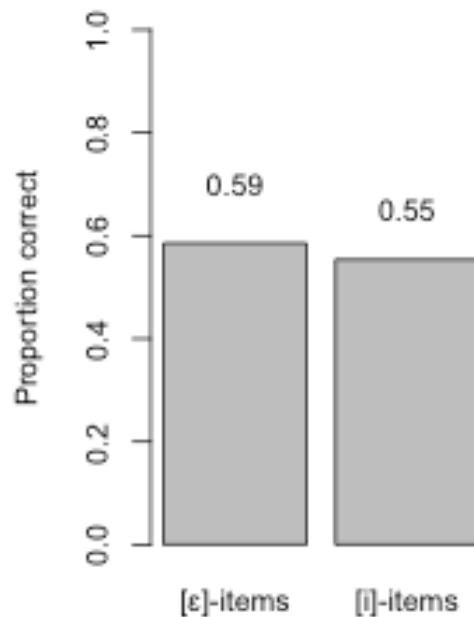
- analysed by means of logistic regression
- [i]-learners & [ɛ]-learners \* > [a]-learners
- [i]-learners = [ɛ]-learners



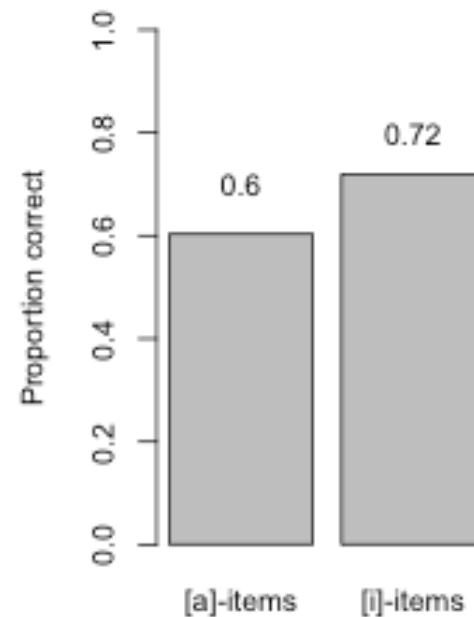
# Plural formation: Generalization

- [a]-learners: [ɛ]-items = [i]-items
- [ɛ]-learners: [i]-items \* > [a]-items
- [i]-learners: [ɛ]-items \* > [a]-items

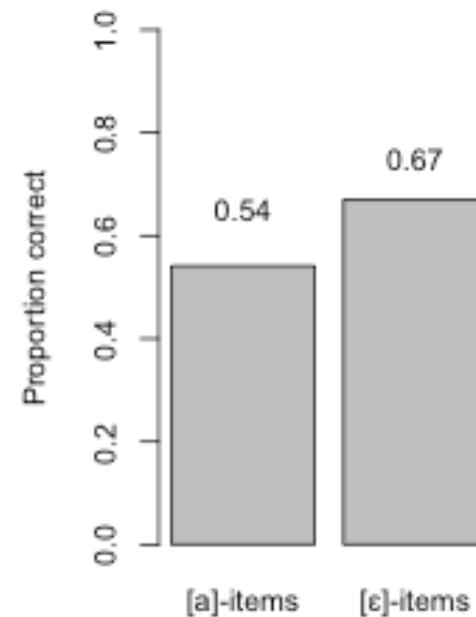
[a]-learners



[ɛ]-learners



[i]-learners



# 5

## Discussion

- high and mid vowel nasalization is learned better than low vowel nasalization
- evidence in favour of a substantive bias which eases perception

predictions		
no substantive bias	substantive bias	
	ease of perception	ease of production
low = high	high > low	low > high

- our results are in line with previous studies using synthetic stimuli although we used natural stimuli
- our participants have no experience with the articulation of nasalized vowels
- ease of perception is independent of language-specific experience

- Wilson (2006): generalization to unmarked patterns
- present study
  - /i/-learners generalize more to /ɛ/- than to /a/-items
  - /ɛ/-learners generalize more to /i/- than to /a/-items
  - /a/-learners do not generalize to other items
- Participants generalize more to non-low vowels because they are unmarked for perception.

# 6

## Conclusion

- successful learning of a vowel nasalization rule depends on vowel height
- further evidence for a substantive bias
- in line with recent research (Wilson, 2006; Finley, 2012; Baer-Henney et al., submitted)
- ease of perception is favoured over ease of production
  - perception before production hypothesis (Flege, 1991)

- Can this pattern be generalized to other languages?
  - experiment with native speakers of another language without nasalized vowels (e.g. Hungarian)
- Would a similar production task show the same results?

- Thank you for your attention!
- Köszönöm szépen a figyelmet!

# 7

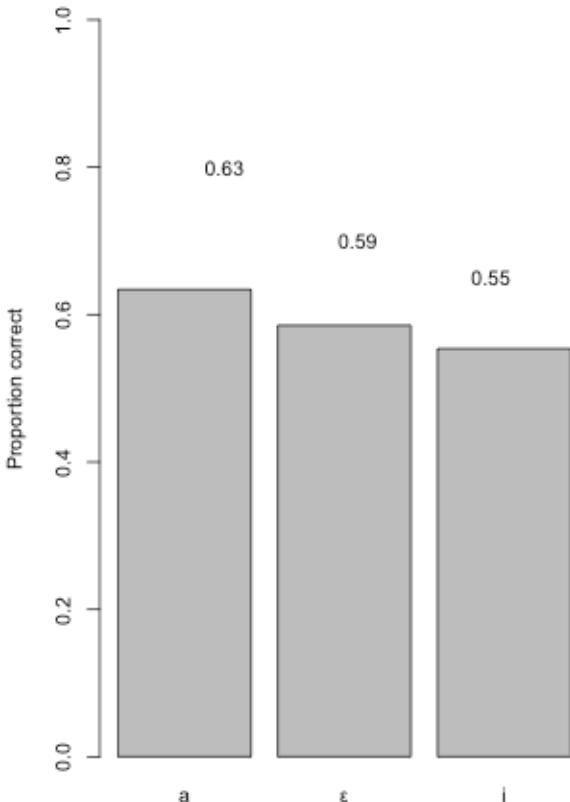
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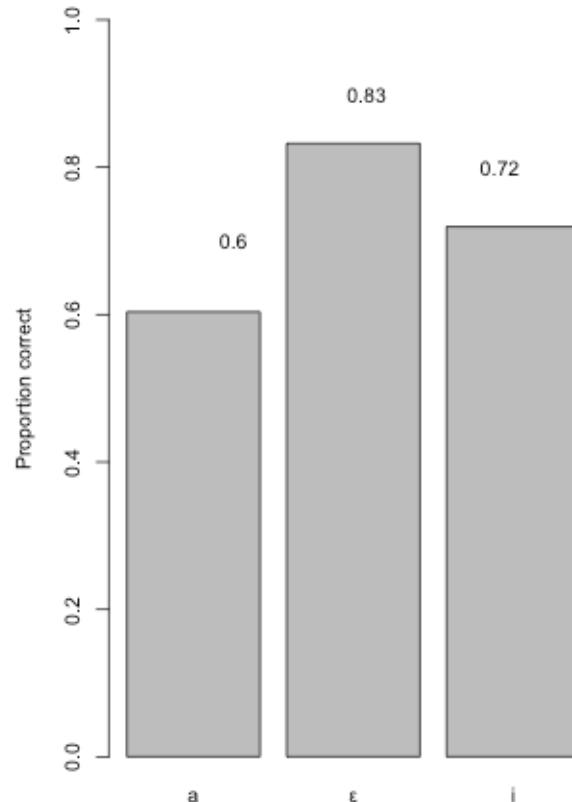


# Results: plural & diminutive formation

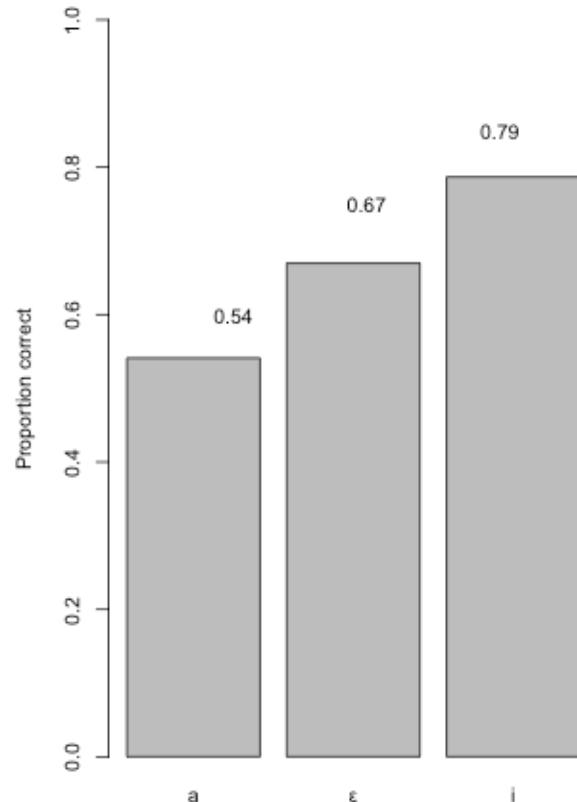
Learning Nasalization as an a-learner



Learning Nasalization as an ɛ-learner



Learning Nasalization as an i-learner



- a-Sg 
- a-Pl 
- a-Dim 
- ε-Sg 
- ε-Pl 
- ε-Dim 
- i-Sg 
- i-Pl 
- i-Dim 
- a-Pl (oral) 
- a-Dim (nasalized) 
- ε-Pl (oral) 
- ε-Dim (nasalized) 
- i-Pl (oral) 
- i-Dim (nasalized) 