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Learning to distinguish morphological categories based on subphonemic detail?

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Theoretical Background

Bootstrapping mechanisms

- Information exchange between domains are beneficial for learners (Pinker, 1987; Höhle, 2009), e.g.

  Prosodic Bootstrapping (Gleitmann & Wanner, 1982; Nazzi et al., 2000; Soderstrom et al., 2003; Wellmann et al., 2012, Wellmann, 2023)

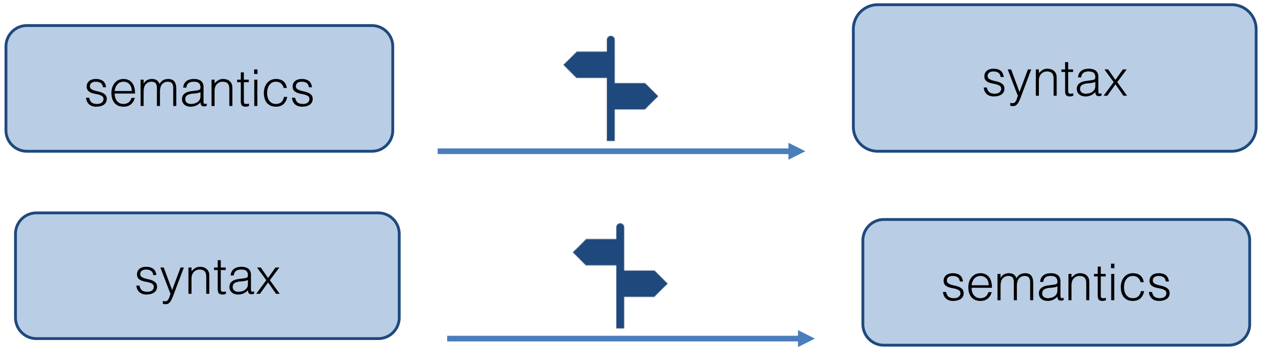
Prosody → Syntax

- syllable lengthening
- F0 lowering
- pauses

- clause boundaries

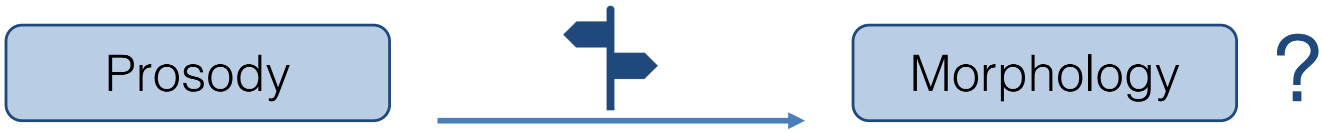
Theoretical Background

- Other bootstrapping mechanisms (non-exhaustive list)



- relevant not only for first language acquisition but also for adult learning and processing (Christophe & Dupoux, 1996; Echols et al., 1997, Cutler et al., 1997; Desai, 2002, Shultz et al., 2010, Sohail & Johnson, 2016)

Theoretical Background



Evidence is necessary:

1. Cues must be present in production.
2. Cues must be perceived.
3. Cues must be made use of in learning.

Theoretical Background

Test case: English final S

There are durational differences between morphological categories.

The bu[s]$_{\text{non-morphemic}}$ leaves at 7.

The cat[s]$_{\text{plural}}$ have good night vision.

The cat'[s]$_{\text{clitic}}$ left the house.

Production

non-morphemic S

>

plural S

>

clitic S

(Schmitz et al., 2021a,b;
Tomaschek et al., 2019;
Plag et al., 2017;
Zimmermann, 2016;
Seyfarth et al., 2017)

Theoretical Background

Test case: English final S

These differences are perceptible and make a difference in comprehension (Schmitz, 2022)

✓ Perception

- ABX Task
- durational differences are perceptible

✓ Comprehension

- number decision / mousetracking
- Exp. 1: pseudoword **plural** vs. **clitics** in real word contexts
- Exp. 2: real word n**on-morphemic** vs. **plural**: *box* vs. *books*
- mismatched S caused detour

Theoretical Background

1. Cues must be present in production. ✓
2. Cues must be perceived. ✓

The next step

Are subphonemic cues strong enough to guide morphological learning?

Do durational cues enable the learner to build up a new morphological representation?

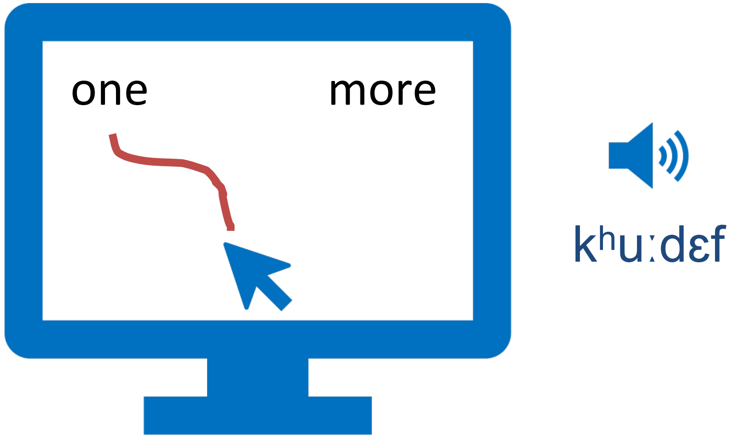
RQ

Can adult L1 speakers of German learn to distinguish the morphological categories SG and PL based on duration?

Method: Artificial language learning

1. Training

2. Number decision



Participants

- 60 adult L1 German speakers in three groups

- PHONEMIC group: Plural is /p/
- PHONETICLONG group: Plural is /fːː/
- PHONETICSHORT group: Plural is /fː/
- Control groups: random distribution

data collection under way…

Stimuli

- Miniature artificial language

CVCVC

- varying consonant combinations
- two item sets for some variation:
  {b, n, d, k} or {l, m, g, t}
- training and test items are different
- half of test items contain attested consonants
- the other half does not

Stimuli

- Miniature artificial language

CV̲CV̲C

- V_1 a tense vowel {a, e, i, o, u}
- V_2 a lax vowel {ɑ, ɛ, ɪ, ɔ, ʊ}

Stimuli

- Miniature artificial language

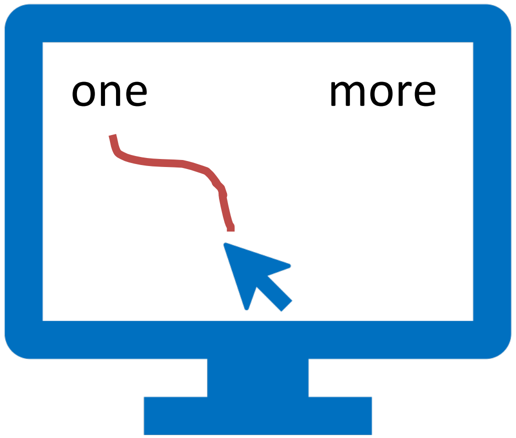
CVCVC

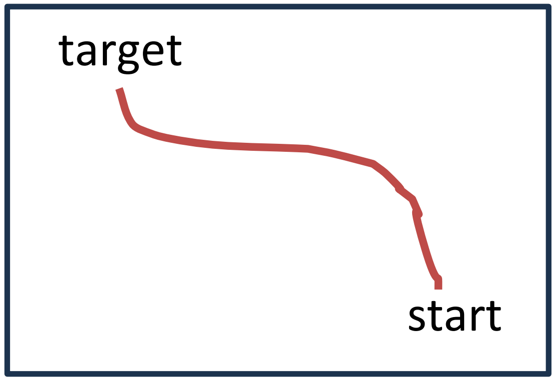
- Final C was different in experimental groups

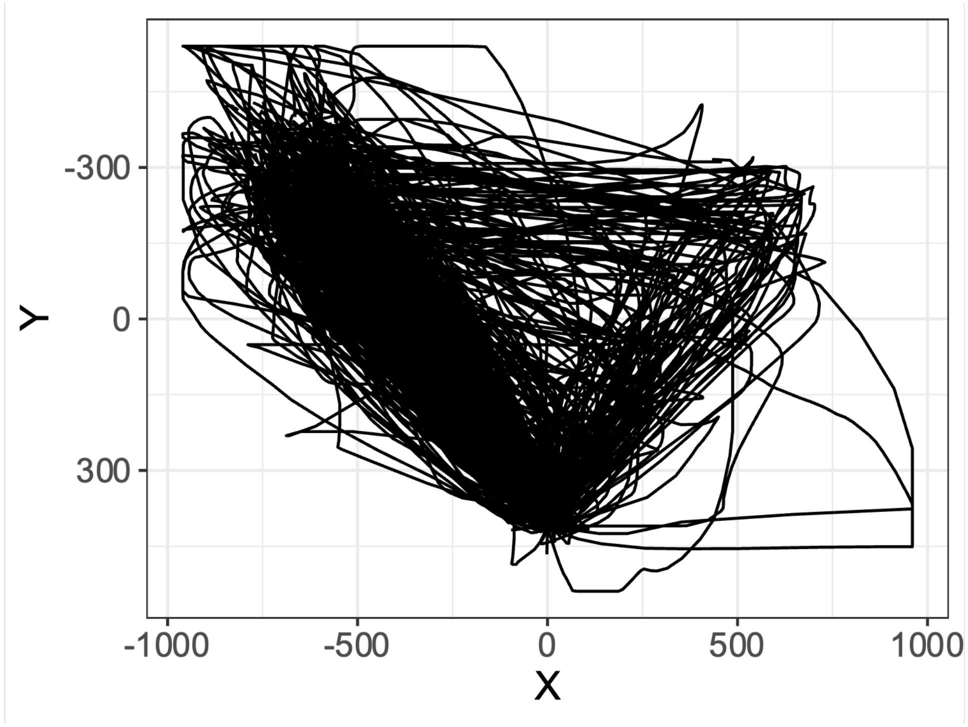
	SG	PL
PhonemiC	f (135 ms)	p
PhoneticLong	f (135 ms)	f (210 ms)
PhoneticShort	f (135 ms)	f (170 ms)

Analysis

The data







- time-normalised
- spatially transformed

Analysis

Dependent variables

- Rough view:

  Accuracy as dependent variable

- Detailed view:

  Coordinates of mouse tracks as dependent variable

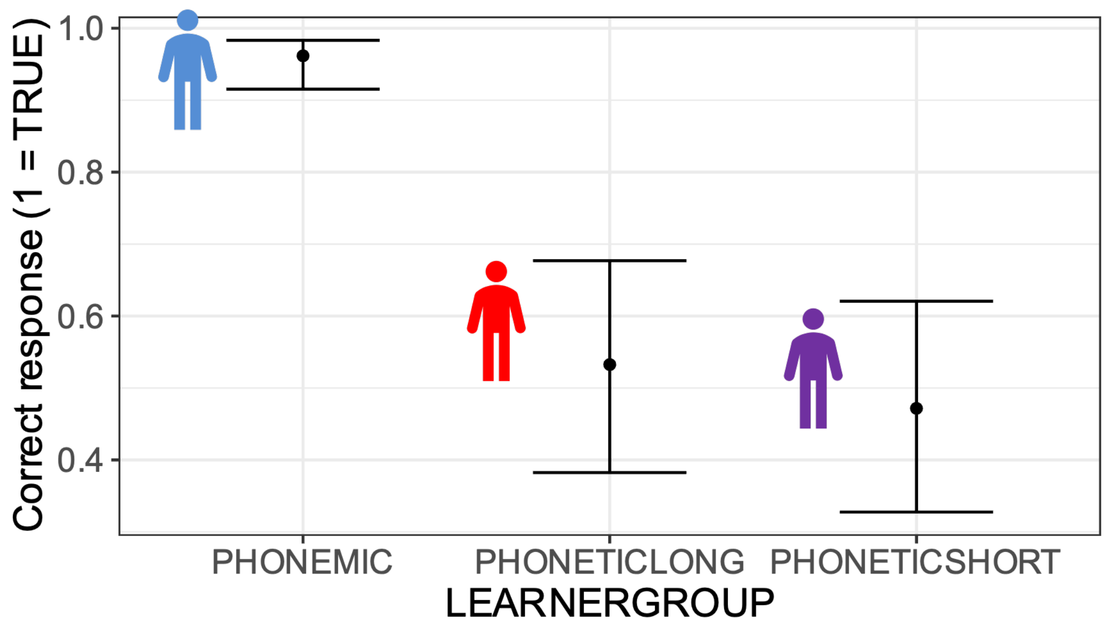
Analysis

Independent variables

- LEARNERGROUP
  - PHONEMIC vs. PHONETICLONG vs. PHONETICSHORT
- L1LIKELIHOOD (Tang & Baer-Henney, 2023)
- L2LIKELIHOOD (Tang & Baer-Henney, 2023)
- other: ATTESTEDNESS
  RESPONSE (SG vs. PL)
  TRIALNUMBER

Results

Accuracy

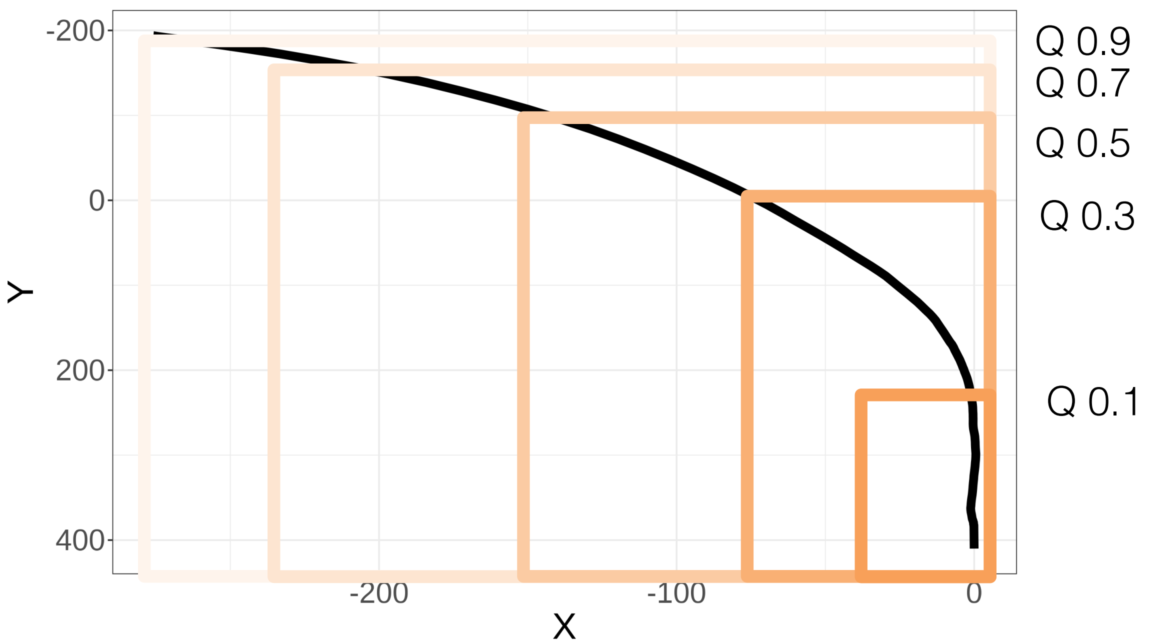


- Generalized linear mixed-effects model (Bates et al., 2015)
- PHONEMIC group learns well
- PHONETIC groups learn worse Do they learn at all?
- Covariates have no effects

Results

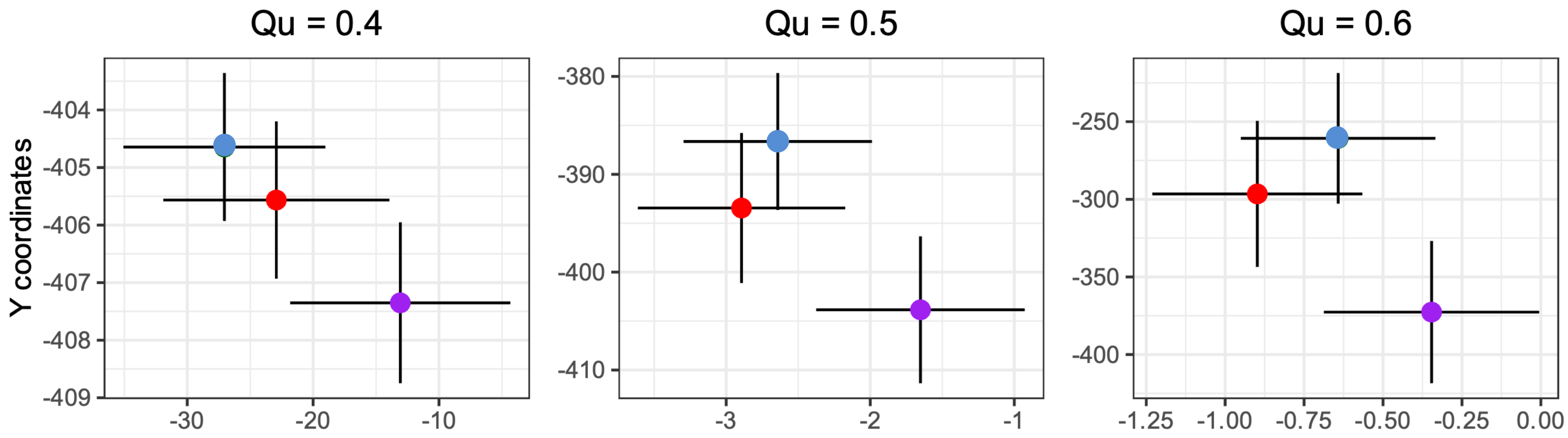
Mouse tracks

- QGAMs: Quantile generalized additive mixed models (Fasiolo et al., 2021)
- fitted to conditional quantiles of the dependent variable: position on x- and y-axis

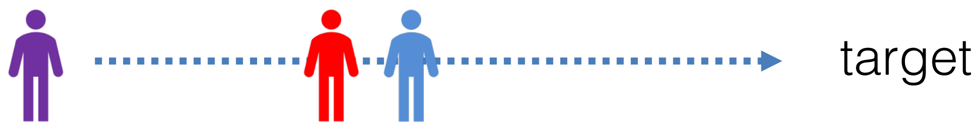


Results

Mouse tracks



- when the journey starts, PHONEMIC groups together with PHONETICLONG, PHONETICSHORT stays behind



Results

Mouse tracks – other effects

- L1LIKELIHOOD - Anti-L1 effect?
  - x-axis: the more similar the test item to German, the further away from target

- L2LIKELIHOOD - Pro-L1 effect
  - X- and y-axis: the more similar the test item to the training language, the straighter the path to the target

Discussion

Evidence is necessary:

1. Cues must be present in production. ✓
2. Cues must be perceived. ✓
3. Cues must be made use of in learning. ✓

Discussion

- clear advantage for the PHONEMIC group in morphological learning
- for subphonemic cues: evidence that they can guide learning, but it is relatively weak
- unclear whether other cues like context, SV-agreement may be more informative in natural learning situations

- Addendum:

A possible mechanism would also play a role in language change: phonetic detail to be morphologised? (Strycharczuk & Scobbie, 2016, 2017)

Thank you!

References

Bates, D., Mächler, M., Bolker, B., & S. Walker (2015). Fitting linear mixed-effects models using lme4. Journal of Statistical Software, 67(1), 1–48.
Christophe, A., & E. Dupoux (1996). Bootstrapping lexical acquisition: the role of prosodic structure. Linguistic Review 13, 383-412.
Cutler, A. Dahan, D., & W. van Donselaar (1997). Prosody in the comprehension of spoken language: A literature review. Language and Speech 2, 133–142.
Desai, R. (2002). Bootstrapping in miniature language acquisition. Cognitive Systems Research, 3(1), 15-23.
Echols, C., Crowhurst, M., & J.Childers (1997). The Perception of Rhythmic Units in Speech by Infants and Adults, Journal of Memory and Language 36 (2), 202-225.
Fasiolo, M., Wood, S. N., Zaffran, M., Nedellec, R., & Y. Goude (2021). Fast Calibrated Additive Quantile Regression. Journal of the American Statistical Association 116(535), 1402–1412.
Gleitman, L. R., & E. Wanner (1982). Language acquisition: The state of the art. In Gleitman, L. R. & E. Wanner (eds.), Language acquisition: The state of the art, Cambridge, MA: Cambridge University Press, 3-48.
Höhle, B. (2009). Bootstrapping mechanisms in first language acquisition. Linguistics 47(2). 359-382.
Nazzi, T., Kemler Nelson, D.G., Jusczyk, P.W., & A. M. Jusczyk (2000). Six- month-olds' detection of clauses embedded in continuous speech: effects of prosodic well-formedness. Infancy 1(1), 123–147.
Pinker, S. 1987. The bootstrapping problem in language acquisition. In Mac-Whinney, B. (ed.), Mechanisms of language acquisition, Hillsdale, NJ: Lawrence Erlbaum, 399– 441.
Plag, I., Homann, J., & G. Kunter (2017). Homophony and morphology: The acoustics of word-final S in English. Journal of Linguistics 53, 181–216.
Seyfarth, S., Garallek, M., Gillingham, G., Ackermann F., & R. Malouf (2017). Acoustic differences in morphologically-distinct homophones. Language Cognition and Neuroscience 33, 1–18.
Schmitz, D., Baer-Henney , D., & I. Plag (2021a). The duration of word-final /s/ differs across morphological categories in English: Evidence from pseudowords. Phonetica 78(5-6), 571-616.
Schmitz, D., Plag, I., Baer-Henney, D., & S. D. Stein (2021b). Durational differences of word-final /s/ emerge from the lexicon: Modelling morpho-phonetic effects in pseudowords with linear discriminative learning. Frontiers in Psychology 12.
Schmitz, D. (2022). Production, perception, and comprehension of subphonemic detail: Word-final /s/ in English. Studies in Laboratory Phonology 11. Berlin: Language Science Press.
Sohail, J., & E. Johnson (2016), How Transitional Probabilities and the Edge Effect Contribute to Listeners' Phonological Bootstrapping Success, Language Learning and Development 12(2), 105-115.
Shultz, T., Berthiaume, V., & F. Dandurand (2010). Bootstrapping syntax from morpho-phonology. In 2010 IEEE 9th International Conference on Development and Learning (52-57).
Soderstrom, M., Seidl, A., Kemler Nelson, D.G., & P. W. Jusczyk. (2003). The prosodic bootstrapping of phrases: evidence from prelinguistic infants. Journal of Memory and Language 49. 249–267.
Strycharczuk, P., & J. M. Scobbie (2016). Gradual or abrupt? The phonetic path to morphologisation. Journal of Phonetics 59, 76-91.
Strycharczuk, P., & J. M. Scobbie (2017). Whence the fuzziness? Morphological effects in inter-acting sound changes in Southern British English. Laboratory Phonology 8(1). 1-21.

References

Tang, K., & D. Baer-Henney (2023). Modelling L1 and the artificial language during artificial language learning. Laboratory Phonology 14(1). 1–54.

Tomaschek, F., Plag, I., Baayen R.H. & M. Ernestus (2019). Phonetic effects of morphology and context: Modeling the duration of word-final S in English with naive discriminative learning. Journal of Linguistics 57. 1–39.

Wellmann, C. (2023). Early sensitivity to prosodic phrase boundary cues: Behavioral evidence from German-learning infants. Doctoral dissertation, Universität Potsdam.

Wellmann, C., Holzgrefe, J., Truckenbrodt, H., Wartenburger, I., & B. Höhle (2012). How each prosodic boundary cue matters: Evidence from German infants. Frontiers in Psychology 3(580).

Zimmermann, J. (2016). Morphological status and acoustic realisation: Findings from NZE. In Carignan, C. & M.D. Tyler (Eds.), Proceedings of the Sixteenth Australasian International Conference on Speech Science and Technology, Parramatta, 201–204.