Reading proficiency and phonemic awareness as correlates for coarticulatory gradients in children

Anisia Popescu* & Aude Noiray*

* Universität Potsdam, anisiapopescu@uni-potsdam.de

Premises

Goal:
Investigate whether a link between speech production maturation, phonological awareness (PA) and reading exists at an early stage of reading acquisition.

Hypothesis:
The development of PA and reading proficiency stimulate the reorganization of spoken language from rather holistic units (large degree of intra-syllabic coarticulation, CD) to greater segmental differentiation in coarticulatory patterns (lower CD).

Predictions:
Negative correlation between CD and PA/reading proficiency: children with advanced PA and reading proficiency should exhibit lower CD.

Methods

Participants: 20 x 👤 and 15 x 👤 (mean age 7.04) German native children

Production task: Ultrasound tongue imaging of pre-recorded disyllabic **C1V**C2ə non-words (target vowels: /iː/, /yː/, /eː/, /uː/, /oː/; target consonants:/b/, /d/, /g/)

PA and Reading assessments: Standard assessments for German (PA: TPB; Reading: SLRT I)
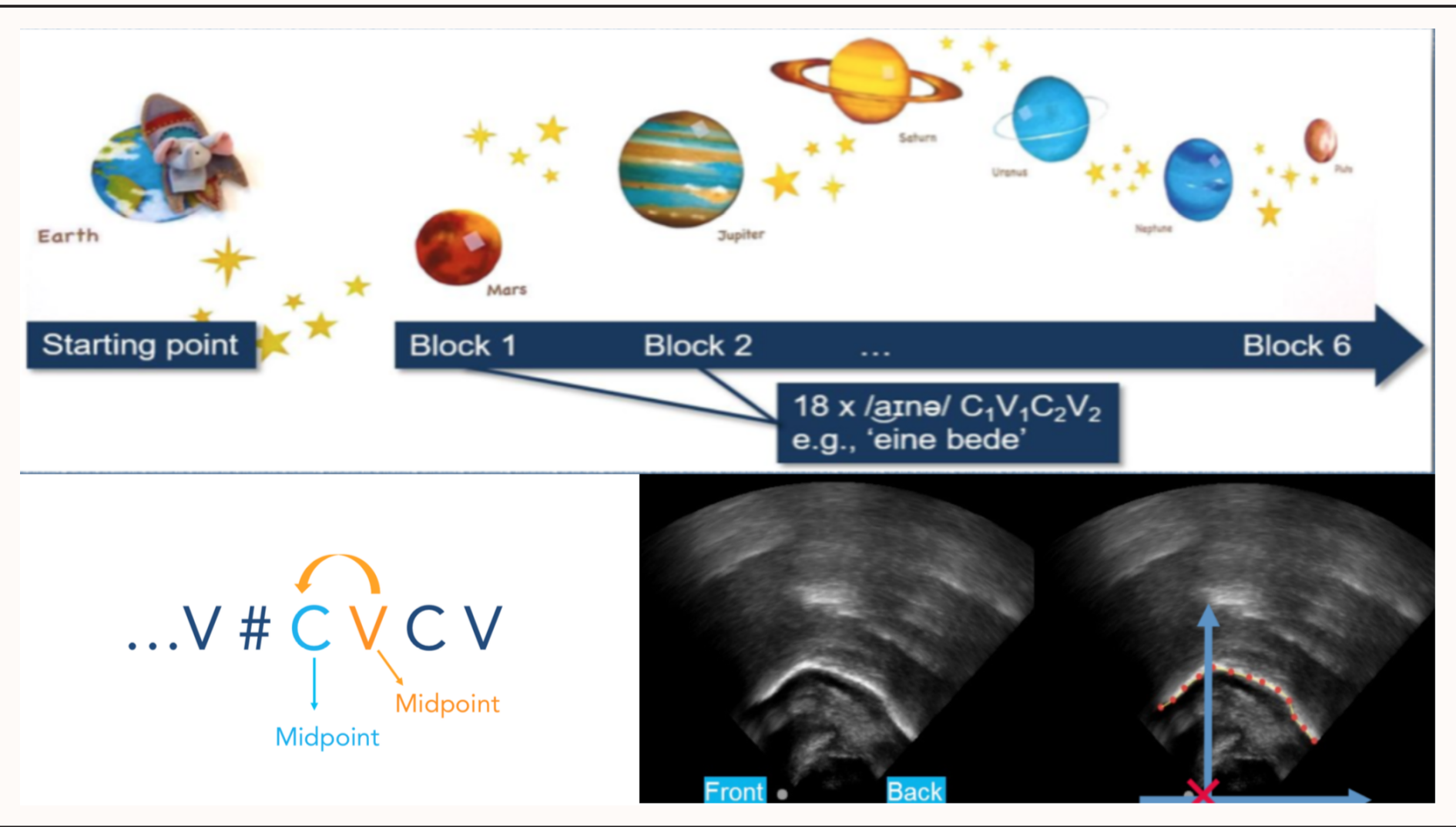

Figure 1: Methods and Materials

Conclusions

Assessments
• First graders perform equally well on large unit manipulation tasks (rhymes), but have variable performance when manipulating smaller units (segments)

Correlations
• The speech of less proficient readers *and* phonologically aware children is characterized by larger production units (e.g. more syllabic).
• Less proficient readers and phonological aware children organize their speech in larger (syllable-size) rather than smaller (segment-sized) units.

Non-linearity
• The observed patterns are non-linear indicating complex interactions between domains (speech motor control and phonological awareness/reading acquisition)

Assessment scores

Reading: Non-word task
• Parameters: *Accuracy* and *Time (s)*
• Considered measure

  • *Reading fluency (RF)*: $\frac{Count_{correctwords}}{Time}$ ($Count_{correctwords}$ = Total nb of words - Mistake count)

Phonological awareness: Two tasks

• Rhyme Production: targeting large sub-segmental units
Children are given a word and are asked to provide words with the same rhyme
• Onset Deletion: targeting small individual segments
Children are given a word with a complex onset and are asked to delete one of the cluster segments
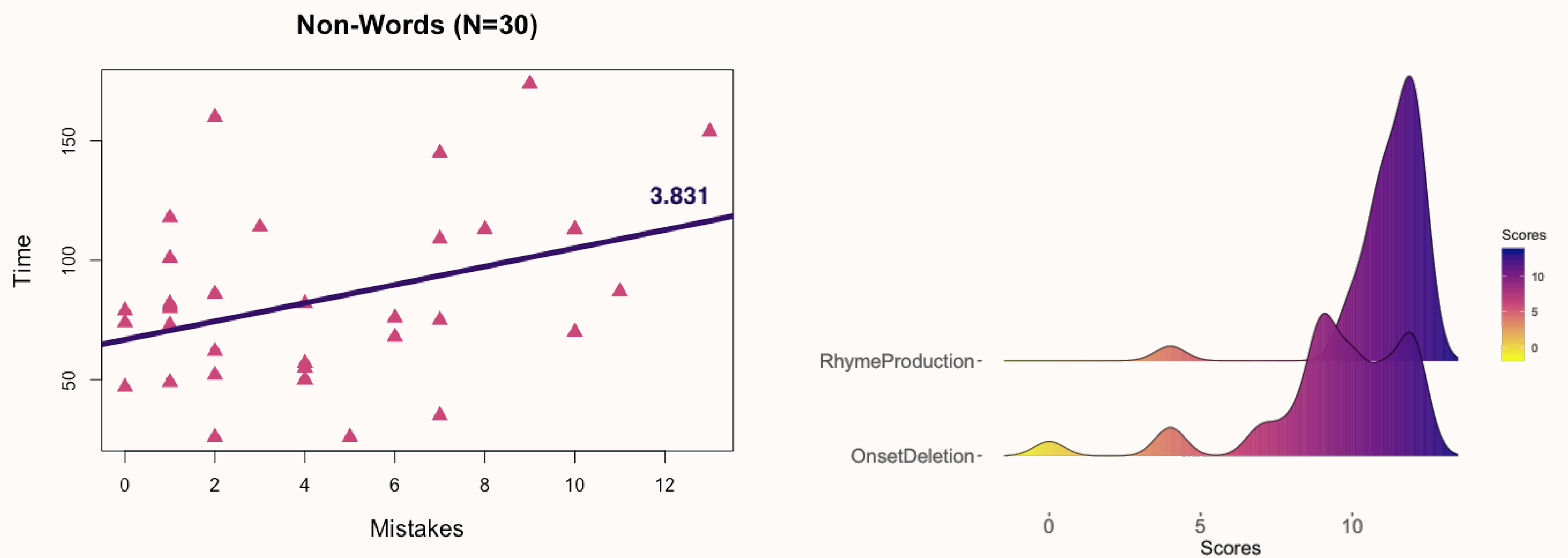

Figure 2: Assessment scores: Reading assessment (left); PA scores (right)

Correlating scores and Coarticulation Degree

General Additive Models:

• Difference in coarticulation degree (CD) as a function of consonantal contexts
• $CD_{/b/,/g/} > CD_{/d/}$
• Labial and velar consonants (/b/, /g/) are less resistant to vocalic influence than the alveolar consonant (/d/)
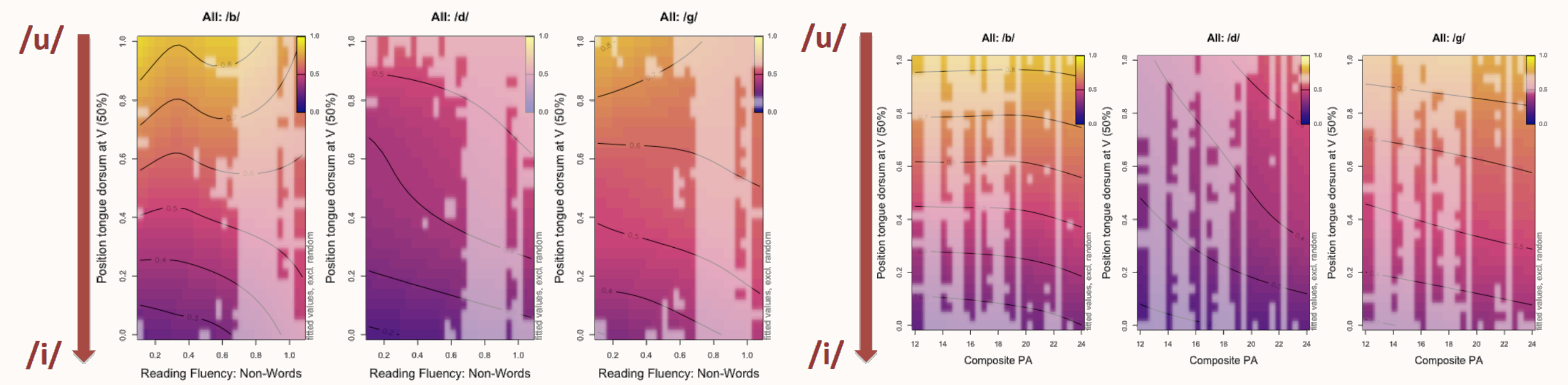

Figure 3: Interaction between CD and RF(left); Interaction between CD and PA (right)

• Strong interaction between reading/phonological awareness proficiency and CD
• More proficient readers exhibit lower CD and greater segmental differentiation in tongue gestures
• Greater phonological awareness also correlates with lower CD
• Both interactions are non-linear (See Table 1: edf > 1)
• Effect of consonantal context

Tensor functions (te)	edf	*p*-value	Tensor functions (te)	edf	*p*-value
te(Reading Fluency): /b/	6.64	$p < 2e-16$	te(Composite PA): /b/	5.10	$p < 2e-16$
te(Reading Fluency): /d/	7.34	$p < 2e-16$	te(Composite PA): /d/	6.52	$p < 2e-16$
te(Reading Fluency): /g/	8.86	$p < 2e-16$	te(Composite PA): /g/	6.13	$p < 2e-16$

Table 1: Tensor smooth terms of the GAM testing for the interactions between Reading fluency (left) and Composite PA (right) and CD per consonantal context /b/, /d/, /g/

Selected References

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