

Coarticulation degree interacts with reading fluency in German beginning readers

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In the first years of life, most children learn to speak and read their native language fluently. With a few exceptions [3,8,9] the two skills have been mostly studied separately. Therefore, it is unclear whether they develop independently of each other or, instead, interact with one another during development. The present study addresses this question in German, an alphabetical language with fairly consistent grapheme to phoneme relationships. German, a language whose writing code targets the same units as speech – phonemes, provides a good testing ground for determining whether the two skills interact. To this end we combined reading assessments with a commonly used measure of speech fluency, anticipatory coarticulation. Vocalic coarticulation degree (CD) reflects the degree of articulatory overlap between a vowel and its preceding consonant. It has been shown that child speech exhibits larger CD than adult speech [2, 3, 5, 6]. Interestingly, a significant decrease in CD has also been found between preschool and primary school aged children [3], suggesting that around the time children learn to read their CD also changes, indicating age might not be the only contributing factor to speech fluency development.

In this study, we hypothesized that children's coarticulatory organization interacts with their reading proficiency, at the time German children learn how to read. More specifically, we expected more proficient readers to show lower CD than poorer readers. To test this hypothesis, we tested 32 German age-matched beginning readers (age-span 6.9 – 7.4 y.o.; mean age 7.2) at the end of their first year of primary school, thus controlling for age and exposure to reading instruction in school. Reading assessments measured accuracy and time for reading real and nonwords [1]. Reading fluency was calculated as the ratio between accuracy and time, in order to differentiate between readers with similar levels of accuracy but different reading speed. For the speech task, children were instructed to produce 6 repetitions (in randomized blocks) of short, pre-recorded utterances of disyllabic $C_1VC_2\partial$ pseudo-words with various vowels (/i/, /y/, /u/, /e/, /o/) and consonants (/b/, /d/, /g/). During production, the movement of children's tongue was recorded using ultrasound tongue imaging [4] and used to estimate CD between target vowels (V) and preceding consonants (C_1). For each child and each target word, CD was calculated as a regression between the tongue positions at V midpoint and its preceding C_1 , allowing us to measure the degree of vocalic anticipation during the production of the consonant. Correlations between reading and spoken fluency were then computed using general additive modeling [10].

Overall, we found that more fluent readers exhibited lower degrees of vocalic coarticulation, i.e., less anticipation of the vowel during the production of the consonant. Given the limited age variation of our participants we take this finding to indicate that a newly acquired skill – reading – interacts with children's speech motor organization. Results suggest that in German, a transparent alphabetical language, the development of grapheme to phoneme to speech motor correspondences necessary for fluent reading may benefit children's coarticulatory organization and language fluency altogether.

References

- [1] Moll, K., Landerl, K. (2010). SLRT-I: Lese- und Rechtschreibtest; Weiterentwicklung des Salzburger Lese- und Rechtschreibtests (SLRT). Bern: Hans Huber.
- [2] Nittrouer, S., Studdert-Kennedy, M., & Neely, S. T. (1996). How children learn to organize their speech gestures: Further evidence from fricative-vowel syllables. *Journal of Speech, Language, and Hearing Research*, 39(2), 379-389.
- [3] Noiray, A., Popescu, A., Killmer, H., Rubertus, E., Krüger, S., & Hintermeier, L. (2019). Spoken language development and the challenge of skill integration. *Frontiers in Psychology*, 10, 2777.
- [4] Noiray, A., Ries, J., Tiede, M., Rubertus, E., Laporte, C., & Ménard, L. (2020). Recording and analyzing kinematic data in children and adults with SOLLAR: Sonographic & Optical Linguo-Labial Articulation Recording system (SOLLAR). *Laboratory Phonology* 11(1): 1-25.
- [5] Noiray, A., Wieling, M., Abakarova, D., Rubertus, E., & Tiede, M. (2019). Back from the future: Nonlinear anticipation in adults' and children's speech. *Journal of Speech, Language, and Hearing Research*, 62(8S), 3033-3054.
- [6] Noiray, A., Abakarova, D., Rubertus, E., Krüger, S., & Tiede, M. (2018). How do children organize their speech in the first years of life? Insight from ultrasound imaging. *Journal of Speech, Language, and Hearing Research*, 61(6), 1355-1368.
- [7] Noiray, A., Ménard, L., & Iskarous, K. (2013). The development of motor synergies in children: Ultrasound and acoustic measurements. *The Journal of the Acoustical Society of America*, 133(1), 444-452.
- [8] Saletta, M., Goffman, L., & Brentari, D. (2016). Reading skill and exposure to orthography influence speech production. *Applied psycholinguistics*, 37(2), 411.
- [9] Saletta, M. (2019). Orthography and speech production in children with good or poor reading skills. *Applied Psycholinguistics*, 40(4), 905-931.
- [10] Wieling, M. (2018). Analyzing dynamic phonetic data using generalized additive mixed modeling: a tutorial focusing on articulatory differences between L1 and L2 speakers of English. *Journal of Phonetics*, 70, 86-116.