

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

The goal of the present study is to examine whether the acquisition of reading in early primary school, coupled with a gain in phonemic awareness (PA), impacts children's spoken language fluency. In particular, we investigate the effect of reading acquisition on coarticulatory degree (CD), which is usually taken to reflect how much articulatory gestures of consecutive phonemes are temporally overlapping. Prior research has shown that between kindergarten and primary school, German children reduce the size of their coarticulatory units and produce more segmentally specified articulatory gestures [1]. There is also a great deal of evidence that during the same period, children gain increasingly detailed structural knowledge of their native language (e.g., [2; 3; 4]). They transition from the awareness of large structural units (words, syllables) to the full spectrum of phonological units including the smallest phonemic particles. Research has shown that in transparent languages, (e.g., German) this knowledge provides a solid foundation for developing literacy (e.g., [5]). Taken together, those findings suggest that in the course of developing *fluency* in their native language, children gain greater access and ability to manipulate segmental information.

While the relation between phonological awareness and reading has been made explicit over the past decades, whether this late-developing relation affects the formerly acquired skill of speech is not fully understood. Speech production also use the native language's phonological system but phonemic units are embedded into continuous articulatory-acoustic streams rather than mediated through discrete printed symbols. Our driving hypothesis is that by stimulating explicit structural knowledge of the language, reading proficiency combined with greater phonemic awareness should impact children's original organization of speech.

A speech production task was designed to estimate intrasyllabic coarticulation degree (CD) in 50 native German children at the end of the first grade (mean age 7.04), presenting no history of language-related disability. Children repeated pre-recorded C1VC2ə non-words by a native female adult model speaker with five tense vowels (/i:/, /y:/, /e:/, /u:/, /o:/) and three consonants (/b/, /d/, /g/). With the technique of ultrasound imaging, we recorded tongue movement and calculated differences in tongue position between target vowels and previous consonants. Tongue data was analyzed with Matlab scripts to extract CD estimates for each child. The raw scores of pseudo-words reading task (accuracy and reading speed), as well as one PA task (a composite of onset segment deletion and segment manipulation) were calculated based on standard German assessments [6,7]. To test the effect of PA and reading on CD, general additive models (GAMs) were used [8]. Greater reading proficiency and phonemic awareness correlated with lower degrees of coarticulation ($p < .0001$) which supports the hypothesis that the speech of less proficient readers is organized in more syllable-sized rather than phoneme-sized units. Non-linear interactions between CD, reading and PA were found as a function of the specific consonant and vowels combined ($p < .0001$). This result provides strong evidence that developing spoken language fluency entails complex multifactorial interactions which are probably not uniform across children.

Word count: 487

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