Does the acquisition of reading affect speech production?

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Spoken language acquisition is shaped by multi-faceted developments in the perception, speech motor and phonological domains. While those develop synergistically in most children, certain speech and language disorders have pointed at deviancies in how children organize speech gestures in utterances (*developmental apraxia of speech [6,12]; developmental dyslexia [2,11]; stuttering [4,5]*). In this study, we are interested in the developmental relation that may exist between spoken language and aloud reading. Both mechanisms require a precise control over speech articulators (*e.g. tongue, lips*) as well as their temporal coordination to produce intelligible phonetic outputs. Both mechanisms also require children to develop phonological awareness (PA), the knowledge that words are composed of smaller units (*syllables, segments*). The main difference between the two mechanisms is that spoken language develops much earlier than reading (through repeated exposure and practice speaking the language) while (aloud) reading requires extensive explicit instruction in school.

The goal of the present study is to test whether a link between speech production maturation, phonological awareness and reading exist in children at the early stage of reading acquisition. In particular, we test the hypothesis that PA development and reading observed in primary school lead to significant changes in spoken language production from an organic, experience-based organization to a more precise organization informed by structural knowledge of the native language. The speech production parameter we are considering here is anticipatory V-to-C coarticulation degree (CD), a measure of the temporal overlap of speech gestures that has been found to decrease with age (i.e. from preschool to the first grade to adulthood) with children becoming more proficient speakers [9, 10]. Hence, if our hypothesis is validated, we should observe a negative relation between CD, PA and reading, that is, children with advanced PA and reading skills should exhibit lower CD as a sign of speech pattern maturation resembling those of adults. To test this hypothesis, assessment of CD, PA and reading ability was conducted in 33 native German children at the end of the first grade (mean age 7.04; 20 females), presenting no history of visual hearing or motor disability. The production task consisted in the repetition of pre-recorded disyllabic C1VC2ə non-words by a native female adult model speaker. Target vowels corresponded to a tense vowel (/i:/, /y:/, /e:/, /a:/) and C1 was one of the four /b/, /d/, /g/ and /z/ consonants. Ultrasound imaging was used to record movement of the tongue during the production of the target utterances. Tongue data was analyzed within SOLLAR (a Matlab-based platform developed for kinematic data analysis [8] to extract CD estimates for each child. The raw score of two PA tasks (rhyme production and segment manipulation) as well as reading task (short text) were calculated based on a standard German assessment procedure [3,7]. For reading, a reading fluency score was calculated based on both speed and the accuracy; for PA we selected tasks taping unto the awareness of large (rhymes) and small (segments) units. To test the effect of PA and reading scores of CD, linear mixed models [1] and general additive mixed effects models are used [13,14, 15]. Results show that for both PA and reading scores have non-linear effects on CD, with high scores correlating with lower degree of coarticulation *($p<2e-16$)*. This indicates that the speech of less proficient readers is associated with greater CD and hence organized in syllable-sized units rather than in segments. These findings, should motivate future studies addressing the acquisition of spoken language fluency in languages using alphabetical writing systems to take factors such as PA and reading into account, in addition to other commonly examined factors such as to speech motor control and anatomical development.

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