Influence of French Cued Speech on consonant production in children with cochlear implants: an ultrasound study

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Although cochlear implant improves deaf children's speech intelligibility (Turgeon et al., 2017; Grandon et al., to be published), the auditory information it provides remains degraded (Colin et al., 2017) and the perception of some acoustic features can be altered (Bouton et al., 2015). These auditory limitations may impact oral language development and lead to persistent language disorders (Geers et al., 2015). Some acoustic studies have highlighted specific impairments in the speech production of CI children (Grandon, 2016; Reidy et al., 2016). Only a few studies have investigated how CI children use their articulators to produce speech (Turgeon et al., 2017). To compensate for the degraded acoustic input some people choose to use Cued French (CF) which supplements the auditory information with a manual cue (Hage & Leybaert, 2006). CF has been shown to improve auditory sentence processing in children with hearing aids (Périer et al., 1990, Leybaert et al., 2010) and to help children build more stable phonological representations (Charlier & Leybaert, 2000). Using CF enhances speech perception even in CI children (Hage & Leybaert, 2006; Leybaert et al., 2010) and in a noisy environment (Bayard et al., 2019). It has also been suggested that CF could improve sentence production (Hage & Leybaert, 2006).

The aim of the present study is to examine the influence of CF on articulatory precision in CI children. Ultrasound imaging of the sagittal profile of the tongue provides objective information on the degree of articulatory precision. As part of an ongoing project on speech development in French, we have collected speech data on 85 normal hearing children (NH) and 17 CI children (Machart et al., 2019). Based on preliminary data analysis, in the present ultrasound study we chose to focus on the 6 consonants /t/, /k/, /s/, /ʃ/, /n/, /ɲ/, which are frequently substituted by CI children, independently of voicing substitutions (Fig.1), and which can be distinguished by the horizontal and vertical position of the tongue. The lingual movements are recorded during the production of simple words (Picture-Naming task) each including one of the targeted consonants followed by vowel /a/. Stimuli have been chosen for their frequency and imageability: tapis /tapi/ *carpet*, carotte /kaʁɔt/ *carrot*, sapin /sapɛ̃/ *fir tree*, chapeau /ʃapo/ *hat*, narine /naʁin/ *nostril*, orignal /oʁiɲal/ *moose*. Three groups of children are examined: 10 typical NH children (NH), 9 CI children with a strictly oral education (CI) and 9 CI children who benefit from a CF education (CIcf). A secondary aim of the study is to test the impact of simultaneous speech and CF production on articulatory accuracy. The CIcf group is therefore split in two subgroups: children who are not able to use CF in production (group 1: 5 children) and children who can use CF when they speak (group 2: 4 children). CIcf children group 2 are asked to utter the words and cue simultaneously (US_CF condition). Acoustic data are transcribed using PRAAT (Boersma & Weenink) and ultrasound data are analyzed using SLURP (Laporte & Ménard, 2018). The tongue position index will be the location of the highest point of the tongue on the y axis (Ménard et al., 2013). The curvature index will be measured following the methods described in Dawson et al. (2015).

The hypotheses are that CI children have a better representation of speech sounds when they benefit from CF, which results in more precise articulation and lingual configurations comparable to those of children with typical development. (H1) We anticipate that CIcf children produce these contrasts more typically and more stably than CI children. More specifically, we expect accuracy scores, acoustic and articulatory parameters to be closer to the NH group in CIcf children than in CI children. (H2) Moreover, we think that using CF during production might improve articulatory control: using the hand will help in positioning the articulators resulting in higher accuracy scores, more typical acoustic parameters, and more typical lingual configurations.

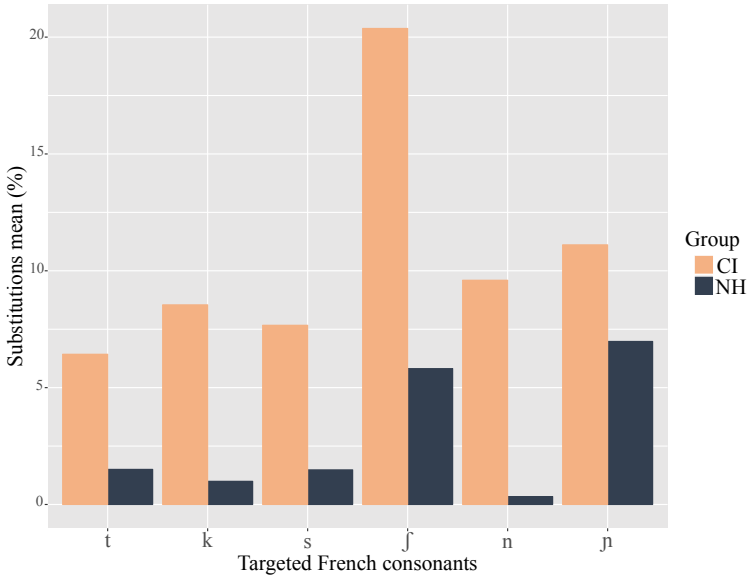

Figure 1: Consonant substitutions

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