An ultrasound study of anticipatory coarticulation in the speech of Italian children who stutter

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Stuttering is a disorder of speech production that typically arises in preschool years, and many accounts of its development implicate motor processes as critical underlying factors (van Lieshout et al., 2011; Smith & Kelly, 1997).

The hallmark characteristics of stuttering (sound repetitions, prolongations and blocks; cfr. Stuttering-Like Dysfluencies, Yairi &Ambrose, 2005) are the result of a motor limitation (van Lieshout, 2004): fluent speech is disrupted as the nervous system fails to generate the appropriate command signals to drive the muscles involved in speech production. The disfluencies characterizing stuttering strongly suggest breakdowns in the motor programming that underlies speech production.

Coarticulation, the spatio-temporal overlap of speech gesture, is a crucial aspect of speech motor control and one of the most studied factor in relation to stuttering (Van Riper, 1971; Sussman et al., 2010).

Few studies have tried to investigate coarticulatory patterns in the speech of stuttering children and results are often equivocal (Subramanian et al., 2003; Chang et al., 2002).

The purpose of this study is to enhance our insights into some crucial factors in the speech motor control: anticipatory coarticulation and stability of speech, using Ultrasound Tongue Imaging data.

Preliminary results will be presented for two school-age Italian children who stutter, and two normally fluent children, matched for age and sex.

The experimental task consisted in the production of dysillabic pseudo-words embedded in a carrier phrase: /ˈCVba/, with the consonant C corresponding to the bilabial /b/, alveolar /d/ and velar /g/ stops and vowel V corresponding to the high /i/, low /a/ and high back /u/.

Participants were asked to hear and repeat the sentences in response to a recorded model spoken by an adult female speaker of Italian. Every target was repeated 12 times, for a total of 108 records, and the order of presentation was randomized.

Children wore an adjustable head stabilisation unit designed by Articulate Instruments for the purpose of holding the ultrasound probe beneath the chin. The ultrasound transducer was adjusted before recording for a midsagittal view centred on the tongue body.

Anticipatory coarticulation was analysed by transposing measure of Locus Equations, commonly used in acoustics (Sussman et al. 1991) to the articulatory domain. Locus Equations are recognised as both a phonetic marker of stop place of articulation and a numerical index of coarticulation in stop + vowel sequences (Krull, 1988). It has been hypothesized that Locus Equations infer movement of the tongue body during the production of a consonant-vowel sequences (Iskarous et al. 2010). This hypothesis will be tested by comparing locus equation data with ultrasound tongue imaging data. The adaptation of Locus Equations to the articulatory domain has been conducted on the lingual data simultaneously recorded with the acoustic signal.

Additionally, the stability of alveolar-vowel productions is analysed by examining token-to-token variability found in multiple repetitions of the same alveolar-vowel sequence. Previous researches have suggested that people who stutter are less stable, even in their fluent productions, than typically fluent speakers (McPhearson & Smith, 2013; Frisch et al. 2016).

Our articulatory data confirm more variability in the stuttering speech, across multiple repetitions of the same token, compared to normally fluent peers.

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