The Effects of Digital Tactile Feedback on Overt Stuttering Frequency

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Review of the Literature

Developmental stuttering is generally considered a speech disorder usually surfacing between two and four years of age (Bloodstein 1995, Starkweather 1987), and is characterized by transient part- and whole-word repetitions, prolongations, and inaudible postural fixations (Bloodstein 1995, Wingate 1964). Substantial evidence indicates that developmental stuttering has a neurological genesis (Ambrose *et al.* 1997, Braun, *et al.* 1997, Fox *et al.* 2000, Salmelin *et al.* 2000, Wu *et al.* 1995), and is dramatically, albeit transiently, reduced by as much as 80-100% with the use of various forms of speech feedback (e.g. altered auditory feedback, auditory choral speech, visual choral speech) sensed by the speaker's auditory and visual modalities (Andrews and Howie *et al.* 1982, Kalinowski *et al.* 2000). The most efficient form of fluency enhancing speech feedback utilizes a 'second speech signal' (Cherry and Sayer 1956, Kalinowski *et al.* 2000), which is a speech signal presented concurrently with the speaker's primary speech signal, and contains speech gestures similar to those in the speakers primary speech signal. For optimal fluency enhancement, a second speech signal should be presented in parallel with the speaker's primary speech signal, so that both the speaker and the speech feedback are in choral unison (Andrews and Howie *et al.* 1982). This effect is achieved when a second speech signal originates from another speaker (e.g. choral speech), or from electronic alterations from the speaker's primary speech, which are then reintroduced to the speaker via headphones (e.g. delayed auditory feedback or frequency shifted feedback, also known as frequency altered feedback). Both auditory and visual second speech signals have been observed to enhance fluency in people who stutter (i.e. auditory choral speech and visual choral speech) (Andrews and Craig *et al.* 1983, Kalinowski *et al.* 2000).

Until relatively recently, it was believed that fluency enhancement via a second speech signal was solely a function of the auditory sensory modality, and therefore interpreted to be an auditory phenomenon (Bloodstein 1995, Kalinowski *et al.* 2000, Starkweather 1987). This interpretation may have lead researchers to associate the etiology of stuttering with functional errors in auditory processing (Postma and Kolk 1992a, 1992b), or associate the second speech signal with the masking effect (Andrews and Craig *et al.* 1983). However, relatively recent research has documented fluency enhancement in those who stutter via an externally-generated visual second speech signal (in the form of visual choral speech), thereby implicating fluency enhancement via a second speech signal as a multi-sensory, rather than solely an auditory, phenomenon (Kalinowski *et al.* 2000). This conclusion led to the speculation that a self-generated digital vibrotactile speech feedback would likewise enhance fluency in those who stutter.

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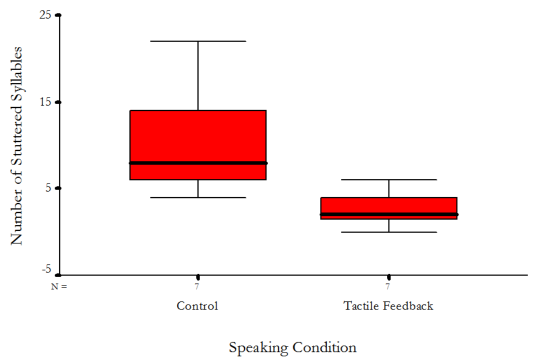

Abstract

Research documents the fluency enhancing effects of (internally and externally generated) speech feedback in both auditory and visual sensory modalities. As such, it is predicted that speech feedback perceived through other sensory modalities will likewise enhance fluency in those who stutter. This hypothesis is based on the theory that fluency enhancing speech feedback is a multi-sensory phenomenon. Consequently, the purpose of this research is to test the fluency enhancing effects of digital vibrotactile speech feedback on stuttering frequency. Adult research participants who stutter were asked to read passages aloud over the telephone, both with and without digital tactile speech feedback. For the purposes of this study, digital vibrotactile feedback was operationally defined as feeling the vibrations of one's thyroid cartilage with the thumb and index finger while speaking. Results from this study indicate a main effect of digital vibrotactile feedback on stuttering frequency. As such, the data may support the notion that fluency enhancing speech feedback is a multi-sensory phenomenon.

Method

Eight adults who stutter participated in this research. Participants reported no other diagnosed speech, language, hearing, or attention disorders. Although all participants had a history of speech therapy, only one was currently enrolled.

Research participants were asked to read passages aloud over the telephone in all speaking conditions. All reading passages have been used in previous peer reviewed research (Kalinowski *et al.* 2000). In the control speaking condition, research participants were asked to read passages aloud, and not to use any treatments or controls that might alter their speech or stuttering. In the experimental condition, research participants were asked to read passages aloud while feeling their thyroid cartilage vibrate (secondary to phonation) with their thumb and index finger.

All telephone calls were made using SKYPE, a free online voice over internet protocol program, and were recorded using HotRecorder 4VOIP, which were converted into the .wav audio file format for later analysis.

Results

Stuttered syllables were counted from the first 300 syllables of each speaking condition. Stuttering was operationally defined as whole- and part-word repetitions, prolongations, or inaudible postural fixations (Bloodstein 1995, Kalinowski *et al.* 2000, Wingate 1964). The distributions of stuttering frequency as a function of speaking condition are presented in Figure 1 (left). Specifically, the mean stuttering frequency was 10.57 stuttered syllables (SD = 7.04) for the control speaking condition and 3.14 stuttered syllables (SD = 3.18) for the tactile feedback speaking condition. The data was transformed (square root) prior to data analysis (Jones, Onslow, Packman, Gebski, 2006). Results of this analysis revealed a significant main effect of visual speech feedback [$F(1,6) = 74.914$, $p = .000$, $\eta 2 = .926$].

Discussion

As predicated, digital vibrotactile feedback did result in significant fluency enhancement. For those within the neurophysiological stuttering perspective, it is tempting to interpret this result as suggesting that speech feedback is indeed a multi-sensory phenomenon. What then, are the components within multi-sensory speech feedback that are necessary and sufficient to enhance fluency in those who stutter? Previous research has suggested that two such components are the speech gesture, and speech-related gestural initiation (Snyder, 2005). As such, fluency enhancement via exposure to the speech gesture and/or gestural initiation has been the topic of research by some neurophysiologically based stuttering researchers (ibid). While the exact neuro-mechanics of this phenomenon remain unknown, it has been hypothesized that the sensory input of exogenous speech-gesture initiatory cues appears to result in the functional bypassing of the deviant neural flaw either by the utilization of exogenous speech initiation via an alternate premotor network, engagement of mirror neuron networks, or perhaps both (Kalinowski, Saltuklaroglu, 2003, Alm, 2005, Snyder, 2006, Snyder & Hough, 2006).