Therapeutic Efficacy of an Inexpensive Prosthetic Stuttering Management Device

Gregory Snyder, PhD. Assistant Professor. Department of Communicative Disorders. University of Mississippi.

Abstract

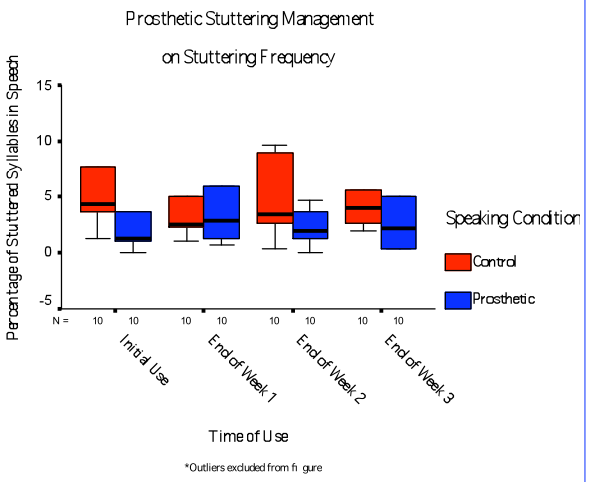
Developmental stuttering is generally characterized as a chronic speech disorder affecting approximately 1% of the world's adult population; stuttering is characterized by ephemeral part- and whole-word repetitions, prolongations and inaudible postural fixations, and may also negatively impact one's social and occupational performance. Despite the limited success of prevailing behaviorally based stuttering treatments, it has been widely documented that exposure to speech feedback significantly enhances fluent speech in those who stutter. While recent advancements in miniaturization and digital signal processing have resulted in truly wearable speech feedback prosthetic stuttering management devices, such devices are often cost prohibitive to many people who stutter. As such, the purpose of this research is to develop and test the efficacy of an inexpensive (<$50) prosthetic device. Initial data reveals that the inexpensive prosthetic device tested in this research may be comparable in performance to other, significantly more expensive, devices. As such, additional research is warranted.

Statement of the Problem

Developmental stuttering is generally believed to be a chronic speech disorder that affects about 1% of the world's (adult) population (Bloodstein, 1995; Starkweather, 1987). This disorder usually surfaces between two and four years of age (Bloodstein, 1995; Starkweather, 1987), and is typically characterized by ephemeral part- and whole-word repetitions, prolongations, and inaudible postural fixations (Bloodstein, 1995; Wingate, 1964). The literature suggests that stuttering has been documented to potentially hinder quality of life, specifically including social, educational, and professional opportunities and performance (Klompas & Ross, 2004; Klein & Hood, 2004). Conventional perspectives on stuttering have suggested that the disorder stems from either a psychological (Bloodstsein, 1995) or speech-motor (incoordination) (Starkweather, 1987) etiology. Subsequently, stuttering treatments have focused on altering the psychology (Bloodstsein, 1995) or speech-motor-behaviors (Starkweather, 1987) of people who stutter. Paradoxically, despite the fact that these two etiological perspectives have been clearly refuted (Stuart, 1999; Armson & Kalinowski, 1995), they remain as the predominant perspectives relative to the treatment of stuttered speech. And while these two treatment perspectives have been administered for decades (Bloodstein, 1995; Starkweather, 1987), there is a paucity of evidence suggesting significant long term treatment efficacy (Bloodstein, 1995). Specifically, conventional pediatric stuttering therapy has not changed the incidence or prevalence of developmental stuttering (Kalinowski, *et al.*, 2005); therapeutic relapse remains the rule, rather than the exception (Snyder, 2002). Listeners often prefer stuttered speech to the "therapeutic speech" taught in speech therapy (Kalinowski, *et al.*, 1994; Franken, *et al.*, 1992); and while existing therapies may provide fleeting reductions of stuttering frequency, they do not result in "true fluency"—which has been operationally defined as speech that is: natural sounding, requiring minimal cognitive attention, and stable across time and environments (Dayalu & Kalinowski, 2001).

Review of Literature

Despite conventional stuttered speech treatments yielding limited success, research documents that fluency is significantly enhanced when a person who stutters speaks with speech feedback (e.g. Choral Speech, Delayed Auditory Feedback, Frequency Altered Feedback) (Andrews, *et al.*, 1982); subsequent reductions in stuttering frequency have been documented to be as dramatic as 85% to 100% (ibid). Historically, the phenomenon was never fully understood (and largely ignored) as it was interpreted within the psychological or speech-motor paradigms. Specifically, it was believed that auditory feedback provided an auditory "distraction" (i.e. psychological perspective) or a slowed rate of speech (i.e. speech-motor coordination perspective), which resulted in fluency enhancement (Bloodstein, 1995; Starkweather, 1987); as such, the use of speech feedback was negatively perceived as being a therapeutic "crutch" (Snyder, 2002). However, the discovery of Visual Choral Speech (Kalinowski, *et al.*, 2000) forced new interpretations of the Enhanced Fluency Phenomenon, as it became a multi-sensory feedback phenomenon enhancing fluency regardless of auditory distractions or changes in speech-rate (ibid; Snyder & Hough, 2003).



Review of Literature (continued)

Advances in neurophysiological imaging have suggested that stuttered speech is associated with deviant speech-related neurolingustic processing (Salmelin et al., 1998, 2000); research has also documented that exposure to (auditory) speech feedback is associated with a functional correction to the deviant stuttered neurolingustic processing (Fox et al., 1996, 2000; Wu et al., 1995, 1997). These changes (i.e. functional corrections) in the neurolingustic processing in those who stutter is associated with significantly enhanced fluency. In short, it has been hypothesized that stuttering is best considered a neurological processing disorder with symptoms manifested in the production of expressive communication (Conture, 1991; Garber & Siegel, 1982; Snyder, 2005a, 2006); moreover, it is hypothesized that exposure to speech feedback modifies the deviant neurolinguistic processing in people who stutter, which results in enhanced fluency (Snyder & Hough, 2003; Snyder & Hough, 2004; Snyder, 2005a, 2005b).

While the concept of prosthetic stuttering management is not new (Molt, 2005), recent advances and miniaturization in technology has revived the prosthetic management paradigm with the introduction of truly wearable prosthetic devices employing the use of a second speech signal, thereby simulating the choral speech phenomenon (Snyder, 2002; Merson, 2003; Molt 2005). However, the prosthetic devices best utilizing the choral speech phenomenon cost between $3495 and $4900 (Snyder, 2005), and are consequently cost prohibitive to many clients who stutter. Therefore, the purpose of this research is to develop an inexpensive (<$50) prosthetic device, and test its efficacy at stuttering amelioration.

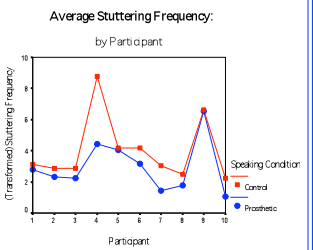
Method

Twelve participants enrolled in this study, although two were ultimately excluded from the dataset due to protocol violations. Participants were asked to wear the device during speech for no less than 3 hours a day for 3 weeks. Participants documented daily usage of the device in a time-log. Speech samples (with and without the device) were taken at the initial use of the device, as well as the 7th, 14th, and 21st day of use. Speech samples were taken over the telephone, with stuttering operationally defined as part- and whole-word repetitions, prolongations, and postural fixations (e.g. silent blocks). Speech sample stimuli utilized reading passages, approximately 300 syllables in length, all of which have been used in previous peer reviewed research.

The prosthetic device consisted of an Apple iPod shuffle, preconfigured with each user's own voiced sonorant sample that was previously captured and processed. The voice sonorant sample consisted of an .wav file of the participant slowly gliding through vowel sounds (a-e-i-o-u) such that the articulators would be in a constant state of transition. This music file (roughly 6 to 9 seconds) was repeated for constant playback while in use. Participants were given the freedom to optimize the volume and ear preference (left vs. right; monaural vs. binaural) based on their own experience.

Results

The data, collapsed over research participant, can be seen in Figure 1 (left); based on a cursory visual inspection, it is apparent that the use of the prosthetic device results in decreased stuttering frequency. The data, collapsed over time, can be seen in Figure 2 (right); based on a cursory visual inspection, it is apparent that the use of the prosthetic device reduced stuttering frequency for all participants, with the exclusion of participant #5 and #9.



With the data was averaged over time, a repeated measure analysis of variance (RM ANOVA) revealed a main effect of speaking condition [$F(1,9) = 8.211$, Greenhouse-Geisser $p = .019$, $\eta 2 = .477$]. When time was included in the analysis as a covariant, a RM ANOVA revealed a trend toward significance relative to a main effect of speaking condition [$F(1,29) = 3.539$, Greenhouse-Geisser $p = .078$, $\eta 2 = .103$]. This analysis also revealed an insignificant interaction between speaking condition and time [$F(1,9) = 0.003$, Greenhouse-Geisser $p = .958$, $\eta 2 = .003$], and a significant interaction between speaking condition and research participant [$F(1,9) = 2.933$, Greenhouse-Geisser $p = .013$, $\eta 2 = .477$]. Removing participants #5 and #9 from the dataset resulted in a significant main effect of speaking condition and a significant interaction of speaking condition and research participant.

Discussion

It is widely accepted that a purely quantitative analysis of stuttering therapeutic efficacy lacks real-life validity, as the real measures of success are tangible improvements in the quality of life in a fashion that is well tolerated by clients. As such, a wealth of qualitative data were also collected. An initial analysis indicates that 60% of the participants indicated that they were "satisfied with the device." Relative to the device's impact on the lives the participants, two responded with "very positive", four responded with "positive", three responded with "no impact" and one responded with "negative impact". When asked about the future use of the device, 4 responded with "yes, regular use", 3 responded with "yes, irregular use", and 3 responded with "no future use". As such, the device used in this study appears to have produced promising results relative to improving the quality of life in some people who stutter.