Utilizing Technology to Improve the Fluency of People Who Stutter

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I. Introduction

**A. Background of the Problem**

Developmental stuttering is a common speech disorder that affects 5% of children with an average population prevalence of 1% (Craig, Hancock, Tran, Craig, & Peters, 2002; Felsenfeld, 2002). Symptoms of developmental stuttering includes excessive repetitions of sounds, syllables, and monosyllabic words, as well as sound prolongations and complete blockages of the vocal tract. Any of these symptoms may be accompanied by physical tension or movements, especially in the head and neck areas (Conture & Kelly, 1991; Wingate, 1964).

Children are often first diagnosed between ages 2 and 5, when they begin forming sentences and connecting thoughts verbally, with a higher occurrence in males than females at a ratio of 2:1. Nearly 80% of these affected children recover naturally from stuttering within one to four years of onset (Andrews & Harris, 1964; Mansson, 2000; Yairi & Ambrose, 1999). More females recover than males, resulting in a more skewed male-to-female ratio of 4:1 in older children and adults (Bloodstein, 1995; Büchel & Sommer, 2004; Felsenfeld, 2002; Yairi & Ambrose, 1999).

Approximately 0.5% to 1% of adults stutter (Bloodstein, 1995). These numbers indicate that most children (about 75%) recover from stuttering naturally. Currently, no foolproof indicators exist to determine if an individual child will naturally stop stuttering or not; but, gender and family history of natural recovery appear to be predictors of natural recovery. Girls are more likely to stop stuttering than boys and children with a family history of natural recovery from stuttering are more likely to stop stuttering (Yairi, Ambrose, Paden, and Throneburg, 1996). In a study by Porfert and Rosenfield (1978), the prevalence of stuttering in a university population was 2.1%; 3.4% were former stutterers. More men than women stuttered. Right handed female stutterers were less likely to have "lost" their stutter than were right handed males. Stutterers, past stutterers, and questionable stutterers all had a family history of stuttering.

People who stutter (PWS) are often stigmatized by society. They are unfairly stereotyped into a group which is often believed to be less intelligent or capable than the average individual (Blood, 2003). As a result, PWS often have impaired self-image, as well as negative attitudes and feelings in regard to their ability to communicate. Many PWS avoid social interaction as much as possible, which may reduce their chances to find romantic partners and friends. It is very reasonable for PWS to avoid both intimate and platonic relationships, since research shows that the majority of people do not find those who stutter to be acceptable romantic partners or friends (Shears, 1969). Finding employment can be a challenging task for PWS (Parry, 2009). Reports of discrimination during the hiring process are not uncommon (Parry, 2009). Just getting through many parts of the day may be challenging for PWS. Adolescents and young adults who stutter usually deal with anxiety which can increase stuttering behavior (Davis, 2006). Treatment for stuttering usually involves working solely on fluency, ignoring the social consequences that the stuttering creates. There is little research about stuttering treatments involving improving quality of life (Howell, 2004).

**B. Statement of the Problem**

How can technology be utilized to help improve the fluency of people who stutter?

**C. Objectives**

●Identify the socio-demographic profile of the respondents.  
●Determine the different medical treatments available that are used to help reduce stuttering in medical technology.   
●Determine how stuttering can be reduced given the gathered data, and given the current technology utilizable.

**D. Significance**

The study aims to further gain knowledge about current medical treatments for stuttering and integrate potential treatments to technology related to computing. Designing and developing a system that involves treatment of stuttering will be beneficial to people with stuttering, speech-language pathologists, and future researchers.

This study will help people with stuttering improve fluency with the use of the system being proposed. This will give them more options when searching for a cure for their stutter. This study will help speech-language pathologists when dealing with people with stuttering. The system being proposed can add to the currently limited knowledge of current treatments for stuttering.

Future researchers can utilize this study to possibly gain a better understanding of stuttering. The proposed system can also lead to potential advancements in terms of using computing technology as a cure for stuttering. Future researchers are also free to carry out follow-up studies that will help improve the development of the study.

**E. Scope and Limitations**

Currently, the study aims to identify ways on how to utilize technology to improve the fluency of people who stutter. Only adolescent people who stutter will be considered in the study since children who are still experiencing developmental stuttering should be ruled out.

II. Related Literature

2.1 Stuttering

Stuttering (alalia syllabaris, alalia literalis or anarthria literalis) is “…a speech disorder in which the flow of speech is disrupted by involuntary repetitions and prolongations of sounds, syllables, words or phrases as well as involuntary silent pauses or blocks in which the person who stutters is unable to produce sounds”. (World Health Organization, 2010). The term stuttering is usually associated with involuntary sound repetition. Stuttering also includes abnormal hesitation or pausing before speech, reffered by people who stutter as blocks, and prolongation of sounds.

2.1.1 Prevalence

Stuttering usually starts in young children where it affects ⩾15% of children in the age of 4–6 years (Bloodstein 1995). Stuttering often resolves before adolescence, leaving a population prevalence of 1%–2% among adults. More males stutter beyond childhood, with males outnumbering females by a ratio of 3:1–5:1 (Yairi et al. 1996).

2.1.2 Primary Behaviors

The primary stuttering behaviors are the signs of disrupted fluency, such as repetition of sounds, syllables, words and phrases, silent blocks and sound prolongation. These differ from the common dysfluencies in all speakers. Dysfluencies may last longer, occur more often, and produced with great effort. Stuttering dysfluencies differ in quality in terms of: repeated movements, fixed postures, or superfluous behaviors. Each of these three categories is composed of subgroups of stutters and dysfluencies (Teesson K, Packman A, Onslow M, August 2003).

2.1.2.1 Repeated Movements (Teesson K, Packman A, Onslow M, August 2003)   
●Syllable repetition—a person who stutters repeats a single syllable word (for example: on—on—on a chair) or a part of a word but still a full syllable such as "un—un—under the..." and "o—o—open".   
●Incomplete syllable repetition—an incomplete syllable is repeated, e.g. consonants without vowels, for example, "c—c—c—cold".   
●Multi-syllable repetition—more than one syllable such as a whole word, or more than one word is repeated, such as "I know—I know—I know a lot of information.".   
  
2.1.2.2 Fixed Postures   
●With audible airflow—prolongation of a sound such as "mmmmmmmmmom".   
●Without audible airflow—such as a block of speech or a tense pause where nothing is said despite efforts.   
  
2.1.2.3 Superfluous Behaviors   
●Verbal—this includes an interjection such as an unnecessary uh or um as well as revisions, such as going back and correcting one's initial statements such as "I—My girlfriend...", where the I has been corrected to the word my.   
●Nonverbal—these are visible or audible speech behaviors, such as lip smacking, throat clearing, head thrusting, etc., usually an effort to break through or bypass a block or stuttering loop.   
  
2.1.3 Variability The frequency of disfluencies of people who stutter, as well as their intensity and duration, vary from situation to situation and from day to day (Bloodstein & Bernstein Ratner, 2008; Costello & Ingham, 1984; Yaruss, 1997a, 1997b).   
  
2.1.3.1 Facilitated Conditions

Researchers have identified conditions or effects (termed “stuttering phenomena” by Bloodstein & Bernstein Ratner, 2008) that significantly minimize disfluencies of people who stutter. Some of these include the adaptation effect, the white noise effect, delayed auditory feedback (DAF), and the metronome effect (Bloodstein & Bernstein Ratner, 2008).

The adaptation effect is a phenomenon where the frequency of stuttering decreases with the stutterer’s repeated readings of the same passage (Johnson & Knott, 1937; Frank & Bloodstein, 1971; Golub, 1955). The reduction of stuttering varies from speaker to speaker; however, a reduction of syllables stuttered by 50% is not uncommon (Bloodstein & Bernstein Ratner, 2008). The adaptation effect is only temporary. A brief time interval, e.g., 30 minutes, between successive readings of the passage will neutralize the adaption effect (Shulman, 1955).

The application of white noise or DAF (i.e., playing a speaker’s voice back to him or her with a brief delay) to the ear of a person who stutters significantly reduces the speaker’s frequency of stuttering (Bloodstein & Bernstein Ratner, 2008; Kalinowski, Armson, Roland-Mieszkowski, Stuart, & Grecco, 1993; Lee, 1951; Stuart, Kalinowski, & Rastatter, 1997). Bloodstein and Bernstein Ratner (2008) observed that introduction of white noise and DAF cause speakers who stutter to use fluency enhancing techniques, they “tend to slow their rate of speech, run their words together, concentrate on proprioceptive and tactile monitoring, or over articulate” (pp. 299-300). The metronome effect has similar results to DAF.

When a person who stutters speaks in time with a metronome their frequency of stuttered events is significantly reduced. This reduction in frequency of stuttering has been attributed to two factors: rhythmicity and syllabification (Azrin, Jones, & Flye, 1968; Brady, 1969). Rhythmicity refers to the rhythm and timing of an individual’s speech. Talking in time with a metronome requires that the speaker keep pace with the timing of the metronome. Syllabification refers to the tend

2.1.3.2 Situational Factors

People who stutter commonly report dramatically increased fluency when talking in unison with another speaker, copying another's speech, whispering, singing, and acting or when talking to pets, young children, or themselves. Other situations, such as public speaking and speaking on the telephone, are often greatly feared by people who stutter, and increased stuttering is reported (Ward, 2006).

Yaruss (1997a) investigated the effect that speaking situation has on the frequency of stuttered events as exhibited by preschool children who stutter. Five situations were observed: 1) parent/child interaction 2) play 3) play with pressure 4) story retell 5) picture description. The speaker’s stuttering varied between all the speaking tasks. There was variability in the mean frequency of more typical (or normal / non-stuttered) disfluencies and less typical (or stuttered / stutter-like disfluencies (e.g. Campbell & Hill, 1987; Meyers, 1986; Yairi, 1996, Yaruss, 1997b) in each situation as well as in which situation the speakers were “most disfluent” and “least disfluent” (Yaruss, 1997a, p. 194). Interestingly, this study showed significantly greater variability in the frequency of disfluencies between different speaking situations than within a single speaking situation.

2.1.3.3 Linguistic Factors

Other researchers have looked into linguistic factors that can affect the amount of disfluencies in speech. The following list summarizes the different findings of researchers showing which situations seem to increase the severity of stuttering.

●On the initial position of a word (Johnson and Brown, 1935; Quarrington, Conway, & Siegel, 1962)   
●On words of more informational value/less predictability (Brown, 1937; Quarrington, 1965)   
●On words beginning with consonants rather than vowels (Johnson and Brown, 1935)   
●Regardless of syllable structure (Logan and Conture , 1997)   
●On content words rather than function words (Howell, Au-Young, & Sackin, 1999)   
●In the earlier position of a constituent/phrase/sentence (Bernstein, 1981; Quarrington, 1965; Taylor 1966)   
●In more grammatically complex sentences (Bernstein Ratner & Sih, 1987; Brown, 1937; Quarrington et al., 1962; Yaruss, 1999)   
●In longer sentences (Yaruss, 1999)   
●In more syntactically complex sentences (Bernstein Ratner, 1997; Bernstein Ratner & Sih, 1987; Bloodstein, 1995; Yaruss, 1999)   
●When the main verb has greater valance (Yaruss, 1999)   
●On longer words (Taylor, 1966)

2.1.4 Perceived Causes

No single, exclusive cause of developmental stuttering is known. A variety of hypotheses and theories suggests multiple factors contributing to stuttering. Among these is the strong evidence that stuttering has a genetic basis (Guitar, 2005). Children who have first-degree relatives who stutter are three times as likely to develop a stutter (Ward, 2006). However, twin and adoption studies suggest that genetic factors interact with environmental factors for stuttering to occur, and many people who stutter have no family history of the disorder (Guitar, 2005). There is evidence that stuttering is more common in children who also have concomitant speech, language, learning or motor difficulties (Ward, 2006).

For some people who stutter, congenital factors may play a role. These may include physical trauma at or around birth, learning disabilities, as well as cerebral palsy. In other people who stutter, there could be added impact due to stressful situations such as the birth of a sibling, moving, or a sudden growth in linguistic ability (Guitar, 2005).

The capacities and demands model has been proposed to account for the heterogeneity of the disorder. In this approach, speech performance varies depending on the capacity that the individual has for producing fluent speech, and the demands placed upon the person by the speaking situation. Capacity for fluent speech may be affected by a predisposition to the disorder, auditory processing or motor speech deficits, and cognitive or affective issues. Demands may be increased by internal factors such as lack of confidence or self-esteem or inadequate language skills or external factors such as peer pressure, time pressure, stressful speaking situations, insistence on perfect speech, and the like. In stuttering, the severity of the disorder is seen as likely to increase when demands placed on the person's speech and language system exceed their capacity to deal with these pressures (Ward, 2006).

2.1.5 Treatments

Before treatment, the assessment is needed. Some characteristics of stuttered speech are not as easy for listeners to detect. As a result, diagnosing stuttering requires the skills of a certified speech-language pathologist (SLP) (American Speech-Language-Hearing Association, retrieved 2014). While there is no complete cure for stuttering, several treatment options exist that help individuals to better control their speech. Many of the available treatments focus on learning strategies to minimize stuttering through speed reduction, breathing regulation, and gradual progression from single-syllable responses to longer words, and eventually more complex sentences. Furthermore, some stuttering therapies help to address the anxiety that is often elicited as a result of stuttering, and consequently exacerbates stuttering symptoms (National Institute on Deafness and Other Communication Disorders, retrieved 2014).

2.1.5.1 Fluency Shaping Therapy

Fluency shaping therapy, also known as "speak more fluently", "prolonged speech", or "connected speech", trains people who stutter to speak fluently by controlling their breathing, phonation, and articulation (lips, jaw, and tongue). It is based on operant conditioning techniques (Ward, 2006). People who stutter are trained to reduce their speaking rate by stretching vowels and consonants, and using other fluency techniques such as continuous airflow and soft speech contacts. The result is very slow, monotonic, but fluent speech, used only in the speech clinic. After the person who stutters masters these fluency skills, the speaking rate and intonation are increased gradually. This more normal-sounding, fluent speech is then transferred to daily life outside the speech clinic, though lack of speech naturalness at the end of treatment remains a frequent criticism. Fluency shaping approaches are often taught in intensive group therapy programs, which may take two to three weeks to complete, but more recently the Camperdown program, using a much shorter schedule, has been shown to be effective (Ward, 2006).

2.1.5.2 Modification Therapy

The goal of stuttering modification therapy is not to eliminate stuttering but to modify it so that stuttering is easier and less effortful. The rationale is that since fear and anxiety causes increased stuttering, using easier stuttering and with less fear and avoidance, stuttering will decrease. The most widely known approach was published by Charles Van Riper in 1973 and is also known as block modification therapy (Ward, 2006). However, depending on the patient, speech therapy may be ineffective.

2.1.5.3 Electronic Fluency Device

Altered auditory feedback, so that people who stutter hear their voice differently, has been used for over 50 years in the treatment of stuttering. Altered auditory feedback effect can be produced by speaking in chorus with another person, by blocking out the person who stutters' voice while talking (masking), by delaying slightly the voice of the person who stutters (delayed auditory feedback) or by altering the frequency of the feedback (frequency altered feedback). Studies of these techniques have had mixed results, with some people who stutter showing substantial reductions in stuttering, while others improved only slightly or not at all (Bothe, Finn, Bramlett, 2007). In a 2006 review of the efficacy of stuttering treatments, none of the studies on altered auditory feedback met the criteria for experimental quality, such as the presence of control groups (Bothe, Davidow, Bramlett, Ingham, 2006).

2.1.5.4 Support

With existing behavioral, prosthetic, and pharmaceutical treatments providing limited relief from the overt symptoms of stuttering, support groups and the self-help movement continue to gain popularity and support by professionals and people who stutter. Self-help groups provide people who stutter a shared forum within which they can access resources and support from others facing the same challenges of stuttering. One of the basic tenets behind the self-help movement is that since a cure does not exist, quality of life can be improved by not thinking about the stammer for prolonged periods. Psychoanalysis has claimed success in the treatment of stuttering (Messer, 1983). Hypnotherapy has also been explored as a management alternative (McCord, 1955) (Oakley and Moss, 1996) (Moore, 1946). Support groups further focus on the fact that stuttering is not a physical impediment but a psychological one (Fisher, 1970).

2.1.5.5 Current Computer Based Therapies

Altered Auditory Feedback (AAF)

There are four types of AAF (Stuart, Xia, Jiang, Jiang, Kalinowski, and Rastatter, 2003). They are Masked Auditory Feedback (MAF), Delayed Auditory Feedback (DAF), Frequency Altered Feedback (FAF) and Combined/multiple feedback (DAF, FAF, MAF). The effectiveness and value of auditory feedback has been documented in the professional literature (Van Borsel, Reunes, and Van den Bergh, 2003). Some of the feedback devices are intended to disrupt feedback (DAF and MAF), and others are intended to enhance normal auditory feedback. MAF refers to the use of sound, generally a noise of some sort, of sufficient intensity to block the auditory feedback of the speaker's own voice to his or her ears.

Feedback on Physiological Status or Production Patterns

Several therapy programs utilize electronic analyses and feedback of acoustic speech characteristics. These devices provide immediate feedback of voice onset patterns, duration, and amplitude/loudness. As each speech production target is introduced to the clients, they receive training on the type of feedback from the voice monitor that indicates the correct achievement of the target. Once the clinician has confirmed that the clients know what to look for on the voice monitor, the clients could practice without the clinician's presence, freeing up the clinician while the clients engage in intensive practice on their targets.

Pacing/Metronome

Many stutterers stutter less frequently when they pace their speech while reading aloud or doing a spontaneous speech task with the beats of a metronome (Martin, Johnson, Siegel, Haroldson, 1985). Doing so will cause stutterers to concentrate on how they are speaking and thus reduce their speaking rates. This technique has been used clinically for several centuries. The metronome beat can be delivered auditorily, visually, tactilely, or by some combination of these senses. The client is told to pace his or her speech while reading aloud or doing a spontaneous speech task with the beats of a metronome which is one word per beat.

Devices that Alter Speech Motor Production Patterns

Research (National Association for Speech Fluency, 2006) has shown that the speech muscles of stutterers do not perform the correct sequence of movements necessary to produce fluent speech. For example, The Fluency Master reduces stuttering by modifying physical factors that affect speech, giving the brain the ability to more effectively control the movement of speech muscles. Fluency Master fosters better hearing of the natural vocal tone associated with speaking. Vocal tone provides information for the brain to use in guiding speech muscle movements.