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Review

Evolution in technology and changes in the perspective of stuttering therapy: A review study



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ABSTRACT

Technology has been revolutionizing health care. The current article is split into three parts, the first portion discusses the usage of technological devices in stuttering treatment, the scan of technical devices may be used specifically in treatment or can be used to offer guidance and thereby improve the pace of expression. They will even help to create physiological improvements. The second section of the article refers to telehealth as a means of providing services to people with stuttering. This approach has become a simple benevolence of technology and has managed to enter the unreached. Teletherapy can also be utilized for individuals who are robbed of treatment owing to isolation from financial restrictions. The third part of the analysis is regarding the apps. Apps may be used as an adjunct to speech language training or can be used during the repair process.

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1. Introduction

Stuttering is one of the major speech disorders alongside voice and articulation. Stuttering can affect individuals of regardless of their age gender and ethnicity. The prevalence figures show that stuttering can be seen in 1% of the total population (Dorsey and Guenther, 2000). Stuttering would interrupt advancing flow of speech, characterized by replications involuntary repetitive prolongations blocks etc. The condition would alter the rhythm of speech. Apart from these factors, stuttering can also consume an impact of quality of life. It can impede socialization reduce the

self-esteem and confidence of a person. Different approaches based on different underlying theoretical principles have been used in stuttering therapy. Some researchers believe that there is no cure for stuttering while this view is negated by few other researchers. Efficacy studies in stuttering have proved that appropriate timely intervention would benefit individuals with therapy. Based on the philosophy of the therapy approaches, the therapy approaches can be divided into two classes: the fluency shaping therapy and stuttering modification therapy. The fluency shaping technique believes in replacing the stuttering behavior with controlled fluency which in turn would decrease the dysfluencies and enhance the fluency in a person with stuttering, stuttering modification therapy on the other hand believes in reducing the severity of stuttering. In addition to these two main approaches, many other therapy approaches based on related principles have been proposed.

The earlier era in speech therapy pertaining to stuttering has seen the use of techniques like stutter fluently bounce technique etc. These techniques were based on the notion that by exercising voluntary control over the involuntary stuttering, the condition can be tackled and the person with stuttering would be able to handle the dysfluencies more confidently. The efficacy was questionable hence limiting the use of therapy techniques based on this principle. Stuttering is caused due to the synchronization issue between the phases of respiration: inspiration and expiration and the solution would be to work on regulating the air flow. The earlier evidence for this line of research was provided by (Schwartz, 1974). However, the sole utility of the therapy approaches based on regulating breathing for speech is questionable and, on many occasions, this approach has been used as adjunct to the fluency shaping therapy or stuttering modification therapy rather than being used a solitary approach used in treating stuttering. The advent of technology has revolutionized stuttering therapy. The current review article deals with the revolution/change technology have induced in stuttering therapy. The review article would be divided into three parts. The first part deals with the technical devices used in speech language therapy, the second part deals with tele-rehabilitation and the third part deals with the apps used in stuttering therapy.

1.1. Review of technical devices in stuttering therapy

Overview: Technical devices have revolutionized health care. The field of communication disorders also has been revolutionized with the boon of technology. Computers are considered as important technical device. These technical devices are often used in treating communication disorders including stuttering. This section of the paper deals with the utility of technical devices in treating dysfluencies. The technical devices can be divided into two classes. The first class of computer device deals with facilitating or easing speech production in persons with stuttering. The physiological status or production pattern is targeted in therapy. The other class of technical devices provides feedback during therapy.

The voice monitor can be used for this purpose. Software's like Speech Easy (Pollard et al., 2009). This device can be used to provide details about the physical parameters of speech at different levels like sounds, words and longer utterances. The software is known to operate on real time basis. The software is known to provide colored visual graphs depicting the change induced on physical parameters. If the parameters are known to fall in place, the graph would be colored green while red is used to represent a situation where the parameters fall out of place. Digital Speech Aid is similar software which can be used for the above-mentioned purpose. Studies on the efficacy of software's are sparse in nature.

1.2. Devices providing feedback

The devices that provide feedback can be divided into four types. (a) Masked auditory feedback (b) Delayed auditory feedback (DAF) (c) Frequency altered feedback (FAF) and (d) Multiple feedback (MF). The first published literature on delayed auditory feedback was published by (Lee, 1950). The effect induced by delayed auditory feedback was termed as startling as per the perspectives of the patients using Delayed Auditory Feedback. The feedback was altered causing the person to alter the volume or pitch of his/her voice. Following this the basic premise of DAF was altered and many studies were published (Howell, 1990; Kalinowski et al., 1993; Macleod et al., 1995). The studies can divide into sub categories (1) Studies based on subject characteristics (2) Studies based on physical parameters

1. Studies based on subject characteristics

- a. **Gender:** The efficacy of DAF as a function of gender was studied as function of gender. Altered Auditory feedback worked best with males than females (Bachrach, 1964; Chase et al., 1961), while this finding is negated by few other authors (Grosser et al., 2001:252-; MacKay, 1968) who opine that the feedback may not vary as a function of gender. The reason as to why altered feedback is more effective for males than females is unknown and is not explained effectively
- b. **Age:** The efficacy of DAF as a function of age has been investigated by many authors (Timmons, 1971; Schiefer, 2004). DAF is known to work best for younger individuals (Siegel et al., 1980; Sparks et al., 2002) compared to older individuals. However, the effect of DAF showed interaction with other variables like the severity of stuttering and delay time. Very limited studies have been carried out on children in regard to DAF. One published study on the efficacy of DAF in children was carried out by (Sassi, 2003). The findings of the study showed that limited utility of DAF in children
- c. **Severity:** The severity of stuttering has been targeted by many researchers (Soderberg, 1960; Stuart et al., 2006). The participants with severe stuttering were known to benefit individuals with severe stuttering than individuals with mild stuttering. The critical severity level warranting the efficacy of DAF is limited.
- d. **Type of Dysfluency:** The relationship between DAF and dysfluency pattern has not been investigated. Van Borsel et al. (2003), however opines that dysfluency pattern may influence the magnitude of stuttering severity induced by severity of stuttering. Continuing with his remarks based on clinical observation, he opines that prolongations are more vulnerable to change than repetitions.
- e. **Nature of fluency disorder:** Delayed auditory feedback has been used in developmental stuttering and neurogenic stuttering. It is proven through many studies that DAF works best for developmental stuttering than neurogenic stuttering. Another study (Marshall and Starch, 1984) reported a case with head injury, which benefited with DAF.
- f. **Anatomical Substrates:** Foundas et al. (2004) conducted a study where the participants with developmental stuttering were divided into sub groups based on the anatomical attributes. DAF was found to be more effective in a group of individuals with an atypical planum temporal asymmetry (i.e. right planumtemporale larger than left planumtemporale) than in a group of individuals with a typical planumtemporale asymmetry (left planumtemporale larger than right planumtemporale). However, this line of research was not extended further to support the findings established in the above said study.

2. Studies based on physical parameters

The other sub category of studies revolves around the physical parameters used in the study. The most significant parameters investigated through the studies include delay time, time, intensity, manner of delivery, speech mode etc.

- a. **Delay time:** The DAF devices allow different delay times. The delay time would range from 10 to 100 ms in 10 ms regulated in steps. MacKay (1968) studies documented a Belgian device called DEFSTUT was used. The delay induced ranged from 0 to 200 ms, Mackay opined that shorter the delay greater was the interference. The term optimum delay was used by Stuart et al. (1997). The optimum delay is assumed to the duration inducing the maximum reduction of stuttering severity. The shortest duration reported to be optimum was 50 ms while most of the researchers call the duration between 250 and 300 ms as optimum.
- b. **Intensity:** Apart from the duration, intensity is another physical property that has been explored through studies. The earliest evidence pertaining to intensity was published in 1957. The above-mentioned study used an intensity of 50db presented in the bone conduction mode (Hoth and Baljić, 2017). The comfort factor also has to be taken into consideration while choosing the intensity.
- c. **Speech mode:** A person with stuttering may confront with different situations in routine. A DAF device is expected to cater to different speech situations like reading aloud, describing pictures, repetition. The earliest evidence was provided by Soderberg (Soderberg, 1960) and Martin et al (Martin et al., 1981).
- d. **Studies on metronome pacing**

Many persons with stuttering are assumed to speak more fluently while reading aloud or doing a spontaneous speech task when they synchronize their speech with the beats of the metronome (Perkins, 1973). The metronome pacing can be controlled by the investigators and the metronome pacing can be altered based on the rate of speech. The metronome pacing would allocate more duration for persons with stuttering, this additional time would allow them to control the rate of speech this in turn enhance the fluency. This technique has been used clinically for several centuries. The metronome beat can be delivered through different modalities like auditory, visual, tactile or the combination of these. The client is told to synchronize his speech with the beats of the metronome as stated earlier. The metronome pacing is further known to improve the rhythm aspects of speech production. This kind of metronome pacing is known to benefit individuals with stuttering, cerebellar ataxia and Parkinson's disease. The pacer rate is adjustable from 50 to 150 beats per minute adjustable in 5 beat increments. The earliest evidence regarding the efficacy of metronome pacing was documented (Fransella and Beech, 1965). The study was carried out on 6 individuals with stuttering and was reported that the dysfluencies reduced in persons with stuttering. The metronome pacing has been used on regular basis since then.

Earlier study (Repp, 2010) was carried out with the intent of investigating the tempo changes in persons who stutter and fluent speakers. Individuals with stuttering performed better with training. Many such studies in the lines of DAF and metronome pacing have been carried out and these methods are found to be effective and is known to complement speech therapy.

2. Section 2: Tele-rehabilitation in stuttering therapy

Tele practice, as defined by the American Speech-Language-Hearing Association (Atcherson et al., 2014) is designed to use

telecommunications technology to link “clinician to client/patient, or clinician to clinician for assessment, intervention, and/or consultation” Over the years tele rehabilitation has developed as a mode of service delivery in the last 15 years This mode of service delivery has gained popularity over the years. Tele rehabilitation is an outcome of technology. Tele practice has been used for neurogenic communication disorders, aphasia, voice disorders and stuttering. Tele practice has been found to be an effective mode of service delivery as it would conserve time and it would require a modest infrastructure. Tele practice has gained immense popularity in the recent years. This section would review the studies on tele rehab carried out in treating stuttering.

The first published study in tele practice in stuttering was published by (Kully, 2000). The study was carried out on one client with stuttering. The client was 38-year-old. Therapy was imparting through video conferencing software. Therapy was delivered for duration of 3 weeks by using integrated treatment approach. However, no formal measures were used to document the efficacy of therapy technique, the participant satisfaction was documented and the findings revealed high satisfaction. The visual and sound quality was high. The basic limitation of the study was that the study was carried out on only one participant and therapy was imparted only for duration of 3 weeks. The next published study on tele practice in stuttering (Sicotte et al., 2003) was carried out on 6 participants. The participants aged from 4 to 19 years. Therapy was delivered by using polycom view station. The study followed a within group design using pre and post-tests. Stuttering Severity Instrument (SSI) was administered on the participants at the baseline and post treatment. Integrated treatment approach was used for providing therapy. The stuttering severity was reported to have reduced 13–36%. The peer rating was high for 5 out of the 6 participants. The participants also rated the technical aspects high while the clinicians providing therapy rated the technology as moderately high. The study was carried out on 6 participants unlike the previous study. More comprehensive measures were used to document the efficacy of therapy. Rating on technical quality was taken from the clients as well as the clinicians.

Carey et al. (2012) and the study was carried out on 3 participants aged 13, 15 and 16 respectively. Therapy was given through Skype with audacity plugin and Pamela add on. Therapy was provided at the home of the clients by using Camperdown treatment.¹ This study was followed by another study by Carey et al. (2014) this time therapy was provided for 14 participants. The sample size was increased in this study. The participants aged from 12 to 17 years. Therapy was provided through Skype as the previous study. Camperdown program was used to deliver therapy. The efficacy of the therapy was documented at two stages one during the course of therapy and second during the maintenance phase the stuttering severity reduced significantly. The technical satisfaction was rated high. The study differed from the previous study in terms of the sample size. The measures used to document the efficacy of therapy, the number of sessions, the technical set up and the infrastructure remained constant across the two studies. In the same lines, some of the published studies have used Lidcombe program². The efficacy of Lidcombe program through the tele practice was verified (Lewis

¹ The Camperdown Program is a treatment program used for stuttering teenagers and adults. It was developed at the Australian Stuttering Research Centre (ASRC) in the year 2006 and is in the line of Lidcombe program and this program uses fluency shaping treatment basically. Some essence of cognitive behavioural therapy and dual tasking is used in the program.

² The Lidcombe Program is a treatment package used for children and is used for children below 6 years. The program also has been used for children older than 6 years also. The nomenclature for the program was based on the suburb of Sydney where the Australian Stuttering Research Centre is located, at The University of Sydney. The treatment is an indirect program as it targets in providing training to the careers or the parents of children with stuttering.

et al., 2008). The same researchers published a study after 6 years where the Lidcombe Program was administered “appears to offer a viable treatment for young children who stutter and who might otherwise have limited access to treatment”.

Bridgman et al (Bridgman et al., 2016) published a study. The study was carried out on 49 participants. Children between 3 and 5 years were the beneficiaries of the therapy. The sample size was 49. The study followed a group design where the participants were divided into clinical and experimental groups. Training was provided for the care givers/parents of children in the experimental group through Skype while the training for care givers/parents of children in control group was provided at the clinics. The stuttering severity measures revealed a reduction of stuttering in both the groups; however, no formal measures were used in the study. The technical aspects were rated high. The parents of children in the experimental group reported flexibility in time. The cost was low for the clients receiving therapy through tele practice mode. Valentine (2014) studied the outcome of therapy in tele practice. The findings of this study revealed. Thus, the published studies prove that the tele rehabilitation/tele practice is an effective mode of service delivery and can provide the same desired output in persons with stuttering. Most of the published studies have been carried out in children and tele rehab has been proved effective.

3. Section 3: Mobile apps in stuttering

In the global scenario, most of the people use smart phones. All the smart phones use apps. Apps can be used for various communication disorders and stuttering is no exception. Apps have health care due to their widespread effects in the field of communication disorders. Along with, other allied medical conditions too, Apps can be used for all the communication disorders. The apps can be used for stimulus presentation, employing materials required for therapy like flash cards, pictures, teaching the concepts and so on. These apps are so flexible, thus in turn can be made used in home training. The apps would enable easy access of therapy materials. It would be feasible to the clinician or the parents relaying on apps as all the information is available on a single platform and would be available at the fingertips. The basic understanding of apps would be a pre-requisite in understanding the utility of apps in communication disorder.

The first published literature on the utility of apps in communication disorder was published (Apps, 2011). Gosnell opines that the utility of the app would maximize the diagnostic and therapeutic power of the clinicians and also it may aid in developing the knowledge of novice clinician. At the same time, the clinicians should be aware of the fact that no single tool fits all the clients. Many commercial apps can be used in stuttering therapy like Kassel program (Euler, 2009), Fluency coach, Speech 4 good and cool speech has been used in regard to stuttering.

3.1. Published literature on apps in stuttering

Madeira et al. (2013) have published an article on the app. The dysfluencies confronted in every-day situations. Mohd Fadzilah and Arshad (2017) developed app called m-health. The app was developed in par with International Classification of Functioning and Overall Assessment of Speakers Experience of Stuttering (OASES) it provides guidance to enhance the quality of stuttering in persons with stuttering.

In a nutshell, the apps chosen may be effective for some clients, for others it may not be as effective so the clinician-employing app should be sensitive about these facts. It is assumed that clinicians should control the technology and the technology should not control the clinicians. The purpose of the app should be understood by

the clinician. The clinician also should be aware of the limitations of the app. In other words, one single app may not have all the features or utilities required by the clients. The clinician should also have the ability to identify the apps which would serve the clients need effectively and check if the client would be able to use the app in his/her absence as in-home training hence the apps should be carefully used.

Concluding Remarks: Technology has been a boon to mankind and technology has revolutionized health care. The current review article tries to collate details about the technology in stuttering under three heading, the utility of technical devices in stuttering management, tele rehabilitation and apps in used in stuttering therapy.

The three sub sections intend to represent three different dimensions of technology on how technical devices can be used to provide therapy, how it can be used as a mode of service delivery and how it can be used as adjunct to speech therapy. Deliberately these three domains were considered as it covers the three different facets of therapy i.e. direct usage, service delivery and adjunct to therapy.

As far as the three dimensions are concerned, more studies have been done in regard to the usage of technical devices in therapy. The concept of delayed auditory feedback has been used over years. The current article reports the efficacy of delayed auditory feedback in regard to demographic variables like age, gender, type of dysfluency, severity of stuttering and anatomical substrates activated during the process. It also reviews on the efficacy of DAF pertaining to variables like the delay time, intensity and the mode of delivery. The article reviews on the utility of metronome pacing in stuttering therapy. The metronome pacing would provide an additional processing time for persons with stuttering as proponents working in stuttering suggest that there is an asynchrony between the thought process and speech production in persons with stuttering.

The second part of the review articles focuses on tele rehabilitation in persons with stuttering. The tele rehabilitation has been used an effective mode of service delivery in the developed countries and off late has been used in developing countries. This mode of service delivery faced obstacles due to the technical layback with growing technology it gained popularity. The current article reviews on the published literature with respect to the tele rehabilitation in persons with stuttering. The efficacy of therapy, perspective of patients, and comparison with face to face therapy is covered in these studies. The third part of the review article deals with apps and the published literature on the utility and efficacy of apps. Thus, holistic view on the revolution of technology in different facets of therapy are blended and covered in this review article.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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