



Types and Tools Available for Fluency Disorder –Speech Therapy

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Abstract - Automatic Speech Recognition (ASR) is the process by which a machine is able to recognize and act upon spoken language or utterances. Speech recognition discipline is a system within sound technologies that tries to gain a seat in the course of advancing technology. Fluency disorder is an interruption in the flow of speaking characterized by a typical rate, rhythm, and repetitions in sounds, syllables, words, and phrases. Artificial recognition and disfluency identification are considered to be complicated in fluency disorders. The fluency disorder which is mainly focused in this paper is stuttering which is characterized by various behaviors that interface with the forward flow of speech. While all individuals are disfluent to some extent, on the surface and differentiate stutterers from non stutterers are the frequency of their disfluency and/or the cruelty of their disfluency. In young children, typical nonfluent speech is initially episodic, and then becomes more cyclical in nature, coming and going without apparent cause or pattern. This paper presents the types of stuttering, stuttering therapy, techniques used for stuttering therapy and mainly focus on the young children.

Keywords - Fluency Disorders, Stuttering, Disfluency, Stuttering Therapy.

I. INTRODUCTION

As human beings, we have the special ability to share our thoughts by talking. We start by forming a thought in our brains. In the brain, this thought is changed into a code we have learned called language. Once the thought is coded into language, the brain sends a message to the muscles that control speech, telling them to move and make the right sounds come out. Then the mouth, face, neck, tongue, and throat muscles move to form words. There might be an interruption or break in the flow of speech. This interruption is called disfluency. Stuttering is a speech disorder in which sounds, syllables, or words are repeated or prolonged, disrupting the normal flow of speech. These speech disruptions may be accompanied by struggling behaviors, such as rapid eye blinks or tremors of the lips. Stuttering can make it difficult to communicate with other people, which often affect a person's quality of life. Speech can be considered only as a different type of signal and processed as a time series. Stuttered speech is rich in events also known as disfluencies, typically repetitions [1]. Stuttered speech is rich in events also known as dysfluencies, typically repetitions. Classical approaches to stuttered speech analyzed dysfluencies in very short intervals, which were sufficient for recognizing simple repetitions of phonemes. However, the problem of repetitions of syllables or words was typically ignored due to high computational demands of classical methods for analysis of longer intervals [19]. Disfluency becomes a speech problem, though, when it gets in the way of everyday talking and is noticeable to other people. A person may have a tough time getting thoughts out. It also can cause a lot of embarrassment or frustration. This paper briefly analyses the causes of disfluency, types of stuttering, techniques available for stuttering therapy. Section II explains the types of stuttering, and Section III describes the stuttering therapy.

II. TYPES OF STUTTERING

Stuttering is a speech disorder in which the normal flow of speech is disrupted by occurrences of disfluencies, such as repetitions, interjection and so on. There are a high proportion of repetitions and prolongations in stuttered speech, usually at the beginning of sentences. World Health Organization identifies stuttering with code F98.5 and defines stuttering as a speech containing frequent repetition or prolongation of sounds or syllables or words, or frequent hesitations or pauses [20]. Consequently, acoustic analysis can be used to classify the stuttered events. The author explains a particular stuttering event to be located as repetitions and prolongations in stuttered speech with feature extraction algorithm. The well known Mel Frequency Cepstral Coefficient (MFCC) feature extraction is implemented to test its effectiveness in recognizing prolongations and repetitions in a stuttered speech. Two classifiers such as Linear Discriminant Analysis based classifier (LDA) and k-nearest neighbors (k-NN) are employed and k-fold cross-validation was applied to measure classifiers performances. The MFCC and classifiers (LDA and k-NN) can be used for recognition of repetitions and prolongations in stuttered speech with the average accuracy of 90% [5]. Stuttering (or stammering) is defined as any disturbance in the flow and time patterning of speech. These disturbances may include one or more of the following behaviors [2, 3, 4].

- audible or silent blocking,
- part or whole-word repetitions,
- phrase repetitions,
- sound prolongations,
- broken words,
- interjections,
- words produced with too much tension,
- circumlocutions and
- any form of struggling behavior associated with speech production .

It is estimated that 3-4% of preschool children and 1-2% of school-aged children are having a stuttering problem [1]. Of these, approximately one half will outgrow their stuttering by early adulthood.

The reasons of stuttering in children are not identified yet. But it is significant that this problem is not influenced only by one factor. But it is influenced by physical, emotional, social reasons or combination of these factors. Most of the people who have stutter, Suffer from nervous problems and lack of social compatibilities. But it is difficult to identify if these nervous problems are the reason of stuttering, or stuttering itself is the result and the influence of nervous problems. Sometimes stuttering may be the result of disorders of nerves and sometimes it may be occurred from some slight physical disorders in childhood[18].

A. Types of Stuttering

There are three types of stuttering

1. Developmental Stuttering,
2. Neurogenic Stuttering and
3. Psychogenic stuttering.

1. Developmental Stuttering

It occurs in young children while they are still learning speech and language skills. It is the most common form of stuttering. Some scientists and clinicians believe that developmental stuttering occurs when children's speech and language abilities are unable to meet the child's verbal demands. Developmental stuttering also runs in families. In 2010, for the first time, NIDCD researchers isolated three genes that cause stuttering. More information on the genetics of stuttering can be found in the research section of this fact sheet. Developmental stuttering (DS) arises in childhood for reasons which are, as yet, not well understood, but may include genetic, motoric, linguistic and neurological factors, which interact with a range of environmental variables [7].

Emotion and Language Contributions to Developmental Stuttering

Childhood stuttering has been associated with emotional temperament. Some recent include temperamental emotional factors in a broad perspective on stuttering. Evidence links emotional reactivity to stuttering, and our own findings link stuttering temperamental proclivities both to emotional reactivity and to stuttering, focused on group differences between Child Who Stutter (CWS) and Child Who do Not Stutter (CWNS) temperament, but did not link those differences directly to instances of stuttering. The study was limited by its correlational design, which did not address direction of causality. Furthermore, temperamental differences, which are cross-situationally stable by definition, cannot readily account for within-child variations in stuttering across situations. The framework Dual Diathesis-Stress (DD-S) attempts to represent why stuttering predictably occurs more in certain situations. The DD-S specifies contributions to stuttering from both internal diatheses, or predisposing factors, and situational stressors in emotion and language [6].

2. Neurogenic stuttering

It is an acquired disorder of fluency disorder resulting from changes in neurological pathology in the brain. Commonly, NS results from stroke, but it may be associated with a range of aetiologies, including brain tumor, degenerative CNS diseases, traumatic brain injury, dementia, Parkinson's disease, drug usage and renal dialysis [7]. Neurogenic stuttering subsequent to stroke often occurs alongside other speech and language disorders. However, stuttering can also remain persistent, and in such cases, as with treating established DS in adults, the emphasis now will be on controlling fluency levels, and helping the client adjust to living with the stutter. A similar situation would arise with a patient suffering with stuttering which is related to a progressive degenerative disease [7].

Acquired Neurogenic Stuttering

The neural underpinnings of Acquired Neurogenic Stuttering (ANS) remain largely speculative owing to the multitude of etiologies and cerebral substrates implicated with this fluency disorder. The author presented the case of a subject with ANS who exhibited marked reduction in disfluencies under Masked Auditory Feedback (MAF), singing, and pacing (speech therapy). The author explained these features in the light of recent explanatory hypotheses derived from Developmental Stuttering (DS), and highlighted on the possible similarity in the neural underpinnings of ANS and DS [8].

3. Psychogenic stuttering

It refers to stuttering where onset appears suddenly, and later in life than Developmental Stuttering (DS), and which can be related to, or associated with, a significant traumatic event, or events. Causes vary widely, but include events such as break up of a relationship, death of a close friend or relative, personal health concerns. The consistent factor amongst

all these events seems to be high levels of stress, anxiety, or both. Some clients describe scenarios which might seem of comparatively minor importance to some, but that give rise to significant stress reactions in others. As such, stress, as perceived by the individual must be regarded as an important diagnostic feature. PS may also arise as a reaction to physical trauma. This can complicate a diagnosis where, for example, stuttering has appeared subsequent to head trauma, but where it is not clear whether the trauma itself, or the reaction to the trauma has been the critical factor. Some earlier researchers suggested that, in contrast to those with DS, PS speakers respond to their speech difficulties with a lack of emotional reaction. Psychogenic stuttering can be caused by emotional trauma or problems with thought or reasoning. At one time, all stuttering was believed to be psychogenic, but today we know that psychogenic stuttering is rare [7].

III. STUTTERING THERAPY

Many of the current therapies for teens and adults who stutter focus on learning ways to minimize stuttering when they speak, such as by speaking more slowly, regulating their breathing, or gradually progressing from single-syllable responses to longer words and more complex sentences. Most of these therapies also help address the anxiety a person who stutters may feel in certain speaking situations. Researchers are working to help speech-language pathologists determine which children are most likely to outgrow their stuttering and which children are at risk for continuing to stutter into adulthood. Today, the major change that has occurred in stuttering therapy concerns young children. Most clinicians believe that early intervention is necessary in order to promote a successful outcome. The process of change in the attitude toward therapy for children consisted of several stages [9]. Katz-Bernstein [10] suggested a different direct therapy for young children, which combines clinical-communicational methods with psycho dynamic and behavioral aspects. The author explained that the fluency problems emerge as problems where there is an attempt to organize inner images, intentions and emotions primarily through the verbal-language channel. This occurs at a stage in development in which language, firstly, is not yet available as a differentiated code and, secondly, where the fine-tuning among the various levels of language, motivation and interaction has not yet been mastered. According to this approach, the child learns to use language to express his feelings through developing imagination, symbolism, and play. The main idea is that fluent speech develops as a result of the combination of several conditions: the child's ability to be connected to his feelings, his capacity for language organization, and his ability to cope successfully with communicational stress [9].

There is still a lot that is unknown about the cause of stuttering, but experts agree that it is probably caused by a combination of factors. First, genetics is believed to play a part because stuttering tends to run in families. Most children that stutter have a family member that also stutters or stuttered as a child. Second, developmental factors are believed to be a contributing factor. During the preschool years, a child's physical, cognitive, social/emotional, and speech/language skills are developing at a very rapid rate. This rapid development can lead to stuttering in children who are predisposed to it. This is why stuttering often begins during the preschool years. Third, environmental factors can have an influence. Some examples of these factors include parental attitudes and expectations, the child's speech and language environment, and stressful life events. This does not mean that parents are doing anything wrong. Often these things are not harmful to a child that doesn't stutter, but can aggravate stuttering in a child that has a tendency to stutter. Finally, the child's fear and anxiety of stuttering can cause it to continue and even worsen [17].

A. Strength-Based Stuttering Therapy

It is a strength-based approach for children who stutter has been advocated for both types of therapy (mental health and stuttering problem). This has been described as a recent paradigm shift in counseling psychology, but it also appears that the roots of modern-day stuttering therapy for even very young children may lie in the notion that for the most part, they should attend to what they do when they talk well, and use this awareness to manage their speech. It's reasonable to conclude that helping the person who stutters. The author have proposed that several contemporary approaches for the treatment of stuttering in young children are not only rooted in the historical beginnings, but are also related to each other in that the significant change agents are not the specific techniques (e.g. operant versus environmental manipulation), but are instead client, clinician and relationship factors that are common across all therapy approaches [10].

B. Mindfulness training

The mindfulness training is used for increasing psychological well-being in a variety of clinical and nonclinical populations. Mindfulness practice results in decreased avoidance, increased emotional regulation, and acceptance in addition to improved sensory-perceptual processing and attentional regulation skills. These skills are important for successful long-term stuttering management on both psychosocial and sensory-motor levels. It is concluded that the integration of mindfulness training and stuttering treatment appears practical and worthy of exploration. Mindfulness strategies adapted for people who stutter may help in the management of cognitive, affective, and behavioral challenges associated with stuttering [11]. Mindfulness can be cultivated through various forms of meditation and informal practice involving either focused attention on something specific like the breath or physical sensations in the body, or open monitoring which is an alert observation to anything like thoughts, feelings, sensations that arises without explicit focus on any object.

Mindfulness training may benefit People Who Stutter (PWS) through improving sensory feedback and attention focus believed to be necessary for fluent speech production. Mindfulness appears to be a practice that may facilitate many critical processes related to stuttering "recovery," or its successful management, in both its psychosocial as well as sensory-motor dimensions. Mindfulness and acceptance based practices appear to be a potentially useful component in stuttering treatment [11].

C. Tools for stuttering therapy

1. Speech fluency treatment

It is an effective and inexpensive speech therapy tool for individuals with speech stuttering problems. The tool, takes the form of software combined with the computing power available in today's personal computers. The software is written to run under Windows 3.1 or Windows 95 on an IBM compatible computer equipped with multimedia capabilities. The software works by illustrating to the client (stuttering patient) when his/her speech is irregular or different from that directed by his/her clinician. Computer generated audio and visual cues are used to illustrate where the client's speech is different from that expected by the clinician. The real-time display of the average magnitude profile corresponding to the clients' spoken utterance serves as visual feedback to the client. The client can visually compare their average magnitude profile to that of the reference utterance and alter their speech to match the reference as required. The onset, start and end locations, amplitude, and duration of the two average magnitude profiles are compared. A score is assigned corresponding to the client's performance in each of these categories. The clients learn to alter their speech sound and word rate, loudness, duration and onset in order to initiate and maintain speech fluency [12].

2. Computer assisted tool

A software tool has been developed to help stuttering children and Parkinson disease clients improve their speech fluency. This tool is used by speech therapists in hospitals and by the patients themselves in their own homes. This personal computer based system is intuitive to use, cost effective, and easily integrated into current speech rehabilitation regimens. The software provides the visual and audio feedback required for clients to be aware of their speech patterns. The program plays a goal phrase and displays an amplitude plot of the signal. The client repeats the phrase, the magnitude of which is superimposed over the goal phrase in real-time. The software compares the speech patterns and documents the progress of the patient in detail. The supervising speech pathologist specified which displayed signals and measured parameters would be useful for improving the speech rehabilitation process. These features enable the client to continue practice at home for delays and months before returning to the clinic. The results of the patients' trials are stored in a disk, which the patients bring to the therapist at each clinical visit. This feature contributes to lowering the costs of speech therapy [13].

D. Computer assisted stuttering therapy

1. Speech Monitor



Fig. 1 layout of Speech Monitor

This software is intended to be used by Speech Language Pathologists and individuals with speech (speaking) difficulties (specifically stuttering and Parkinson's disease). Some people have increased fluency and voice control under Delayed Auditory Feedback (DAF) or Frequency-shifted Auditory Feedback (FAF). It is best to experiment with different levels of DAF and FAF (up shifted and downshifted) to find the best setting for each individual. The software has built-in functionality for recording so that the individual can compare their speech under different settings. At this time there is no functionality for playing the recordings back from within the Speech Monitor [14].

2. Fluency Coach



Fig. 2 layout of Fluency Coach

Choral speech is a recognized fluency-inducing phenomenon which occurs when people who stutter speak in unison with another voice. The Fluency Coach software incorporates both DAF and FAF to give you an opportunity to experience choral speech in the comfort of our home or office. The *DAF* will help to simulate choral speech by providing an echo which will be perceived as a different person talking along with us. Changing the DAF will allow us to test the speech at both long and short delays, so that we can determine what is most effective for us. To further simulate the choral speech effect, *FAF* is used as well. *FAF* is a pitch shift of sound so the brain can easily distinguish a "second voice". The combination of DAF and FAF is referred to as *Altered Auditory Feedback (AAF)*. The Recording and Playback feature allows to record and save the speech as a sound file in our computer. This can be particularly useful for

the self-evaluation component of speech therapy. It can also be used for transcription of our speech, in order to identify particular words, syllables or sounds which give us the most problems and to then compose word lists for reading practice on the basis of the transcription. The recorded speech can also be useful to a speech-language pathologist when planning for therapy and to track the progress to improve the fluency [15].

3. Fluency Master



Fig. 3 layout of Fluency Master

The Fluency Master improves perception of the natural vocal tone associated with speaking. Vocal tone consists of a "buzz" that is generated by vibrations of the vocal folds in the throat, and is transferred to the ears through the soft tissues, cartilage, and bones of the throat and skull. Vocal tone is a natural, internal component of speech, and provides a "background" sound that is always present inside our body when we talk. By using the fluency master we can hear a recording of our speech. A tape recorder does not capture the vocal tone that travels inside our body from the throat to the ears, yet we hear this sound when we are listening to our self speak. The Fluency Master uses a miniature microphone to detect vocal tone. The vocal tone signal is processed by the Fluency Master and the vocal tone sound is delivered to the ear through a small ear mold. The Fluency Master helps control stuttering and enhance fluent speech in the majority of people who try it. The Fluency Master fits comfortably behind the ear. The Fluency Master is "user-friendly." It is easy to put on, easy to use on a daily basis, and does not interfere with normal hearing. The Fluency Master helps control stuttering regardless of stuttering severity. The Fluency Master is effective for stuttering that is mild, moderate, or severe [16].

4. Basic Fluency System



Fig. 4 layout of Basic Fluency System

The Basic Fluency System provides two or three types of altered auditory feedback (AAF).

1. Delayed auditory feedback (DAF) immediately reduces stuttering about 70% at normal speaking rates without training, mental effort, or abnormal-sounding or abnormally slow speech. 55% carryover fluency after removing the device, without speech therapy. With speech therapy, DAF can induce a slower speaking rate with stretched vowels to make even severe stutterers nearly 100% fluent.

2. Pitch-shifting frequency-shifted auditory feedback (FAF) immediately reduces stuttering about 70% at normal speaking rates and induces speech motor changes in stutterers. Only Casa Futura Technologies stuttering treatment devices have octave-scale FAF downshifting (pitch shifting). Combining DAF and FAF increases effectiveness.

3. Optional (\$25 additional) manual sine wave masking auditory feedback (MAF) pulls stutterers out of silent blocks at the touch of a button.

The Sennheiser PC131 headset has a noise-canceling microphone to eliminate noise at the source. Electronic circuits filter high-frequency noise above your vocal range. Moderate (-0.4 octave) FAF effectively reduces stuttering yet is *acoustically transparent* if the device picks up background noise. An optional throat microphone eliminates background noise even in extreme conditions.

5. School DAF



Fig. 5 layout of School DAF

The School DAF provides one type of altered auditory feedback (AAF).

- Delayed auditory feedback (DAF) immediately reduces stuttering about 70% at normal speaking rates without training, mental effort, or abnormal-sounding or abnormally slow speech. The device trains 55% carryover fluency (after removing the device), without speech therapy. With speech therapy, DAF can induce a slower speaking rate with stretched vowels to make even severe stutterers nearly 100% fluent.

6. SmallTalk-500

The Smalltalk immediately reduces stuttering, while training you to no longer need the device. It's the world's smallest DAF/FAF anti-stuttering device, and now includes Bluetooth wireless technology. The SmallTalk provides two types of altered auditory feedback (AAF).



Fig. 6 layout of SmallTalk - 500

1. Delayed auditory feedback (DAF) immediately reduces stuttering about 70% at normal speaking rates without training, mental effort, or abnormal-sounding or abnormally slow speech; and trains 55% carryover fluency (after removing the device), without speech therapy. With speech therapy, DAF can induce a slower speaking rate with stretched vowels to make even severe stutterers nearly 100% fluent.

2. Pitch-shifting frequency-altered auditory feedback (FAF) immediately reduces stuttering about 70% at normal speaking rates and induces speech motor changes in stutterers. Combining DAF and FAF increases effectiveness. Only Casa Futura Technologies anti-stuttering devices have clinically proven pitch-shifting FAF.

IV. CONCLUSION

While earlier software used in speech therapy was usually limited to preset exercise patterns chosen by speech language pathologists according to their professional judgment, the latest intelligent systems cover all main speech therapy issues, including diagnosis, therapy exercises, performance monitoring, instant feedback both to the client and the speech language pathologist and especially it is not affordable to buy by the parents of the children with speech disorders as it is expensive and also not a user-friendly. The children who delayed in their milestones in the preschool stage should get the proper therapy in the early stages. The proper use of technology in their everyday practice, including the use of training software will help them to improve in their speech quality. The Future work was planned to develop the voice based assistance software for the preschool children who have fluency disorder, as well as the system to be created by which the training can be given for them.

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