DSA (DIGITAL SPEECH AID) FOR STUTTERING PEOPLE

Marek Roland - Mieszkowski
Digital Recordings - Advanced R & D, 5959 Spring Garden Rd., Suite 1103, Halifax, Nova Scotia, B3H-1Y5, Canada

Andrzej Czyzewski & Bozena Kostek
Technical University of Gdansk, Sound Engineering Department, ul. Narutowicza 11/12, 80-952 Gdansk, Poland

Introduction

The **Digital Speech Aid** (Fig.1) is based on advanced digital signal processing technology. The software developed for the device exploits new approach to stuttering disorder. With DSA many stuttering people can speak fluently (or more fluently) in any fashion and at any rate.

Results of the **DSA** testing supports authors' theory, that stuttering is a physiological disorder, in most cases of a neurological basis. Stutterers become nervous because they stutter (not as believed by some, that they stutter since they are nervous).

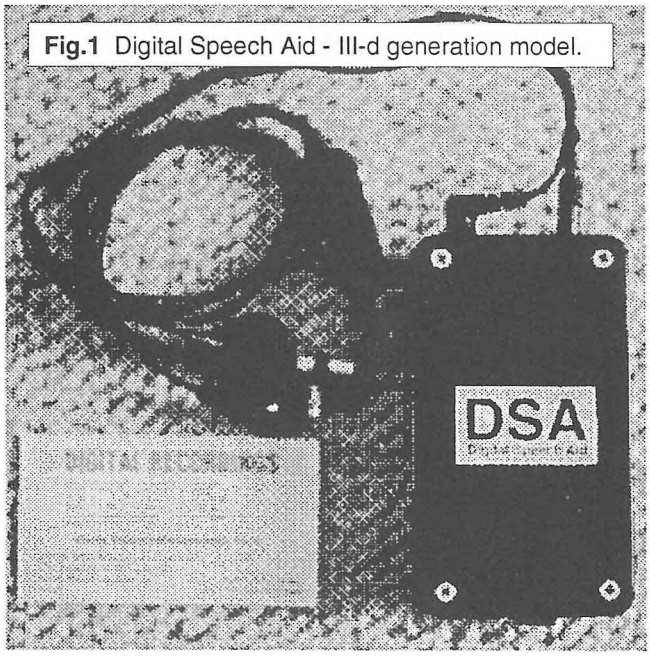

Fig.1 Digital Speech Aid - III-d generation model.

Origins of Stuttering and Conventional Treatment

In many cases stuttering was believed to be caused by psychological disorders and nervousness of the person. This stigma still exists in the large part of the society and large part of the medical and health community. Many stutterers themselves believe in this very strongly. Outcome of this believe is not only great suffering on the part of the person, due to the fact of being labeled as "weird", "nervous" and "psychologically unstable" but also very often wrong approach to the treatment of the disorder.

Treatment offered by the Speech Pathologists involves various techniques to slow down the speech, coordinate speech production with breathing, change in various ways way of speaking and pronouncing words etc. It also involves some counselling and relaxation therapy, which very often overlaps with work and input from the Psychologist. These techniques work to certain degree and results depend very much on the particular case. Also they work often better in the clinical setting than in the real world, where person cannot concentrate as much on speech production. And unfortunately many of these techniques require a conscious effort on the part of the stutterer. Many people give up the speech therapy because in some cases they feel that fluent, but unnatural sounding speech is worse then stuttering itself. It is estimated that about 5% to 10% of stutterers are receiving some form of the therapy (indicative of the current treatments effectiveness) [1].

If stuttering is a physiological disorder (of neurological nature in most cases), telling a person to control it does not make much sense. It is like telling a person with faulty vision to take off glasses and to concentrate to see better.

New approach to understanding of stuttering

Several years ago, authors started a series of experiments to find what are the mechanisms of stuttering and whether one could use some techniques to compensate for this physiological (in authors' opinion) deficiency of speech.

Review of literature and consultations with several experts in the field reviled, that very little is known about stuttering and even less is understood. Authors were stunned by the many misinterpretations of the facts and experimental results [1].

It became obvious later why it is so - simply majority of the people in the field of the Speech Pathology have very little background in mathematics, physics, acoustics, electronics and signal processing. Therefore they are not equipped to interpret available data correctly. For this reasons authors' new approach and interpretations were met with skepticism in some cases and with hostility in others [2].

Digital Speech Aid (DSA)

DSA (Fig.1) is a small 11cmx6cmx3cm (LxWxH), sophisticated, electronic device with 256 different program settings. DSA uses a microphone and pair of earphones. It operates on batteries. The device is relaxing and non-disturbing. With DSA a person can speak in any fashion and at any rate. DSA is most effective in the case of "Classical Stutterers" who consist about 80% -> 90% of the stuttering population. Significant improvement or total fluency is observed in about 40% -> 60% of "Classical Stutterers". Rest of them also improve to various degrees. Device was and is still tested in real life, not artificial laboratory situation. Improvements were observed in all situations : in the office, at home, on the telephone, during public meetings, presentations, good and bad days, etc. Improvement is instant, however, we observe increase in effectiveness during the first 2 -> 6 weeks. After that it seems to remain the same. In majority of cases there is a carryover effect - person remains more fluent for 2 hours -> 2 weeks after using DSA. Significant improvement in self-esteem and self-confidence are observed. People like to use DSA and say that it is relaxing. Many people also indicate, that they feel, that they cannot stutter. Long term effects seem to support authors' theory and expectations - DSA is still effective (same level) after being used for 10 months.

First clinical trials - June 1992

First prototypes of DSA (II generation) were finished in May 1992. Some of the first clinical trials were very exciting and the device met with good approval from the stuttering people. Here are some of the remarks from this early study in Poland :

- *"....I think that Digital Speech Aid (DSA)is extremely effective in the elimination of stuttering, even in cases of very severe stuttering. ....During my 30-years long practice as a speech pathologist, no technique was as successful. I believe that we finally have the green light for people who have till now problems with elimination of stuttering ...We are waiting very anxiously for DSA to appear on the market and become available for all stuttering people....." Halina Stawikowska, Speech Pathologist, June 04, 1992.*
- *"....Speaking with DSA brought me big relief. I realized, that I can also speak like normal person, at relatively fast rate.All the sudden I got new surge of power.....This device helped me also in the inter-personal contacts. I am not afraid anymore !....It is fantastic to realize, that spoken word does not have to be "bumpy". Thank*

you , thank you, thank you !!!....", Anna Grudzien, 21 years old, June 05, 1992.

- *"....Speaking with DSA eliminates prolongation of vowels, speech becomes more fluent... Improvement is very good, much better then with the DAF (Delayed Auditory Feedback). In my case it was particularly noticeable in the German language, which I am studying and in which I stutter much more often then in the Polish language. While reading in German, with DSA I did not stutter at all....", Jacek Szot, 24 years old, June 03, 1992.*
- *"... I think, that use of DSA is relaxing.It is difficult to stutter. I could speak fast without stuttering. Normally I speak slow.....", Prof. Antoni Stawikowski, Astrophysics, May 31, 1992.*

Long term effects - DSA (III-d generation model)

Long-term effects were and are tested right now.The initial results are very encouraging. It is expected that due to the relaxing and reassuring effect of DSA, the base-line stuttering level will decline (we observed this already in some cases). The effectiveness of the device is expected to remain the same for removal of the "natural level" of stuttering. In a sense DSA is expected to work as a prosthetic device.It does not mean however, that it has to be worn all the time.It can be only used in most difficult situations and as a backup. Below are some remarks from some patients who did use DSA for over period of 3 to 10 months :

- *"...my experience with DSA for past 7 months has been good....In past years talking on the phone was my reason to be nervous to speak to people. With DSA I now find it to be no problem to answer a phone and have a normal conversation. I recommend DSA for anyone with a speech stoppage and stuttering." John Dunphy, Dartmouth, Nova Scotia, Canada, March 25, 1994.*
- *"..Over the course of a few months, I became very comfortable with the speech device (DSA). ...I have less apprehension with "feared words" and stutter quite a bit less than before using the device. My confidence in speaking has improved over the time I used the device and the "carry-over" time has also increased. My fluent speech will last sometimes half a day without the device." 25 years old female stutterer, Halifax, Nova Scotia, Canada, December 19, 1993.*
- *"When I first began to use the DSA I noticed a dramatic increase in my fluency when speaking especially on the phone.....It has been so wonderful to have the freedom of not being afraid to use the phone, to call to make appointments etc.....My life has changed now since I have used DSA.....it is a wonderful machine to use." Lori Paruch, Halifax, Nova Scotia, Canada, April 04, 1994.*

Facts about stuttering and implications for treatment

About 4% of children and 1% of adults stutter. Stuttering changes with age. People stutter to a varying degree and in different ways. Often people stutter on particular sounds. Often rate of the stuttering varies for given individual (depending on various factors). Stuttering usually depends on language used by the person. Males stutter 3 times more often than females. Stuttering starts in the early age and in some cases goes away at later age. In many cases food and alcohol (or other chemicals) change stuttering - better or worse. In many cases exercise and physical activity change stuttering. In many cases stress changes the rate of stuttering - better or worse.

Becoming suddenly deaf leads to total fluency. With shadow speech (whispering) or choral speech (with other person) - majority of cases is fluent (90% ?). When singing or talking in noise (cafeteria, bar, music) - majority of cases is fluent (90% ?). Lowering or increasing pitch of the ones voice, assuming foreign accent and slowing down the rate of speech production also results in increased fluency .

Amplification or attenuation of the voice , delay of the voice in the range 1->100 ms, white or other types of noise, frequency shifting of the voice in the range -1 -> +1 octave, reverberation of the voice, combination of the above increases fluency.

It is obvious that hearing plays very important role in speech production and control. It is clear that stuttering is caused by physiological disorder, neurological in nature in most of the cases. Speed of propagation of neural signals seems to play important role, lower frequencies are more important than higher (facts and experiments), vocal tone is very important (facts and experiments). Stuttering seems to be correctable by the processing of sound (facts and experiments).

How to correct stuttering via Signal Processing ?

Methods of stuttering correction could be divided into three broad categories :

- **Masking-noise**, etc. make signal unusable for control in the Speech Control System (SCS). SCS relies on other afferent channels in this case (Fig.2).
- **Non-Masking** - DAF, FAF, Reverberation seems to be better, since signal is not as disturbing and it is comprehendible as voice by the higher levels of Speech Synthesis System (SSS), therefore helping in this synthesis (Fig.2). However SCS is probably not using this signal for the control (servo) purposes.
- **Correction** - signal is shaped via DSdP (Digital Sound Processing) in such a way as to correct for deficiencies and at the same time make it still acceptable by SCS for the control (servo) purposes. This is the preferred way of correcting, since it will be more effective and pleasant to use by the stutterer. Authors' hypothesis is that it is possible to use this type of systems in certain cases of stuttering. Further tests and experiments are required.

Hypothesis about SCS :

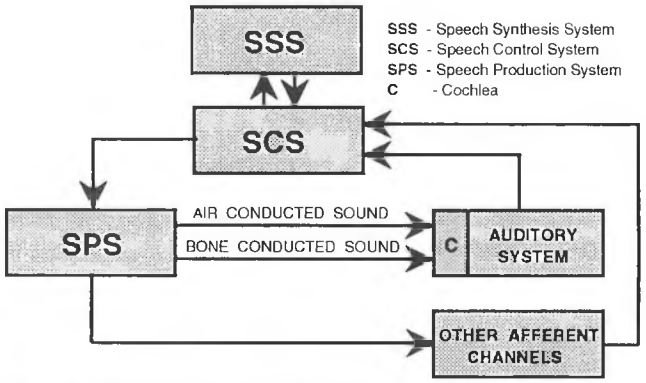

Fig. 2 Block diagram of the speech production system.

In stutterers the auditory signal is used by SCS, but from time to time the voice signal is not being accepted leading to prolongations and other observed stuttering effects (Fig.2). By manipulating signal via DSdP, one can obtain auditory feedback which will be on one hand acceptable by SCS for control (servo) purposes and on the other hand will lead to correction of speech production. This should in turn lead to fluency. Hopefully this could be done for all sounds produced by the stutterer. Also one would hope, that this correction will be working over the whole range of variability (stress, alcohol, etc).

Introduction of some kind of processing - ear plugs, amplification, equalization, filtering, DAF, FAF, DSA, noise, etc. changes auditory feedback. SCS is comparing the remembered signal (by the already formed and "fixed" neural network) with the produced signal and is correcting its shape. If SCS cannot do this, it will get stuck (stuttering effect) - system is trying to overcome a problem and is trying to do this over and over again. Since most of the SCS work is under a subconscious control, the stutterer has very little control over it.

Conclusions

Authors believe, that we are very close to explaining the stuttering disorder. Our hope is that scientists from different fields will join forces together in order to advance our knowledge of this disorder and its treatment. Without this approach this progress will be as slow as in the last several decades.

References

[1] Hermes Electronics, internal report " The Digital Speech Aid", Halifax, Nova Scotia, Canada, December 1993.

[2] Roland-Mieszkowski M., book "Career Assassination", Halifax, Nova Scotia, Canada, to be publishedd.