SPEECH PERCEPTION AND PRODUCTION

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 Czyzewske & 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-4 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 believes 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 than 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 13 cmx6cmx3cm (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% to 90% of the stuttering population. Significant improvement or total fluency is observed in about 40% to 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 to 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
AUDITORY

reassuring effect of DSA, the base-line stuttering level will decline

Long-term effects were and are tested right now. The initial results

Long term effects - DSA tor over period of 3 to 10 months :

backup. Below are some remarks from some patients who did use

prosthetic device. It does not mean however, that it has to be worn all

level" of stuttering. In a sense DSA is expected to work as a

device is expected to remain the same for removal of the "natural

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-100 ms, white or other types of noise, lrequency shifting of

is fluent (90% ). When singing or talking in noise (cafeteria, bar,

cases exercise and physical activity change stuttering. In many cases

in some cases goes away at later age. In many cases food and alcohol

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 different

channels in this case ( Fig.2).

• Non-Masking - DAF, FAF. Reverberation seems to be better,

since signal is not as disturbing and it is comprehensible 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, DSS, 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

helping in this synthesis (Fig.2). However SCS is probably not

helping in this synthesis ( Fig.2).

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”.


Nova Scotia, Canada, to be published.