# Updates to PDA-Enhanced Speech Treatment for Parkinson's Disease

## Background

At least 89% of individuals with Idiopathic Parkinson Disease (IPD) have disordered speech and voice<sup>[1]</sup>, however only 3-4% receive speech treatment<sup>[4]</sup>. Previous studies utilizing the Lee Silverman Voice Treatment (LSVT®) for individuals with IPD have generated the first short and long-term efficacy data for speech treatment for individuals with IPD <sup>[3 4 5 b]</sup>. Despite these advancements in establishing the efficacy of speech treatment for individuals with IPD, the need for "real world" treatment of speech remains unmet for the vast majority of these individuals. A few of the many reasons for this are that individuals may have physical limitations which make it difficult for them to come to therapy, they may not have easy access to treatment provided by a therapist with knowledge of voice and speech in IPD, or they may have limited insurance benefits.

The advent of high-performance personal digital assistants (PDAs) with advanced sound processing capabilities offers the potential to address the challenge of treatment accessibility. PDA's have the portability to adapt clinician-directed treatment to home selftraining, thus preserving feedback and clinician monitoring<sup>[7]</sup>. The usefulness of portable feedback devices for individuals with PD has been previously investigated. Zicker et al. <sup>18</sup> found that an individual with PD was able to temporarily modify her behavior when she received feedback from a device that her speech was too soft. In addition to being a therapy tool, PDA's have the capability to acquire multi-site treatment effectiveness data that can evaluate the delivery of consistent treatment among clinicians. Ultimately, these large data sets could be combined to establish speech therapy as "standard care".

The purpose of this ongoing research is to continue to improve upon the automation of components of the LSVT® on PDA devices. The LSVT® consists of a variety of voice exercises including sustained vowel phonation, pitch exercises, reading and conversational activities. Prototype devices used in this study are programmed to collect data on sound pressure level (SPL), fundamental frequency (F0) and duration of phonation, as well as provide feedback to individuals on their performance during LSVT® therapy and homework sessions. We have named the device the LSVT Companion (LSVTC).

Results from a pilot study <sup>[9 0]</sup> demonstrated the feasibility of utilizing the LSVTC as an adjunct to LSVT® therapy and also as a data collection device. The LSVTC was able to reliably collect data on SPL, F0 and duration of phonation and provide feedback regarding performance during LSVT®. Based on that preliminary data, and on comments provided by the pilot subject and the clinicians involved, several modifications and enhancements to the original LSVTC were planned and implemented. These enhancements and modifications were designed to make the LSVTC more accessible to individuals with IPD with visual, motor and cognitive impairments.

# **Visual enhancements**

One of our goals is to create a software application with a simple, yet efficient interface, capable of providing feedback in a manner that is easily understood by individuals with a variety of cognitive abilities. The first version of the LSVTC (Figure 1) employed simple bar graphs to indicate SPL, pitch, and time. These graphs are still available, however they have been updated with backgrounds in bright, contrasting colors to make the targeted goals easier to discern. These new backgrounds provide immediate feedback regarding performance towards target SPL goals and require minimal effort to interpret.

Figure 2 shows this type of graph applied to the conversation exercise. The color green was selected as the indicator for "good loudness" in all exercises because it utilizes common knowledge of "green means go", and thus is easily understood by the clients with minimal explanation. This type of graphical feedback can be used for all of the exercises of the LSVT®. In addition, other graphical feedback elements have been developed to express the physical quantities of the exercises in a more basic, intuitive fashion. The clinician can select which feedback method to use for each exercise, based on each individual client's visual and cognitive needs. An example of these new visual enhancements, applied to the sustained vowel duration exercise, is illustrated in figure 3.

The original feedback for the pitch range exercises was a bar graph that displayed both pitch and SPL. Due to the complex and abstract nature of this graph, it could be challenging for some individuals who are not able to attend to two types of visual feedback moving in different directions at the same time. A new screen was developed to provide this information in a less complex, more familiar way (Figure 4).

Figure 5 shows another form of the SPL graph, used in the functional phrases exercise. The phrases are now shown on the screen, one at a time. It is important for this part of the LSVT® treatment that these phrases be functionally relevant to each individual person. Thus, each client generates their own phrases for this section. In order to accommodate this requirement, the software was written so that these phrases can be individually programmed for each client.

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Figure 1: The LSVT Companion



Figure 2: Screenshot of a graph applied to the conversation exercise. The blue line indicates SPL (vertical axis) over time (horizontal axis). The colored background corresponds to different SPL regions: red means "bottom limit", the threshold for voice detection; yellow means "low", below the target; green means "good", equal or above the target. The top limit of the graph corresponds to the maximum desired SPL value.



Figure 4: Screenshot of the pitch range exercise module. A piano keyboard is displayed to indicate pitch. A flashing blue key indicates instant pitch and an arrow points to the target high or low pitch. Thus, the individual simply watches the blue key ascend or descend on the keyboard as they raise or lower their pitch. The green lamp above the piano lights up to indicate if the individual maintains the target SPL during the exercise.



Figure 3: An additional way to receive feedback for the sustained vowel duration exercise. SPL is expressed by a thermometer, where the blue "mercury column" raises according to the instant loudness, and colored bands on the back plate indicate the targets. A clock indicates duration, with a green dot marking the target.



Figure 5: Screenshot of a graph applied to the functional phrases exercise. The graph works in the same way as described in figure 2. The phrases are shown on the right window, one at a time.

### Auditory feedback

Due to the fact that individuals will, at times, be using this device instead of participating in face-to-face therapy, it is important that they receive feedback (both positive and negative), which closely emulates what would be received from a clinician in a therapy session. Thus, in addition to the written comments shown on the screen, we have incorporated auditory feedback phrases, such as "Good job!", "Let's get louder.", "Great!", "Can you go any higher?", as well as short instructions at the beginning of each exercise. These feedback phrases allow for a more natural experience when performing a therapy session with the LSVTC at home. The device is able to store a large number of feedback phrases, sorted by categories. This allows the device to behave less "machine-like" and avoids monotony in the type of feedback that is supplied.

In addition, this auditory feedback is helpful for individuals who learn better in an auditory mode or who exhibit visual problems, which may make reading the visual feedback at the top of the screen difficult.

# The PC (desktop/laptop) version

Our focus while developing the LSVTC has been on portability. Therefore, we chose one of the off-the-shelf available PDA devices, with the necessary multimedia capabilities, as the original platform for the LSVTC. However, the need has arisen for other platforms as well. Several individuals that have had contact with the LSVTC asked for the possibility of using it on laptop or even desktop computers; giving away portability in favor of more comfortable visualization and operation offered by larger computer monitors. This PC application can also be helpful to individuals with motor impairments who may have difficulty utilizing a stylus to activate small buttons on the PDA. To answer these needs, we have ported the LSVTC application to the well-established PC/Windows platform, while keeping the same functionality of the original version.

#### Other enhancements and future research

The output file generated from the performance data has been slightly modified, making it easier for the clinicians to download and process these data as they use the device as a data collection tool . In addition, the LSVTC Manager software, which provides functionality for individualizing targets for each patient and overall configuration of the session, has been improved. There is also a new module in the LSVTC Manager Software to help in the calibration process of the PDA devices used.

Calibration is one of the main topics to be dealt with in the near future. We are studying calibration procedures that are less time consuming to perform while still providing reliable results. In addition, we are currently researching a more robust pitch tracker algorithm, to minimize errors that have at times been reported during the pitch range exercises.

The goal of the LSVTC has been to make speech treatment a reality for more individuals with IPD and allow them to reap the benefits of functional communication and expression. The current and future enhancements discussed in this poster demonstrate the continued progress and commitment towards this goal.

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