

# A Single-Switch Performance Evaluation Tool

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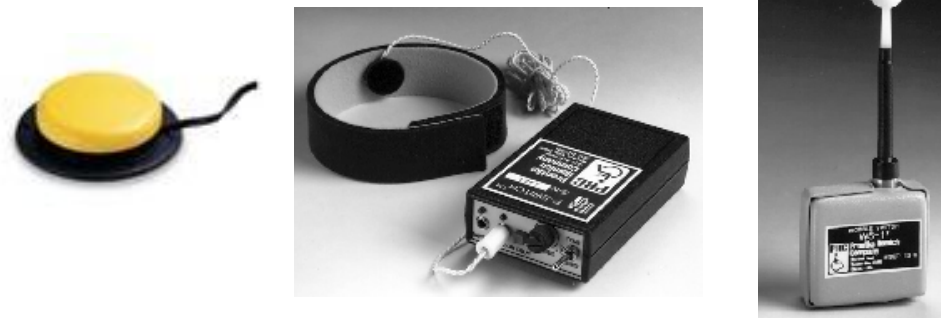
## 1 Abstract

Those with disabilities are sometimes limited to interacting with technology through a single switch interface. The particular switch type and its positioning in relationship to the user are critical factors for optimizing use. However, the state of practice for selecting an appropriate switch type and a likely position for it is mostly trial and error at this point in time. This project describes the development of a system that allows clinicians to use actual client performance data to make informed choices about switch type and position. Example systems were developed in a variety of programming languages by teams of senior computer science students enrolled in the Adaptive Technologies (CSCI 406) course at Millersville University.

## 2 Background

For many people with disabilities, assistive (or adaptive) technology (AT) can be helpful in achieving their educational, vocational, and personal goals. For some, the AT human interface can be direct selection, such as using a keyboard (standard or special) or pointing to targets and making selections directly using various means, such as with a headstick. Such methods generally result in the highest rate of performance since variations in time to selection for different selection mechanisms are based mainly on the user's physical movements, not on any specific characteristics of the interface itself, other than what is predicted by Fitt's Law (Dix, Finlay, Abowd, and Beale, 2004).

However, other users of AT cannot make direct selection or cannot, for various reasons, use it well (i.e. high entry rate and low error rate). For some of these people the use of one or more single switches is required. Single switches can take many forms and can be activated in many ways (see Figure 1). In particular, they can be used to control a scanning process in which choices are made available in a timed sequence and chosen upon switch activation. Single switches also can be used for entering codes, such as Morse Code, either with multiple switches or by distinguishing short and long activations.



**Figure 1:** Some single switches – a large button switch, a micro-switch, and a wobble switch.

### **3 Evidence-Based Practice**

When a form of single switch interaction is being considered for the human interface, significant issues surround the selection of the switch type, switch positioning, and the development of switch skills. After determining the various switch options to be considered, each must be tried. It is common that the same switch can be used in many different ways. For example, a button switch could be mounted for activation by head movement or by pushing with the foot. Likewise, pushing with the foot could be implemented in many different ways: the switch could be mounted to the front, left, right, top, or bottom of the foot. The user's performance may be quite different depending on these choices.

The measurement of performance using a switch can be valuable in evaluating the proper selection of switch type as well as the positioning of the switch. Without performance measurement, it is unlikely that the best performance for an individual will be achieved. This is a principle of evidence-based practice, an approach that promotes the collection, interpretation, and integration of valid, important, and applicable patient-reported, clinician-observed, and research-derived evidence (Romich and Hill, 2000).

### **4 The Project**

This project is an outgrowth of a National Science Foundation grant (Liffick, 2003) to integrate AT into a computer science curriculum. During the Fall 2005 semester, 12 students participated in an advanced course offered to senior computer science majors on the topic of computerized aids for those with disabilities (CSCI 406: Adaptive Technologies). The students were formed into six teams to develop the Single Switch Performance Test (SSPT). Three teams used Visual Basic (VB) for development, two used Shockwave Flash, and one used Java. All teams developed useful systems, though one of the VB and the Java systems were the most successful. The main advantage of the Java version (developed by students Sean Eidemiller and Jason Sterner) is its portability to OS X and Linux systems. The main disadvantage of the Flash versions was the apparent inability to store the results of the tests in files.

#### **4.1 The Single Switch Performance Test System**

Single Switch Performance Test (SSPT) is a clinical tool to facilitate the measurement of performance using a single switch. SSPT measures three parameters: 1) time to activate the switch, 2) time to release the switch, and 3) speed of repeated switch activations.

A Practice Mode allows the switch user to get a feel for the activation of the switch prior to administering performance tests. Some switches have an audible click that can be heard. However, some individuals may have hearing impairment, some switches have no click, and/or the site (e.g., under the foot) and/or ambient noise may preclude any activation feedback. Audio and visual feedback within SSPT indicates activation of the switch and is maintained until the switch is released.

The Activation Performance Test is initiated with a switch activation and release. Then, ten tests are performed. For each test, following a random time from the previous switch release, the stimulus is provided and the time from stimulus to switch activation is recorded. When the ten test trials are completed, the average time is displayed.

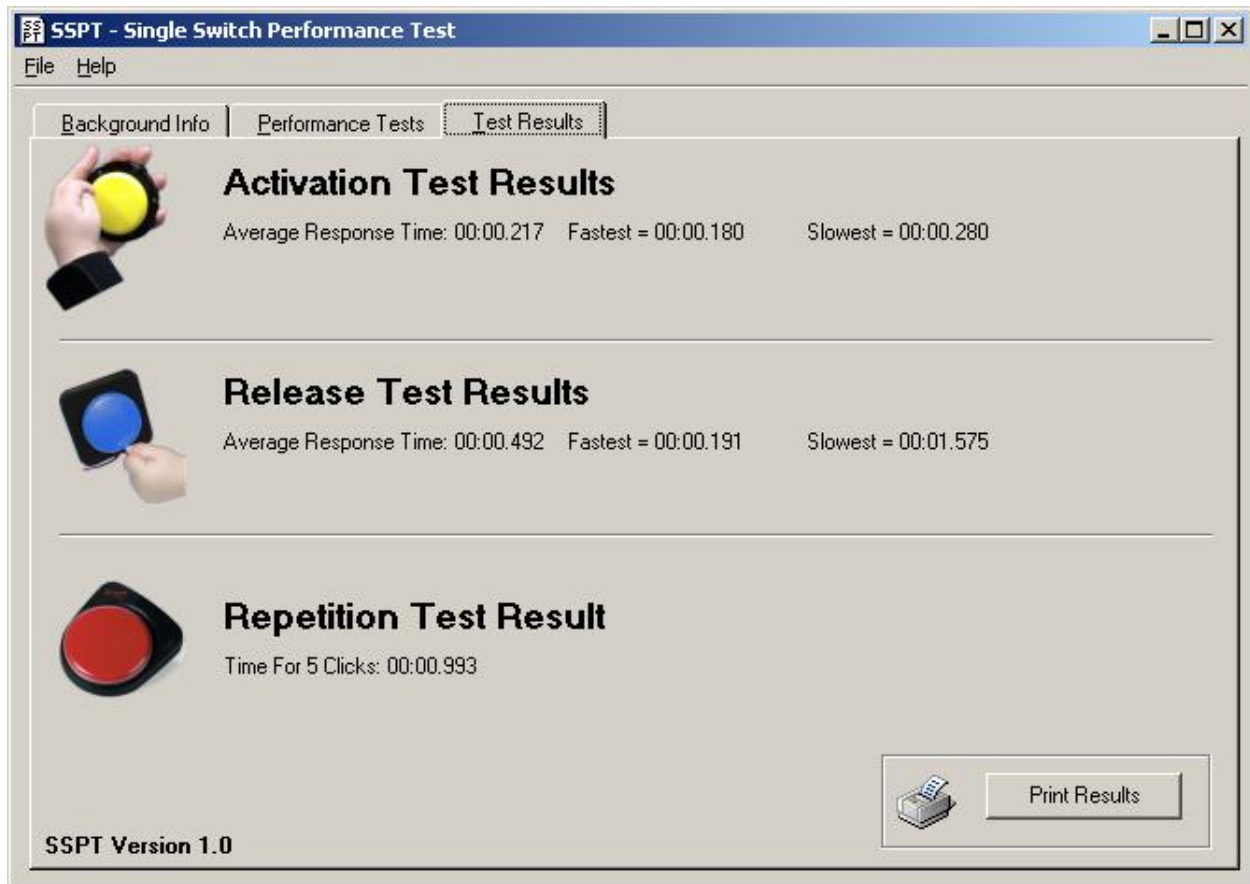
The Release Performance Test is initiated when the switch is activated and maintained. After the switch has been held for a random duration, the stimulus is provided and the time to release the switch is recorded. This is repeated ten times. When the ten test trials are completed, the average time is displayed.

The Repetition Performance Test is initiated with a switch activation and release. Following a random delay, the stimulus is applied and maintained while the subject activates and releases the switch five times. The time is recorded. When the test trials are completed, the total time is displayed.

Figure 2 shows the results display after conducting all three tests with the Visual Basic version developed by students Dan Yocum and Josh Huber.

#### **4.2 Limitations**

SSPT is intentionally simple in order to keep the support to a minimum and to allow free distribution. For example, it does not allow consideration of the anticipation factor, measure or report errors, or identify fatigue factors. More



**Figure 2:** Results summaries from a Visual Basic version of SSPT. Times shown are in seconds.

comprehensive collection and analysis of performance data is possible. One approach that can be used with augmentative/alternative communication (AAC) devices is to collect language samples using language activity monitoring (LAM). [4] This would reflect actual use of the AAC system.

### 4.3 Applications of SSPT

The primary application for SSPT is as a clinical tool for measuring switch performance. It can be used to compare performance using different switches, different control sites, and methods of presenting stimuli. This data results in an objective approach to switch selection and placement.

Another application for SSPT is the ongoing evaluation of switch performance. This data provides feedback and can offer guidance relative to the acquisition of switch skills. Analysis of this data can indicate which methods and techniques are producing the desired outcomes and also can indicate when achievable levels of performance have been reached.

The secondary application for SSPT is research and product performance testing. Little is presently known about how people with disabilities learn and use switches. Switch developers can use SSPT to test their devices and to help AT practitioners understand the performance that can be achieved.

## 5. Conclusions

This project achieved two main goals. First and foremost, it developed a clinical tool for AT service providers to use that provides performance data that can be used to select switch type and position for those using single-switch interfaces. Secondly, it provided these teams of computer science students with an opportunity to gain experience in AT issues directly related to their field.

## 6. References

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