KEYBOARDING ACCURACY FOR A STUDENT WITH PHYSICAL DISABILITIES: A SYNERGISTIC APPROACH

S. JOHN OBRINGER

KENNETH COFFEY

GARY MCFADDEN

JILL ETHERIDGE

REBECCA POUNDER
Mississippi State University

ABSTRACT

The purpose of this study was to examine a synergistic application of three different technologies to improve the keyboarding accuracy of an individual with significant motor disorders. Three keyboarding technologies were layered to measure the power of each technology independently and collectively. The results show a significant increase in typing accuracy using the technologies in an integrated manner. Implications and suggestions for future research are put forth.

For a significant number of students with physical disabilities such as cerebral palsy, handwriting may not be a viable option because of severe limitation in fine motor control. Typing is often a more feasible alternative (Tumlin & Heller, 2004). In addition, typing skills become increasingly important as a student ages and transitions to the workplace. However, utilizing the traditional keyboard may also be problematic for many individuals with cerebral palsy.

Cerebral palsy is a non-progressive disorder affecting movement and posture. The condition can be caused by neurological damage to the motor control centers of the brain during the prenatal, perinatal, or postnatal period. Cerebral palsy affects the tone of muscles and compromises voluntary and involuntary muscle control (Kirk, Gallagher, Anastasiow, & Coleman, 2006).

Due to a loss of cerebral inhibitory signals to the antagonistic muscles in persons with cerebral palsy, the individual finger movements used in keyboarding are difficult to perform (Steenbergen, Veringa, & Hulstijn, 1998). The more salient difficulties in keyboarding for persons with cerebral palsy include problems with: anticipating, generating, coordinating, positioning, grip and lift force, typing speed, dwell time, and force modulation (van Roon, Steenbergen, & Hulstijn, 2000).

As noted, a limitation for persons with cerebral palsy is difficulty in using a traditional keyboard to access a word processor or computer (Harrysson, Svensk, & Johansson, 2004). Because of this difficulty with the traditional keyboard, a number of modifications have evolved. Rather crude adaptations such as keyboard guards, often homemade, were utilized to improve accuracy. In later years these keyguards became commercially available from typewriter manufacturers. A keyguard, a raised shield which overlays the keyboard, has holes over each key to allow the typist to strike only one letter at a time, thereby preventing multiple keys from being hit (Government of Canada, 2005).

The traditional keyboard was arranged so that the most often utilized keys were struck with the fingers having the least power, those being the ring and small fingers. The theory was that these less powerful fingers would be less likely to bind the striking mechanism (Steenbergen et al., 1998). Steenbergen et al. (1998) studied four individuals with hemiparesis cerebral palsy using a standard, often referred to as QWERTY, keyboard to measure typing effectiveness. The researchers concluded that the "standard 'QWERTY' keyboard hampers typing performance extensively, especially for subjects with left spastic hemiparesis" (p. 64). The authors noted that the smaller, weaker fingers reduced typing performance for individuals with spasticity to a much greater extent than they do for persons without disabilities. The researchers suggested that the individuals with spasticity could benefit from a keyboard arranged to better utilize their strengths. One program that offers a viable alternative to the standard keyboard arrangement is IntelliKeys, which interfaces with most standard computers. This adaptation is a system of overlays which utilizes larger icons, increased spacing between icons, and a number of different keyboard arrangements including personally customized keyboards (Intellitools, n.d.).

In addition to an alternative keyboard and keyguard, word prediction software can be a significant aid for students with motor difficulties. Word prediction software was first created for students with physical disabilities (MacArthur, 1999). Word prediction software greatly reduces the number of keystrokes by predicting the word or short phrases based on the initial input. Users will have typically three to five choices appear on the screen, from which they can select by pressing only one key or by operating the mouse. As they continue their input the software further refines the choices to a more narrow range. The words predicted are typically based on "word frequencies and grammatical algorithms" (Lewis, Graves, Ashton, & Kieley, 1998, p. 97). Newer generations of this software can actually learn new words that the student uses and adjust a specific individual's repertoire of frequently used words. As with most software, each generation has become more efficient and is, therefore, utilized by more and more individuals with keyboarding difficulties. The most common prediction software package is Co:Writer, which was used in this study (Co:Writer, n.d.).

Because the appropriate utilization of adaptative technology for individuals with physical disabilities remains a significant challenge (Athes, 2001), this study was designed to address this issue. The purpose of this study was to measure the effectiveness of three different adaptations on typing production and accuracy in a student with spastic cerebral palsy.

SUBJECT DESCRIPTION

The subject for this study is a female college student with severe spastic quadriplegic cerebral palsy. She is a senior majoring in educational psychology. The student is nonambulatory, uses an adapted power chair, and has extreme dysarthric speech. Due to her upper limb involvement, fine motor activities such as handwriting have not been attainable. The university's office of student services provides tutorial assistance in a number of areas, especially writing tasks. The student also has an attendant 30 hours per week to assist with personal care and other life skills.

METHODS

Using single subject methodology, the effectiveness of three layers of adaptations on typing production and accuracy were assessed. The statistical model used for the study was a randomized block design. To accomplish this three trials were scheduled, once a week for three weeks. In each trial the subject was asked to type a paragraph for five minutes and then take a ten minute break to avoid fatigue. After this ten minute break, the student was directed to type the second paragraph for five minutes. This routine was followed for the third and final paragraph.

The trials consisted of typing three short paragraphs selected from a keyboard training text. These short paragraphs were prepared in a 24 point font to allow the subject to more easily track the characters. The three paragraphs were used in the same order for each of the three trials. The order in which the technologies were used varied between trials so that by the end of trial three each paragraph had been typed using each technology. Table 1 provides a listing of the paragraphs and the order in which the technologies were used.

At the start of each trial the subject was reminded that there would be five minutes to type followed by a ten-minute break. In order to test the accuracy of each technology, the subject was also instructed not to backspace. Before each typing session, the subject was allowed to adjust the position of the keyboard and paper holder. The paragraph to be typed was turned over as the timer was started, and when the timer was stopped the paragraph was placed face down. This ensured that the subject could only type the paragraph during the given five minute time limit. If any unwanted menu was inadvertently pulled up during testing, then the timer was stopped, the menu was closed, and the timer was restarted.

Following each trial, the number of characters typed by the subject was calculated by the word processing program to obtain a total character count. Then the errors in the subject's work were counted. An error was any character that was substituted for, added to, or left out of the subject's work. These errant characters were then compared to the total number of characters typed by the subject to determine an accuracy rate. A SAS program was run to compare the accuracy rate among the three keyboarding adaptations.

RESULTS

Figure 1 shows the results of the testing. Within each of the three trials, there is an increase in typing accuracy with each added level of technology. For example, in Trial 1, the accuracy with Intellikeys alone was 48%. When the keyguard was added to the Intellikeys keyboard, the accuracy increased to 84%. When Co:Writer software was used with the Intellikeys and keyguard, the accuracy increased to 93%. As can be viewed in Figure 1, similar results are shown for Trial 2 and Trial 3.

TABLE 1
Order of Technology Use

Paragraph	Trial 1	Trial 2	Trial 3
1	Intellikeys alone	Co-Writer with Intellikeys Intellikeys and Keyguard	Keyguard with Intellikeys Intellikeys
2	Keyguard with Intellikeys	Intellikeys alone	Co-Writer with Intellikeys and Keyguard
3	Co-Writer with Intellikeys and Keyguard	Keyguard with Intellikeys	Intellikeys alone

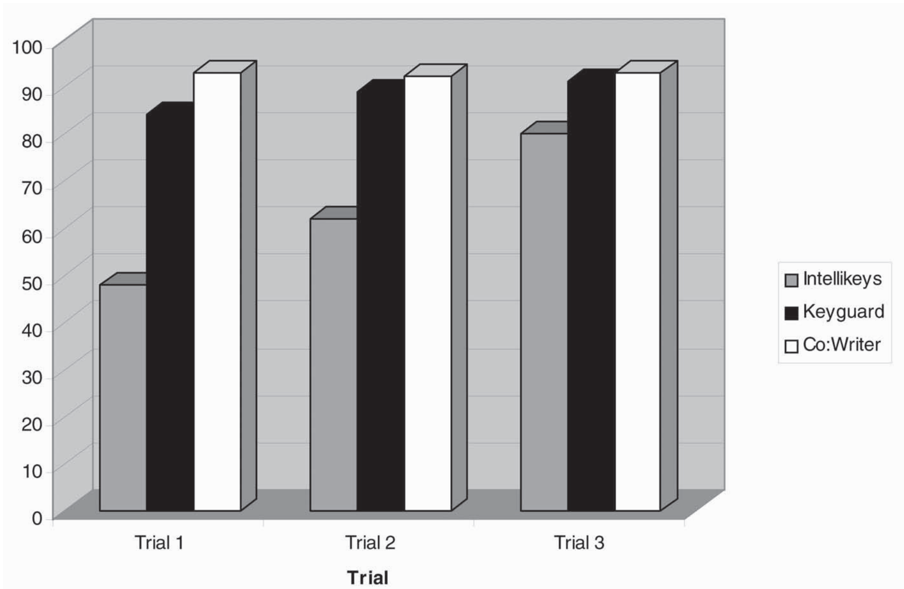

FIGURE 1.

Accuracy versus Technology for Each Trial.

Figure 2 shows the change in accuracy among trials for each specific technology. For Intellikeys, the accuracy increased from 48% in the first trial to 81% in the third trial. When the keyguard is used with Intellikeys the accuracy was 84% in Trial 1 and increased to 92% in Trial 3. Finally, when Co:Writer software was used with Intellikeys and the keyguard the accuracy in Trial 1 was 93% and was essentially unchanged at 94% in Trial 3.

DISCUSSION

These preliminary results show that the use of an adapted keyboard, keyguard, and word prediction software can together increase the typing accuracy for an individual with cerebral palsy. Within each trial, the accuracy increased with the addition of each added level of technology.

With the Intellikeys adapted keyboard, there was a significant increase in accuracy from Trial 1 to Trial 3. For the use of the keyguard, the increase through the trials was less noticeable since the initial accuracy was high (83%). With Co:Writer software, there was only a slight change during the

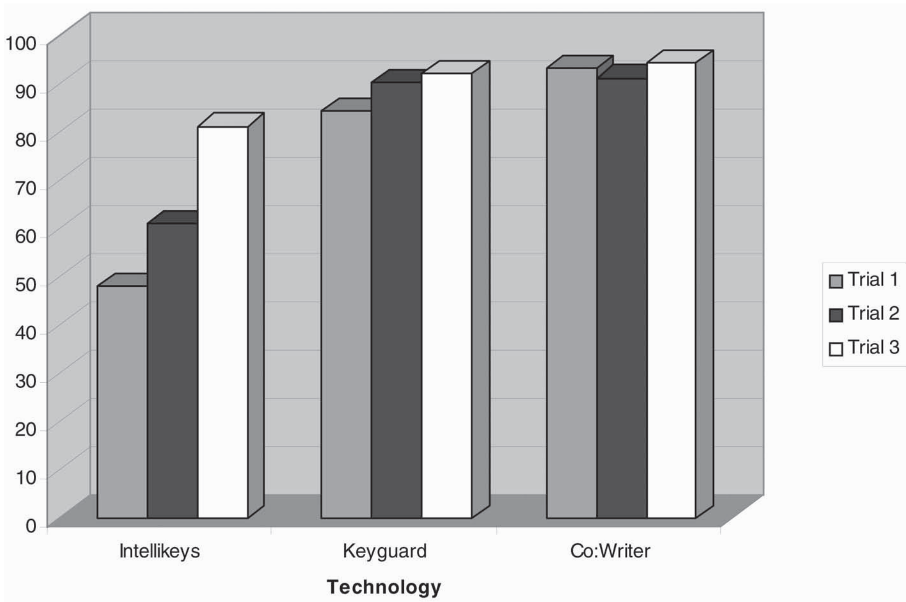

FIGURE 2.

Accuracy versus Trial for Each Technology.

three trials because the initial accuracy was very high (93%). An interesting finding was that the initial accuracies for both the keyguard and Co:Writer software were higher than the final accuracy for the Intellikeys alone (see Figure 2).

The results of the study provide a number of lessons for persons using assistive technology. First, a single piece of assistive technology, when used in isolation, may not result in an appreciable difference in functioning. Second, multiple layers of assistive technology may be needed for a person with moderate to severe motor impairments. Third, educators and rehabilitation specialists may need to creatively combine a variety of technologies to obtain a synergistic effect.

Because this was a single case study and not a comprehensive evaluation of each of the three technologies, this study should be replicated with additional subjects. Also additional studies should be performed to evaluate the effects of the three technologies on keyboarding speed. However, this preliminary case study does show that utilizing synergistic combinations of assistive technology can increase the keyboarding accuracy of an individual with physical disabilities.

REFERENCES

Athes, G.H. (2001). Making it accessible. *Computerworld, 35*(22), 56–57.

Co:Writer Solo. (n.d.). *Word prediction redefined . . . Prediction PLUS vocabulary development*. Retrieved August 15, 2005, from http://www.donjohnston.com/catalog/cow4000d.htm

Government of Canada. (2005). *Definition of key guards for keyboards*. Retrieved August 16, 2005, from http://www.apt.gc.ca/dProdExpandE.asp?Action="&Id=294

Harrysson, B., Svensk, A., & Johansson, G.I.. (2004). How people with developmental disabilities navigate the internet. *British Journal of Special Education, 31*(3), 138–142.

Intellitools: Intellikeys. (n.d.). *The alternative programmable keyboard*. Retrieved August 18, 2005, from http://www.intellitools.com/products/IntelliKeys/home.php

Kirk, S.A., Gallagher, J.J., Anastasiow, N.J., & Coleman, M.R. (2006). *Educating exceptional children* (11th ed.). New York: Houghton Mifflin.

Lewis, R.B., Graves, A.W., Ashton, T.M., & Kieley, C.L. (1998). Word processing tools for students with learning disabilities: A comparison of strategies to increase text entry speed. *Learning Disabilities Research & Practice, 13*, 95–108.

MacArthur, C.A. (1999). Overcoming barriers to writing: Computer support for basic writing skills. *Reading & Writing Quarterly, 15*, 169–192.

van Roon, D., Steenbergen, B., & Hulstijn, W. (2000). Reciprocal tapping in spastic hemiparesis. *Clinical Rehabilitation, 14*, 592–600.

Steenbergen, D., Veringa, A., & Hulstijn, W. (1998). Manual dexterity and keyboard use in spastic hemiparesis: A comparison between the impaired hand and the 'good' hand on a number of performance measures. *Clinical Rehabilitation, 12*, 64–72.

Tumlin, J., & Heller, K.W. (2004). Using word prediction software to increase typing fluency with students with physical disabilities. *Journal of Special Education Technology, 19*(3), 5–14.

Address correspondence to Dr. S. John Obringer, Department of Counseling, Educational Psychology, and Special Education, P.O. Box 9727, Mississippi State University, Mississippi State, MS 30762. sjo1@ra.msstate.edu