A Computer Program for Enhancing Visuomotor Skills

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Occupational therapists frequently use pencil-and-paper tasks in treating patients with visuomotor deficits. These tasks may include having the patient trace lines of different widths. As a patient's accuracy improves, the width can be decreased and the line direction changed. The score and the length of time taken to complete the task are recorded to monitor changes in the patient's proficiency.

The therapist's decision to increase the complexity of a visuomotor task is based on the patient's accuracy in tracing the line, the length of time taken, and the complexity of the line. The therapist must take time to measure and record these factors, which may delay giving the patient immediate feedback on his or her performance.

We designed a computer program that provides increasingly difficult visuomotor tasks and immediately displays a patient's time and accuracy scores. This program enables therapists to shape the patient's performance to a higher level of competence by modifying the stimulus line to ensure that the patient is challenged yet successful. The program uses lines that are fundamental in handwriting or printing (e.g., horizontal, vertical, diagonal, and sine waveforms).

Conceptual Basis

Our computer program is based on shaping, a technique for the improvement of motor accuracy in handwriting. Turner, Calhoun, and Adams (1981) defined shaping as

a procedure whereby a complex response is taught by rewarding successive approximations to that response; initially, even the smallest approximation to the desired behavior is reinforced. (p. 514)

Shaping motor responses to improve prewriting skills (e.g., developing a correct grasp, copying simple forms, tracing lines) has been an accepted approach in occupational therapy for many years (Ayres, 1974; Banus, Kent, Norton, Sukienicki, & Becker, 1979; Frostig, 1970; Lindsey & Beck, 1984). Dunn (1982) presented a program for the shaping of motor skills necessary for writing. The effective remediation of visuomotor deficits requires a systematic approach within a hierarchical framework. This treatment technique demands progressively more sophisticated responses from the child based on a developmental continuum (Beery, 1982; Lindsey & Beck, 1984).

Banus and colleagues (1979) discussed the need to address both motor planning and accuracy when treating patients with visuomotor deficits, especially for the motor skill component. They suggested the use of a variety of treatment techniques, including pencil-and-paper tasks of increasing complexity. Frostig (1972), who also recognized the benefits of progressively difficult pencil-and-paper tasks to cor-
rect visuomotor deficits, designed a program requiring greater accuracy through the use of decreasing line widths and requiring more refined motor planning through an increase in the variation of the stimulus lines. Lindsey and Beck (1984) reviewed various programs for the remediation of visuomotor deficits and noted that all of them developed a systematic approach in which the copying of various lines was part of the program. In addition to measuring motor accuracy, Ayres (1974, 1980) stressed the importance of shaping motor skills as part of prewriting training. Sovik (1981) believed that feedback on a child’s performance was critical in the refinement of pencil-and-paper skills. Other authors have suggested that variability in the practice of motor tasks is beneficial in the development of refined skills. The tracing of stimulus lines is often included as part of elementary handwriting programs (Askow, Otto, & Askow, 1970; Graham & Miller, 1980.)

These treatment concepts in the literature formed the basis for our computer program. The present paper describes how the program was developed, what it does, and how it is used as an adjunct to a treatment program for patients with visuomotor deficits.

The Fine Motor Control Computer Program

Development

The program was designed to provide pencil-and-paper tasks that would stress practice and shaping for the improvement of visuomotor skills and that would automatically score and time the performance of these tasks. These objectives are consistent with the views and developmental approaches cited in the literature review and were used to develop the following criteria for a computer program:

1. The program would closely resemble the use of a pencil or pen; therefore, the use of a joystick or a graphics tablet was eliminated.
2. Basic line forms, for example, vertical, horizontal, diagonal, and sine waveforms, would be included.
3. Patient performance would be timed and displayed.
4. The computer would calculate and display immediate percentage of error scores.
5. The program would be fast enough to be repeated several times in a 30-min treatment session.

These criteria were presented to engineers at the Naval Underwater Systems Center (NUSC) in Newport, Rhode Island, who were establishing a project to use high technology to help persons with physical disabilities. We developed the resulting software program within approximately 1 year.

Description

The computer program incorporates accepted therapeutic techniques for the remediation of visuomotor deficits and then provides immediate, objective data on the patient’s performance. Although computer programs are commercially available to assist in developing handwriting skills, they usually rely on the use of switch-based monitor overlays and either do not provide objective data of the performance or do not allow for the shaping of skills.

The NUSC computer program uses a Gibson light pen, an Apple l1e computer, two disk drives, and a color monitor. A white stimulus line appears on the monitor, and the therapist chooses the width and shape (i.e., straight or sinusoidal) to meet the patient’s needs. When the pen is placed on the screen, a beep signals that timing of the performance has begun. The patient is instructed to draw on the white line; when the end of the line is reached, another beep signals completion. After the computer displays the performance time and the percentage of errors (see Figure 1), the therapist chooses the difficulty of the next stimulus line. The visual display can be changed quickly, allowing 20 to 30 different lines to be presented and traced in 30 min. The therapist records the times and the grades on score sheets to track the patient’s progress over several sessions.

A patient’s performance of drawing on the stimulus line is timed from start to finish. The accuracy of the performance is displayed immediately as a percentage of error score. The advantages of the speed and accuracy scores are that (a) they are immediately displayed, (b) they are objective, and (c) changes in

Figure 1. A light pen is used to trace a sine wave. The performance time and percentage of errors are displayed on the screen.
the scores can be used to show progress over a period of time.

Therapists use the scores to systematically determine the difficulty of the next stimulus line. Thus, by presenting a patient with objective results and progressively more difficult stimulus lines on the monitor and by providing verbal reinforcements, the therapist can successfully shape the patient’s performance.

The objective data have also been useful in documenting improvement in both the speed and accuracy of a patient’s visuomotor control. For example, the data presented in Figure 2 are the scores of an 18-year-old inpatient with traumatic brain injury who improved both time and error scores through practice over a 3-day period.

**Application**

Since 1984, occupational therapists at our hospital have used the NUSC Fine Motor Control Computer Program with more than 50 patients. Most of the patients have been adolescents who have sustained traumatic brain injury; they have had a wide array of physical disabilities, such as ataxia, spasticity, visual field loss, and hemiplegia, which have compromised their visuomotor control. Many of these patients have been motivated by using a computer for practice tasks. The computer program is an adjunct to the total occupational therapy program and is presented under the direction of an occupational therapist. For most patients, the training sessions last 20 to 30 min and are given four to five times a week. The patients have shown improvement in both speed and accuracy of performance.

**Summary and Availability**

The NUSC Fine Motor Control Computer Program helps to improve prewriting skills by shaping motor responses. It provides stimulating tasks and, by automatically grading and timing performances and displaying the results, provides the therapist and the patient with immediate feedback. Such feedback is an advantage that is unavailable with traditional tools, such as the Frostig (1972) visuomotor and developmental learning materials. Additionally, because immediate feedback indicates the area needing the most improvement, therapists can encourage their patients to go faster or to be more accurate. Clinically, use of the fine motor control program has been beneficial to a variety of patients. Further objective documentation of the effects of this program need to be assessed to substantiate clinical observations.

The NUSC Fine Motor Control Program is available from the authors for $15. As noted earlier, this software program requires the use of a Gibson light pen and a color monitor.

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**References**


