The Use of Computers in Occupational Therapy for Visual-Scanning Training

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Key Words: cognitive rehabilitation • computers (use in therapy) • eye movements

This study examined the effect of computer-assisted remediation, with the use of specific visual-scanning software, in the retraining of a functional scanning deficit. Three subjects who displayed significant deficits in visual scanning were selected. A single-subject study was conducted, involving an ABA multiple baseline across-subjects design. Introduction of computer-based intervention with visual-scanning software occurred after 2 to 3 weeks of the gathering of baseline data. Removal of this intervention followed six to nine sessions of 15 to 30 min each over 3 weeks, and data were collected over a 2-week return-to-baseline phase. The dependent variables—speed, accuracy, and the number of re-referencing glances—were measured on functional performance of a grocery-shelf scanning task. Analysis with the two standard deviation band method did not reveal a significant change in performance on the functional task between the three phases. Visual and graphic analyses confirmed that computer intervention did not significantly affect performance on the functional task. The clinical significance of the results suggest that software-assisted remediation may not be an appropriate modality for achievement of a functional occupational therapy outcome.

Use of the computer as a therapeutic tool is becoming commonplace in rehabilitation centers throughout the country. Software-assisted remediation for cognitive retraining is seen as having many advantages. Parameters, such as stimulus exposure time and level of difficulty, can be altered precisely and systematically to meet a patient’s or clinician’s needs. The computer provides objective records of a patient’s performance and provides immediate feedback. This document can be used to motivate and monitor a patient’s progress as well as assess the potential use of the computer as a tool in the patient’s personal or vocational endeavors. Conversely, the computer, as it is used to execute the therapeutic intervention, has been criticized for being overly task-specific and for failing to offer remediation that can then be generalized to daily living skills.

The therapeutic value of computers in cognitive rehabilitation is a timely issue. However, studies that measure outcome on a functional scale or that compare the computerized simulation techniques relative to other modalities are scarce. Given the increasing use of this new technology together with the amount of time, money, and energy devoted to the selection, acquisition, and training in the use of hardware and software, the issue of therapeutic merit of computer-simulated techniques needs to be examined.

Literature Review

Research on the use of therapeutic software in cognitive rehabilitation is emerging, but at a much slower rate than computers are being implemented into clinical practices. In one of the first papers to address the implications of computers in occupational therapy practice, English (1975) concluded:

Computers have good potential for assisting in professional education, as well as in research. They could be particularly useful for storing the data on treatment techniques that therapists are beginning to collect in peer review. Once data is collected, analyzed, and stored, therapists would be able to call this information from the data bank in order to learn about all available treatment methods for a particular problem. Thus, clinical decisions would be made on a broader knowledge base. (p. 169)

Over the last decade, clinicians have resorted to the computer not only as an administrative tool, but also as a therapeutic medium. Anecdotal studies that address the issue of computer implementation in traditional occupational therapy settings (Armstrong, 1989; Lynch, 1989; Reed, 1986; Sidler, 1986; Story & Sbordone, 1988) reflect the ambiguity of its role. The authors discuss occupational therapy theory and history as it relates to modern technology, pose questions of validity and ethics, make recommendations for incorporating computers into the therapy setting, and critically review software. Some of the questions raised have been, Who can benefit most from computer-assisted remediation? When, where, and how should the computer be implemented into clinical
practice? What are the parameters for its use and expected outcomes? and What are some of the merits and limitations of its use?

Empirically based studies that have attempted to answer questions of application and efficacy have been unable to provide data that reliably support or refute the use of computers within the realm of occupational therapy (Armstrong, 1989; Batchelor, Shores, Marosszely, Sandanam, & Lovarini, 1983; Bracy, Lynch, Sbordone, & Berrol, 1985; Gianutsos & Matheson, 1986; Lynch, 1989; Sivak, Hill, & Olson, 1984; Story & Sbordone, 1988). Batchelor et al. (1983) reported that computer-assisted cognitive therapy is no more effective than noncomputerized techniques in remediating disorders of attention, memory, information processing, and higher cognitive functioning in the acute phase of recovery for head-injured patients. Although their results were limited to neuropsychological outcomes, they suggested problems in the software itself and challenged many of the earlier assumptions regarding the inherent therapeutic benefit of computers. In a pilot study, Sivak et al. (1984) investigated remediation of perceptual deficits using commercially available computer-generated tasks. They concurred with some of the earlier studies that computer-assisted remediation is no more effective than other modalities. Bracy et al. (1985) also reported that no significant difference was observed on a comprehensive function in the acute phase of recovery for head-injured and stroke who received computerware assisted remediation using therapeutic software and 10 control subjects who played video games on a computer.

The efficacy and application of computer-assisted remediation has been further addressed from a theoretical perspective. Sohlberg and Mateer (1989, in press) have discussed the benefits and potential pitfalls of using computers in cognitive rehabilitation. In addition to giving the clinician latitude to observe and record qualitative performance data, the computer, they contended, provides the following:

1. Controlled, often adjustable, rate of stimulus presentation
2. Automatic collection and compilation of performance data
3. Efficient means to administer repetitive tasks
4. Objective feedback.

In the last few years, researchers have tried to accurately define the role of the computer in the clinical setting. Sohlberg and Mateer (in press) made the important distinction that the computer is merely a medium for presenting information and that research should focus on specific aspects of computer-assisted application. "There is nothing inherent in the computer itself that will facilitate cognitive recovery" (Sohlberg & Mateer, in press). Factors such as the selection of software, observation of performance, provision of feedback, schedule of remediation, and choice of adjunct therapies will all contribute to or compromise the outcome of intervention. The therapist must add ingenuity and creativity to the task to maximize the potential therapeutic benefits (Sohlberg & Mateer, in press). In his closing remarks at the Santa Clara Valley Medical Center Eighth Annual Conference, Head Trauma Rehabilitation: Coma to Community, Dr. William Lynch presented on the issue of cognitive retraining through computers. He emphasized that the computer is like any other piece of equipment and not efficacious in every situation:

Computers are great for some, good for many, and of little use with a significant minority of brain-impaired patients. We need to be wise in our selection both of the programs to be used, and in our choice of which patients will benefit. (as cited in Bracy et al., 1985, p. 13)

Threats to the internal validity of computer-assisted remediation are reiterated throughout the literature (Bracy et al., 1995; Gianutsos & Matheson, 1986; Lynch, 1989; Sohlberg & Mateer, in press; Story & Sbordone, 1988) and focus primarily on the selection of software. Software selection must have a therapeutic rationale, properly address the targeted cognitive impairment, and fit well within the theoretical model adopted by the clinician. The computer is no more than a tool, and its therapeutic value depends on the therapist's skill in effectively using software and in generalizing cognitive gains to functional adaptations (Sohlberg & Mateer, in press). Story and Sbordone (1988) cautioned that remediation should not end with the mastery of simple computer tasks. It is, conversely, the beginning of what should be a carefully sequenced graded series of both computerized and non­computerized exercises and experiences designed to enable the patient to reenter society at the highest possible level of functioning.

Computer-based remediation, used judiciously, would seem a valid and effective adjunct to traditional therapeutic practice. Survey data suggest that there are probably more rehabilitation centers using computers as a therapeutic modality than not using them. Spicer and McMillan (1987) reported that almost one third of their sample associated nonuse of computers in occupational therapy with a concern regarding the legitimacy of the personal computer as an occupational therapy treatment tool.

Although the clinical picture seems to suggest that the computer is a reliable and valid therapeutic modality, the debate over the therapeutic merit, if not application, of software-assisted therapy is unresolved. Recent literature has not provided an empirically based rationale for the success or failure of the computer as it is used to present specific software, the literature is only beginning to suggest the importance of efficacy studies of therapeutic software already on the market. "When neither therapist nor patient understands fully the rationale for a medi-
A wide variety of software is targeted for the remediation of impairments in attention, memory, visual perception, and cognitive executive functions, such as problem solving and judgment. The clinician is challenged in making sound decisions regarding software, provision of feedback, schedule of remediation, data collection, and choice of adjacent therapies based on the information that is available. Whether the therapist subscribes to an impairment approach, in which the computer is used to target specific cognitive processes, or an acquisitional frame of reference (Mosey, 1970), in which the patient practices the task repeatedly until the skill is learned, the necessity for empirical data exists. Despite the worldwide proliferation of computer hardware and software, efficacy of computer-based cognitive remediation has not been thoroughly studied. To gauge the effectiveness of intervention, we must find some measurable and residual impact to everyday functioning. The present study was designed to determine whether software-assisted remediation of visual scanning in patients with head injury affected functional performance, as measured on a grocery-shelf scanning task.

Method

The study employed a single-subject ABA multiple baseline across-subjects design. Each of the subjects completed all three phases of the study. Intervention was introduced at staggered points in time across separate baselines. Subsequently, intervention and withdrawal began and ended after a predetermined interval had passed.

Subjects

Three subjects (2 men and 1 woman) with deficits in visual scanning were selected from a residential facility for adults with severe closed head injury in Tacoma, Washington. The subjects varied demographically and neuropsychologically. Criteria for inclusion in the study were as follows:

- Visual scanning deficit below normal limits in two of the four quadrants of the Visual Search Task (Kimura, Barnett, & Burkhart, 1981). For each quadrant, \( M = 6.0 \) sec, \( SD = 2.0 \) sec.
- Intact visual discrimination, visual memory, and visual figure-ground average performance on three of the eight subtests (Visual Discrimination, Visual Memory, and Visual Figure-Ground) of the Test of Visual-Perceptual Skills (Gardner, 1982) (average performance = scaled score of 8 ± 2; standard error of measurement = 2).
- Functional bilateral manual dexterity score within two standard deviations of the norm on three of the seven subtests (Small Common Objects, Large Light Objects, and Large Heavy Objects) of the Jepsen-Taylor Test of Hand Function (Jepsen, Taylor, Trieschmann, Trotter, & Howard, no date).
- Adequate sustained attention. The subjects were to display sustained attention skills by responding to an auditory target on the Attention Process Training (APT) Attention Assessment (based on Sohlberg and Mateer's [1987] Attention Training Model) \( (M = 29.9/30 \) correct; \( SD = 0.30 \)) and be able to sit and attend for 3 min while working on a cognitive visual-scanning task, such as Cancellation Worksheets IVA or VB (based on Sohlberg & Mateer's Attention Training Model).
- No prior or current use of Visual Scanning II or III (Bracy, 1982) software programs.

Baseline A. Performance measures of speed, accuracy, and referencing glances were collected during a grocery-shelf scanning activity. Each subject stood in front of three shelves, one of which was at eye level, and was asked to remove designated items from the shelves and place them on the counter below. A photograph of the targeted item was placed in midline and at eye-level on one of the shelves. The examiner replaced the photographs, one at a time, as each successive item was removed from the shelves and placed on the counter. Ten targeted items were placed on the shelves, two each at 15°, 30°, 45°, 60°, and 75° on either side, above and below midline. These parameters were selected based on information that defines the peripheral visual field as extending 60° inward and 95° outward when the eye is in the straightforward position (Toglia, 1989). Additional items were placed on the shelves as a distraction and to make the task more realistic. The 10 targets were placed on the
shelves randomly each time, but the background items remained unchanged throughout the study. Half of the items were somewhat similar, for example, soup cans where only the label was different. The rest of the items were unique, for example, a cereal box, a jar of spaghetti sauce, and a can of tuna. Each subject’s performance on the shelf scanning task was measured for speed, accuracy, and number of referencing glances before, during, and after intervention with the visual-scanning software. Target behaviors and measures for the functional grocery-shelf scanning task were as follows:

- **Scanning time**—Each subject was timed from the moment the first photograph was placed in the subject’s mid–visual field to the time the last designated item was removed from the shelf and placed on the counter. Scanning time was measured in seconds.
- **Scanning accuracy**—An error was recorded if the subject removed the wrong item from the shelf and did not recognize and correct the error before placing the item on the counter.
- **Scanning referencing glances**—A video record of each session was analyzed to document the number of referencing glances made back to the picture before the subject identified and removed the designated item from the shelf.

A baseline performance on shelf scanning of at least five, and at most, seven data points was established on consecutive afternoons for each subject. During the baseline phase, no computerized visual-scanning training was administered.

**Intervention B**. An intervention of software-assisted training in visual scanning was initiated on different days for the 3 subjects. Intervention sessions were conducted three afternoons per week for 15 to 30 min at a time and were continued for 3 weeks, for a total of six to nine sessions per subject.

Visual Scanning II and III (Bracy et al., 1982) were the software programs used because they were designed to train subjects to use scanning eye movements in a pattern similar to that used in reading (i.e., left to right across rows, top to bottom), which is most consistent with visual-scanning patterns used to locate grocery items on shelves. Each subject rehearsed visual-scanning tasks on the computer, and adjustments were made in the parameters of the program as the subject’s performance improved. Auditory feedback was given during the session to motivate and monitor the subject’s performance. Target behaviors and computer-generated measures for the computerized visual-scanning intervention were as follows:

- **Visual Scanning II time**—This task required that the subject locate and match a target displayed at the bottom of the screen with one that appeared randomly on the upper two thirds of the screen. Various numbers and symbols appeared on the screen to serve as distractions. Average response time was measured for the correct and incorrect responses. Average correct response time was used for analysis of the data. Response time was measured in seconds.
- **Visual Scanning II accuracy**—The number of correct and incorrect responses was recorded. The percentage of correct responses was used for analysis of the data.
- **Visual Scanning III time**—This task required that the subject move the cursor up or down to match the target highlighted on one side of the screen with its counterpart on the opposite side of the screen. The target would switch from the right to the left side of the screen and back. The average response time for the right and left visual fields, based on 10 trials, was recorded, and this mean was used for analysis of the data. Response time was measured in seconds.
- **Visual Scanning III accuracy**—The number of correct responses from both the right and left visual fields, based on 10 trials, was recorded. A percentage based on the average of these two numbers was used for analysis of the data.

On days where performance was also measured on functional performance of the grocery-shelf scanning task, the computer intervention preceded shelf scanning. Consequently, the timing and pattern of intervention was not interrupted.

**Return to Baseline A**. For 2 weeks after intervention, no direct visual-scanning training occurred. Ongoing therapy continued as it had throughout the baseline and intervention phases. Measures of performance on the functional task (grocery-shelf scanning) were made throughout the period of nonintervention. Six data points were collected for each subject on the shelf scanning task during the 2-week return-to-baseline phase.

**Data Analysis**

The two-standard-deviation-band method was used to establish the statistical significance of changes in performance between baseline, intervention, and return to baseline. The mean and standard deviation were also used to establish trends in the variability of responses. Serial dependency, which refers to the fact that sequential responses emitted by the same person will be correlated, was measured through examination of the autocorrelation in the data. Bartlett’s test was used to determine whether the autocorrelation coefficient was statistically significant. If the autocorrelation coefficient was greater than 2/\sqrt{n}$, where \(n\) equals the number of baseline observations, the autocorrelation coefficient was considered
significant (Ottenbacher, 1986). If serial dependency had been established, then the C statistic would have been computed. Finally, graphic analysis and computation of simple regression lines were used to illustrate the learning trends in the data. Trend lines were computed for each phase for discussion of the potential treatment effect. Changes in level, variability, trend, and slope were examined.

Results

Statistical Analysis

Lack of statistical significance with the two-standard-deviation-band method suggests that software intervention targeting visual scanning did not affect functional performance. The means and standard deviations for the functional grocery-shelf scanning task are shown in Table 1.

The autocorrelation coefficient was computed for each phase separately and for the entire data series for each dependent variable. In all but one case where the slope is equal to 0.0, the data do not demonstrate a significant degree of autocorrelation. With the one exception, there was not a significant coefficient in any phase or series, and therefore the data were not treated as serially dependent.

Table 1
Mean and Standard Deviation Computed for the Functional Grocery-Shelf Scanning Task

<table>
<thead>
<tr>
<th></th>
<th>Time (in sec)</th>
<th>Accuracy (%)</th>
<th>Referencing Glances</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Subject 1</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>115.10</td>
<td>83.0</td>
<td>2.40</td>
</tr>
<tr>
<td>SD</td>
<td>25.55</td>
<td>11.0</td>
<td>1.40</td>
</tr>
<tr>
<td>Intervention</td>
<td>95.80</td>
<td>95.0</td>
<td>1.20</td>
</tr>
<tr>
<td>SD</td>
<td>15.05</td>
<td>8.5</td>
<td>1.45</td>
</tr>
<tr>
<td>Withdrawal</td>
<td>79.50</td>
<td>98.0</td>
<td>1.30</td>
</tr>
<tr>
<td>SD</td>
<td>1.85</td>
<td>4.1</td>
<td>1.05</td>
</tr>
<tr>
<td><strong>Subject 2</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>207.30</td>
<td>90.0</td>
<td>1.80</td>
</tr>
<tr>
<td>SD</td>
<td>86.95</td>
<td>11.0</td>
<td>0.98</td>
</tr>
<tr>
<td>Intervention</td>
<td>196.50</td>
<td>92.0</td>
<td>2.20</td>
</tr>
<tr>
<td>SD</td>
<td>64.20</td>
<td>8.0</td>
<td>1.70</td>
</tr>
<tr>
<td>Withdrawal</td>
<td>154.20</td>
<td>98.0</td>
<td>0.83</td>
</tr>
<tr>
<td>SD</td>
<td>38.60</td>
<td>4.1</td>
<td>0.75</td>
</tr>
<tr>
<td><strong>Subject 3</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>140.80</td>
<td>94.0</td>
<td>2.20</td>
</tr>
<tr>
<td>SD</td>
<td>38.30</td>
<td>5.5</td>
<td>1.30</td>
</tr>
<tr>
<td>Intervention</td>
<td>140.80</td>
<td>95.0</td>
<td>1.80</td>
</tr>
<tr>
<td>SD</td>
<td>52.75</td>
<td>5.5</td>
<td>0.75</td>
</tr>
<tr>
<td>Withdrawal</td>
<td>106.00</td>
<td>97.0</td>
<td>0.83</td>
</tr>
<tr>
<td>SD</td>
<td>12.85</td>
<td>5.0</td>
<td>0.75</td>
</tr>
</tbody>
</table>

Figure 1. Subjects' performance on the time variable. Note. The vertical dotted lines separate the three phases of treatment. Trend lines for each phase are represented to provide a quantitative indication of the rate and quality of performance throughout baseline, intervention, and return to baseline. Consecutive data points are connected, indicating direction. Nonconsecutive data points are not connected. The time elapsed between these points varies from 2 to 4 days, due to absenteeism.

Graphic Presentation and Visual Analysis

Graphic presentation and visual analysis remain the most widely used and easily understood methods of data analysis for single-system designs (Ottenbacher, 1986). Visual inspection was used to interpret and derive meaningful clinical implications from these data. Changes in level, variability, trend, and slope were noted in the visual analysis.

Figures 1, 2, and 3 illustrate the results of intervention on each dependent variable during the functional performance task of grocery-shelf scanning. Figure 1 illustrates that for each subject, the overall trend in scanning time was decelerating, indicating continuing gradual im-
Figure 2. Subjects' performance on the referencing glances variable. Note. The vertical dotted lines separate the three phases of treatment. Trend lines for each phase are represented to provide a quantitative indication of the rate and quality of performance throughout baseline, intervention, and return to baseline. Consecutive data points are connected, indicating direction. Nonconsecutive data points are not connected. The time elapsed between these points varies from 2 to 4 days, due to absenteeism.

Figure 3. Subjects' performance on the percentage correct variable. Note. The vertical dotted lines separate the three phases of treatment. Trend lines for each phase are represented to provide a quantitative indication of the rate and quality of performance throughout baseline, intervention, and return to baseline. Consecutive data points are connected, indicating direction. Nonconsecutive data points are not connected. The time elapsed between these points varies from 2 to 4 days, due to absenteeism.
change in level that coincides with the introduction or withdrawal of intervention should be greater than would be expected from variability alone. The amount of variability that can be tolerated in a data series is not generally agreed on in single-case research. However, because a stable response pattern was not established during the baseline phase, the subsequent variability introduces a limitation to the validity of conclusions drawn regarding the changes in level. Interestingly, the degree of variability of the data diminished throughout the study. This was observed visually and was verified through calculation of the means and standard deviations for each dependent variable during each phase of the study. In every case, the standard deviation surrounding the dependent variable in the third phase was smaller than in the second or first. Intervention may have affected the variability in the subject's response pattern. Although one cannot make highly accurate predictions from these data about successive performance, the decreasing variability suggests that responses were less due to random chance and more to a true measure of performance and learning. It is not clear whether learning was the direct result of intervention or the result of practicing the task.

Figure 2 shows that an overall decelerating trend existed for referencing glances. In addition, variability in the data decreased from the first phase to the third. Consequently, a greater number of data points fell between 0 and 1 in phase B and the second A phase than in the first A phase.

It should be noted that this variable was difficult to measure, as some referencing glances were made using gross head movement, and some were accomplished by eye movement alone. In addition, familiarity with the items and with the setup may account for the need to make fewer referencing glances, rather than clear improvement in the accuracy and efficiency of visual scanning.

The floor effect is of particular importance for this variable as well as for the third variable (i.e., percentage correct). Unfortunately, the first A phase was not carried out long enough to allow any of the subjects to achieve this floor, so it is not possible to determine how much of the B phase and second A phase are due to learning and practice with the grocery-shelf scanning task.

Figure 3 shows that an overall accelerating trend exists for accuracy. Here too, variability throughout the data decreased from the first A phase to the second A phase. For Subjects 1 and 2, in the second A phase, 100% accuracy was achieved in five of six sessions, compared with only one and two of seven sessions in the first A phase. Subject 3 does not show such dramatic change, suggesting that something brought about this change.

Throughout intervention, with one exception, each of the 3 subjects showed improvement on scanning time and either maintained or reduced his or her number of errors on both of the visual-scanning computer programs. It is interesting to note that the rate of change in scanning time throughout intervention is, in every case, larger for the functional shelf scanning task. Conversely, the rate of change in accuracy on the functional scanning task is smaller than on the computer task. Because computer intervention probably did not affect or predict performance on the functional scanning task, improvement on one may be unrelated to or independent of improvement on the other. That is, the learning of visual scanning on a computer may not carry over into a functional performance area and vice versa. Practice of the specific task may be the critical predictor of rate and quality of outcome performance.

The figures show that the trends in the data were naturally occurring ones due to learning and suggest that intervention had little, if any, effect on functional performance. In addition, significance was not shown through the two-standard-deviation-band method, further suggesting that the software-based intervention did not affect functional performance. No significant, reliable change between the three phases was noted visually or through statistical analysis.

Clinical Significance

Although not statistically significant, the results have clinical implications. The high degree of variability in the data limited the indication for traditional single-subject statistical analysis, but made visual inspection of the data more applicable. In the absence of any statistical significance, a few well-supported observations were made through visual interpretation of the results. In general, these observations suggest that learning occurred throughout the study on both the shelf-scanning and computer visual-scanning tasks. The subjects' scanning time and accuracy generally improved throughout all three phases. The rate of improvement suggests that learning proceeds at a faster rate in some areas of the shelf scanning task and in other areas of the computer task. This notation, in conjunction with the computation of the two-standard-deviation band, suggests that learning was not interrelated or codependent. In this instance, the acquisition of computer-based visual-scanning skills are not generalizable to daily living skills and do not have a residual effect on functional performance.

The results of this study do not suggest that software-assisted remediation has no place in cognitive rehabilitation, nor do they suggest that the teaching of a specific performance skill is the most efficient way to remediate a functional performance deficit. The results imply that software intervention alone may not be effective in remediating a functional deficit in performance. Further, this study reiterates the inherent limitations of the computer and its software. The image on the computer screen is two-dimensional, limited by the size of the
screen and, thus, the motor demands on the patient. The motor components, which are limited to controlling the keyboard, switch, or mouse, are not equivalent to the physical demands of most work, leisure, and self-maintenance activities. Software is limited only by the ingenuity of the therapist, though it may not necessarily target the specific skill or impairment that the catalog uses to promote it. Conversely, the narrowness of focus in teaching a functional performance skill has the potential to restrict generalizability and limit the extent of recovery. Therefore, within a particular model, an appropriate combination of computer-based remediation targeting distinct cognitive areas and the acquisition of functional performance skills in work, leisure and self-care activities is paramount to recovery. It is critical that we as occupational therapists monitor the progress of our patients based on functional gains to justify or accommodate change in the therapy program. The well-researched and judicious use of software-assisted remediation may be appropriate for the targeting of a specific cognitive impairment, but keeping the therapy goal in mind, the results of this study suggest that it may not be the best tool, used alone, for mediating change in a functional performance area.

Conclusion and Recommendations

Study Limitations and Implications for Future Research

"A major problem inherent in many reports of cognitive treatment outcomes is the confounding of results by the training of assessment tools" (Sohlberg & Mateer, 1987, p. 128). To support a claim for having improved an underlying cognitive process, the change in the criterion task (i.e., the dependent variable) must not merely reflect practice effects or task familiarity. The major limitation in this study was that in order to illustrate the effect of software-assisted remediation on a functional performance skill, the criterion task had to simulate a functional skill. One might argue that improved performance may or may not have been affected by the training of a specific cognitive process through computer intervention, but rather, may be the result of familiarity with the criterion task.

An additional but intentional limitation of this study was the choice of software. These programs were chosen because they claim to target visual scanning. They may not be the best programs that target this area, and they certainly address other cognitive processes as well. As a result, the research conclusions are somewhat limited to the validity and reliability of the claims made by the software manufacturers. Future research should carefully analyze clinically significant and popular software programs that claim to target a specific cognitive process.

Lastly, there were limitations within the research design itself. The significance of the data may have been increased through the extension of each of the phases of the study, particularly the baseline and intervention phases. Intervention should not be introduced until a stable response pattern is demonstrated during baseline. More data points and less variability would have allowed additional statistical analyses and higher validity and reliability. A more precise measure of accuracy may have provided more significant results on the effect of intervention and learning on this variable. In addition, it would have been interesting to record performance on the computer after a 2-to-3 week hiatus to study the residual effects and learning behaviors with this modality.

Summary

This study examined the effect of software-assisted remediation of visual scanning on a functional performance outcome measure. Standing alone, it neither absolutely supports nor refutes the validity of computer-based remediation in the achievement of performance-based occupational therapy goals. The results should highlight the inherent advantages of the computer and supplement that with reliable and valid evidence of the computer's therapeutic benefits and pitfalls. In addition, they should challenge some of the claims made by software companies, help to define the role of computer-based remediation in cognitive rehabilitation, and emphasize the importance of directly addressing performance problem areas through occupational therapy intervention.

Whereas impairment is concerned with the function of body parts, systems, or processes in isolation, disability is concerned with the integrated functioning of the entire person that is required to accomplish tasks, interactions, and other human behaviors. (Holm, 1990)

Those who subscribe to the World Health Organization's hierarchical model believe that occupational therapy should intervene at the disability level rather than the impairment level. In this case, occupational therapists should question whether or not the computer is useful at the disability level of intervention. As a final outcome, this study reiterates the need for future research to use this type of experimental design to measure the efficacy of computers throughout the sphere of cognitive rehabilitation—from the focus of both impairment and disability.

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