PDAs as Cognitive Aids for People With Multiple Sclerosis

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OBJECTIVE. Cognitive impairment is a common symptom for people with multiple sclerosis (MS). This study evaluated the effects of an occupational therapy training protocol using personal digital assistants (PDAs) as assistive technology for people with cognitive impairment related to MS.

METHODS. Twenty participants were trained to use PDAs by an occupational therapist. Assessments of functional performance were taken at the start of an 8-week pretreatment period, at the beginning and end of training, and 8 weeks after the conclusion of training.

RESULTS. Participants demonstrated the ability to learn how to use basic PDA functions and retain learning for at least 8 weeks. Functional performance increased significantly with PDA use, and this gain was maintained at 8-week follow-up.

CONCLUSION. This study provides evidence of an association between an intervention providing training in the use of a PDA and improvements in the everyday function of people with cognitive impairment related to MS.


Multiple sclerosis (MS) is a degenerative nerve disease characterized by wide-ranging symptoms that may include chronic fatigue, spasticity, weakness, tremor, pain, and cognitive impairment. Occupational therapists play a key role in helping people manage the functional problems caused by this disease. The symptoms associated with MS vary, but it is estimated that from 45% to 65% of people with MS have a measurable cognitive impairment, typically in the areas of working and prospective memory, attention and concentration, abstract reasoning, problem solving, speed of information processing, verbal fluency, and visuospatial skills. Within that group, cognitive impairment is the most disabling symptom for 10% of clients (LaRocca, 2000). Because MS typically strikes young adults in the prime of their lives, cognitive impairment can dramatically affect job performance and familial and social life.

The study of cognitive impairment related to MS is an emerging field. Few studies demonstrate the efficacy of any therapeutic intervention for this problem. Most of the literature on rehabilitative interventions for cognitive impairment among adult populations comes from brain injury researchers, yet even in that field, a paucity of intervention studies have been able to demonstrate functional improvement in real-world settings. In fact, this lack of evidence led researchers conducting an influential pair of recent meta-analyses to forcefully call for ecologically valid studies of cognitive rehabilitation interventions (Carney et al., 1999; Cicerone et al., 2000).

Personal computers and the field of cognitive rehabilitation emerged at the same time, in the 1970s. Since then, computers have played a role in cognitive rehabilitation interventions. Gamelike remedial programs that purport to improve concentration, attention, and memory have been widely used (Bracey, 1983;
Sbordonne, 1986; Wood & Fussey, 1987). Unfortunately, although research shows that users with cognitive impairment may improve their game scores after using such programs, people do not typically transfer the learning to their everyday lives (Kerner & Acker, 1985; Lynch, 1992; Prigatano et al., 1984). For this reason, the use of computers as compensatory rehabilitation tools may hold more promise than their use in remedial therapy. Again, however, little ecologically valid research supports the use of computers as compensatory cognitive aids. On the desktop platform, several reminder and task-prompting systems have been developed for people with cognitive impairment, but little research has reported on their efficacy in improving users’ everyday functional performance.

Handheld computers may offer promise as compensatory cognitive aids: They are portable and can be used both at home and in the community. The earliest suggestion that a handheld computer might be used in this way appeared in a rehabilitation text a decade before mass-marketed personal digital assistants (PDAs) emerged (Harris, 1984). In 1988, an occupational therapist–neuropsychologist team published the first research article on the topic. They used an early PDA, the Psion Organizer (Psion, PLC, London), which had innovative calendar, diary, memo pad, and alarm features that have become standard on today’s handheld computers and electronic personal organizers. The team found that a 25-year-old woman who had experienced a brain hemorrhage adhered to a daily schedule better when using the Psion than when using a paper-based schedule (Giles & Shore, 1989).

During the next decade, as consumer use of PDAs skyrocketed worldwide, only one other research team reported on their use as cognitive aids. In the first of two studies involving people with brain injury, a 22-year-old man demonstrated the ability to respond to a Psion Organizer programmed as a reminder system during his inpatient hospitalization—attending therapy and asking for medication on schedule (Kim, Burke, Dowds, & George, 1999). In the second study, 12 outpatients with brain injury were trained to use a Psion, and each participant was lent a device. Responding to a telephone survey several weeks later, 9 of the 12 reported that they found the Psion “useful” as a memory aid, and 7 continued to use the device on a daily basis after the supervised trials ended (Kim, Burke, Dowds, Boone, & Park, 2000). The study did not describe how participants were trained to use the Psion, and it did not track functional outcomes or record how participants actually used the devices from day to day.

Single-subject case studies have shown that electronic reminder systems helped a person with cognitive disability access community activities more independently (Gorman, Dayle, Hood, & Rumrell, 2003) and adhere to a daily schedule (Giles & Shore, 1989). Other researchers have found that an electronic pager (Kirsch, Shenton, & Rowan, 2004; Wilson, Emslie, Quirk, & Evans, 2001; Wilson, Scott, Evans, & Emslie, 2003), a portable voice recorder (Hart, Hawkey, & Whyte, 2002; Van Den Broek, Downes, & Johnson, 2000), and a cell phone used as a pager (Wade & Troy, 2001) helped people with cognitive disabilities perform assigned tasks or recall therapy goals.

To date, however, no published studies have reported on the usefulness of off-the-shelf Palm (Palm, Inc., Sunnyvale, CA) or Pocket PC devices as cognitive aids, even though they have become ubiquitous in consumer culture during the past decade. The devices are pocket sized, lightweight, and durable. They offer multiple organizational functions; support add-on software; and have greatly improved screen size, readability, and memory capacity over the Psion Organizer. The only studies to have used the devices report not on the capabilities of the devices themselves but on disability-specific software designed to be used with them (Davies, Stock, & Wehmeyer, 2002b, 2003, 2004; Levinson, 1997; Sterns, 2005; Wright et al., 2001). This oversight in the assistive technology field is unfortunate because innovative tools to help people with cognitive impairment are greatly needed. Therefore, the current study used inexpensive, off-the-shelf Palm Zire 31 PDAs (Palm, Inc., Sunnyvale, CA).

The theoretical basis for this intervention included principles drawn from client-centered practice, diffusion of innovations theory, and cognitive rehabilitation theory. Client-centered practice emphasizes partnership and collaboration between clinician and client in solving everyday functional problems identified by the client (Law, 1998). This study used the Canadian Occupational Performance Measure (COPM; Law et al., 2004), a client-centered assessment tool, to elucidate participant needs. Training was conducted in participants’ homes with a focus on collaboratively addressing the everyday problems they identified.

Diffusion of innovations theory focuses on strategies for encouraging the adoption of new technologies (Rogers, 2003). This study followed diffusion of innovations principles in using a common consumer PDA and building on participants’ prior use of cognitive strategies and electronic devices while facilitating practical solutions for their problems.

Cognitive rehabilitation theory emphasizes the importance of repetition, stepwise learning, the provision of learning materials in a variety of formats, and the scaffolding of new learning on previously learned materials (Sohlberg & Mateer, 2001). Accordingly, the study included verbal, graphic, written, and hands-on instruction, provided in a stepwise fashion across training sessions, to provide repeti-
tion and reinforcement as participants learned to use the PDA.

Purpose

This study was designed to examine the relationship between the use of a PDA by people with cognitive impairment related to MS and functional performance of everyday tasks. Three hypotheses were proposed:

1. Participants will learn to use a PDA and independently demonstrate basic PDA functions, as trained, for at least 8 weeks.

2. Participants will demonstrate improved functional performance of everyday life tasks and satisfaction with their performance, as measured on the COPM.

3. Participants will demonstrate improved functional performance as measured on the Craig Handicap Assessment and Rating Technique–Revised (CHART–R; White-neck, Charlifue, Gerhart, Overholser, & Richardson, 1998).

In addition, the Rivermead Behavioral Memory Test–Extended (RBMT–E; Wilson, Cockburn, & Baddely, 1991) was used to measure change in behavioral memory during the study period. Participants were asked not to use their PDAs as compensatory aids during RBMT–E assessment. No significant change was expected on this test, because the intervention was intended to compensate for—rather than remediate—cognitive impairment.

Method

Design

This quasi-experimental study used an A–B–C repeated measures design in which A represented an 8-week pretreatment period, B represented a 3-week training intervention, and C represented an 8-week posttraining period. The intervention consisted of providing each participant with a PDA and training him or her in its use as an organizer during two 60-min and two 90-min home visits.

Participants

Volunteers were recruited from the University of Virginia Multiple Sclerosis Clinic and the Blue Ridge Chapter of the MS Society. The study was approved by the University of Virginia Institutional Review Board, and all volunteers consented to participate. To participate, volunteers needed to have MS, live in the community, and demonstrate cognitive impairment on the study instruments. Specifically, they needed to score 28 or lower on the RBMT–E profile scale (a 0–48 scale), score 75 or lower on the CHART–R cognitive subscale (a 1–100 scale), and describe functional deficits related to cognitive impairment on the COPM. In addition, participants needed to rate “cognitive difficulty” as either their most or second-most troubling MS symptom. The study investigator conducted the assessments.

Additional criteria were used to help rule out difficulties in using a PDA that were not related to cognitive impairment. Participants had to have functional vision and hearing as well as dexterity sufficient to successfully manipulate a PDA stylus in operating the device. Participants could have had previous experience with PDAs, although no one was using one at the time of the intervention. The only compensation for participation in the study was that participants were allowed to keep their PDAs at the end of the trial.

Measurement Tools

The study used four measurement instruments:

• RBMT–E. A widely used test of everyday memory, the RBMT–E “was developed to detect impairment of everyday memory functioning and to monitor change following treatment for memory difficulties” (Wilson, Cockburn, & Baddely, 1985, p. 855). The RBMT–E assesses working and prospective memory, attention, and executive function in simulated everyday tasks. RBMT–E profile scoring includes a ranking of behavioral memory performance with the following categories: impaired (0–18), poor (19–27), average (28–36), good (37–42), and exceptionally good (43–48). Validity (Wilson et al., 1991) and reliability (Wilson, Cockburn, Baddely, & Hiorns, 1989) have been shown to be high. The RBMT–E often is used as a correlative test for validity of other cognitive assessments. RBMT–E scores have been shown to be more ecologically valid than those of traditional psychometric tests of behavioral memory constructs (Wilson et al., 1989).

• COPM. The COPM is a semistructured interview assessment and is used across disability categories by occupational therapists. Using their own words, participants self-identify areas of functional performance deficit in everyday life and rank their performance and satisfaction with performance in each area from 1 to 10 (1 = low, 10 = high). Studies have shown the test to be valid (Dedding, Cardol, Eyssen, Dekker, & Beelen, 2004; Polgar & Barlow, 2002) and reliable (Bosch, 1995).

• CHART–R. This interview tool assesses functional performance across areas of everyday activity. The CHART–R is based on an early version of the World Health Organization’s (WHO’s) International Classification of Function (WHO, 1980) and investigates levels of performance across six domains: (1) physical indepen-
dence, (2) cognitive independence, (3) mobility, (4) occupation, (5) social integration, and (6) economic self-sufficiency (Whiteneck, Brooks, et al., 1992). Four studies support the CHART–R as a reliable and valid instrument for measuring level of functional performance (Dijkers, 1991; Hall, Dijkers, Whiteneck, Brooks, & Krause, 1998; Segal & Schall, 1995; Whiteneck, Charlifue, Gerhart, Overholser, & Richardson, 1992). The researcher did not administer the CHART–R Economic Self-Sufficiency subscale because questions pertaining to household income might be considered unnecessarily intrusive.

- A checklist designed by the researcher also was used to assess how well participants could demonstrate use of a PDA’s functions and how many entries participants logged on their PDAs. The checklist was used to examine retention of training and everyday use of the PDA after training ended. As such, this instrument served as a “process measure” of treatment fidelity.

The COPM and CHART–R were administered four times, as follows: (1) on initial assessment, 8 weeks before training; (2) on the day that training began; (3) on the day that training ended; and (4) 8 weeks after completion of training. The RBMT–E was administered only on the first and final visits. The study checklist was administered during training and on the final visit to record participants’ ability to demonstrate PDA functions day to day and to record the number of actual PDA entries each week.

**Procedure**

The independent variable in this study was the training intervention in the use of a PDA as a cognitive aid. Table 1 provides a chronological account of the phases of the study.

During Week 1, participants were assessed using the COPM, CHART–R, and RBMT–E. During the pretraining period (Weeks 2–9), participants were encouraged to continue using whatever cognitive strategies they had in place before the study (all participants had reported the use of low-tech reminder systems, such as calendars or sticky notes; none had previously used a PDA). The investigator did not initiate any contact with participants during this period. The intervention phase was conducted during four home visits: the first two occurred on successive days, and the other two took place over the following 2 weeks. On the initial training visit (Week 10), two of the assessment instruments (COPM and CHART–R) were administered again, and the participant was given a PDA and shown how to enter data using the stylus. The investigator then loaded Palm Desktop software (Palm, Inc., Sunnyvale, CA) onto the participant’s home computer and showed him or her how to enter calendar and alarm entries using the Palm Desktop software. The participant was then shown how to transfer this information to the PDA by means of a USB-mediated operation called a “hot sync.” The next day, the investigator returned for a 60-min visit, during which use of the calendar and alarm features were reviewed and the participant was taught to use the address book feature called “Contacts” and the to-do list feature called “Tasks.” Participants were encouraged to transfer appointments, medication schedules, and other items from paper-based schedulers to the PDA, appending a reminder alarm to each.

During Week 11, the investigator returned for a 60-min visit, during which the participant demonstrated how to use the features previously taught and was trained in any additional features he or she wished to learn (e.g., playing games or downloading digital photos to the PDA). During Week 12, the investigator returned for a 90-min visit, during which (1) previous learning was reviewed, (2) participant

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**Table 1. Chronological Phases of the Program**

|------------|--------------------------|-----------|---------|---------------------------|---------------------------|-------------|--------------------------|
| Training   | None                     | None      | • Provide PDA and install desktop software  
               |             | • Train in use of calendar, reminders  
               |             | • Review and train in use of contacts, tasks  
               |             | • Review, troubleshoot, train in use of additional features, as requested  
               |             | • Troubleshoot only at request of participant  
               |             | • Participant involvement in study ends  
               |             | • Participants keep PDAs |

*Note: CHART–R = Craig Handicap Assessment and Rating Technique–Revised; COPM = Canadian Occupational Performance Measure; RBMT–E = Rivermead Behavioral Memory Test–Extended; PDA = personal digital assistant.*
questions related to using the PDA were addressed, (3) the PDA was inspected for entries posted by the participant, and (4) the assessment measures were again administered. This visit concluded the training intervention.

During the 8-week post-training period (Weeks 13–20), participants were allowed to contact the investigator by phone or e-mail with troubleshooting questions as needed, but the investigator did not initiate any contact with participants. During this period, 3 participants contacted the investigator for assistance. Final assessment using the COPM, CHART–R, RBMT–E, and the PDA usage checklist occurred in Week 21. This assessment completed the participants’ involvement in the study. All participants were allowed to keep the PDAs.

Data Analysis

Findings were entered into SPSS Version 11 for Mac OS X, and repeated-measures analysis of variance (ANOVA) calculations were conducted to determine whether a statistically significant improvement in COPM and CHART–R scores may have occurred across the four administrations of the tests. A t-test comparison was conducted for the two administrations of the RBMT–E. Frequency calculations were made for data on competency in using the devices and on actual usage figures.

Results

Twenty-one volunteers who met study criteria were accepted into the study. One person dropped out for personal reasons during the pretraining period (her results were not included in the study); everyone else completed the study.

Participant characteristics were as follows: 16 participants were women and 4 were men, a gender ratio that is slightly higher than the gender frequency of MS incidence in the general population. Their ages ranged from 37 to 73 years (Mdn = 50). Only 2 participants (ages 69 and 73) were past retirement age, yet all but 1 participant had retired from full-time jobs (3 continued home-based part-time employment) because of MS symptoms. Nineteen participants were White; 1 was African American.

Thirteen participants were married, 2 lived with significant others, 3 were single, 1 was divorced, and 1 was widowed. Year of diagnosis with MS ranged from 1965 to 2003 (median date = 1994). Thirteen participants had relapsing-remitting MS, 3 had primary progressive MS, 3 had secondary progressive MS, and 1 had chronic progressive MS.

Functional cognition scores were as follows: On the RBMT–E, 7 participants ranked in the lowest category (impaired), 12 ranked in the poor category, and 1 ranked in the average category. Profile scores (possible range = 0–48) ranged from 4 to 28 (M = 20.65, d = 8.38). Scores on the CHART–R Cognition subscale (possible scores 0–100) ranged from 28 to 75 (M = 56.90, d = 16.33). Participants were asked to rate how much common MS symptoms affected their performance of everyday tasks. All rated cognitive problems as either their most important (11 participants) or second most important (9 participants) symptom.

The following sections describe the findings for each hypothesis.

Learning to Operate a PDA

To determine whether participants had learned to operate their PDAs, they were asked to demonstrate independent operation of the device after training was completed. All participants demonstrated the ability to independently make calendar entries, set alarms and repeating-event reminders, and make address book and memo entries 1 week after the completion of training. Eight weeks after the conclusion of training, 19 participants (95%) were independent in making calendar, address book, and memo entries. One participant (who had an MS exacerbation requiring hospitalization 1 week before final assessment) required a demonstration to perform all basic PDA functions. Three participants (15%) required a single verbal cue to set calendar alarms and repeating-event reminders.

Actual Usage of a PDA

Frequency of use was determined by counting calendar events for each week of the study. All PDAs showed calendar events recorded each week, a finding that supports successful retention of training and the actual use of PDAs in everyday activities. Use of the calendar function, however, varied widely. For example, a counting of calendar entries for the 8th week after training ended showed that 1 participant averaged 27 reminder alarms each day, whereas another entered only 3 during the whole week.

Change in COPM Measures of Performance and Satisfaction

During the COPM interview, each participant spontaneously self-identified five functional deficits related to cognitive impairment that he or she found most affected functional performance in everyday life. Participants rescored each problem area during the following three test administrations. Although participants described individualized problems, on examination, the researcher estimated that their descriptions fit 12 broad categories of functional performance deficit (see Table 2).
A repeated-measures ANOVA for the mean scores on COPM Performance and Satisfaction With Performance scores delivered significant results \( (F = 96.02, p < .001, df = 3, \eta^2 = .83 \) for performance; \( F = 104.92, p < .001, df = 3, \eta^2 = .85 \) for satisfaction with performance). The sphericity assumption was not met, so the Huyn–Feldt correction was applied. The result also was significant under this test \( (F = 96.02, p < .001, df = 3, \eta^2 = .83 \) for performance; \( F = 104.916, p < .001, df = 3, \eta^2 = .847 \) for satisfaction).

Post hoc comparisons were performed using the Bonferroni adjustment for multiple comparisons (see Figure 1). Performance did not significantly change during the 8-week baseline period \( (M = .137, SE = .109, p > .05) \), but a significant improvement was noted during the treatment period, with a large effect size \( (M = 4.008, SE = .390, p < .001, r = .79) \). Performance dropped during the posttreatment period, although the effect size was low \( (M = 0.340, SE = .071, p < .01, r = .10) \), but remained significantly higher than initial assessment scores \( (M = 4.315, SE = .437, r = .73) \) and Week 10 pretreatment scores \( (M = 4.173, SE = .411, r = .76) \), in both cases with large effect sizes.

Satisfaction with performance scores showed similar results (see Figure 2), with no significant change noted during the 8-week baseline period (mean difference \( [M = .143, SE = .127] \), but a significant improvement noted during the treatment period, with a large effect size \( (M = 4.435, SE = .408, r = .81) \). Satisfaction with performance fell during the post-treatment period; the effect size was small \( (M = .262, SE = .068, r = .0001) \), but it remained significantly higher than initial assessment scores \( (M = 4.315, SE = .437, r = .80) \) and Week 10 pretreatment scores \( (M = 4.173, SE = .411, r = .80) \), with large effect sizes in both cases.

### Table 2. Frequency of Performance Deficits From Canadian Occupational Performance Measure \( (N = 20) \)

<table>
<thead>
<tr>
<th>Categories Derived From Deficits Identified by Participants</th>
<th>Frequency</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Keeping track of appointments</td>
<td>11</td>
<td>55</td>
</tr>
<tr>
<td>Taking medications on schedule</td>
<td>11</td>
<td>55</td>
</tr>
<tr>
<td>Remembering important events</td>
<td>11</td>
<td>55</td>
</tr>
<tr>
<td>Dealing with distractions</td>
<td>9</td>
<td>45</td>
</tr>
<tr>
<td>Multitasking (doing two or more things at the same time)</td>
<td>9</td>
<td>45</td>
</tr>
<tr>
<td>Following through on plans</td>
<td>7</td>
<td>35</td>
</tr>
<tr>
<td>Performing multistep tasks (e.g., cooking, shopping, checkbook)</td>
<td>7</td>
<td>35</td>
</tr>
<tr>
<td>Staying focused on a project</td>
<td>6</td>
<td>30</td>
</tr>
<tr>
<td>Remembering names and faces</td>
<td>6</td>
<td>30</td>
</tr>
<tr>
<td>Not losing keys, other items</td>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td>Managing frustration</td>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td>Performing routine activities of daily living</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

Figure 1. Canadian Occupational Performance Measure mean change on performance scores across four testing periods.

### Change in CHART–R Measures of Functional Performance

Like the COPM, the CHART–R assessment was administered four times, and a repeated-measures ANOVA was calculated for each of the five subscales to determine whether a change in its measure of functional performance had occurred. As with the COPM, subscale ANOVA calculations violated sphericity, so the Huyn–Feldt correction was applied. As Table 3 shows, significant change at \( \alpha = .05 \) was
found for the Mobility, Cognitive, and Social subscales. The Physical and Occupational Performance subscales did not show a significant change.

For each of the three subscales that showed a statistically significant change, post hoc comparisons were performed using the Bonferroni adjustment for multiple comparisons. Statistically significant change occurred between test administrations only within the cognitive and mobility subscales. Improvement in cognitive handicap scores occurred during the treatment period, with a small effect size ($M = 16.40, SE = 2.66, p < .001, r = .43$). No significant change was noted during the baseline ($M = 0.30, SE = .16, p > .05$) and posttreatment ($M = 0.70, SE = .33, p > .05$) periods. Improvement in mobility handicap scores also occurred during the treatment period, with a small effect size ($M = 4.40, SE = 5.69, p < .01, r = .11$). There was no significant change during the baseline ($M = 0.05, SE = .15, p > .05$) and posttreatment ($M = 0.25, SE = .16, p > .05$) periods.

### Change in RBMT–E Measure of Behavioral Memory

A paired-samples $t$ test was conducted for the means from pretest and posttest RBMT–E profile scores to compare change between the two conditions. No significant change at the $\alpha = .05$ level was found [$M = 1.667, SD = 3.633, SEM = .856, t(17) = .195, p = .848$ (two-tailed)].

### Discussion

Nineteen of 20 (95%) participants in this study demonstrated the ability to learn how to use the basic organizational functions of a PDA and retained skill in using basic device features for 8 weeks. This finding supports the use of a brief, participant-centered, home-based training intervention and the use of consumer-level devices as cognitive aids. Whereas research during the past decade has focused on either caregiver-programmed electronic devices (Giles & Shore, 1989; Gorman et al., 2003; Hart et al., 2002; Kim et al., 1999; Kirsch et al., 2004; Mihailidis, Barbenel, & Fernie, 2004; Wade & Troy, 2001; Wilson, Evans, Emelie, & Malinek, 1997; Wilson et al., 2001, 2003) or simplified add-on software (Davies, Stock, & Wehmeier, 2002a; Levinson, 1997; Wright et al., 2001), this study provides evidence that people with cognitive impairment can learn to independently operate off-the-shelf PDAs as assistive technology. Because occupational therapists traditionally address the functional implications of cognitive disability, they are well suited to conduct such treatment.

The study also found a significant mean increase in functional performance in everyday life tasks along with increased satisfaction with functional performance, as measured on the COPM. As shown in Table 2, functional difficulties cited by participants focused on tasks that may be affected by impaired memory, attention, and executive function. PDAs—which are designed to act as task organizers and reminder systems—appear to assist in improving functional performance by helping people compensate for these cognitive deficits. Strong effect sizes suggest that these improvements have real-world importance, not just statistical significance.

When examining cognitive deficits among clients, occupational therapists traditionally focus on the specific everyday activities affected by those deficits. The COPM is a useful tool for addressing those issues because it requires people to self-identify specific functional difficulties. The difficulties most often cited by participants (managing appointments, medications, important events, distractions, and multitasking; see Table 2) may be the problems most affected by the intervention in this study, and clinicians are encouraged to consider PDA training for clients who present with these issues. Participants demonstrated improved functional performance in the areas of cognition and mobility as measured on the CHART–R, although the effect sizes for those measures were small. Further research is recommended to refine the functional performance areas and underlying cognitive impairments affected by this approach.

This study shows that competence in using a PDA, as well as functional performance increases as measured on the COPM and CHART–R, carry over for at least 8 weeks after

### Table 3. Repeated-Measures Analysis of Variance of Craig Handicap Assessment and Rating Technique—Revised Subscales, With Huyn–Feldt Correction Applied

<table>
<thead>
<tr>
<th>Subtest</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>$F$</th>
<th>$p$</th>
<th>$\eta^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical</td>
<td>203.70</td>
<td>1.08</td>
<td>188.97</td>
<td>.636</td>
<td>.445</td>
<td>.032</td>
</tr>
<tr>
<td>Mobility*</td>
<td>361.90</td>
<td>1.03</td>
<td>352.72</td>
<td>11.662</td>
<td>.003</td>
<td>.380</td>
</tr>
<tr>
<td>Cognitive*</td>
<td>5,254.60</td>
<td>1.02</td>
<td>5,153.27</td>
<td>39.130</td>
<td>.000</td>
<td>.673</td>
</tr>
<tr>
<td>Social*</td>
<td>620.95</td>
<td>1.11</td>
<td>560.545</td>
<td>6.630</td>
<td>.015</td>
<td>.259</td>
</tr>
<tr>
<td>Occupational</td>
<td>1,365.85</td>
<td>1.34</td>
<td>1,020.485</td>
<td>3.061</td>
<td>.082</td>
<td>.139</td>
</tr>
</tbody>
</table>

Note. SS = sum of squares; MS = mean square.

*Significant at $\alpha = .05$. 

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training. Because MS symptoms may fluctuate widely over time, future investigators may wish to follow participants beyond 8 weeks after treatment to determine more accurately the lasting impact of any rehabilitative effort.

The functional improvements associated with this intervention occurred even though RBMT–E results showed no significant change in behavioral memory during the study period. This result makes sense because the intervention was intended to compensate for cognitive dysfunction rather than remediate it. Because participants were not allowed to use a PDA during the RBMT–E assessment, a finding of no significant change in RBMT–E scores strengthens the argument that a relationship exists between the intervention and functional improvement in everyday life tasks.

All participants in this study used some sort of cognitive aid before the intervention, the most prevalent being sticky notes and pocket calendars. Participants continued to use those tools during the 8-week pretraining period. Using a PDA significantly increased functional performance above that observed when using low-tech tools, suggesting that PDAs may be more effective than the pen-and-paper technologies traditionally offered in cognitive rehabilitation.

The effort to develop ecologically valid research for people with cognitive impairment is still in its infancy, and much work needs to be done. As the only extant research on assistive technology for cognition to measure functional change with behavioral rating scales, this study confirms previous research into the efficacy of portable electronic devices as cognitive aids and points the way to work that may further clarify the benefits that may be expected from such devices. Occupational therapists have a role to play in conducting outcome studies of this nature. The intervention described herein is brief, straightforward, and inexpensive. As the first research to demonstrate an ecologically valid result for any cognitive rehabilitation intervention with the MS population, this study provides an avenue for occupational therapists to pursue in helping people with MS live more independent and satisfying lives.

Limitations

The study sample was neither randomized nor fully representative of the MS population as a whole. Because the sample consisted of people who were community dwelling, with intact vision, hearing, and dexterity, the results should be applied cautiously to other factions of the MS population. Future research plans include a randomized, controlled trial with a larger, more inclusive sample.

As with any self-report instruments, the COPM and CHART–R rely on the subjective accuracy of respondents. Although every effort was made to reduce response bias in people with cognitive impairment, the results must be reviewed cautiously. Threats to scoring bias may have been reduced by having assessments and trainings administered by separate people.

This study involved a home-based training program in the use of assistive technology for cognition. Additional research is needed to determine the extent to which the training led to the observed benefit compared with the device.

Conclusion

A brief, home-based occupational therapy training intervention was sufficient to teach people with cognitive impairment related to MS how to use a PDA; competence in using the PDA was retained for at least 8 weeks after training. Using a PDA significantly improved participants’ functional performance and satisfaction with functional performance in everyday life tasks. Those improvements were not the result of remediation (i.e., improved behavioral memory) but rather because of training by an occupational therapist in the use of a PDA as a compensatory assistive technology. ▲

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