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Enhancing Independent Task Performance for Individuals with Mental Retardation Through Use of a Handheld Self-Directed Visual and Audio Prompting System

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Abstract: Computer technology offers promising new approaches to reducing the dependence of people with mental retardation on others. This article reports results of a beta test of the utility of a Windows CE based multimedia palmtop computer program (Visual Assistant) for use in supporting individuals with mental retardation to more independently complete community-referenced vocational skills. Project personnel identified system requirements that would be required to accommodate the needs of people with mental retardation, and then developed and tested a "proof-of-concept" prototype of the Visual Assistant system. Results from the beta test demonstrated support for using a multimedia training program on a palmtop PC to enhance self-direction of adults with mental retardation in performing community-based vocational tasks. Use of the Visual Assistant prototype resulted in improved task accuracy and decreased use of external prompts from a support person on two different vocational tasks. Implications for use of palmtop and handheld PC technology to increase the independence and self-determination of individuals with mental retardation and other developmental disabilities is considered.

Community integration and inclusion in the economic, political, social, cultural, and educational mainstream of society are highly valued outcomes for education, habilitation, and other programs supporting people with mental retardation (Center for Human Policy, 2000; Hayden & Abery, 1994; Bradley, Ashbaugh, & Blaney, 1994). Perhaps the most significant change in the lives of people with mental retardation across the 20th Century was the shift in focus from congregate work and living settings as preferred (indeed, often as the only available) options to the community as the optimal living and working environment (Braddock, Hemp, Parish, & Westrich, 1998). Design of supports that achieve community integration across life domains is of critical interest to and importance in the field of mental retardation. The American Association on Mental Retardation's 1997 definition and classification manual defined supports as those "resources and strategies that promote the interests and causes of individuals with or without disabilities; that enable them to access resources, information and relationships inherent within integrated work and living environments; and that result in their enhanced interdependence, productivity, community integration, and satisfaction" (Luckasson et al., 1992; p. 101). In another discussion of the concept of supports as contained in the AAMR definition, Luckasson and Spitalnik (1994) suggested, "supports refer to an array, not a continuum, of services, individuals, and settings that match the person's needs" (p. 88). These

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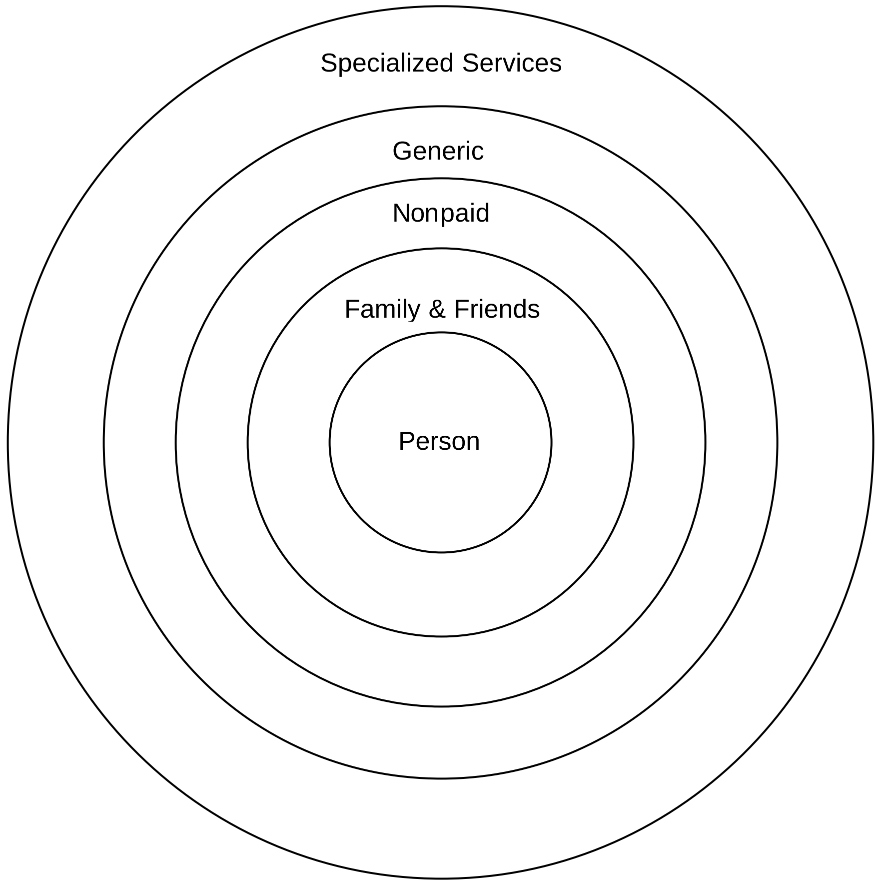

Figure 1. Constellation of Supports (from Luckasson and Spitalnick, 1998)

authors refer to a 'constellation' of supports needed by people with mental retardation where, as depicted in Figure 1, the person is in the center. This figure depicts types of supports, generally radiating outward from self-directed and self-mediated supports, like the person, his or her family and friends and non-paid supports, like coworkers or neighbors, to generic supports (those that everyone uses) and specialized supports, such as those provided in a mental retardation service system.

It is clear that the supports envisioned by the AAMR 1992 classification process encompass a wide array of resources and strategies, including linking individuals with friends, family members, neighbors or coworkers to provide whatever assistance might be needed for the person to perform the function; providing instruction or training to the person to enhance their independence; modifying the environment to ensure access; or providing assistive technology and other accommodations that assist the person to perform necessary functions more independently. While discussions about such supports have occurred across all life domains, there has been more debate, perhaps, about providing supports in the area of employment than in other life domain areas. This sometimes contentious discussion has primarily focused on the use, definition, and feasibility of natural supports in work environments (Test & Wood, 1996).

Independent of which side of the natural supports debate one is on, it does seem evident that, as illustrated in Figure 1, the "most natural support" (Wehmeyer, Sands, Knowlton, & Kozleski, in press) is the person himself or herself. We have suggested (Davies, Stock, & Wehmeyer, 2001; Wehmeyer, 1998) that computer-based technology provides a promising means to enable people with mental retardation and other developmental disabilities to become, in essence, their own support. This includes the use of technology to accommodate for limitations introduced by the person's disability as well as the use of computer technology to educate and train people in a self-directed manner. Moreover, traditional vocational training and support methods primarily include direct modeling of desired tasks combined with various types of visual, verbal, and physical cueing

(Browning & Irvin, 1981; Chadsey-Rusch, & Gonzalez, 1996; Wehman & Hill, 1985). These training and support methods are generally very staff intensive and thus quite expensive to the supporting agency. Alternative approaches to training and support that are designed to provide more cost-effective training paradigms are worthy of consideration.

For the most part, there has been little attention paid to the opportunities that computer technology, such as multimedia, may offer for providing training and other types of supports to people with mental retardation in community-based settings. *Multimedia* is a term used to describe computer programs that integrate standard text and graphic displays with high quality audio and visual presentations, all presented via a single computer system. There have been two principle barriers to multimedia computer-based training and support that must be addressed if people with mental retardation are to benefit from such forms of support. First, there are limitations to use of such devices inherent in the fact that desktop computers are ill equipped for use in computer-assisted training and other supports when the tasks that must be performed are away from the computer. Certainly the computer can be used to orient a person to a remote task, but it provides no assistance when the individual leaves to perform the task in the community setting or even in the next room. Second, the most frequently used input devices (keyboard and mouse) are not easily mastered by people with mental retardation and despite the fact that touch screen devices for desktop PCs are available, they are not widely available in most community-based work settings. The possibility of using *portable* multimedia training with palmtop computers addresses these barriers and offers exciting potential as an adjunct training method for skill enhancement and ongoing support for individuals with mental retardation in a variety of community settings, including vocational and employment settings.

In this study, we examined the utility of state-of-the-art portable computer technology for providing community-based vocational training and support to individuals with mental retardation. Devices that operate the Windows CE operating system include an integrated touch screen for device operation and are specifically designed for portable use. The training software developed for this platform involved using digital pictures of job tasks sequenced and linked with audio instructions. We have previously used picture task sequences and audio instructions to successfully teach individuals with mental retardation the complex task of operating an automated teller machine (Davies & Stock, 1995a) and to perform various independent living and work tasks (Davies & Stock, 1994; 1997a; 1997b; Stock & Davies, 1997; Stock, Davies, & Secor, 1996).

One of the greatest advantages of using computer technology and multimedia for training is the ability to customize the training to meet the needs of the person. Using digital photographs for training allows support staff to record tasks being performed in their actual environments, thus minimizing deficits related to the inability to generalize learning from one environment to another. In addition, this system may allow individuals to learn more complex task sequences than otherwise possible by maximizing the advantages of individual control over the audio/picture sequences and the ability to repeat the training as many times as necessary to learn the task.

There are a number of parameters that need to be considered when examining the utility of computer assisted training and supports. Okolo, Bahr, and Rieth (1993) reviewed research on computer assisted instruction for students with limited support needs, and identified a list of features for effective software that included:

- Clear, uncluttered screens
- Consistent commands and features from screen to screen
- Appropriate sequencing and pacing
- A full range of appropriate examples
- Allow students to respond at a high rate
- Graphics and animation that contributes to, rather than distract from, learning
- Frequent, informative feedback
- Adequate number of opportunities for practice
- Multiple exposures to a word or a fact

We (Davies et al., 2001) have identified several other features for developing effective software specifically for people with mental retardation, including:

- Combined use of pictures and audio prompts for navigation
- Interface designs, such as oversized buttons, that maximize the effectiveness of touch screen or single switch input devices
- Linear designs of software operation
- Use of “Error minimization” features, such as removing buttons from the screen at times when their use is inappropriate
- A complete set of customization options that allow professionals to adapt the software to the unique needs of a variety of end-users
- A database management system to allow for tracking of progress

- Considerations for enjoyable and compelling use of the software
- A research-based process for determining system requirements and design efficacy

The overall objectives of the beta test of the Visual Assistant training package were to establish technical merit, feasibility of use, and required functional features of a portable multimedia training system for teaching and supporting specific community-based skills to individuals with mental retardation. This analysis addressed three primary research questions: (1) Can multimedia training and support mechanisms (visual and audio) improve the ability of individuals with mental retardation to perform community-based vocational tasks independently? (2) Can multimedia training and support mechanisms allow individuals with mental retardation to learn more complex tasks than would otherwise be possible? and (3) Can multimedia training and support mechanisms reduce the amount of support time required by support providers to assist individuals with mental retardation with acquiring community-based vocational skills?

Method

Participants

Study participants were volunteers with mental retardation receiving community-based vocational supports from a local agency and through a school district's community-based program for students with mental retardation ages 18 to 21. There were ten participants (eight men and two women) in the study group ranging in age from 18 to 70 (Mean age = 41.9 years, *SD* = 15.91). Scores from intelligence testing (the WAIS-R) for study participants ranged from 39 to 72 (Mean IQ = 54.8, *SD* = 10.37). Informed consent was obtained from all subjects prior to beginning the study, and study participants were compensated for participation.

Device Design

Visual Assistant is a multimedia training program designed to run on the Windows CE platform that allows a special needs user to view step-by-step pictures along with audio instructions on the computer at his or her own pace. Audio instructions and digital pictures can be created to customize the system to provide self-directed training on a wide variety of tasks. Tasks are task-analyzed according to the specific training and support needs of each individual user. Individual pictures and audio instructions are then integrated into the task for each discreet step in the task. Each task can be represented on the palmtop computer screen with an icon that users press to initiate task instructions. After a task is selected, the picture for the first step is displayed and the first audio instruction is played. The user then presses a "Done" button after they complete the step. This then loads the next step picture and the user presses a "Play" button to hear the associated audio instruction. This sequence is followed until all steps have been completed and the task is finished. The device has an internal speaker to hear the audio instructions, or headphones or an earphone can be used. Palmtop computers are portable, unobtrusive devices and are increasingly used by the general public, thus making them desirable for community-based learning tasks, including employment-related tasks. In fact, use of mainstream technology devices to provide "assistive supports" have the effect of including individuals with mental retardation in society rather than excluding them due to stigmatizing special equipment.

Procedure

Two different vocational tasks were identified that were representative of the type of activities required for working in a community-based employment setting, the first task being a pizza box assembly and the second a software packaging task. The Visual Assistant prototype system was set up to provide training and support opportunities on these specific tasks. Each participant in the study received training on how to operate the Visual Assistant prototype. Each experimental session began with project staff providing a verbal overview of the tasks to be performed to the study participant. Each participant was then provided a demonstration of how to perform each vocational task. Following this, each participant was asked to complete the task two times, once with the Visual Assistant prototype and once without it. The order in which the participant completed the task with the Visual Assistant prototype was randomized, with half of the participants performing the first attempt of the task with the Visual Assistant trainer and then without it for the second trial, and half beginning with the traditional approach. In addition, to help minimize the impact of the first task trial on performing the second task trial, the participant was required to perform the first attempt of each of the two different vocational tasks and then the second task attempt of each task.

In summary, each participant followed a sequence similar to the one listed below:

1. All participants received training on pizza box assembly.

2. All participants received training on software packaging.
3. All participants received training on using Visual Assistant.
4. Half of the participants first completed the pizza task using the Visual Assistant, while the other half completed it without.
5. During all tasks across all conditions, participants received prompts when needed and other supports necessary to successfully complete the task.
6. Participants switched conditions (with Visual Assistant or without) and completed the software task.
7. Participants completed the pizza task reversing conditions from first time with the same task (e.g., with or without Visual Assistant).
8. Participants completed software task reversing conditions from the first time with the same task (e.g., with or without Visual Assistant).

A data recorder was present for each session to observe study participants and keep track of the number of prompts needed and the number of errors made while completing each task. Each participant performed both tasks twice, according to the procedure detailed previously. A data recording form was used to tally prompts and errors made completing the tasks. In addition to these assessments, a questionnaire was used to collect feedback from both study participants and support professionals that observed the sessions as a means of collecting social validation information.

Research Design and Analysis

The beta study utilized a two-group within-subjects design (Campbell & Stanley, 1963) comparing the outcomes for all participants with mental retardation who engaged in the vocational tasks with and without support from the portable visual/audio training and support provided with Visual Assistant. Dependent variables (see below) on the two tasks were analyzed to examine the steps required in performing the task. Tables 1 and 2 provide a detailed summary of the steps for the two tasks that were used.

TABLE 1
Eight Steps for Pizza Hut Box Assembly and Audio Messages Associated with that Step

Step	*Displayed Task Description*	*Audio Messages for Pizza Hut Box Assembly*
1	Take a box and fold side flaps upward	"Take a box and fold the side flaps upward"
2	Fold in flaps on front corners	"Next, fold in the flaps on the front corners"
3	Fold front flap up and over, and tuck it in	"Now fold the front flap up, and then over, and then tuck it in the two slots"
4	Fold in upper corners of side flaps	"Next fold in the upper corners of the side flaps"
5	Fold top of box forward, keep side flaps in	"Fold the top of the pizza box forward-keep the side flaps tucked in"
6	Close lid of the box, keep side flaps in	"Close the lid of the pizza box, keeping the side flaps tucked in"
7	Place coupon sheet on top of the box	"Now with the box closed, place a coupon sheet on top of it"
8	Take red coupon sticker and attach it to the box	"Take one of the round red stickers off the roll and use it to attach the pizza coupon on to the box"

Data were collected on the following dependent variables: 1) independence measured by the number of prompts required for each step; and 2) accuracy measured by the number of errors made for each vocational task. If the participant was unable to complete any single step in a task after three prompts, the task was marked as not completed. The dependent variables are detailed in Table 3.

TABLE 2
Eight Steps for Software Packaging Task and Associated Audio Messages

Step	***Displayed Task Description***	***Audio Messages for Software Packaging***
1	Pick up box and unfold it	"First pick up a box and unfold it so that it's open"
2	Fold in and close bottom flap of box	"Next, fold in and close the bottom flap of the box"
3	Put one green booklet inside box	"Now put one of the green booklets inside the box"
4	Put one CD inside box	"Next, put a CD inside the box"
5	Fold and close top of box	"Now fold and close the top of the box"
6	Take finished MoneyCoach box and put it in a shipping box	"Now take the MoneyCoach box that you have been working on and put it inside the white shipping box"

7	Place a flyer inside shipping box and close it	"Now place a flyer inside the shipping box and then close it"
8	Take a mailing label and stick it on the box near center	"Now take one of the mailing labels off the sheet and stick it on the top of the box near the center"

TABLE 3
Dependent Measures

Variable	*Measured by:*
Independence	Number of verbal or gestural prompts per step, maximum of three prompts per step.
Accuracy	An error was scored when a test subject performed an incorrect action. Only a prompt was recorded if a test subject asked for help before taking an incorrect action.

Paired comparisons *t*-tests were used to evaluate mean differences between the Visual Assistant condition and the control (i.e., no Visual Assistant) condition. Mean differences in number of help prompts required and the number of errors made were tested for significance at the .05 level with a one-directional test. To ensure that observed effects of the independent variable were not specific to one particular task, each individual's scores for the two tasks were combined to provide a calculated score representing average errors and average prompts for each task. The two tasks were of somewhat different difficulty levels and combining the data from the two tasks for each individual helped to control for extraneous effects that may be due to one particular task. Data were analyzed using SPSS PC+.

Results

Table 4 presents findings from the paired comparison *t*-test. The average errors per task when individuals used Visual Assistant was 0.75, with a standard deviation of 0.83. The average errors per task when individuals did not use the Visual Assistant prototype was 2.25, with a standard deviation of 2.05. The observed mean difference for errors per task was statistically significant ($p < .006$).

Second, as is also depicted in Table 4, the number of requests for help during the testing session was recorded for each subject. In general, participants made a limited number of requests for help. The average prompts per task when individuals used Visual Assistant was 1.05, with a standard deviation of 1.19. The average prompts per task when individuals did not use the Visual Assistant prototype was 2.40, with a standard deviation of 2.56. The observed mean difference for errors per task was statistically significant ($p < .032$).

Discussion

Results of this beta study supported the contention that using a multimedia training approach with a palmtop PC can effectively enhance independence for adults with mental retardation in performing community-based vocational tasks. Use of the Visual Assistant prototype resulted in improved task accuracy and increased independence for ten adults working on two different vocational tasks as compared to performance on the same tasks following instruction but without the Visual Assistant. These results must be considered preliminary, given the limited number of participants.

One of the most promising aspects of the Visual Assistant process and similar handheld computers is its potential for reducing the need for human assistance of individuals with mental retardation when performing activities of daily living. Activities that require ongoing training or support can be programmed into the Visual Assistant system to reduce the number of external prompts needed and to reduce the errors made during such tasks. This technology, in essence, provides a computer-based means to implement self-regulation and self-management strategies, including permanent prompts or antecedent cue regulation, self-instruction, and self-monitoring strategies, all of which have been determined to have utility in promoting more positive outcomes for people with mental retardation. Permanent prompts are visual or picture cues individuals use to guide their behavior and have been used to teach lengthy and complex

TABLE 4
Mean Comparisons for Task Conditions

Dependent measure	*Visual assistant*	*No visual assistant*	*One tailed significance*
Errors per task	$X = 0.75$*	$X = 2.25$*	
(Average number of errors on the two tasks-lower scores are better)	$SD = 0.83$	$SD = 2.05$	$p < .006$
Independence	$X = 1.05$*	$X = 2.40$*	

(Total help prompts needed - lower scores are better)	*SD* = 1.19	*SD* = 2.56	*p* < .032

*Significant difference

work task sequences (Bambera & Cole, 1997; Wacker & Berg, 1993) and to promote on-task behavior and independent work performance (MacDuff, Krantz, & McClannahan, 1993; Mithaug, Martin, Agran, & Rusch, 1988). The Visual Assistant system provides an easy way to use digital images to provide such prompting. Self-instruction involves teaching individuals to provide their own verbal cues prior to the execution of target behaviors. Individuals with mental retardation have been taught to use self-instruction to solve a variety of work problems (Agran & Moore, 1994; Hughes & Rusch, 1989), to complete complex, multi-step sequences (Agran, Fodor-Davis, Moore, & Martella, 1992) and to generalize desired responding across changing work environments (Agran & Moore). Self-instruction allows an individual to provide him or herself with sufficient verbal information to cue a response, information that might otherwise not be provided by a service provider. Use of the handheld or palmtop PC device allows for recording of prompts and reminders, including the possibility for the person to record his or her own prompts.

Self-monitoring involves teaching individuals to observe whether they have performed a targeted behavior and whether existing performance criteria were met. Among several applications reported in the research literature are the effects of self-monitoring on facilitating job-task changes (Sowers, Verdi, Bourbeau, & Sheehan, 1985) and evaluating how often a task was completed (Mace, Shapiro, West, Campbell, & Altman, 1986). For individuals who do not need prompts to guide their tasks, the Visual Assistant could be used simply to monitor their progress, a visual checklist, as it were.

One of what we considered the more interesting observations during the beta study was the fact that every one of the participants, without exception, seemed to thoroughly enjoy operating the Visual Assistant prototype. Experiences with Visual Assistant often elicited comments of self-confidence and self-praise. For example, after completing the session using the Visual Assistant prototype, one participant exclaimed, "I am smart. I did it. I'd like to do that again!" Another participant, when asked after the session what he thought of using the system, replied, "I'd like to get one of those myself." It was clear that the use of the Visual Assistant was, in and of itself, a preferred activity.

Another of the clear benefits of the Visual Assistant system is the capacity of the system to personalize the training and support experience for each person. Digital pictures of the individual's actual work tasks in a familiar work setting, combined with personalized audio instructions, allows the Visual Assistant system to be tailored to the person's unique support needs in an ecologically valid manner.

When using Visual Assistant, participants made significantly fewer errors on the vocational tasks than when not using the Visual Assistant prototype, even though the number of requests they made for help were fewer. This finding provides support for the contention that a portable Windows CE training system can be a useful adjunct to training and supports to promote community inclusion. One obvious benefit resulting from using multimedia, as an additional training tool is to reduce staff time required training certain tasks. Individuals who could benefit from the self-directed, repetitive nature of the Visual Assistant device would be able to learn the task by spending more one-on-one time with the Visual Assistant system, and less one-on-one time with job coaches or supported living staff. This would enable support professionals to focus more attention on people who required more intensive supervision and training. Moreover, we would hypothesize that the increased self-direction provided by the process should enhance individual self-determination.

Handheld or palmtop PCs are becoming increasingly prevalent in society. They present a seemingly ideal platform in which to design software that can provide supports in the community. Because they are commercially available (not to mention fairly desirable), there is no stigmatizing effect from using them. As they become more accepted and used by the general population, the cost of owning one will undoubtedly decrease, making them economically viable. They are, as we have indicated, highly portable and lend themselves to use in training and support situations, and use a simple input process (touch screen). There are barriers to their wide utilization by people with mental retardation. Those barriers are similar to those that have limited use of technology by people with mental retardation over time (Wehmeyer, 1998), including relative user-friendliness (or lack thereof) of the operating system and the device itself (for example, switch placement

and ease of use). Moreover, development of software that is accessible to people with mental retardation remains a problem area. In all, however, and despite these limitations, we suggest that handheld computers with appropriately designed software present a potentially powerful way to decrease the dependence of people with mental retardation on others for training and support and to increase self-determination and community inclusion.

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