J Dev Phys Disabil (2012) 24:197–215
DOI 10.1007/s10882-011-9259-8

REVIEW ARTICLE

Use of Computer-Based Interventions to Promote Daily Living Skills in Individuals with Intellectual Disabilities: A Systematic Review

Sathiyaprakash Ramdoss · Russell Lang · Christina Fragale · Courtney Britt · Mark O'Reilly · Jeff Sigafoos · Robert Didden · Annemiek Palmen · Giulio E. Lancioni

Published online: 29 October 2011

Abstract We provide a systematic analysis of studies investigating the effectiveness of computer-based interventions (CBI) to promote daily living skills (e.g., navigating public transit, shopping, and food preparation) in individuals with intellectual disability. This review synthesizes intervention outcomes and describes software features and system requirements for each CBI. This review has three aims: (a) to evaluate the evidence-base regarding CBI, (b) to inform and guide practitioners interested in using CBI and, (c) to stimulate and guide future research aimed at promoting daily living skills in individuals with intellectual disability. The majority of the participants in the reviewed studies were identified as having moderate intellectual disability. The results of this review suggest that CBI is a promising approach for promoting daily living skills in individuals with intellectual disability. Additional research is needed before CBI could be considered a well-established intervention.

S. Ramdoss (✉) · R. Lang · C. Fragale · M. O'Reilly
Department of Special Education, The Meadows Center for the Prevention of Educational Risk, The University of Texas at Austin, 1 University Station D5300, Austin, TX 78712, USA
e-mail: sathiya.ramdoss@mail.utexas.edu

R. Lang
e-mail: russlang@txstate.edu

R. Lang · C. Britt
Clinic for Autism Research, Evaluation, and Support, Texas State University-San Marcos, San Marcos, TX, USA

J. Sigafoos
Victoria University of Wellington, Wellington, New Zealand

R. Didden · A. Palmen
Radboud University Nijmegen, Nijmegen, The Netherlands

G. E. Lancioni
University of Bari, Bari, Italy

Keywords Computer-based instruction · Community living skills · Computer-assisted · Daily living skills · Intellectual disabilities

Individuals with intellectual disability (ID) often struggle to obtain independence, and learn the skills required for daily living (Westling and Fox 2004). The development of daily living skills (e.g., navigating public transit, food preparation, and hygiene) is therefore an important treatment priority for people with ID (Matson, Dempsey, and Fodstad 2009; Matson, Rivet et al. 2009; Neef et al. 1978). Daily living skills are considered essential to enhancing independence. Regardless of whether an individual has mild or severe intellectual disability, the acquisition of these skills may lead to increased independence and is thought to reduce passivity and learned helplessness (Parmenter 1993). Over the past four decades, a considerable amount of attention has been directed towards developing effective instructional strategies for teaching daily living skills to individuals with intellectual and developmental disabilities (e.g., Westling and Fox 2004).

One instructional approach that has been used to promote daily living skills is in vivo-instruction (e.g., Cuvo and Klatt 1992). In-vivo instruction involves the use of natural stimuli in the criterion environment. For example, Morrow and Bates (1987) taught people with severe ID to do their laundry using clothes in a real laundry room. A potential benefit to in-vivo instruction is that it might promote the use of the skills in natural environments and reduce the need to program for generalization using additional instructional techniques (Hutcherson et al. 2004; Stokes and Baer 1977). However, there are often logistical complications involved with in-vivo instruction, including scheduling, funding, and time constraints that may reduce the feasibility of implementation (Mechling and Gast 2003; Wissick et al. 1999). Additionally, it might also be inconvenient or unsafe to teach a person skills during real live situations (e.g., teaching street crossing in vivo before a certain level of mastery).

A second instructional approach for teaching daily living skills is the use of video-based instruction (VBI; Rayner et al. 2009; Sturmey 2003). VBI involves the learner observing a video recording of the target skill occurring in the natural environment and then providing opportunities for the person to imitate the target behaviors or skills that were shown in the video (Mechling et al. 2005). VBI has been successfully used to teach food preparation (e.g., Rehfeldt et al. 2003; Sigafoos et al. 2005), shopping and self-care skills (e.g., Norman et al. 2001).

A third approach for teaching daily living skills involves the use of computer-based intervention (CBI; Ramdoss, Lang et al. 2011; Ramdoss, Mulloy et al. 2011). In CBI, like VBI, the computer delivers instruction by presenting visual and audio stimuli related to the target skill. However, unlike VBI, CBI also allows the learner to interact with the program using external hardware devices such as touch screens, trackballs, switches, keyboards, or scanners (Mechling et al. 2003). This interaction with the learner is viewed by some as one way of providing more sophisticated instructional components than can be provided via VBI; such as, specific reinforcement contingencies, corrective feedback, and tailored prompting hierarchies (Higgins and Boone 1996; Mechling et al. 2005).

These various instructional approaches have been addressed in several previous literature reviews focused on strategies to promote daily living skills for individuals with ID. Mechling (2008a) conducted a literature review of studies focusing on teaching cooking skills to individuals with moderate intellectual disability, and found that instructions and prompting delivered by picture-based systems, handheld personal computers, auditory systems, and VBI have been effective. Morse et al. (1996) reviewed studies that taught grocery shopping skills to individuals with ID and found that verbal instruction with modeling and role play, videotape and slide show examples, serial and concurrent sequencing strategies, and backward chaining were effective teaching procedures. Finally, Palmen et al. (in press), reviewed the literature aimed at improving adaptive skills in high-functioning young adults with autism spectrum disorders (ASD) and found that a variety of high- and low-technology instructional modalities have been used with success to teach social, vocational, and domestic skills. In addition to previous reviews related to daily-living and adaptive skills in individuals with ID, there have also been several reviews on the use of CBI in the treatment and education of individuals with ASD. In one such review, Ramdoss, Lang et al. (2011) concluded that CBI is a promising intervention approach for improving communication skills of people with ASD. Similarly, Ramdoss, Mulloy et al. (2011) reviewed evidence suggesting that CBI is an effective means of academic instruction for students with ASD.

A systematic review of the use of CBI to teach daily living skills to individuals with ID, however, has not been previously conducted. Given the importance of daily living skills and the obstacles often inherent to in-vivo instruction (e.g., cost and logistical difficulty of moving students from schools to criterion community settings) such a review would appear to be warranted. This current review has three aims: (a) to evaluate and synthesize the evidence-base, (b) inform and guide practitioners interested in the use of CBI and (c) stimulate and guide future research aimed at using CBI to promote daily living skills.

Method

Studies were included in this review based on pre-determined inclusion criteria. Each included study was analyzed and summarized in terms of (a) participant characteristics, (b) daily living skill(s) targeted, (c) pertinent details regarding the computer hardware and software, and (d) outcomes of CBI.

Search Procedures

Systematic searches were conducted in four electronic databases: Education Resources Information Center (ERIC), Medline, Psychology and Behavioral Sciences Collection, and PsycINFO. The keyword fields in all four databases were searched using the terms (intellectual disab*) or (developmental disab*) or (mental retardation) or (autis*) or (asperger*) or (PDD*) and (independent) or (daily living) or (life skills) or (self-help) or (hygiene) or (adaptive) and (computer) or (computer based) or (computer assisted). The search was restricted to articles written in English and published after 1990 in peer-reviewed journals. Following the electronic database searches, the reference sections of studies meeting the inclusion criteria (see below) were searched to identify additional studies for possible inclusion.

Table 1 Summary of Included Studies

Citation	Participant characteristics	Daily-living skill(s) targeted	Computer-based intervention	Outcomes
Ayres and Cihak 2010	2 males and 1 female; with ID[1]; all 15 years old	Setting the table, preparing soups and sandwiches	*Software*: I can! Daily Living and Community Skills *Hardware*: Windows PC, headphones, mouse or trackball *Procedure*: Teacher provided a brief description of the computer program. Students were then asked to put on headphones and follow the program's directions. The program presented video models depicting targeted skills from a first-person perspective. After watching videos, participants interacted with the program to practice skills. The program provided auditory and visual prompts in a least-to-most hierarchy. Following computer sessions, task performance and skill acquisition were assessed in vivo. *Time*: once daily, 3 days a week and 2 to 4 min to complete a session	*Outcomes*: Positive; Sequential accuracy of all the three tasks increased for all the three participants and was maintained at 1 and 2 day follow-ups. However, sequential accuracy deteriorated at 6 and 12 weeks follow-up for all the participants. After reviewing the tasks with CBI, all the participants reacquired the skill.
Ayres et al. 2006	3 males and 1 female, with ID[1]; all 14 years old	Purchasing items at the grocery store using a "dollar plus" strategy	*Software*: Project Shop *Hardware*: NR2 computer, headphones *Procedure*: Program began with the student asked to pay a random total from $0.01 to $9.99 by a cashier who waited up to 5 s for a response. Students paid the requested amount by mouse-clicking the video provided on the bottom of the screen. When they finished paying, they clicked the closed wallet-finished button. Program allowed 5 s to initiate a response	*Outcomes*: Mixed; Three out of four participants learned to use dollar-plus purchasing strategy and successfully generalized the acquired skill to natural environment.

Table 1 (continued)

Citation	Participant characteristics	Daily-living skill(s) targeted	Computer-based intervention	Outcomes
			and waited 20 s to complete it. The program provided descriptive and corrective feedback. Following correct responses to 80% of trials without prompts in CBI, students were exposed to community-based probes to assess generalization. *Time*: 10 trials per session and one session per day.	
Ayres et al. 2009	2 males and 1 female with autism; 7.7, 9.2, and 9.6 years old	Setting the table, preparing soups and sandwiches	*Software*: I can! -Daily living and Community Skills *Hardware*: Macintosh and Windows PC and a two-button mouse *Procedures*: CBI delivered step-by-step instructions for each skill in a first-person perspective video. Following the video, students completed tasks in computer simulation. If students did not give a correct response during the simulation after 10s a prompt was delivered. Following the independent responses to 90% or more of the steps in task analysis for target skills on at least three occasions, students were exposed to in vivo probes. *Time*: 5 min per session and 2 sessions per day. Total number of computer sessions to reach mastery criterion ranged from 6 to 19 sessions.	*Outcomes*: Positive; All three participants mastered the skills and generalized to a natural environment. Skills were maintained at 2 week follow-up.
Davies et al. 2003	5 males and 4 females with ID; 25 to 58 years and (M=35.8 years old)	Using the ATM[3]	*Software*: ATM Sim *Hardware*: A touch screen was used, but the rest of the hardware was NR.	*Outcomes*: Positive; Improved level of proficiency for using ATM in a community setting for all participants.

Table 1 (continued)

Citation	Participant characteristics	Daily-living skill(s) targeted	Computer-based intervention	Outcomes
			Procedures: The program provided a simulated ATM and gave audio and visual prompts. Participants were guided through a step-by-step instruction for ATM operation and provided with feedback. Following the successful operation of simulated ATM in two conditions (i.e., with voice and without voice instruction) three times each, students were exposed to real ATM. *Time*: 20–45 min of training for each participant.	
Hansen and Morgan 2008	3 males with ID; 16 to 17 years old	Purchasing items at the grocery store	*Software*: Project Shop *Hardware*: NR *Procedures*: CBI consisted of video modeling and interactive practice sessions. Interactive sessions consisted of 5-step purchasing sequence (e.g., selecting the checkout line, placing the items on the conveyor). Participants responded by clicking appropriate pictures in each step. Auditory feedback was provided throughout practice sessions. After reaching mastery criterion with CBI, students were exposed to community probe *Time*: 30 min for DVD instructional session once a week and 30 min session for 4–5 days per week for CD-ROM practice sessions.	*Outcomes*: Positive; Grocery purchasing skills of all three participants increased and generalized to three untrained grocery stores. Skills were maintained at 30 day follow-up.
Hutcherson et al. 2004	3 females and 1 male; 3 with ID and 1 with autism; 14 to 16 years old	Selecting items in a grocery store	*Software*: Project Shop, developed by using a multi-media authoring tool Authorware 5.2 *Hardware*: Computer with Windows 95 or higher versions with a CD-ROM.	*Outcomes*: Positive; Skill performance increased for all four participants

Table 1 (continued)

Citation	Participant characteristics	Daily-living skill(s) targeted	Computer-based intervention	Outcomes
			Procedures: Program displayed photographs of grocery items on a shelf and prompted participants to match the item appearing in the screen with different items displayed on the shelf. Instruction became progressively more difficult as the number of distracting stimuli on the shelves increased. The computer provided model and auditory prompts. Auditory reinforcement was provided for correct responses. All participants took computer-based probe under supervision and supports were provided to maneuver computer program. Following three unprompted correct responses or four out of five unprompted correct responses, students were exposed to the next instructional condition. *Time*: 40 trials	
Mechling and Cronin 2006	2 males and 1 female with Down syndrome and moderate to severe ID; 17.11, 20.8, and 21.4 years old	Placing order at fast food restaurants using an alternative communication device	*Software*: HyperStudio 4.0 (Roger Wagner Publishing, Inc. 2011) *Hardware*: DELL Latitude laptop; Sony digital video camera *Procedures*: Computer program presented video recordings, photographs, and voice recordings to simulate ordering at fast food restaurants. Instruction began with students watching a video-segment of an adult entering a fast food restaurant, followed by the cashier asking questions common when placing an order. Each step was introduced with photographs paired with a recorded voice. All prompts were delivered by the program. The student responded using a speech	*Outcomes*: Mixed; two of the three participants learned to order using their speech generating device immediately following CBI. One participant required additional instruction. All participants had 50% to 100% of correct responses during the maintenance probes conducted up to 104 days following CBI.

Table 1 (continued)

Citation	Participant characteristics	Daily-living skill(s) targeted	Computer-based intervention	Outcomes
			generating device. The instructor sat next to the student, provided reinforcement, and advanced the computer program. Following 100% of correct responses across three trials for three consecutive sessions in CBI, generalization probes were taken *Time*: 3 trials per session, 10–15 min per trial across 3 to 4 days.	
Mechling and Gast 2003	2 males and 1 female with mild or moderate ID; 11.8, 16.9, and 18.7 years old	Selecting items in a grocery store	*Software*: HyperStudio 3.1 (Roger Wagner Publishing, Inc. 2011) and Apple video player *Hardware*: Macintosh 3G Powerbook computer, Sony video handycam, Samsung panorama slim zoom auto-focus camera, Hp scan Jet scanner, and Iomega Jazz drive with 1GB capacity *Procedure*: The program presented four aisle signs in a horizontal position and grocery list words appeared on the bottom of the frame. The student selected the aisle sign that corresponded with the list and then the correct item. After the item was selected it was crossed off the list. The instructor provided prompts. Following 100% unprompted correct responses for three consecutive sessions, generalization probe was given in store. *Time*: 2–3 days per week; average number of sessions=20.	*Outcomes*: Positive; Ability to match the words on the list to the aisle signs and then locate the correct items increased for all three participants. All three participants generalized skills to a novel grocery store.

Table 1 (continued)

Citation	Participant characteristics	Daily-living skill(s) targeted	Computer-based intervention	Outcomes
Mechling et al. 2003	2 males and 1 female with moderate ID; 16.1, 17.11, and 18.7 years old	Using debit card to purchase items	*Software*: HyperStudio 4.0 and Touch Window *Hardware*: Dell latitude notebook computer, touch screen, ZIP drive, CD player, and a Sony digital video camera *Procedure*: Video models depicting the entire task (e.g., from items being placed in the counter to taking receipts and bags) were presented. After videos, students were presented with photographs of a debit card machine and visual prompts and directions on how to complete transactions on the computer screen. If a student responded correctly within 3 s by touching appropriate places on the screen, the CBI advanced to the next step in the task. Video prompts were implemented after incorrect responses. The instructor sat next to the participants to provide error corrections and reinforcement. Generalization probes began after one session with 100% of correct unprompted responses. *Time*: 12 min per session with 6 trials per session and 2 sessions per day.	Outcomes: Positive; The mean percentage of steps correctly completed to operate the debit machine increased for all the participants. All three participants learned to perform the majority of the steps to operate machines independently and generalized the acquired skills to novel stores. Maintenance data taken for two of three participants indicated skills were maintained in both CBI store and novel stores.
Mechling et al. 2002	3 females and 1 male with moderate ID; 9 to 17 years old (*M*=13.1 years)	Reading signs of grocery aisles and items	*Software*: HyperStudio, 3.1 (Roger Wagner Publishing, Inc. 2011) and Apple video player *Hardware*: Macintosh 3G Powerbook computer, touch screen from Edmark corporation, Samsung Panaroma Slim Zoom 1150 autofocus camera, 35 mm Kodak film, HP scan Jet 5p scanner and Iomega Jazz drive with 1GB disk capacity	*Outcomes*: Positive; All four participants improved and generalization to a novel grocery store occurred for all participants.

Table 1 (continued)

Citation	Participant characteristics	Daily-living skill(s) targeted	Computer-based intervention	Outcomes
			Procedure: Video segments and still photographs depicting movement throughout the store, location of aisles and close-up of items were used to portray designated actions chosen by the participant using the touch screen. Training involved a set of chained steps for touching aisle sign words on the computer screen and selecting target items on the aisle. Task was presented using a total task sequence with a system of least prompts. Instructors provided necessary support for all the participants to navigate through the CBI activity. Generalization probes began after one session of 100% correct unprompted responses. *Time*: 2–3 days per week; approximate time to complete a session = NR	
Mechling and O'Brien 2010	2 females and 1 male; 2 with moderate ID and 1 with PDD-NOS; 19.2, 19.2 and 20.11 years old	Using public bus transportation	*Software*: MS PowerPoint, and Windows movie maker *Hardware*: Dell Latitude laptop, Canon ZR830 digital video camcorder, and Magic touch screen. *Procedure*: Video models and prompts were presented from a first person perspective. Video models began with a picture of the destination store and a recorded voice gave directions. The program then presented a video model of bus routes, photographs of landmarks and recorded verbal cues associated with landmarks (e.g., "Look for Olive Garden"). After watching the video models,	Outcomes: Mixed; All three participants met the criteria for correctly pushing the "request to stop" button during CBI sessions, however, only two of the three participants generalized the skills with 100% correct performance on all three in-vivo sessions. Maintenance data were collected up to 52 days.

Table 1 (continued)

Citation	Participant characteristics	Daily-living skill(s) targeted	Computer-based intervention	Outcomes
			the program offered instructional trials with video prompts. During the instructional trials, participants used the touch screen to select the request to stop the bus signal. Following 100% unprompted correct responses for one session (i.e., three trials), generalization probes were started. Time: Each instructional trial lasted for 10 min, three instructional trials using video prompting a day for 2–3 days per week.	

[1] Intellectual Disability

[2] Not Reported

[3] Automatic Teller Machine

Inclusion and Exclusion Criteria

In order to be included in this review, a study had to meet three criteria. First, an intervention delivered via a computer software program must have been evaluated. Second, the study had to contain at least one participant with an ID (i.e., IQ<70). Third, a study must have measured at least one dependent variable pertaining to a daily living skill. For the purposes of this review, daily living skills were defined as skills that are essential to functioning in every-day life (e.g., hygiene and dressing) and/or taking part in community activities (e.g., shopping in a grocery store and ordering a meal in a restaurant).

Studies were excluded from this review for the following reasons. First, due to immense change in the capacity and diversity of applications of computer technology over the past two decades, studies published prior to 1990 were excluded in order to focus on more contemporary technology. Second, studies in which computers were used solely as a means to deliver reinforcers (e.g., Soares et al. 2009) or deliver VBI (e.g., Sigafoos et al. 2005) were excluded. Finally, computer programs that allowed only minimal input and control (e.g. play, stop, next) were considered video technologies, analogous to DVD players, and were excluded (e.g., Kinney et al. 2003).

Data Extraction and Coding

Initially 108 studies were retrieved from this electronic database search. The abstracts of these 108 studies were then screened against the inclusion and exclusion criteria. Ultimately, 11 studies were included in the review. The 11 included studies were summarized in terms of: (a) participant characteristics, (b) daily living skills targeted, (c) details regarding the computer-based instruction, and (d) intervention outcomes (including any relevant social validity or treatment acceptability data). Outcomes of CBI on daily living skills were summarized as either "positive", "mixed", or "negative" using criteria presented by Machalicek et al. (2007). A classification of "positive" indicated that all participants registered gains on all dependent measures. A classification as "mixed" indicated that the participant(s) improved on some dependent measures and remained constant or declined on the others. "Mixed" was also used if some participants improved, but others did not. Classification as "negative" indicated that the participants' independent and daily living skills declined or remained constant on all dependent measures (i.e., there was no improvement).

Inter-rater Agreement

A summary was produced for each of the 11 included studies by the first author. The accuracy of these summaries was then assessed by a co-author using a checklist that included the initial summary of the study and five questions regarding various details of the study. Specifically: (a) Is this an accurate description of the participants? (b) Is this an accurate description of the daily living skills targeted? (c) Is this an accurate description of the intervention? And (d) Is this an accurate description of the results? In cases where the summary was not considered accurate, the summary was edited to improve accuracy. This process was continued until 100% agreement regarding the accuracy of the summaries was reached. The resulting summaries were then used to create Table 1. This approach provided a measure of inter-rater agreement on data extraction and analysis. There were 44 items on which there could be agreement or disagreement (i.e., 11 studies with 4 questions per study). Initial agreement was obtained on 40 items (90%) and then corrected until there was 100% agreement.

Results

Table 1 summarizes the 11 studies included in this review in terms of: (a) participant characteristics, (b) daily living skills targeted, (c) the CBI methods and materials, and (d) outcomes.

Participant Characteristics

Collectively, the 11 studies provided CBI to a total of 42 participants. Twenty-four (57%) of the participants were male and the remaining 18 (43%) were female. The ages of the participants ranged from 7.7 to 58 years (M=19.1 years). In addition to ID, four participants had a diagnosis of autism (Ayres et al. 2009; Hutcherson et al. 2004) and one study involved a participant with the diagnosis of PDD-NOS (Mechling and O'Brien 2010). Although IQ scores were rarely reported, the participant descriptions provided by the authors of the included studies suggest that the majority of the participants could best be described as having moderate ID. One study included participants described as having moderate to severe ID (Mechling and Cronin 2006).

Hardware and Software Programs

A variety of hardware devices were used including headphones, digital video camera, auto-zoom focus camera, scanner, and external hard-drives. Participants used a variety of external devices to provide input during CBI. In six studies, participants operated mouse/trackballs and interacted using the click function (Ayres and Cihak 2010; Ayres et al. 2006; Ayres et al. 2009; Hansen and Morgan 2008; Hutcherson et al. 2004; Mechling and Gast 2003). A touch-screen was used in four studies (Davies et al. 2003; Mechling 2008a, b; Mechling et al. 2002; Mechling and O'Brien 2010). One study involved the participants using speech-generating devices to make selections (Mechling and Cronin 2006).

Six studies used software programs that were specifically designed for the purposes of their intervention. Three of these studies used the program "Project Shop" (Ayres et al. 2006; Hansen and Morgan 2008; Hutcherson et al. 2004) and two used a program named "I can! Daily Living and Community Skills" (Ayres and Cihak 2010; Ayres et al. 2009). One study used a program named "ATM Sim" (Davies et al. 2003). Five studies used commercially available multi-authoring tools such as "Hyper Studio (Mechling and Cronin 2006; Mechling and Gast 2003; Mechling 2008a, b; Mechling et al. 2002) and Microsoft PowerPoint and Windows Movie Maker (Mechling and O'Brien 2010). Software programs that are specially designed to teach daily living skills (i.e., Projectshop, I can! Daily living and community skills, and ATM Sim) were no longer commercially available at the time this review was conducted and the operating system and other system requirements are not clearly identified.

Target Skills

Across studies, a variety of dependent variables associated with daily living skills were examined (i.e., grocery shopping, preparing food, using automated banking machines [ATM], using debit machine, placing orders in fast food restaurants, and navigating public transport). Five studies examined the effectiveness of CBI on teaching some aspects of grocery purchasing (Ayres et al. 2006; Hansen and Morgan 2008; Hutcherson et al. 2004; Mechling and Gast 2003; Mechling et al. 2002). For instance, Mechling et al. (2002) examined the efficacy of CBI on reading grocery aisle signs. Hutcherson et al. (2004) and Mechling and Gast (2003) used CBI to teach grocery item selection. Hansen and Morgan (2008) measured the effectiveness of CBI on teaching a 5-step purchasing sequence that included, among others, selecting the checkout line and placing the items on the conveyor. Finally, Ayres et al. (2006) used CBI to teach a strategy for determining how much money to hand the checkout person (i.e., the dollar amount plus one more dollar to cover the change called the dollar plus strategy).

Two studies examined the effectiveness of CBI on teaching the participants to set the table and simple meals (i.e., Ayres and Cihak 2010; Ayres et al. 2009). One study used CBI to teach the use of a debit card (Mechling 2008a, b) and another study used CBI to teach the use of an ATM machine (i.e., Davies et al. 2003). Mechling and Cronin (2006) used CBI to teach how to place an order in fast-food restaurants. Finally, a study conducted by Mechling and O'Brien (2010) used CBI to train students to use public bus transportation.

Outcomes

Thirty-nine of the 42 participants (93%) acquired the targeted daily living skill via CBI. In all of the studies baseline was conducted in the criterion environment (e.g., at the real grocery store, bus stop, or restaurant in which the behavior was expected to occur once taught) and CBI was implemented in a separate instructional setting (e.g., home or school). Following CBI outcome measures were again taken in the criterion environment. The most common approach used to promote generalization during CBI was to use videos or images taken directly from the criterion environment to make the simulated training setting as similar to the criterion setting as possible. For example, Mechling and Cronin (2006) created a video by recording within the actual grocery store where the participants were going to shop and that video was then used for the CBI simulation. Out of the 11 studies, 8 reported positive outcomes for all participants, and three reported mixed outcomes (i.e., Ayres et al. 2006; Mechling and Cronin 2006; Mechling and O'Brien 2010).

To illustrate a mixed-outcome study, Ayres et al. (2006) found that CBI was effective in teaching dollar-plus purchasing strategy to three out of their four participants. Throughout the study, the one participant without positive outcomes

(Emily) exhibited variable performance during baseline in-vivo probes and during computer instruction sessions. She had a medical condition that occasionally resulted in the interruption of the session to provide her with medication and rest. Even though Emily reached a high of 100% correct performance during one session, her medical conditions might have prevented her from concentrating on given tasks and inhibited her from stabilizing her performance. As another example, two of the three participants in the Mechling and Cronin (2006) study showed an immediate increase in their correct use of their AAC device following CBI, but one participant did not use the AAC device during the first generalization probe session. Instead of using the AAC device, this participant (Chris) reverted back to an old form of communication by holding up one finger to indicate his food choice. As suggested by the study authors, allowing Chris to select his own communication device might have helped increase his frequency of device use. Finally, in the study conducted by Mechling and O'Brien (2010), all three participants met the criteria for pushing "request to stop bus-signal" during CBI session. However, only two of those participants generalized the skills with 100% accuracy during all of the in-vivo sessions. The remaining participant did not generalize the skill in the first generalization in-vivo condition following CBI. Instead of pushing the request to stop bus signal button independently, she continued to require a prompt from teacher.

Six of the included studies assessed the maintenance of acquired skills (i.e., Ayres and Cihak 2010; Ayres et al. 2009; Hansen and Morgan 2008; Mechling and Cronin 2006; Mechling 2008a, b; Mechling and O'Brien 2010). Follow-up probes were conducted from 2 weeks to 15 weeks following the CBI. In all of these six studies, target skills were maintained at similar levels to the final intervention phase.

Discussion

Our systematic search yielded 11 studies involving the use of CBI to teach daily living skills to 42 individuals with ID. The current research base must be considered limited because of the small number studies ($n=11$) and participants ($n=42$). Additionally, the diversity of the participants in terms of age, the range of skills targeted for instruction, and the various types of CBI programs that were implemented prevent firm conclusions regarding the characteristics of participants most likely to benefit from CBI and the types of daily living skills most efficiently taught via CBI. However, because more than 93% of the individuals that participated in these studies acquired the targeted skills, our analysis of these studies suggests that CBI is a promising intervention strategy for teaching daily living skills to individuals with moderate ID. In terms of the goals of this review, to inform and guide practitioners and identify directions for future research, a few important considerations emerge.

First, the software programs specifically designed for instruction of individuals with ID (i.e., Project shop, I can! Community and daily living, and ATM Sim) appear to no longer be commercially available for practitioners. Although this is disheartening, five studies utilized programs designed for general purposes that can be adapted to deliver CBI and are currently being manufactured and marketed (i.e., Hyperstudio, MS PowerPoint, and Windows Movie maker). As stated in previous reviews involving CBI (e.g., Ramdoss, Lang et al. 2011), these more general purpose software programs require the teacher or parent to develop the instructional materials. As such, the quality of the instructional materials and the success of the intervention are likely to depend more on the quality of presentation and the knowledge of the curriculum developer than on the software itself.

Second, given the need for interventions to be efficient and accessible to practitioners in order to be socially valid (Lang et al. 2010), the lack of commercially available software programs for this purpose must be considered a potential impediment to the adoption and use of CBI by practitioners, and there would seem to be a need and market for this type of specialized software. Future software designed for this purpose should consider the qualities of effective instruction. It is important to remember that CBI is an intervention delivery mechanism not an intervention within itself (Ayres and Cihak 2010). As recommended by Higgins and Boone (1996), researchers should continue to investigate and empirically validate the effective components of educational software programs (e.g., varied presentation, portability, naturalistic stimuli, user interface) in order to inform the development of specialized educational software for individuals with ID.

Third, hardware plays an almost equally important role in the usability and versatility of CBI. Recent technological advances in hardware would seem to have set the occasion for continued evolution of CBI and, given the success of the studies reviewed here, research involving new hardware appear warranted and promising. For example, only a few studies have been conducted using hand-held computer devices to teach individuals with developmental and intellectual disabilities (e.g., Davies et al. 2003). Considering the emerging utility of touch-screen interface technology and the shrinking size of computers (e.g., iPod-touch, iPad), the development of special education applications for these devices would seem likely. One concern regarding CBI is the generalization of skills from the computer environment to the natural criterion environment. These more portable and dynamic devices could be used to covertly prompt and teach within the natural environment and reduce concerns related to generalization across settings. For example, a child who uses a handheld computer to receive promotes related to grocery shopping may be more likely to use the skill in the grocery store following intervention than a child who uses a similar program to teach grocery shopping skills in their classroom (Stokes and Baer 1977).

In this review, we identified a variety of daily living skills that have been taught with CBI. There are several factors that should be considered when selecting which daily living skills to target for instruction. First, it is important to determine what other skills may be needed in order for the individual to actually use the target skill in the community. For example, teaching a person to checkout in a grocery store or order in a restaurant are only functional skills if the individual is able to get to the locations. Second, as skills such as ATM use, transportation, and exchange of money are taught, it is important to be sure that they are simultaneously learning the safety skills required to prevent victimization. For example, an individual who is taught to withdraw money from an ATM should also be taught under what conditions doing so might be unsafe and not to give money to strangers under suspicious circumstances (Mechling 2008b). Finally, practitioners and researchers interested in the use of CBI should be careful to ensure that a chosen skill is taught together as a part of "skill clusters" rather than an isolated skill (Mechling and Gast 2003). For instance, five studies demonstrated that individuals were able to acquire skills that are essential for grocery purchase. However, these studies have focused on different aspects of grocery skills and taught them as an isolated skill (e.g., reading aisle signs, item selection, 5-step purchasing sequence, and paying the amount using dollar-plus strategy). In some cases, this may leave open the possibility that the desired terminal skill purchasing groceries may remain out of reach.

In conclusion, the current research base is encouraging and it appears that the accelerating development of technology is benefiting individuals with ID. However, more research into CBI is needed before this approach could be viewed as well-established for teaching daily living skills to individuals with ID.

References

*Studies included within the review

*Ayres, K., & Cihak, D. (2010). Computer- and video-based instruction of food-preparation skills: Acquisition, generalization, and maintenance. *Intellectual and Developmental Disabilities, 48*, 195–208.

*Ayres, K. M., Langone, J., Boon, R. T., & Norman, A. (2006). Computer-based instruction for purchasing skills. *Education and Training in Developmental Disabilities, 41*, 253–263.

*Ayres, K. M., Maguire, A., & McClimon, D. (2009). Acquisition and generalization of chained tasks taught with computer based video instruction to children with autism. *Education and Training in Developmental Disabilities*, *44*, 493–508.

Cuvo, A. J., & Klatt, K. P. (1992). Effects of community-based, videotape, and flash card instruction of community-references sight words on students with mental retardation. *Journal of Applied Behavior Analysis, 25*, 499–512.

*Davies, D. K., Stock, S. E., & Wehmeyer, M. L. (2003). Application of computer simulation to teach ATM access to individuals with intellectual disabilities. *Education and Training in Developmental Disabilities, 38*, 451–456.

*Hansen, D. L., & Morgan, R. L. (2008). Teaching grocery store purchasing skills to students with intellectual disabilities using a computer-based instruction program. *Education and Training in Developmental Disabilities, 43*, 431–442.

Higgins, K., & Boone, R. (1996). Creating individualized computer-assisted instruction for students with autism using multimedia. *Focus on Autism & Other Developmental Disabilities, 11*, 69–78.

*Hutcherson, K., J., Langone, K., Ayres, K., & Clees, T. (2004). Computer assisted instruction to teach item selection in grocery stores: An assessment of acquisition and generalization. *Journal of Special Education Technology 19*, 33–42.

Kinney, E., Vedora, J., & Stromer, R. (2003). Computer-presented video models to teach generative spelling to a child with an autism spectrum disorder. *Journal of Positive Behavior Interventions, 5*, 22–29.

Lang, R., O'Reilly, M. F., Sigafoos, J., Machalicek, W., Rispoli, M., Shogren, K., et al. (2010). Review of teacher involvement in the applied intervention research for children with autism spectrum disorders. *Education and Training in Autism and Developmental Disability, 45*, 268–283.

Machalicek, W., O'Reilly, M. F., Beretvas, N., Sigafoos, J., & Lancioni, G. E. (2007). A review of interventions to reduce challenging behavior in school settings for students with autism spectrum disorders. *Research in Autism Spectrum Disorders, 1*, 229–246.

Matson, J. L., Dempsey, T., & Fodstad, J. C. (2009). The effect of autism spectrum disorders on adaptive independent living skills in adults with severe intellectual disability. *Research in Developmental Disabilities, 30*, 1203–1211.

Matson, J. L., Rivet, T. T., Fodstad, J. C., Dempsey, T., & Boisjoli, T. (2009). Examination of adaptive behavior differences in adults with autism spectrum disorders and intellectual disability. *Research in Developmental Disability, 30*, 1317–1325.

Mechling, L. C. (2008a). High tech cooking: A literature review of evolving technologies for teaching a functional skill. *Education and Training in Developmental Disabilities, 43*, 474–485.

Mechling, L. C. (2008b). Thirty year review of safety skills instruction for persons with intellectual disabilities. *Education and Training in Developmental Disabilities, 43*, 311–323.

*Mechling, L. C., & Cronin, B. (2006). Computer-based video instruction to teach the use of augmentative and alternative communication devices for ordering at fast-food restaurants. *Journal of Special Education, 39*, 234–245.

*Mechling, L. C., & Gast, D. L. (2003). Multi-Media instruction to teach grocery word associations and store location: A study of generalization. *Education and Training in Developmental Disabilities*, *38*, 62–76.

*Mechling, L., & O'Brien, E. (2010). Computer-based video instruction to teach students with intellectual disabilities to use public bus transportation. *Education and Training in Autism and Developmental Disabilities, 45*, 230–241.

*Mechling, L. C., Gast, D. L., & Langone, J. (2002). Computer-based video instruction to teach persons with moderate intellectual disabilities to read grocery aisle signs and locate items. *The Journal of Special Education, 35*, 224–240.

*Mechling, L. C., Gast, D. L., & Barthold, S. (2003). Multimedia computer-based instruction to teach students with moderate intellectual disabilities to use a debit card to make purchases. *Exceptionality, 11*, 239–254.

Mechling, L. C., Pridgen, L. S., & Cronin, B. A. (2005). Computer-based video instruction to teach students with intellectual disabilities to verbally respond to questions and make purchases in fast food restaurants. *Education and Training in Developmental Disabilities, 40*, 47–59.

Morrow, S., & Bates, P. E. (1987). The effectiveness of three sets of school-based instructional materials and community training on the acquisition and generalization of community laundry skills by students with severe handicaps. *Research in Developmental Disabilities, 8*, 113–136.

Morse, T. E., Schuster, J. W., & Sandknop, P. A. (1996). Grocery shopping skills for persons with moderate to profound intellectual disabilities: A review of the literature. *Education and Treatment of Children, 19*, 487–517.

Neef, N. A., Iwata, B. A., & Page, T. J. (1978). Public transportation training: In vivo versus classroom instruction. *Journal of Applied Behavior Analysis, 11*, 331–344.

Norman, J. M., Collins, B. C., & Schuster, J. W. (2001). Using an instructional package including video technology to teach self-help skills to elementary students with mental disabilities. *Journal of Special Education Technology, 16*, 5–18.

Palmen, A., Didden, R., & Lang, R. (in press). A systematic review of behavioral intervention research on adaptive skill building in high-functioning young adults with autism spectrum disorder. *Research in Autism Spectrum Disorders*.

Parmenter, T. R. (1993). International perspective of vocational options for people with mental retardation: The promise and the reality. *Mental Retardation, 31*, 359–367.

Ramdoss, S., Lang, R., Mulloy, A., Franco, J., O'Reilly, M., Didden, R., et al. (2011). Use of computer-based interventions to teach communication skills to children with autism spectrum disorders: A systematic review. *Journal of Behavioral Education, 20*, 55–76.

Ramdoss, S., Mulloy, A., Lang, R., O'Reilly, M., Sigafoos, J., Lancioni, G., et al. (2011). Use of computer-based interventions to improve literacy skills in students with autism spectrum disorders: A systematic review. *Research in Autism Spectrum Disorders, 5*, 1306–1318.

Rayner, C., Denholm, C., & Sigafoos, J. (2009). Video-based intervention for individuals with autism: Key questions that remain unanswered. *Research in Autism Spectrum Disorders, 3*, 291–303.

Rehfeldt, R., Dahman, D., Young, A., Cherry, H., & Davis, P. (2003). Teaching a simple meal preparation skill to adults with moderate and severe mental retardation using video modeling. *Behavioral Interventions, 18*, 209–218.

Roger Wagner Publishing, Inc. (2011) *Hyperstudio 4.0*.

Sigafoos, J., O'Reilly, M., Cannella, H., Upadhyaya, M., Edrisinha, C., Lancioni, G. E., et al. (2005). Computer-presented video prompting for teaching microwave oven use to three adults with developmental disabilities. *Journal of Behavioral Education, 14*, 189–201.

Soares, D., Vannest, K., & Harrison, J. (2009). Computer aided self-monitoring to increase academic production and reduce self-injurious behavior in a child with autism. *Behavioral Interventions, 24*, 171–183.

Stokes, T. F., & Baer, D. M. (1977). An implicit technology of generalization. *Journal of Applied Behavior Analysis, 10*, 349–367.

Sturmey, P. (2003). Video technology and persons with autism and other developmental disabilities. *Journal of Positive Behavior Interventions, 5*, 3–4.

Westling, D. L., & Fox, L. (2004). *Teaching students with severe disabilities* (3rd ed.). Upper Saddle River: Merrill Prentice-Hall.

Wissick, C. A., Gardner, J., & Langone, J. (1999). Video-based simulations: Considerations for teaching students with developmental disabilities. *Career Development for Exceptional Individuals, 22*, 233–249.