People with Intellectual and Sensory Disabilities Triggering a Tablet's Delivery of Task Instructions by Walking to the Tablet: Proof-of-Concept Study

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Table of Contents

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Abstract

Background: People with intellectual and other disabilities tend to have problems performing multistep tasks. To alleviate their problems, technology solutions have been developed that provide task-step instructions. Instructions are generally delivered on people's request (e.g., as they touch an area of a computer or tablet screen) or automatically, at preset intervals.

Objective: The present study carried out a preliminary assessment of a new tablet-based technology system that presented the task instructions when people walked close to the tablet rather than when they performed fine motor responses (e.g., scrolling) on the tablet screen.

Methods: The system consisted of a tablet and a wireless camera and was programmed to present the first or next instruction of a task sequence as soon as the participants approached the tablet, that is, as the participants were spotted by the camera that was positioned before the tablet. Six participants were involved in the study. For three of them, two instructions were used for each task step. For the other three participants, a single instruction was used for each task step. Instructions consisted of pictorial representations combined with brief verbal description of the corresponding action (task step). The impact of the system was assessed for each of the two groups of participants using a non-concurrent multiple baseline design across individuals.

Results: All participants were successful in using the system. Their mean frequency of correct task steps were close to or above 11.5 for tasks including 12 steps. Their level of correct performance tended to be much lower during the baseline phase when they were to get the task instructions from a regular tablet through scrolling responses.

Conclusions: The findings, which need to be interpreted with caution given the preliminary nature of the study, suggest that the new tablet-based technology system might be a useful tool for supporting the performance of multistep tasks.

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Abstract

Background: People with intellectual and sensory or sensory-motor disabilities tend to have problems performing multistep tasks. To alleviate their problems, technology solutions have been developed that provide task-step instructions. Instructions are generally delivered on people's request (e.g., as they touch an area of a computer or tablet screen) or automatically, at preset intervals.

Objective: The present study carried out a preliminary assessment of a new tablet-based technology system that presented task-step instructions when participants with intellectual and sensory disabilities walked close to the tablet (i.e., did not require participants to perform fine motor responses on the tablet screen).

Methods: The system entailed a tablet and a wireless camera and was programmed to present instructions when the participants approached the tablet, that is, as the participants were detected by the camera that was positioned before the tablet. Two instructions were available for each task step. One instruction concerned the object(s) that the participants were to collect, the other concerned the "where" and "how" the object(s) collected would need to be utilized. For three of the six participants, the two instructions were presented in succession, with the second instruction being presented once the required object(s) had been collected. For the other three participants, the two instructions were presented simultaneously. Instructions consisted of pictorial representations combined with brief verbal phrases. The impact of the system was assessed for each of the two groups of participants using a non-concurrent multiple baseline design across individuals.

Results: All participants were successful in using the system. Their mean frequency of correct task steps were close to or above 11.5 for tasks including 12 steps. Their level of correct performance tended to be much lower during the baseline phase when they were to get the task-step instructions from a regular tablet through scrolling responses.

Conclusions: The findings, which need to be interpreted with caution given the preliminary nature of the study, suggest that the new tablet-based technology system might be useful for helping people with intellectual and sensory disabilities perform multistep tasks.

Keywords: Technology; tablet; task; instructions; intellectual disability, visual impairment, hearing impairment

Introduction

Background

People with intellectual disabilities tend to have problems carrying out multistep tasks due largely to their difficulties in remembering the different steps included in the tasks and the order in which the steps are to be performed [1-5]. The problems may be even greater in situations in which intellectual disabilities are combined with sensory or sensory-motor impairments [6-8]. In spite of the difficulties encountered, fostering the ability to carry out multistep tasks remains a main rehabilitation objective, critical for ensuring that people will be able to achieve functional occupation and have a constructive role within their daily contexts and possibly within vocational contexts [1, 9-12]. Such an achievement is considered critical to advance the people's condition and offer them new socially adaptive opportunities and improve their quality of life [8, 11, 13-19].

Given the relevance of enabling people to manage the performance of multistep tasks, a large variety of studies have been conducted with the aim of reaching such a goal with the support of technology solutions [1, 4, 20]. The technology solutions, which have been designed to provide people with instructions to perform the task steps correctly and in the right sequence, present several differences [10, 21]. The most obvious differences concern (1) the characteristics of the instructions provided (e.g., static pictorial images versus video clips illustrating the steps to be performed with or without an accompanying verbal phrase describing the steps), and (2) the way those instructions are made available [1, 4].

With regard to the latter aspect (i.e., the way the instructions are made available), two main approaches can be pointed out. The first approach relies on the use of computer or tablet devices that present instructions for the task steps based on participants' request. The request typically consists of the participants performing a specific response such as touching an area of the computer or tablet screen [5, 9, 22-24]. The second approach relies on the use of computer, tablet, or smartphone devices that present the instructions automatically, at preset time intervals, and thus avoid that the participants need to produce specific request responses [7, 25, 26]. The intervals between instructions are decided by staff personnel who are familiar with the participants and the time they require for carrying out the different task steps.

The second approach may be considered advantageous for participants who cannot successfully use the first approach because they have problems in providing appropriate responses on the computer or tablet screen (e.g., are inaccurate in producing touching and scrolling responses necessary to use these devices) [27, 28]. On the other hand, the presentation of instructions at preset time intervals may not always be consistent (in synchrony) with the participants' performance. Although staff may have estimates of the times required by the participants for carrying out the task steps, the participants' response speed and efficacy may fluctuate within and across days and make the intervals programmed based on those estimates too long or too short [8, 16]. This may lead to the participants missing some instructions and related task steps or having to wait for the instructions.

A possible way to bypass the shortcomings of the aforementioned approaches may involve the development of a technology system that (1) presents the instructions without requiring the participants' performance of fine motor responses on the computer or tablet's screen, and simply (2) links the instruction presentation to the participants' walking to the system [8, 16, 27]. Such system would ensure that participants who have problems in performing accurate motor responses on a computer or tablet screen (see above) do not need to use those responses. At the same time, this system would guarantee that the instructions are delivered at the appropriate time (in strict connection with the people's performance) rather than at preset time intervals [8, 16, 29].

Objectives

This study was aimed at setting up such a system and carrying out a preliminary evaluation of it with six participants with intellectual and sensory disabilities. The system consisted of a tablet and a wireless camera and was programmed to present instructions when the participant approached the tablet, that is, as the participant was spotted by the camera that was positioned before the tablet. Two instructions were available for each task step. One instruction concerned the object(s) that the participants were to collect, the other concerned the "where" and "how" the object(s) collected would need to be utilized. For three of the participants, the two instructions were presented in succession, with the second instruction being presented once the required object(s) had been collected. For the other three participants, the two instructions were presented simultaneously. Instructions consisted of pictorial representations combined with brief verbal phrases. For each of the two groups of participants, the study was conducted following single-case research methodology.

Methods

Participants

Table 1 lists the participants included in the study (dividing them in two groups of three based on their use of the task-step instructions; see below), and reports their chronological ages and their Vineland age equivalents for daily living skills (personal sub-domain) and receptive communication. The participants, whose names (see

Table 1) are pseudonyms, were between 23 and 62 years of age. All of them were diagnosed with sensory disabilities. Specifically, Allie had severe hearing loss. Sylvie, Rowan, Demi, and Jolene had serious impairments of their neuro-visual system leading to severe limitations in their visual acuity. Emory presented with severe limitations in her visual acuity as well as severe hearing loss. The use of eyeglasses allowed all participants to discriminate pictorial images of familiar objects on a tablet screen and to easily orient within familiar contexts. The Vineland age equivalents (measured via the second edition of the Vineland Adaptive Behavior Scales [30, 31] ranged from 4 years to 5 years and 3 months on the personal daily living skills and from 3 years and 4 months to 4 years and 3 months on receptive communication. All participants attended rehabilitation and care centers. The psychological services of those centers classified their level of functioning within the moderate intellectual disability range. No IQ scores were available.

Table 1
Participants' chronological age and Vineland age equivalents for Daily Living Skills (Personal sub-domain) (DLSP) and receptive communication (RC)

Participants (pseudonyms)	Chronological age (years)	Vineland age equivalents [1, 2]	
		DLSP	RC
Rowan	23	4;2	3;4
Allie	62	5;3	3;11
Sylvie	48	4;0	3;4
Jolene	48	4;4	4;3
Emory	61	5;1	3;11
Demi	49	5;1	4;3

[1] Age equivalents are based on the Italian standardization of the Vineland scales [30].

[2] Vineland age equivalents are reported in years (number before the semicolon) and months (number after the semicolon).

The participants were recruited for the study based on a number of general criteria. First, they were unable to carry out multistep tasks without staff guidance or specific step instructions. Second, they could use pictorial representations alone or in combination with simple verbal phrases as instructions for the performance of task steps. Third, they expressed their willingness to use the technology system adopted in this study (and shown to them in advance) for carrying out multistep tasks involving familiar material and areas of their daily contexts. Fourth, they had poor fine motor skills and were considered unable to reliably use a tablet for accessing a series of task-step instructions. Fifth, staff supported their involvement in the study and considered technology-aided task engagement a positive goal for the participants and their contexts.

Ethical Approval and Informed Consent

As mentioned above, the participants had expressed their willingness to use the technology system to carry out tasks involving familiar material. Moreover, staff had indicated that the participants would enjoy performing the tasks provided that difficulties and errors (frustration) would be largely avoided as it was expected within this study. While these two points made the study appear a positive experience for the participants, it was not possible for them to read and sign a formal consent document. Due to this, their legal representatives were directly involved in the consent process, that is, they read and signed the consent forms on the participants' behalf. The study complied with the 1964 Helsinki declaration and its later amendments and was approved by an institutional Ethics Committee.

Setting, Sessions, Tasks, Instructions, and Research Assistants

Familiar rooms of the participants' daily contexts constituted the setting for the study. Sessions were typically carried out one or two times per day, 4 to 6 days a week. At each session, the participants were asked to perform one task. Tasks consisted of combinations of 12 steps. Each step involved two simple actions, which were familiar and meaningful to the participants, for example, "take the toilet paper" and "bring the toilet paper to the men's room". The combinations of steps (and related actions) led to a recognizable and practically relevant outcome (i.e., to a type of task such as setting up a bathroom and cleaning the entrance, arranging the living room and putting away papers and books, preparing or cleaning the dining room [16]). The tasks could be flexible, that is, could include different combinations of steps on different days based on practical and environmental conditions [16]. Moreover, a number of steps could be used across different tasks. Nine tasks were available for each participant. Table 2 provides a combination of 12 steps that could be included in a task such as supplying the bathroom and arranging the kitchen.

Table 2

A combination of 12 steps for supplying the bathroom and arranging the kitchen

- Take the toilet paper and bring it to the men's bathroom
- Take the towel and bring it to the ladies' bathroom
- Take the toothpaste and bring it to the men's bathroom
- Take the toilet paper and bring it to the ladies' bathroom
- Take the deodorant and bring it to the ladies' bathroom
- Take liquid soap and bring it the men's bathroom
- Take the aluminum and bring it to the microwave
- Take paper towels and put them in the kitchen drawer
- Take the chips and put them on the kitchen table
- Take the flowers and put them in the kitchen sink
- Take the newspaper and put it in the black waste basket
- Take the empty bottles and put them in the white waste basket

The instructions the tablet provided for the two actions involved in each task step consisted of two pictures (see Figure 1 A and Figure 1 B) accompanied by brief verbal phrases (see the Technology System section below). For the first three participants listed in Table 1, that is, Rowan, Allie, and Sylvie, the two pictures were presented separately (i.e., one at a time in sequence) and each picture was accompanied by a verbal phrase matching it. For the other three participants, that is, Jolene, Emory, and Demi, the two pictures were presented simultaneously (i.e., one next to the other, as shown in Figure 1A and Figure 1B) and were accompanied by a verbal phrase matching them (see below).

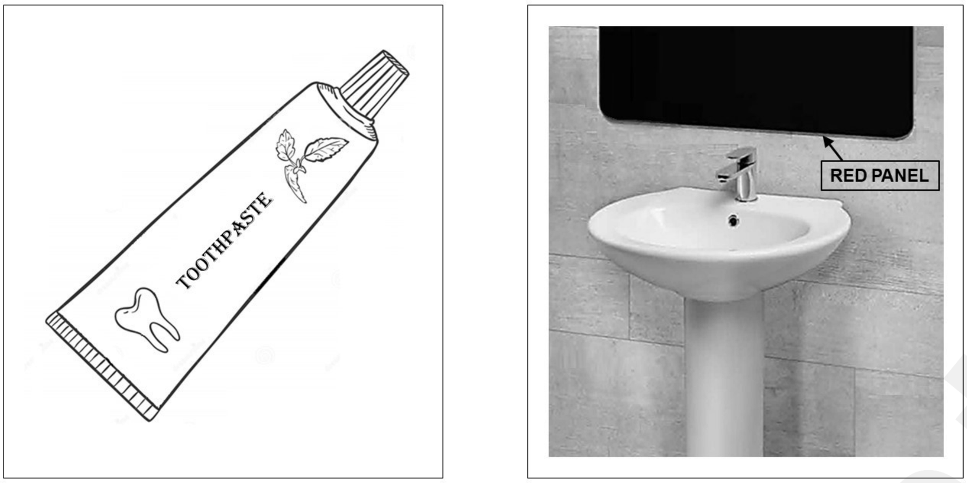

Figure 1 A. The two pictures represent the actions of collecting the toothpaste and bringing it to the washbasin of the red bathroom.

Figure 1 B. The two pictures represent the actions of collecting two bottles from a shelf and putting them in the refrigerator.

The presentation of the two instructions available for each task step in sequence or simultaneously was based on the participants' history, that is, their use of the pictures within their daily contexts, under supervision of regular staff personnel. The research assistants were four females who held a master degree in Psychology and had experience with the implementation of technology-aided programs with people with intellectual and multiple disabilities as well as with data collection strategies.

Technology System

Basic Components

The technology included (1) a Samsung Galaxy tablet with Internet connection and MacroDroid and CloudEdge applications, and (2) a DEATTI wireless (battery-powered) camera with passive infrared sensor (www.DEATTI.com). The tablet was also fitted with the (1) pictures and verbal phrases used as instructions for the task steps, (2) positive-feedback pictures and praise words shown after the completion of each task step, and (3) videos with the participants' preferred music, comic sketches, or food preparation presented after the completion of the last task step. The tablet was located in one of the rooms used for the tasks. The camera was positioned about 1.5 meters before the tablet. By walking to the tablet, the participants automatically activated the camera making it send an input to the tablet via the CloudEdge application. Such input was used by the MacroDroid application to make the tablet present task-step instructions.

Instructions Presentation

As mentioned above, the first three participants (i.e., Rowan, Allie, and Sylvie) received the two instructions available for each task step in succession (see the Setting, Sessions, Tasks, Instructions, and Research Assistants section). With a task step such as "bringing liquid soap from a store cabinet to the sink area of a specific bathroom", for example, the instruction the participants received the first time they approached the tablet consisted of a picture showing the liquid soap inside a store cabinet (or simply the liquid soap) accompanied by the verbal phrase "take the soap". The instruction they received the second time they approached the tablet for that step (while they were carrying the soap they had collected at the cabinet) involved a picture representing the soap on the sink of the red bathroom accompanied by the verbal phrase "bring the soap to the red bathroom". Once a step was completed, approaching the tablet led to the tablet's presentation of (1) positive feedback with a picture showing hand clapping, thumbs up, or another representation indicating approval and a praise word, and then (2) the first instruction for the following task step. The process continued as described above for all other steps of the task and included the presentation of a 2.5-minute video of a preferred (music, comic, or food preparation) event following the completion of the last step. After the delivery of an instruction, the system had a brief period (15-25 seconds) of inertia/idleness to ensure that the participant could go back for a second look at the tablet screen without a change of instruction.

For the last three participants (i.e., Jolene, Emory, and Demi), the tablet presented the two instructions available for each task step simultaneously. For example, for a step such as "bringing liquid soap from a store cabinet to the sink area of the red bathroom" (see above), the tablet presented a picture showing soap (or soap in the cabinet) to the left and a picture showing soap on the sink of the red bathroom to the right, and accompanied such presentation with a phrase like "take the soap and bring it to the red bathroom". Returning to the tablet (i.e., after completing a step) triggered the tablet's presentation of positive feedback plus praise word followed by the presentation of the instructions for the next task step. The positive feedback and praise word after each step completed, the video of a preferred event at the end of the task, and the idleness of the tablet after the delivery of an instruction were as for the first three participants.

Experimental Conditions and Data Analysis

The study started with a pre-test verifying whether the participants could carry out the tasks independent of specific step instructions. After the pre-test, each of the two groups of participants had a baseline phase followed by an intervention phase. These phases were implemented according to a non-concurrent multiple baseline design across participants [32, 33]. In practice, the participants of each group received different numbers of baseline sessions before the start of the intervention with the technology system. Pre-test, baseline and intervention sessions were implemented by the research assistants. To make sure that their application of the procedural conditions was accurate (that their level of procedural fidelity was high) two strategies were adopted. One involved their preliminary familiarization with those conditions while the other involved regular feedback on their performance [34]. Feedback was delivered by a research coordinator who had access to video-recordings of the sessions.

The participants' data concerning the task steps correctly performed were reported in graphic form. To simplify the graphic presentation, data points were made to represent blocks of sessions. The baseline and intervention frequencies of correct task steps were compared using the "Percentage of data points Exceeding the Median" (PEM) method [35, 36]. This method, which is one of the most practical tools to evaluate single-case research data, served to determine how many data points of the intervention phase were above the baseline median.

Pre-test

The pre-test included five sessions. Each session started with the research assistant asking the participants to carry out a task. The request was made via a simple verbal statement and a general pictorial representation. The statement summarized what the participants were to do (e.g., “you can supply the bathroom and set up the kitchen table”). The pictorial representation could consist of a drawing of the areas (bathroom and kitchen table) involved in the task. The research assistant did not intervene if the participants carried out steps involved in the task. If the participants remained passive for 30-60 seconds or carried out a step not involved in the task, the research assistant provided guidance for a task step (e.g., helped them to bring the toilet paper to a red bathroom). The session continued until the participants had carried out all task steps or had received research assistant’s guidance for the performance of two steps. All the steps omitted as well as those carried out with research assistant’s guidance were counted as non-correct. At the end of a session, the participants were presented with a 2.5-minute video of preferred music, comic, or food preparation events.

Baseline

The baseline included 7, 8, and 13 sessions for the participants of the first group and 6, 8, and 12 sessions for the participants of the second group. Those sessions served to determine whether the participants were able to use a tablet independently to obtain task-step instructions and then carry out those steps. Each session started with the research assistant placing a tablet on a desk and asking the participants to use it to get the instructions for a specific task. Meanwhile, the research assistant demonstrated how to use the tablet (i.e., operating horizontal scrolling) to receive the step instructions. If participants were unsuccessful or passive for 30-60 seconds, the research assistant provided guidance (i.e., carried out the tablet scrolling for them and ensured that they performed the task step indicated by the tablet instructions). Two research assistant’s guidance instances were allowed per session. The session lasted until the participants had carried out the last step of the task or failed to progress (e.g., due to a new unsuccessful/passive period following the research assistant’s guidance instances or to inaccurate scrolling leading them to skip the instructions or shut the presentation process). At the end of a session, the participants were presented with a 2.5-minute video of preferred music, comic, or food preparation events.

Intervention

The intervention phase included 97, 83, and 88 sessions for the participants of the first group, and 87, 64, and 69 sessions for the participants of the second group. During the intervention, the participants had the technology system that worked as described in the Technology System section. The objective was to determine whether the system was suitable to help the participants carry out the tasks correctly. Each session started with the research assistant accompanying the participants to the area where the tablet was available (i.e., just before the camera). When the camera detected the participants, the tablet was triggered to produce the first instruction delivery. All the rest was as described in the Technology System section. The first two sessions served as introductory sessions in which the research assistant could provide guidance any time the participants showed signs of hesitation or difficulty. During the following (regular intervention) sessions, no research assistant's guidance was available except if a participant asked for it.

Data Recording

Data recording concerned (a) the number of task steps performed correctly (i.e., in line with the step descriptions and independent of research assistant's guidance) within the sessions, and (b) the length of the sessions. Data were recorded by the research assistants responsible for the implementation of the sessions. Interrater agreement was assessed by having a reliability observer record the participants' performance of the task steps and the sessions' length in 21 to 23% of the participants' sessions. The percentage of agreement (computed by dividing the number of sessions in which the two raters reported the same number of correct steps and session lengths differing less than 1.5 minutes by all the sessions in which agreement was checked and multiplying by 100%) ranged between 91 and 100% across participants.

Results

Figures 2 and 3 report the baseline and intervention data for the first group of participants (i.e., Rowan, Allie, and Sylvie) and the second group of participants (i.e., Jolene, Emory, and Demi), respectively. The black triangles represent mean frequencies of correct task steps over blocks of two sessions. Occasional blocks with three sessions (at the end of the phases) are marked with an arrow. The figures do not report the two introductory sessions carried out at the start of the intervention phase.

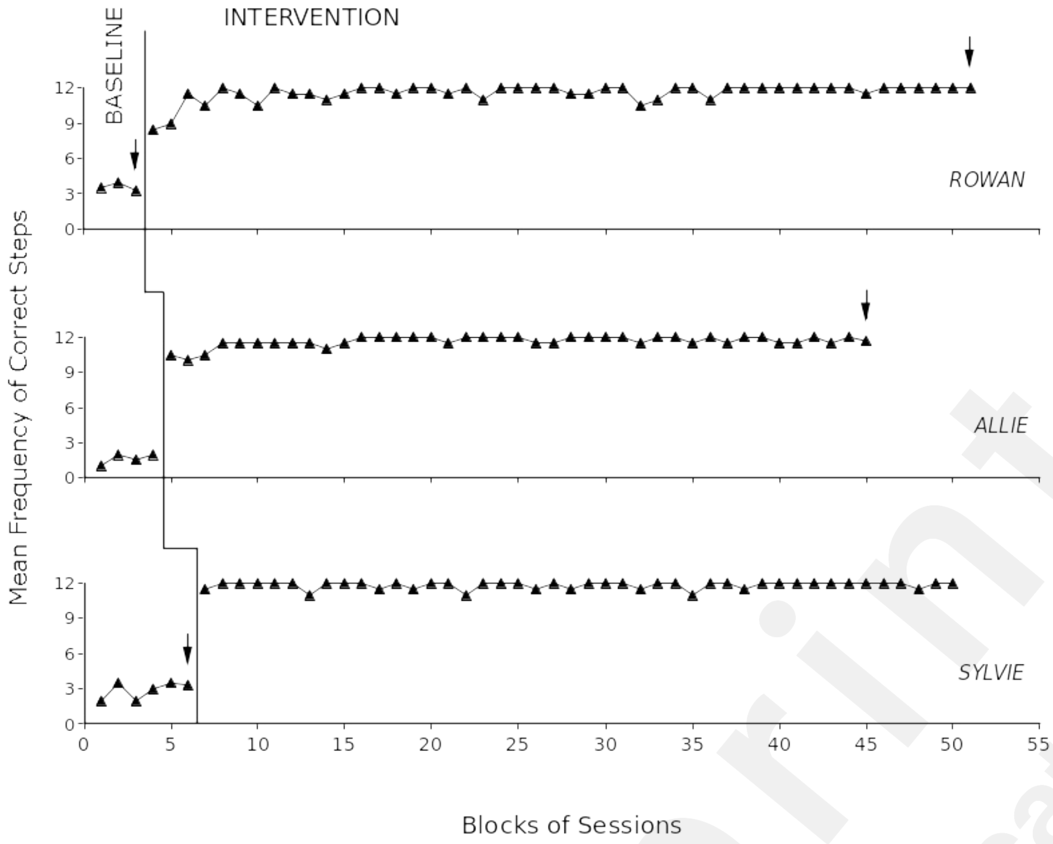

Figure 2. The three graphs report the baseline and intervention data for Rowan, Allie, and Sylvie. Each data point represents the mean frequency of correct steps over a block of two sessions. Blocks of three sessions are marked with an arrow.

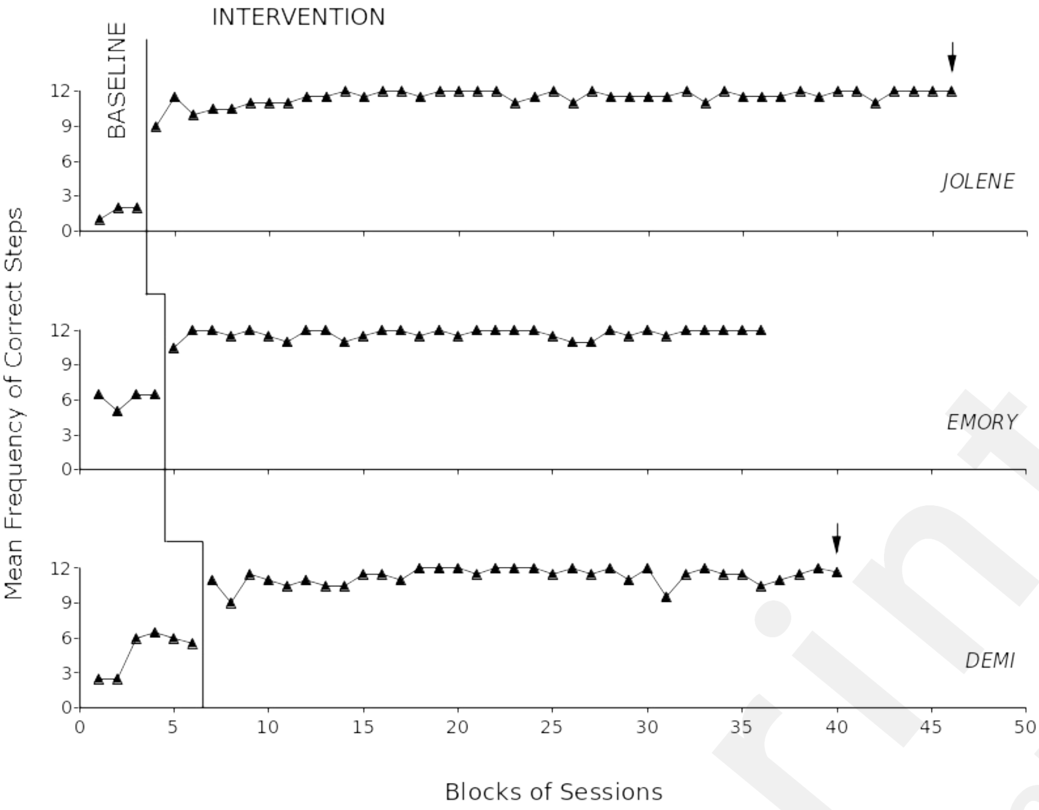

Figure 3. The three graphs report the baseline and intervention data for Jolene, Emory, and Demi. Data are plotted as in Figure 2.

During the pre-test, the participants' frequency of correct task steps per session was (virtually) zero. Indeed, they could carry out a single step (not necessarily involved in the task presented) or remained inactive. All sessions were interrupted after they had received guidance for two task steps. The mean session length was below 10 minutes for all participants.

During the baseline, the participants' mean frequency of correct steps per session varied between about 1.5 (Allie) and 6 (Emory) out of the 12 steps available for each of the tasks. Such frequency reflected their inaccurate (unreliable) use of the tablet (i.e., skipping step instructions or blocking the scrolling process and closing the instructions' presentation) with consequent omission of many task steps. The mean session length was between about 6.5 (Jolene) and 14.5 (Emory) minutes. The mean length across participants was about 11.5 minutes.

During the intervention, the participants carried out the tasks successfully and the mean frequency of task steps performed correctly per session varied between near 11.5 (Jolene and Demi) and above 11.5 (all other participants). The mean session length varied between about 15 (Demi) and 29.5 (Allie) minutes. The mean length across participants was about 19.5 minutes. The session length reported for pre-test, baseline, and intervention always included the 2.5-minute preferred video shown at the end of the sessions. The large differences in the session length observed during the intervention (when the frequency of correct steps was similar across participants) mainly reflected differences in the participants' performance speed. The PEM method showed indices of 1 for all participants (i.e., all their intervention data points were higher than their median baseline frequency value) confirming the strong impact of the intervention with the technology system on their task performance.

Discussion

Principal Findings

The results suggest that the technology system used during the intervention was adequate to help the participants receive step instructions in a timely fashion and without the need of producing specific responses on the tablet. The participants' high frequency of correct task steps and the stability of such frequency across the intervention phase suggest that the instruction process was suitable to them and that they had sufficient motivation to maintain their task performance over time [37-39]. In light of the above, a few considerations may be in order.

First, the new technology system seems to have the characteristics required to bypass the limitations of the two main instruction technology approaches typically used with people with intellectual and developmental disabilities, that is, the approach requiring the participants to seek the instructions through simple responses on the tablet or computer's screen and the approach providing automatic presentation of the instructions, at preset time intervals [1, 4]. Indeed, by avoiding the need for fine motor request responses, the new system can successfully help participants who, due to poor fine motor skills, would fail to benefit from the first approach. Moreover, by ensuring a timely presentation of the step instructions based on the participants' walking to the tablet, the new system would avoid any reliance on pre-arranged instruction deliveries and related risks of instruction neglect in case of performance difficulties or slowness.

Second, the system can be flexible concerning the way the instructions are presented. As viewed in this study, for example, the system can be set to present the two instructions concerning each task step at successive times for people who can handle only one simple instruction at a time (people with poor working memory [40, 41]). The system can also be set to present the two instructions of each step simultaneously for participants who are able to handle more complex instruction inputs. Technically, the system could also be set up to present the step instructions in small chunks with people who have a relatively high level of functioning or have become very familiar with the tasks on hand and no longer need an analytic step by step instruction process [42-45].

Third, the system can be easily used for supporting tasks that may change across days in terms of the steps included. The most direct and fast way to arrange the sequence of steps included in the task at any particular day is to provide the system with a sequence of numbers representing the codes for those steps [16]. To facilitate the use of the system by staff and caregivers who have limited familiarity with technology, the system could be fitted with a series of tasks and variations thereof that can be selected by writing their names or any other code used in storing them in the tablet memory.

Fourth, the use of a webcam to trigger the tablet to present instructions can be considered a rather simple technology solution [46-49]. Indeed, the webcam is a small battery-powered device connected to the tablet via Bluetooth, a device that is much simpler and easier to operate than conventional motion sensors such as the Philips Hue motion sensor [50]. Moreover, the webcam's cost (about US$ 60) is largely affordable [51]. When using the system within a daily context, one would be advised to locate the webcam and the tablet in a room corner, This would minimize the risk that people sharing the room with the participants can accidentally interfere with the system's functioning.

Limitations and Future Research

The study presents four basic limitations, namely, a small number of participants, lack of generalization and maintenance data, lack of participants' satisfaction data, and lack of a social validation of the technology and its impact. The first limitation reflects the preliminary nature of the study, prevents one from making general statements about the findings reported, and underlines the need of new studies with additional participants [52-54]. The second limitation calls for new studies directed at (1) extending the number of sessions implemented and the intervention period to verify whether the intervention effects last and consolidate over time, and (2) carrying out the sessions in different settings (provided these were familiar to the participants) to determine how extensively and profitably the system could be employed within daily contexts [38, 54-56].

The third limitation calls for the adoption of a check of how the participants perceive the intervention program. The check could consist of having the participants choose between the sessions with the system and other types of daily occupation. Large levels of preference for the sessions over the other types of occupation would suggest participants' satisfaction with the sessions [57-60]. The fourth limitation underlines the need that new studies include staff and caregivers in the evaluation of the technology and its impact as these personnel are finally responsible for applying the program and its technology in daily contexts. A practical way to include these personnel in the evaluation could involve (1) the personnel's access to videos reporting the performance of different participants during intervention sessions, and (2) the personnel's rating of the videos on points such as the participants' comfortableness during the sessions, the relevance of their task performance, and the overall acceptability and applicability of the intervention program [61, 62].

Conclusions

In conclusion, the results of the study suggest that the technology system used for the intervention program implemented with the six participants was effective in helping them carry out fairly complex tasks independently and accurately. While encouraging these results are to be taken with caution given the limitations of the study mentioned above. New studies will be expected to address those limitations and provide the evidence necessary to determine the applicability and impact of the present technology-aided program. New research may also assess the possibility of upgrading and optimizing the technology so as to facilitate and extend its use across settings and people.

Compliance with Ethical Standards

Conflict of interest. The authors declare that they have no conflicts of interest.

Ethical approval. The study was approved by the Ethics Committee of the Lega F. D'Oro, Osimo (AN), Italy (P072820235). All procedures performed were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed consent. The participants' legal representatives provided written informed consent for the participants' involvement in the study.

Data Availability. Data are available on request from the corresponding author.

Author contributions. GL was responsible for setting up the study, acquiring and analyzing the data, and writing the manuscript. NS, MO'R, and JS collaborated in setting up the study, analyzing the data, and editing the manuscript. GA, IO, VC, and LD collaborated in setting up the study and the technology system, in acquiring and analyzing the data, and in editing the manuscript.

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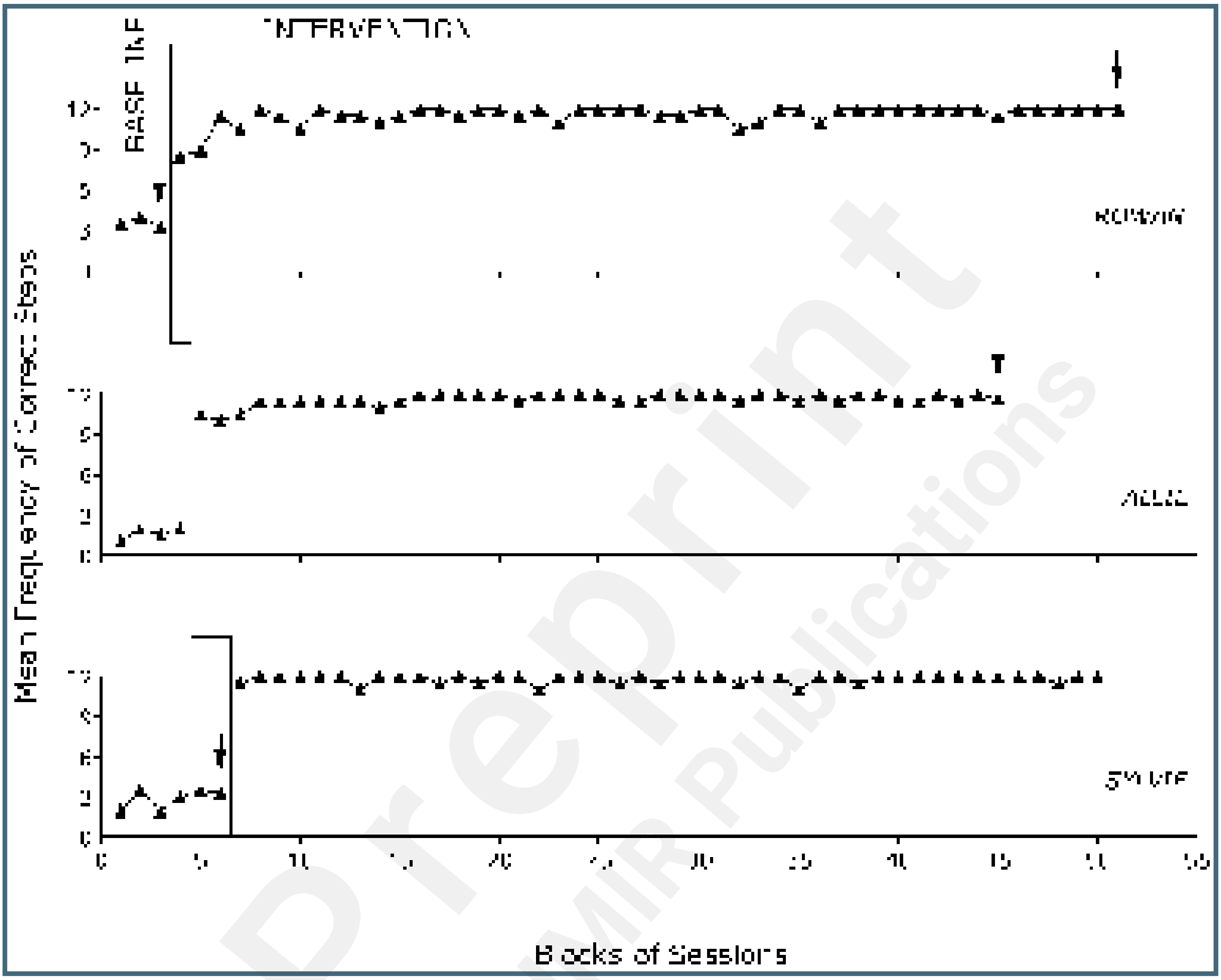
Supplementary Files

Figures

The two pictures represent the action of collecting the toothpaste and bringing it to the washbasin of the red bathroom.

The two pictures represent the action of collecting two bottles from a shelf and putting them in the refrigerator.

The three graphs report the baseline and intervention data for Rowan, Allie, and Sylvie. Each data point represents the mean frequency of correct steps over a block of two sessions. Blocks of three sessions are marked with an arrow.



The three graphs report the baseline and intervention data for Jolene, Emory, and Demi. Data are plotted as in Figure 3.