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ORIGINAL RESEARCH

People with intellectual and visual disabilities access basic leisure and communication using a smartphone's Google Assistant and voice recording devices

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ABSTRACT

Purpose: This study assessed a new technology system to help six participants with intellectual and visual disabilities manage leisure engagement and communication with distant partners in an independent manner.

Methods: A nonconcurrent multiple baseline design across participants was used to assess the effects of the new technology system. This included a Samsung Galaxy J4 Plus smartphone with Android 9.0 operating system, mini voice recording devices, and a Bluetooth speaker. The smartphone was provided with a Google account and Internet connection. The participants could activate the smartphone's Google Assistant and thus access leisure events, start telephone calls or send messages by triggering mini voice recording devices. Each device, when triggered, uttered a specific verbal request (i.e., a request for a leisure option or for a communication partner to call or to reach by messages). Messages received from those partners were read automatically by the smartphone.

Results: During baseline (when the voice recording devices were not available), the participants did not manage to activate the smartphone's Google Assistant and thus did not access leisure events and did not make telephone calls or send messages independently. During the post-intervention phase (when the voice recording devices were available), all participants accessed leisure events and made telephone calls or sent and received messages independently, remaining positively engaged throughout the 10-min sessions. Staff rated the new technology system positively.

Conclusion: The new technology system may be a useful resource to help people like the participants of this study access basic leisure and communication independently.

➤ IMPLICATIONS FOR REHABILITATION

- A technology system relying on commercial devices may be practical and acceptable in daily programs for persons with intellectual and other disabilities.
- Such system may be used for supporting the persons' independent leisure engagement and communication with distant partners.
- A system may be accessible to persons with significant disabilities if the responses needed to operate it are simple.
- Simple hand-pressure responses may be sufficient to operate a system that relies on the input of mini voice recording devices

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Leisure; communication; smartphone; Google Assistant; voice recording devices; intellectual disability; visual impairment

Introduction

People with moderate to severe intellectual disability and visual or motor impairments may have serious difficulties in engaging in leisure activities independently as they are known to frequently lack the skills needed to reach and/or properly use conventional devices available for leisure engagement [1–4]. Similarly, these people may have serious difficulties in interacting with relevant partners (e.g., family or staff members) not present in their immediate context [4,5]. In fact, these people may often be unable to use telephone devices or other instruments as required to connect with distant communication partners [6–10]. Given the importance of alleviating this situation, there is general consensus on the need to develop and assess intervention strategies suitable for the purpose [4,11–14]. In line with this consensus, efforts have been made during the last few years to set up technology systems that could help the participants deal with both leisure engagement and communication with distant partners in a largely independent manner [15–19].

For example, Lancioni et al. [18] used a tablet which showed images of leisure options and photos of relevant partners and scanned (illuminated) those images/photos, one at a time for 5 s. The participants could choose any leisure option or partner by covering with their hand the proximity sensor of the tablet while the option/partner was being scanned. If the choice concerned a

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leisure option (e.g., music), the tablet presented four or five choice alternatives related to that option (e.g., four or five preferred songs). Selection of one of the songs (with the aforementioned response) led the tablet to play that song for 1.5 min. If the participant's choice concerned one of the communication partners, the tablet set up a video call with that partner so the participant could interact visually and verbally with that partner. While the results of the study were highly encouraging with each of the eight participants involved, two basic questions can be raised about the aforementioned technology system. First, the visual presentation of the choice options and the scanning process (as well as video calls) do not suit participants with blindness or severe visual impairment. Second, reliance on telephone calls might be problematic for individuals who are anxious about engaging in telephone interaction and probably need an alternative form of contact such as messaging [16,20,21].

These two questions were addressed in a study by Lancioni et al. [16], in which seven participants were provided with a smartphone and three groups of pictures or three groups of miniature objects. Pictures were used for the participants who had functional vision, while miniature objects were used for the participants who presented with blindness or minimal residual vision. The first group of pictures/objects referred to communication partners. The second group involved one picture/object referring to the telephone and other pictures/objects referring to specific messages (e.g., "I love you") that could be sent out to one of the partners available. The third group of pictures/objects referred to leisure options. Each picture/object was fitted with a frequency-coded identification tag [22] that made it recognizable by the smartphone. If the participant placed a picture/object of the third group in touch with the smartphone, the smartphone recognized the leisure option and played an event related to it for 1.5 min. If the participant placed a picture/object representing a communication partner in touch with the smartphone, this asked the participant to select the next picture/object. If the next picture/object was the one representing the telephone, the smartphone set up a telephone call to that partner. If the next picture/object was one that represented a message, the smartphone sent out that message to the partner. The smartphone was also programmed to read out any messages received from the partners.

The positive results of the aforementioned studies (a) are encouraging as to the possibility of using technology systems to help participants with special needs manage independent leisure engagement and independent contact with distant partners, and (b) represent an incentive to design new, functional technology systems. One of the new systems could be designed to require fairly simple responses for its activation and thus suit individuals with relatively serious developmental disabilities (which could also include blindness) and/or high levels of anxiety. For these individuals, relying on simple responses would be relevant not only for acquiring successful performance but also for making such performance more positive and enjoyable.

The aim of this study was to set up and assess such a new technology system that would allow participants to make requests for leisure events or communication opportunities through simple hand-pressure responses. Those responses served to activate mini voice recording devices whose spoken messages/requests (a) triggered the Google Assistant of a smartphone and hence (b) led the smartphone to deliver what the requests indicated. The new technology was assessed with six adults with intellectual and visual or visuo-motor disabilities. For five of those participants, the technology was arranged to allow access to leisure events and telephone calls. For the sixth participant, the telephone calls (known to cause anxiety to him) were substituted with messaging.

Method

Participants

Table 1 lists the participants by their pseudonyms, and reports their chronological ages, their visual conditions, and their age equivalents for daily living skills (personal sub-domain) and receptive communication measured on the second edition of the Vineland Adaptive Behaviour Scales [23,24]. The participants' chronological ages were between 30 and 56 years. Four participants were blind (Noemi, Brooke, Oscar, and Elias) while the other two had functional residual vision. One of these two (Lukas) also presented with motor impairments that precluded independent walking. All participants attended rehabilitation and care centres. The psychological records of those centres indicated that their intellectual disability had been estimated to be in the moderate or moderate to severe range. Their Vineland age equivalents for daily living skills (personal sub-domain) varied between 3 years and 6 months and 4 years and 4 months. Their Vineland age equivalents for receptive communication varied between 3 years and 11 months and 5 years and 10 months. In terms of verbal production skills, two participants (Brooke and Elias) could utter a few recurring sentences in a rather comprehensible way while other phrases were difficult to understand for people not familiar with them. Two participants (Noemi and Carly) usually uttered two-word sentences, which could be difficult to understand for people not familiar with them. The last two participants typically used single-word utterances.

The participants represented a convenience sample [25] and were recruited based on a number of criteria, which had been verified through direct observations and staff consultations. First, all participants were interested in (and relished) a variety of leisure events such as songs, stories, and traditional music. Second, all participants except Elias were known to enjoy telephone contacts with relevant/preferred communication partners (e.g., family and staff members). Elias showed anxiety about telephone calls, but enjoyed message exchanges (i.e., enjoyed sending messages as well as receiving messages and having those messages read to him). Third, all participants had the skills required for operating

Table 1. Participants' pseudonyms, chronological age, visual conditions, and Vineland age equivalents for *Daily Living Skills* (*DLS-P*) and *Receptive Communication* (*RC*).

Participants (pseudonyms)	Chronological age (years)	Visual conditions	Vineland age *DLS-P*	Equivalents[a,b] *RC*
Noemi	56	Blindness	4;0	4;6
Brooke	33	Blindness	4;3	5;1
Lukas	34	Functional vision	3;6	3;11
Oscar	30	Blindness	4;2	4;3
Carly	52	Functional vision	4;1	3;11
Elias	42	Blindness	4;4	5;10

[a]The age equivalents are based on the Italian standardization of the Vineland scales [23].
[b]The Vineland age equivalents are reported in years (number before the semicolon) and months (number after the semicolon).

the technology system set up for this study and had voiced their willingness to use it (i.e., following a research assistant's demonstration of how it worked). Moreover, in light of the aforementioned criteria, they were expected to enjoy the use of the system. Fourth, staff responsible for the participants' daily care and rehabilitation had expressed their support for the study and the technology system, which they had previewed.

Given the participants' inability to read and sign a consent form that would authorise their involvement in the study, their legal representatives had signed such form on their behalf. The study complied with the 1964 Helsinki Declaration and its later amendments and was approved by a relevant Ethics Committee.

Setting, sessions, and research assistants

The centres that the participants attended served as the setting for the study sessions. The sessions were conducted on an individual basis, typically two to four times a day, three to six days a week. Baseline, intervention and post-intervention sessions were set to last 10 min. Yet, any leisure event, telephone call, or message sending process started within the 10-min limit would be completed even if this required an extension of the total session duration. For the last participant (i.e., Elias), the messages received during the intervention and post-intervention sessions were automatically read to him by the smartphone at the conclusion of the sessions (i.e., once the 10-min limit had elapsed and any leisure event or message sending process had ended). Within each session, the participants were free to choose among various leisure options that they could access and among preferred communication partners that they could call on the telephone or reach *via* text messages in the case of Elias. Research assistants who were familiar with people with intellectual and other disabilities and technology-aided programs were responsible for implementing the sessions and recording the data (see below).

Measures and data recording

The measures recorded during the sessions were: (a) the leisure events the participants accessed independently, (b) the amount of time they spent with those events, (c) the telephone calls made independently or the messages sent out independently plus the messages received (Elias), and (d) the amount of time spent on telephone calls (i.e., including those in which a partner's prerecorded answer was heard; see below), or on sending messages and having the messages received read out. Data recording was carried out by the research assistants in charge of the sessions. Interrater agreement was assessed in 21 to 29% of the participants' sessions by having a reliability observer join the research assistant in data recording. Agreement required that the reliability observer and research assistant (a) recorded the same number of leisure events and of telephone calls or messages, and (b) reported cumulative engagement times for the leisure events and for the calls or messages sent and received (automatically read out) that did not differ more than 1 min. Agreement occurred in more than 90% of the sessions of each participant.

Technology

The technology system used during the intervention and post-intervention phases of the study involved a Samsung J4 Plus smartphone with Android 9.0 operating system, mini voice recording devices, and a Bluetooth speaker. The smartphone was (a) provided with a Google account and Internet connection, which allowed the participants to access Google Assistant and Google Play Music, and (b) fitted with WhatsApp Messenger and MacroDroid applications. The latter of these applications served to program some basic functions of the smartphone (see below). The smartphone was also supplied with the telephone numbers of the participants' communication partners, and a variety of audio files. These files included (a) the participants' preferred leisure events, (b) a verbal reminder, and (c) communication partners' pre-recorded vocal answers.

The mini voice recording devices were (a) square, box-like instruments with a side of 8 cm and a thickness of 2.5 cm (Borgione, art.804925, Italy) and could be activated through a simple hand-pressure response. During the intervention and post-intervention phases, the participants could activate the smartphone's Google Assistant through a series of eight mini voice recording devices, each of which contained one recorded message/request. The requests of four devices concerned preferred leisure options, such as songs ("Hey Google shuffle rock"), comedy sketches ("Hey Google shuffle comedy") or stories ("Hey Google shuffle story") (see *Participants*). The requests of the other four devices concerned calls to specific (preferred) communication partners (e.g., "Hey Google call Janet") (see *Participants*). For one of the participants (i.e., Elias), the calls were replaced by sending text messages (e.g., "Hey Google send Mary WhatsApp: A big kiss to you — OK"). To provide some choice variations, one of the devices concerning leisure options and/or communication partners could change across sessions (i.e., replaced by a device concerning a different leisure option or a different partner).

The MacroDroid application served to set up three smartphone's functions, which were active during the intervention and post-intervention phases. First, if a communication partner did not respond to a telephone call, the smartphone would play a pre-recorded answer of that partner. Second, for the participant who used text messages (Elias), the smartphone would automatically read any text message received from the communication partners. Third, the smartphone would verbally remind the participants of the choice options available in connection with their first (if any) 20- or 25-s inactivity period following the end of a leisure event, telephone call or message.

The Bluetooth speaker served to increase the loudness of the leisure events delivered by the smartphone. This was thought to make the events more enjoyable for some of the participants. The same speaker also ensured that a call conversation could be heard by the participant on speakerphone.

Experimental conditions and data analysis

The study was carried out according to a nonconcurrent multiple baseline design across participants [26]. Initially, there was a baseline phase, which included different numbers of sessions for different participants (i.e., as required by the design). The baseline was followed by an intervention phase (introducing the technology system and ensuring successful responding by the participants) and a post-intervention phase. During the intervention and post-intervention phases, the technology system worked as described in the *Technology* section. Video-recordings of the sessions were watched by a study coordinator who provided feedback to the research assistants to ensure adherence to procedural conditions (i.e., to ensure procedural fidelity [27]). The post-intervention phase was followed by a staff survey aimed at gathering the staff's opinion about the technology system and its impact.

The participants' baseline and post-intervention data, that is, (a) the frequencies of leisure events accessed and phone calls

made or text messages sent and received as well as (b) the engagement time for leisure, calls, and messages were reported in graphic form. In order to simplify the graphic display, the data points reported in the graphs represented blocks of sessions (rather than single sessions). To determine the effectiveness of the technology system, the baseline and post-intervention session data (i.e., frequencies and time values) of each participant were compared using the "percentage of nonoverlapping data" (PND) method [28].

Baseline

The baseline included four to eight sessions. During those sessions, the participants were seated at a desk with a smartphone such as that described in the *Technology* section. Yet, the MacroDroid application was deactivated and the mini voice recording devices were absent. The session started with a response demonstration on how to access a leisure event. For example, the research assistant told the participants that if they wanted to listen to music the phrase to utter was: "Hey Google shuffle rock". The participants had 20 s to utter such sentence and activate Google Assistant. If the participants did not succeed in uttering the sentence and activating Google Assistant, the research assistant did it on their behalf and thus the participants could listen to a preferred song for 1.5 min [18]. If the participants did not manage to perform any new request for about 30 s after the end of the song, the research assistant suggested a sentence to make a phone call (the first five participants) or send a message (Elias) (see *Technology*). If the participants did not manage to use such a sentence during the following 20 s, the research assistant did it for them so that a telephone call was started or a text message was sent. The same process continued until the end of the session.

Intervention

The intervention included 8 to 10 sessions during which the participants sat at a desk with the smartphone as in baseline. Yet, contrary to the baseline, the MacroDroid application was activated and the mini voice recording devices were on display in front of the participants. The devices, whose position was arranged as most functional for the participants' responses (see Figure 1), worked as described in the *Technology* section. Pictures or miniature objects already discriminated by the participants were glued on the devices to help the participants recognize those devices readily (i.e., in terms of the leisure options and partners they represented). If the participants activated a device concerning a leisure option (e.g., "Hey Google shuffle rock"), the Google Assistant selected one of the files available within that leisure option (e.g., one out of about 10 preferred songs) and made the smartphone play that song for 1.5 min [18].

If one of the first five participants (Noemi, Brooke, Lukas, Oscar, and Carly) activated a voice recording device concerning a communication partner, the Google Assistant ensured that that partner would be called. If the partner responded, an interaction between partner and participant would follow. During the interaction, the partner would, among others, greet the participant, ask questions to which the participant could reply, and respond to any possible question the participant could formulate/hint. If the partner being called did not respond, the MacroDroid was programmed to make the smartphone play a pre-recorded answer of that partner (i.e., to alleviate possible frustration). Such answer lasted about 20 s and consisted of the partner greeting the participant and explaining that it was not possible to have a talk at that particular time but it would be very nice to talk soon. If the last participant (Elias) activated a voice recording device concerning a communication partner, the Google Assistant made the smartphone utter a sentence in which the name of the partner and a message were included (e.g., "Hey Google send Jenny WhatsApp: I am fine and you? — OK"). The message was different for different partners and included brief statements/questions such as the one mentioned above or greeting and love expressions. Messages received from the partners were automatically read by the smartphone at the beginning of the session and at the conclusion of it (i.e., once the 10-min limit had elapsed and any leisure event or message sending process had ended).

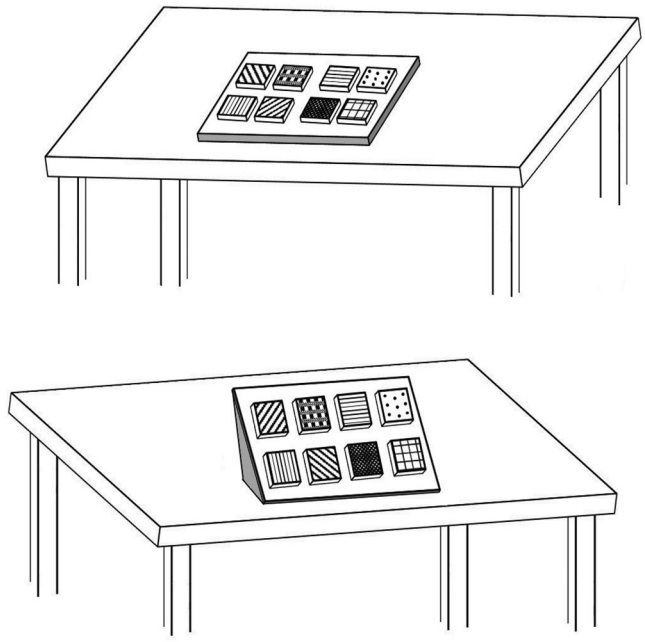

Figure 1. The diagram shows two slightly different arrangements of the voice recording devices. The devices were covered by pictures/photos or miniature objects (appearing as different surface patterns in the diagram) that represented the leisure options and communication partners.

During the initial intervention sessions, research assistants used physical and verbal guidance/prompts to help the participants make their choices and so access leisure events and interact with partners (i.e., by making telephone calls or sending messages). Thereafter, the guidance was faded out so that by the end of the phase, all participants managed the technology successfully (i.e., accessing leisure events and making telephone calls or sending messages independently). Only an automatic smartphone's reminder about the choice options could occur during a session (see *Technology*).

Post-intervention

The post-intervention phase included 97–129 sessions. During the post-intervention sessions, conditions were as at the end of the intervention phase, that is, the participants were to perform independent of any guidance from research assistants.

Staff survey

Thirty-six staff persons including 33 women and 3 men of 26–58 ($M = 37$) years of age were involved in the survey. They worked (i.e., implemented education/rehabilitation interventions) in the rehabilitation and care centres in which the study was carried out, but were not connected with the study or the participants.

Initially, each staff member was informed via telephone about the survey. Thereafter, the staff member received via e-mail a three-page document set up via Google Forms. The first page contained questions concerning the staff member's age and sex. The second page contained a 3-min video in which a research assistant introduced the technology available for the study and demonstrated how the participants used it to access preferred leisure events and to make telephone calls or send messages. The third page contained four questions for each of which the staff member was to provide a score of 1–5 (with 5 being the most positive score) before sending the document back directly via computer. The questions were: (1) How much do you think the technology system can help the participants access preferred leisure events and contact preferred partners?, (2) How much do you think the participants can enjoy using the technology system?, (3) How much do you think the technology system could suit the participants' daily program?, and (4) How much do you like (recommend) the technology system?

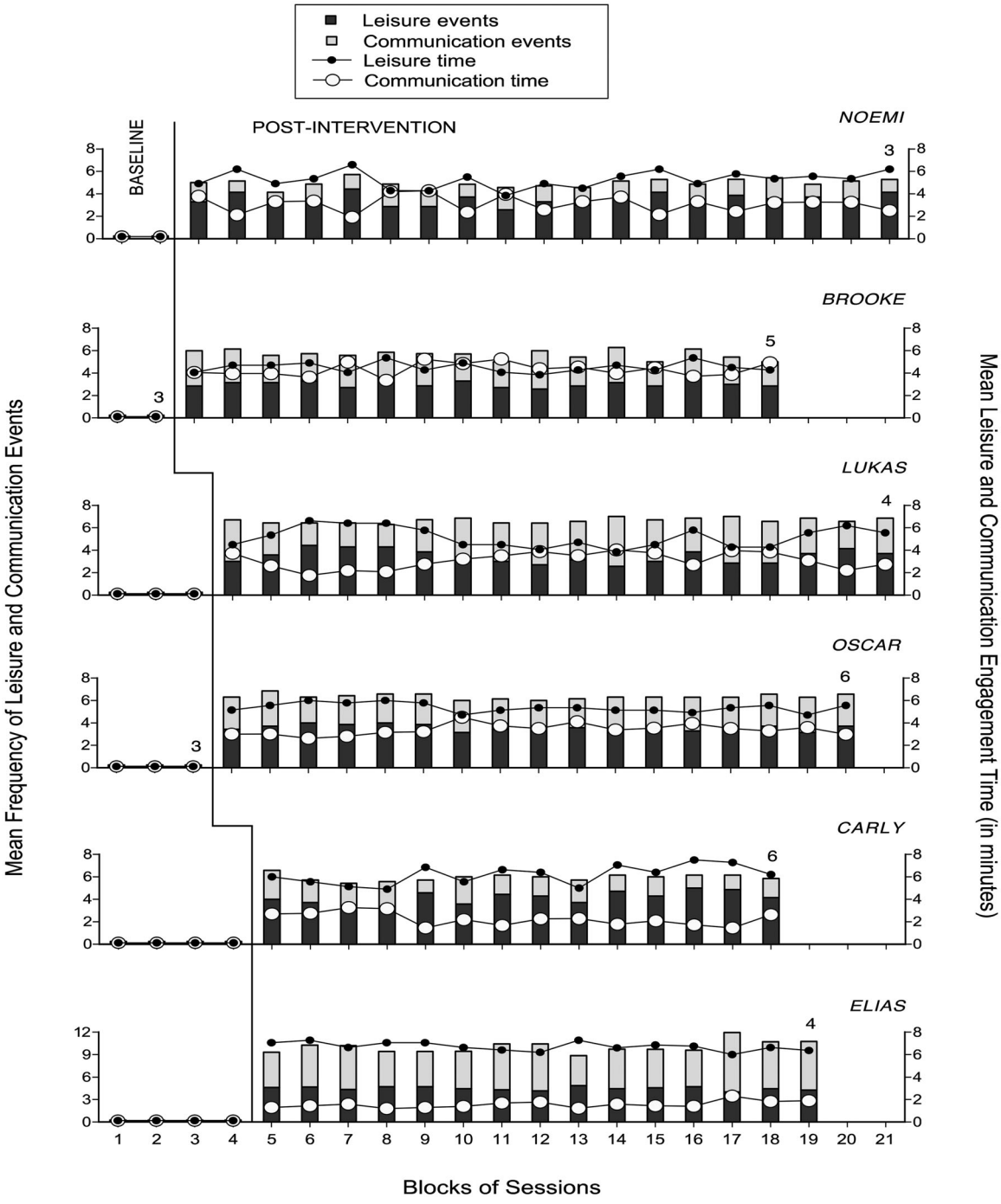

Figure 2. The panels report the participants' data during the baseline and the post-intervention phase. The bars in their entirety show the participants' mean cumulative frequency of leisure events accessed and telephone calls made (first five participants) or messages sent and received (Elias) per session over blocks of sessions. The dark and light grey sections of the bars represent the mean frequency for leisure events and calls or messages, respectively. The black dots and empty circles represent the participants' mean engagement time (in minutes) with leisure events and calls or messages sent and received within the same blocks of sessions, respectively. Blocks include two sessions during the baseline and seven sessions during the post-intervention. Exceptions (i.e. at the end of the phases) are marked with a numeral indicating how many sessions are included.

Results

The panels of Figure 2 report the participants' data during the baseline and the post-intervention phase. The bars in their entirety show the participants' mean cumulative frequency of leisure events accessed and telephone calls made (first five participants) or messages sent and received (Elias) per session over blocks of sessions. The dark and light grey sections of the bars represent the mean frequency for leisure events and calls or messages, respectively. The black dots and empty circles represent the participants' mean engagement time with leisure events and calls or messages sent and received within the same blocks of sessions, respectively. Blocks include two sessions during the baseline and seven sessions during the post-intervention. Exceptions (i.e., at the end of the phases) are marked with a numeral indicating how many sessions are included. The figure does not report the 8 to 10 intervention sessions serving to introduce the participants to the technology system and ensure an independent use of it.

During baseline, the participants did not manage to independently activate the smartphone's Google Assistant and thus did not access leisure events and did not make telephone calls or send messages independently. Consequently, their performance levels were rated as zero. During the intervention sessions, all participants learned to use the technology system, thus accessing leisure events and making telephone calls or sending and receiving messages independently. During the post-intervention phase, all participants continued to be successfully active in terms of leisure engagement and communication (i.e., telephone calls and messaging). The mean frequency of leisure events accessed during the post-intervention phase varied between 3.0 (Brooke) and 4.4 (Elias) per session. The mean engagement time with leisure events varied between 4.5 min (Brooke) and 6.7 min (Elias) per session. The mean frequency of telephone calls made by the first five participants varied between 1.4 (Noemi) and 3.2 (Lukas) per session. Their mean engagement time with telephone calls varied between 2.2 min (Carly) and 4.3 min (Brooke) per session. The mean frequency of messages sent out and received by Elias was 5.5 per session. His mean engagement time with the messages was 1.6 min per session.

The staff members' mean scores for the four survey questions were 4.14, 4.28, 4.22, and 4.39, respectively. These scores suggest that the system was rated as quite effective in helping the participants access leisure and communication, enjoyable for the participants to use, suitable for the participants' daily program, and worthy of recommendation.

Discussion

The results of the study suggest that the new technology system was effective in helping participants with intellectual and visual disabilities to access leisure events and make telephone calls or send and receive messages. These data (a) support previous evidence in the area emphasizing the importance of technology-aided interventions to promote independent leisure and communication engagement [16,18,19,29], and (b) extend that evidence by showing how a relatively easy-to-use technology system can be an effective intervention alternative for persons with relatively limited response skills. It is also noteworthy that staff rated the new technology system quite positively. In light of the above, a number of considerations can be put forward.

First, the new technology system can be suitable for people with blindness as well as for people with functional vision. In the first case, the voice recording devices can be covered with mini objects that represent the leisure options and the partners available. In the second case, the voice recording devices can be covered with easily discriminable pictures/photos. The use of these devices can be very practical. Indeed, they allow the choice of a leisure or communication option to be performed with a simple hand-pressure response that can be immediate and straightforward, thus avoiding any frustration and failure for the participants.

Second, the same technology system can also be used for participants who are more comfortable with message exchanges than with telephone calls. With regard to this point, one may observe that the messages the last participant (Elias) sent out were rather limited and preset for the various communication partners (i.e., an arrangement made to simplify his response requirements). Even with those limited messages, however, the participant could get in touch with relevant partners and stimulate the partners to send back relatively elaborate messages that seemed capable of making the interaction a satisfactory and lasting experience [16,30–32].

Third, the new technology system allows a more restricted range of choices compared to the ranges available in systems previously developed [16–18]. On the one hand, a narrow range of choices may be considered a disadvantage/limitation. On the other hand, the same narrow range might be viewed as a positive fit for individuals with relatively low functional and occupational skills (i.e., adequate to satisfy the individuals' needs/desires within intervention sessions such as those used in this study) [33,34]. Small variations in the choice opportunities available to these individuals might be ensured by changing some of the voice recording devices on display across sessions (thus providing the individuals with slightly different sets of request options on different sessions).

Fourth, the new technology system can be considered easily accessible given that its components are common everyday tools (i.e., smartphone, Google Assistant, and WhatsApp) or readily available commercial gadgets and applications (i.e., mini voice recording devices, Bluetooth speaker, and MacroDroid) [35,36]. In addition to being accessible, the aforementioned technology components are also quite affordable in terms of cost and thus more likely to be available in daily contexts [6,37,38]. For example, the type of smartphone used is a common and fairly inexpensive model. The cost of each mini voice recording device ranges between $15 and $20. Similarly inexpensive are also the Bluetooth speaker and the MacroDroid.

Fifth, in spite of the aforementioned accessibility and affordability, it must be remembered that the new technology system is not ready-made for use within an intervention such as that reported in this study and requires to be specifically arranged. In fact, the smartphone needs to be supplied with a variety of files concerning the participants' preferred leisure events and the communication partners' telephone numbers and pre-recorded answers. The MacroDroid needs to be programmed to control special smartphone's functions (e.g., playing partners' pre-recorded answers and reading out the messages received). Specific messages/requests are to be recorded in the mini voice recording devices so as to ensure that they can trigger the Google Assistant and get the smartphone to play leisure events, start telephone calls, or send out messages.

Sixth, the staff's positive ratings of the technology system and its impact can be considered practically relevant. In fact, the staff worked in the centres in which the participants received their daily treatment and thus could be considered (a) knowledgeable about the needs of the participants, and (b) capable of discriminating a technology solution that might be helpful for those

individuals from technology solutions that might not be very suitable for them [39–41]. Taken together, the staff's ratings might be seen as an overall endorsement of the technology system and a preliminary acceptance for its use in daily contexts.

Limitations

Some limitations of the study should be mentioned here. The first limitation is the small number of participants involved in the study and the fact that the last participant used a different communication strategy (messaging) as compared to the strategy (telephone calls) used by the other participants. New research should verify the strength of the technology system with additional participants using both communication strategies [42,43]. A second limitation of the study is the fact that the communication partners (i.e., family members and staff involved in the telephone calls or message exchanges) were not interviewed as to (a) the perception they had of their interactions with the participants and (b) their possible suggestions to enhance those interactions (i.e., make them more functional and/or enjoyable) [16,44,45]. Both points seem to be particularly important with regard to whether partners would continue to be motivated by their role, and thus ensure that what was observed in the study could last and improve over time. A third limitation of the study is the lack of investigation as to the effects of the intervention and post-intervention sessions on the participants' mood and satisfaction. While one would expect positive changes in these emotional areas to occur (as the sessions included preferred/enjoyable leisure and communication options), research should be carried out to ascertain the presence and extension of those changes [46,47].

Conclusion

In conclusion, the results of the study suggest that the new technology system was effective in helping participants with intellectual and visual disability to access leisure events and make telephone calls or send and receive messages through simple hand responses. The fact that the technology system can be operated with very simple responses might make it a useful option for participants with limited functional and motor skills offering them opportunities not previously available to them. Notwithstanding the above, new research addressing the limitations of this study is needed before one can make general statements about the technology, its applicability, and its practical implications. New research might also help to determine how extensively the technology should be made available during the day [48].

Ethical approval

The study was approved by a relevant Ethics Committee. 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. Written informed consent for the participants' involvement in the study was obtained from their legal representatives.

Author contributions

GL was responsible for setting up the study, acquiring and analyzing the data, and writing the manuscript. NS, MO, JS, GA, VC, and LD collaborated in setting up the study and/or analyzing the data and writing/editing the manuscript

Disclosure statement

No potential conflict of interest was reported by the author(s).

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