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Assistive Technology to support occupational engagement and mobility in persons with multiple disabilities

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Abstract

These two studies extended the evaluation of technology-aided programs for fostering occupational engagement and mobility in persons with multiple disabilities (i.e., severe to profound intellectual disability and blindness or limited residual vision). In Study I, the program (a) provided auditory cues to guide three adults to various desks, at each of which a simple occupational activity was to be carried out, and (b) ensured preferred stimulation at each of the desks. In Study II, the program (a) provided auditory or visual plus auditory cues to guide two adolescents to gather five objects of a collection at five different desks and put each of them into a container located at a sixth desk, and (b) ensured preferred stimulation at each desk. The results of both studies were largely positive with all participants learning to move from one desk to

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the next independently to deal with the activities/objects properly. The results were discussed in light of previous evidence in the area and in terms of practical and technical implications for daily intervention with persons with multiple disabilities.

Keywords: Technology-based programs; Occupation; Mobility; Multiple disabilities.

1. Introduction

An objective of great relevance in any intervention plan for persons with severe/profound intellectual or multiple disabilities (e.g., combinations of intellectual disability and blindness or limited residual vision) is to increase and improve their occupational engagement (Lancioni, Singh, O'Reilly, Sigafoos, Oliva, Campodonico *et al.,* 2008; Van der Putten & Vlaskamp, 2011; Bunning, Kwiatkowska, & Weldin, 2012; Belva & Matson, 2013; Bunning, Smith, Kennedy, & Greenham, 2013; Fox, Burke, & Fung, 2013; Hostyn & Maes, 2013; Lancioni, Singh, O'Reilly, Sigafoos, Alberti, Oliva *et al.*, 2013; Lima, Silva, Amaral, Magalhães, & de Sousa, 2013). Fostering their occupation gives them an opportunity of (a) being active and focusing on adaptive responses (i.e., thus countering their tendency to passivity or problem behavior), (b) performing activities that might give meaning to their time and might be useful and appreciated within the context in which they live, (c) gaining a socially positive image with possibly beneficial implications in terms of acceptance and respect by staff and caregivers, and (d) engaging inmild physical exercise which can be quite valuable, particularly for individuals with extended sedentariness (Van Naarden Braun, Yeargin-Allsopp, & Lollar, 2009; Wennberg & Kjellberg, 2010; Taylor & Hodapp, 2012; Ayres, Mechling, & Sansosti, 2013; Lancioni, Singh, O'Reilly, Sigafoos, Alberti, Perilli *et al.,* 2014).

Promoting occupation in persons with multiple disabilities may pose serious challenges. In fact, many of these persons may have limited activity skills and manage the use of only few, specific types of material/objects and with simple response schemes (Hällgren & Kottorp, 2005; Sheppard & Unsworth, 2011; Foley, Jacoby, Girdler, Bourke, Pikora, Lennox *et al.*, 2013; Fox *et al*., 2013). They might also have problems remaining engaged for any reasonable length of time independently. Indeed, providing them with large quantities of material at any single time might (a) confuse them as to the performance required and (b) fail to motivate them to stay busy without the presence of reinforcing stimulation (Lancioni, Singh, O'Reilly, Green, Oliva, & Campodonico, 2013). Moreover, asking them to move from one simple activity (i.e., involving a small amount of material) to another might be excessive given their generally limited initiative level and the insecurity deriving from their blindness or serious visual disabilities (Lancioni *et al.,* 2008; Lancioni, O'Reilly, Singh, Sigafoos, Alberti, Boccasini *et al.,* 2014; Maes, Vos, & Penne, 2010).

In light of the afore mentioned situation and of the relevance of ensuring independent and sustained engagement with these persons, recent research has emphasized two points. First, arranging small activities at different places may be more practically feasible as well as more beneficial and preferable for the participants than presenting large activities at a fixed place (Frey, 2004; Lancioni *et al.*, 2014). Second, technology may provide the necessary support to help the persons move from one place (small activity) to the next and ensure some form of reinforcing stimulation so that the persons maintain their motivation and engagement for the time programmed (Uslan, Russell, & Weiner, 1988; Bellamy, Croot, Bush, Berry, & Smith, 2010; Chantry & Dunford, 2010; Lancioni, Singh, O'Reilly, Sigafoos, Alberti, Scigliuzzo *et al.*, 2010; Lancioni, Sigafoos, O'Reilly, & Singh, 2013; Näslund & Gardelli, 2013; Lancioni, O'Reilly, Singh, Sigafoos, Alberti, & Boccasini, 2014).

These two studies were an extension of those recently reported by Lancioni, O'Reilly *et al.* (2014). In Study I, three adults with severe to profound intellectual disability and blindness were guided via technology-aided auditory cues to various engagement locations (desks). At each desk, they (a) found a small activity to carry out within a specific time (at the end of which the cues of the following desk were automatically activated), and (b) obtained preferred stimulation. Study II involved two adolescents diagnosed with severe to profound intellectual disability and blindness or limited residual vision. A technology-aided program based on auditory or visual plus auditory cues guided the participants to gather each element of a collection at five different desks and put them together into a container located at a sixth desk. These participants also obtained preferred stimulation at each of the desks.

2. Study I

2.1. Method

2.1.1. Participants

The participants (Chris, Leonard, and Gladys) were 39, 43, and 42 years old, respectively. They had congenital encephalopathy with blindness and intellectual disability, which had been estimated to be in the severe to profound range by the psychological services of the center for persons with multiple disabilities that they attended. They could understand simple verbal instructions dealing with recurring activities and body positions. Their active communication was limited to a few requests concerning preferred objects or toilet and occurred through vocal expressions that staff could interpret or basic gestures. They were able to perform a number of simple activities, such as sorting or assembling objects, but seemed unable to move from one activity (once this had been completed) to the next without staff prompting. This apparent inability was seen as a serious social and practical problem (i.e., emphasizing the participants' dependence and requiring staff time investment). Staff were interested in a technology-aided program that would help the participants extend their engagement time through independent transition from one activity to the next. Moving across activities distributed over the space of a room was rated favorably also in view of the mobility aspect (Lancioni, O'Reilly *et al*., 2014). The participants' legal representatives had signed an informed consent for this study, which had been approved by a scientific and ethics committee.

2.1.2. Setting, activities, moves, sessions, and data recording

The study was carried out in an activity room, in which six desks (each with the material for one activity) were available at a distance of about 2 m from one another. The activities were familiar to the participants (e.g., sorting and assembling objects; see Participants). Sessions consisted of the performance of the six activities available on the desks. Data recording concerned the activities, the moves from one desk to the other, and the length of the sessions. An activity and a move were recorded as correct if the participants appropriately used (e.g., sorted or assembled) at least two thirds of the 8-15 objects available and made the transition from one desk to the next independent of guidance from the research assistant, respectively. Given that the research assistant accompanied the participants to the first desk, a session offered the participants five occasions to move independently (i.e., one occasion for each of the next five desks/activities). Inter rater reliability on recording the afore mentioned measures was checked in about 25% of the sessions. Agreement (with the two raters reporting the same number of correct activities and correct moves, and session lengths differing less than 40 s) was registered in more than 95% of the sessions used for reliability for each of the participants.

2.1.3. Materials and technology

The materials included (a) the six desks mentioned above each of which contained objects for a specific activity, and (b) an audio-recording device with preferred songs and preferred drinks. The activities available at the desks could change across sessions so as to introduce a certain variation in the performance required and to allow the participants to exercise their activity skills. Each desk (except the first one; see below) contained (a) an automated box to provide verbal cues and verbal praise, and (b) an optic sensor (photocell) to detect the participant's arrival. The boxes and optic sensors were connected to an electronic unit programmed to regulate them. Each intervention session started with the research assistant accompanying the participants to the first desk for the performance of the first activity and switching on the electronic unit. At the end of a programmed interval, which was generally somewhat longer than 1 min (i.e., the time considered necessary for the performance of the first activity), the electronic unit activated the boxand optic sensor of the second desk. This box presented verbal cues (i.e., calls/encouragements occurring at intervals of 8 s) to the participant so that he or she would move to the next desk/activity. When the participant reached the second desk and was detected by the optic sensor, the box emitted praise sentences (i.e., preferred stimulation; see below). The same process was repeated for each of the remaining desks. Once the preset activity time for the sixth desk had ended, the research assistant called the participant and provided him or her with praise, 1-2 min of music, and a drink (i.e.,events considered to be preferred based on preliminary observations and screening; see Lancioni, O'Reilly *et al*., 2014).

2.1.4. Experimental conditions

For each participant, the study involved an ABAB sequence, in which A represented baseline phases without technology support and B represented intervention phases with technology support (Barlow, Nock, & Hersen, 2009).

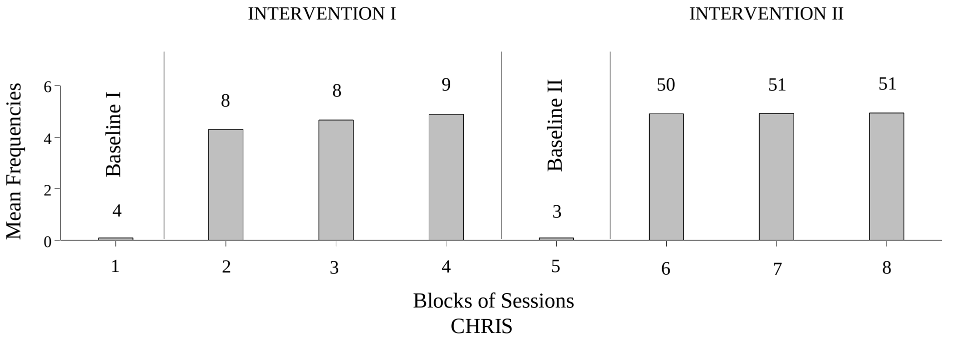
Baseline I and II. The baseline phases included two to four sessions. The participants were guided through the desks/activities and then accompanied to the first of the series with the encouragement to work. If the participants did not leave a desk within about 2 min from their arrival, the research assistant provided them guidance to do so and move to the next desk. At the end of the sessions, the participants received praise, music and a drink as described above.

Intervention I and II. The intervention phases included 25 and 152 sessions for Chris, 32 and 70 sessions for Leonard, and 36 and 91 sessions for Gladys. During the intervention sessions, the conditions matched those described in the *Materials and technology* section. Stimulation was also available at the end of the sessions (see above). Guidance from the research assistant occurred if the participants did not reach a new desk within about 45 s from the onset of the verbal cues. Prior to the start of the first intervention phase, the participants received three practice sessions, in which guidance from the research assistant was available to ensure adequate performance.

2.1.5. Results

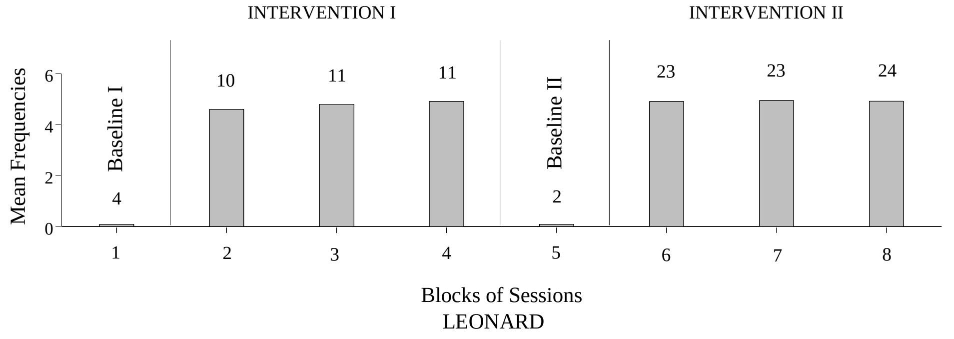
The bars of Figures 1-3 represent mean frequencies of moves from one desk/activity to the next performed independently per session, over blocks of sessions, for Chris, Leonard, and Gladys, respectively. The number of sessions included in each block/bar is indicated by the numeral above it. During the first baseline, the participants' mean frequencies of independent moves were zero. Their mean percentages of activities carried out correctly (not reported in the figures) were about or above 90. During the first intervention phase, all three participants learned to respond to the verbal cues appropriately and their mean frequencies of independent moves per session were near five (i.e., they independently managed nearly all the moves for which cues were available). Their mean percentages of correct activities were above 90. The data of the second baseline and second intervention phases matched those of the previous, corresponding phases. The overall mean length of the intervention sessions was close to 8 min.

Figure 1



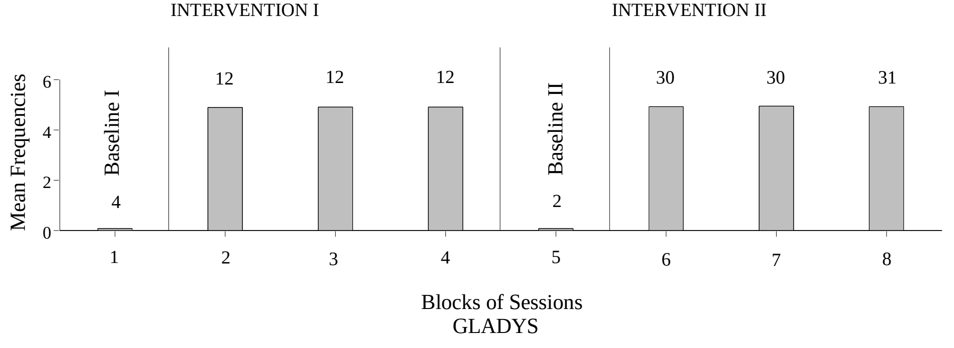
The bars represent mean frequencies of movesfrom one desk/activity to the next performed independently per session, over blocks of sessions. The number of sessions included in each block/bar is indicated by the numeral above it.

Figure 2



Data plotted as in Figure 1.

Figure 3



Data plotted as in Figure 1.

3. Study II

3.1. Method

3.1.1. Participants

The participants (Tyler and Ethel) were 17 years old and had congenital encephalopathy with intellectual disability that previous psychological evaluations had estimated to be between the severe and profound levels, and limited residual vision functional for orienting toward light sources (Tyler) or blindness (Ethel). Ethel was also affected by epilepsy, for which she received medication, and spasticity combined with hip and foot abnormalities, which made her walking relatively slow. Tyler did not have any speech abilities while Ethel could utter a few sounds that parents and staff interpreted as names of persons around her. Both understood a few verbal instructions dealing with common activities, such as eating, drinking, and going to the toilet. Their active communication was limited to food, games, or toilet and generally occurred through gestures or pulling on parents or staff. They could use objects in a very simple manner (e.g., taking and putting them into containers). Moreover, they were not necessarily motivated in handling objects or proficient in collecting them from different areas of a room because of their visual and orientation problems. Given this situation, their occupational engagement was limited and unsatisfactory and intervention strategies to enhance it were considered necessary. Staff and parents were highly interested in the use of a technology-aided program to foster in dependent object use and mobility. The parents had also signed an informed consent for this study, which had been approved by a scientific and ethics committee.

3.1.2. Setting, responses, sessions, and data recording

The study was carried out in an activity room with six desks available for the sessions. Five desks contained an object (e.g., one element of a set/collection for kitchen use) while the sixth had a container in which the five objects of the collection were to be gathered. The first five desks were at a distance of over 1.5 m from one another. The distance between the sixth desk and each of the others was over 3 m. Each session required the participant to pick up an object at each of the first five desks, in the right order, and place it into the container available at the sixth desk. In practice, 10 partial response sequences were involved; five consisted of moving to a desk (i.e., one of the first five) and taking an object and five consisted of moving to the sixth desk and putting away the object taken at one of the other desks. Data recording concerned (a) how many of the partial response sequences were performed independently of guidance from the research assistant (see Study I), and (b) the length of the sessions. Recording and reliability for both measures matched those of Study I.

3.1.3. Materials and technology

The materials consisted of the afore mentioned desks, objects, and container, a large ball and specific light displays (see below).The technology at each of the desks included (a) an automated box providing verbal cues (Ethel) or verbalplus light cues (Tyler) as well as verbal praise and music and (b) an optic sensor (photocell). The box used at the sixth desk was also connected to complex light displays (e.g., fiber lights) for Tyler. Boxes and optic sensors were radio linked to an electronic unit, which controlled their functioning during the sessions. Each intervention session started with the participant standing near the sixth desk and receiving cues from the box on the first desk. The cues consisted of stroboscopic light flashes, which were accompanied by verbal encouragements at intervals of 20 s (for Tyler) and verbal encouragements occurring at intervals of about 8 s (for Ethel). The participant was expected to reach that desk and take the object on display. Taking the object activated the optic sensor on the desk and caused the box to emit verbal praise and 5 s of preferred music. This was followed by the automatic activation of the box at the sixth desk, which started to emit cues (i.e., as the box of the first desk). The participant was expected to transport the object to the sixth desk and place it into the container available there. Placing the object in the container activated an optic sensor, which caused the box to activate praise and 10 s of preferred music (for Ethel) or all that plus light displays (for Tyler). The end of the stimulation activated the box at the second desk and the process continued the same way until the participant had placed the last (fifth) object into the container. Following the final stimulation at the sixth desk, the research assistant provided Tyler with a large ball with which he could play for 2-3 min and Ethel with direct social attention for 2-3 min (i.e., with additional occasions of preferred stimulation).

3.1.4. Experimental conditions

For each participant, the study involved an ABAB sequence, in which A and B represented baseline and intervention phases, respectively (Barlow *et al.*, 2009).

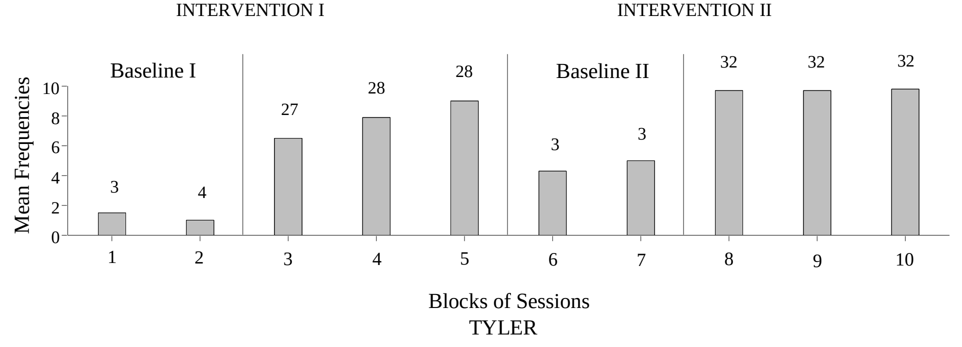
Baseline I and II. The baseline phases included four to seven sessions, which started with the participants being guided through the desks and encouraged to start (i.e., directed toward the first desk). The desks and objects were arranged as described in the *Materials and technology* section. The boxes, optic sensors, and electronic unit were available, but no cues or stimulation were used. Guidance from the research assistant occurred if the participants (a) did not walk for about 1 min or did not reach a desk within 2-3 min, (b) reached a wrong desk (i.e., a desk other than the one expected according to the sequence programmed; see above), (c) failed to take an object or did not leave a desk after about 1 min from arriving at it. At the end of the sessions, the participants were allowed to play with the ball (Tyler) and receive social attention (Ethel), as described above.

Intervention I and II. The intervention phases included 83 and 96 sessions for Tyler and 74 and 88 sessions for Ethel. During the intervention sessions, conditions matched those described in the *Materials and technology* section. The technology provided the participants with verbal or verbal and light cues to move to the desks and positive stimulation at their arrival at each of the desks. Stimulation was also available at the end of the session (see above). Guidance from the research assistant was available as in the baseline. Intervention I was preceded by six practice sessions (see Study I).

3.1.5. Results

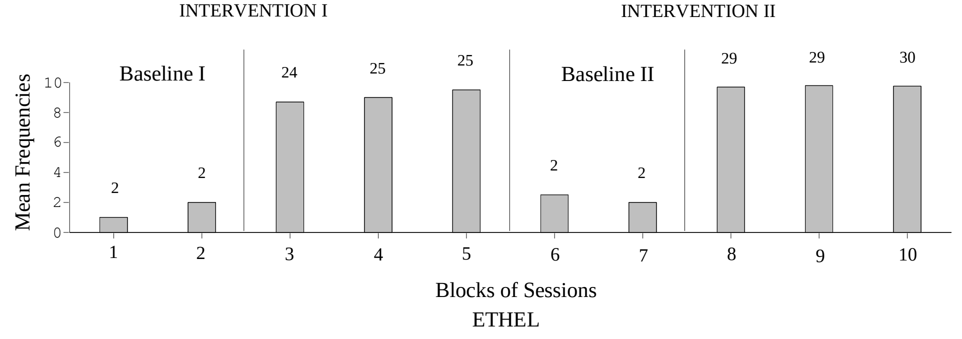
The bars of Figures 4 and 5 represent mean frequencies of partial response sequences performed independently per session, over blocks of sessions, for Tyler and Ethel, respectively. The number of sessions included in each block is indicated by the numeral above it. During the first baseline, the participants' mean frequencies of partial response sequences performed independently per session were below two. During the first intervention phase, the same mean frequencies increased to near eight and nine per session for the two participants, respectively. The second baseline showed a clear decline in the participants' performance. The second intervention phase showed a new performance improvement with the mean frequencies increasing to near 10 per session for both participants. The mean session lengths (not reported in the figure) were (a) about 8.5 and 6.5 min during the two intervention phases, respectively, for Tyler, and (b) above 12 min during both intervention phases for Ethel.

Figure 4



The bars represent mean frequencies of partial response sequences performed independently per session, over blocks of sessions. The number of sessions included in each block is indicated by the numeral above it.

Figure 5



Data plotted as in Figure 4.

4. General discussion

The results of the two studies show that technology-aided programs were helpful in fostering occupational engagement and mobility in persons with multiple disabilities. These results extend previous evidence available from studies based on the use of technology solutions (Uslan *et al.*, 1988; Lancioni *et al.*, 2008, 2010; Lancioni, O'Reilly, *et al.*, 2014; Lancioni, Singh, O'Reilly, Sigafoos, Alberti, *et al*., 2013, 2014). The implications of these results may be relevant from (a) a practical standpoint (i.e., daily contexts dealing with persons with multiple disabilities could see new opportunities and strategies for helping these people make progress), and (b) a technology stand point (i.e., support packages could be developed to foster sustained engagement and some level of mobility in persons who are likely to fail on both these aspects without special help).

Daily contexts are frequently faced with the dilemma of how to provide extra supervision to ensure new, higher levels of occupation and mobility for persons with multiple disabilities when personnel resources are relatively scarce (Maes *et al*., 2010; Luckasson & Schalock, 2012; Lancioni, Sigafoos, *et al.*, 2013). While the dilemma is real and opportunities of reconciling the intervention demands with the available resources seem fairly limited, the present studies and a few others before them have shown a different way to confront the situation and find a compromise answer to the dilemma. The compromise answer is the use of technology-aided programs that can partially replace staff supervision (Borg, Larsson, & Östergren, 2011; Hällgren, Nygård, & Kottorp, 2011; Foley & Ferri, 2012; Wehmeyer, Tasse, Davies, & Stock, 2012; Lancioni, Sigafoos, *et al.,* 2013; Lancioni, O'Reilly, *et al.,* 2014).

Any technology solution to be acceptable within a daily context has to satisfy a number of basic requirements. For example, it needs to be relatively practical for staff personnel, friendly toward the participants, and affordable in terms of costs (Hubbard Winkler, Vogel, Hoenig, Cowper Ripley, Wu, Fitzgerald *et al.,* 2010; McDougall, Evans, & Baldwin, 2010; Scherer, Craddock, & Mackeogh, 2011; Dahlin & Rydén, 2011; Wallace, 2011; Lancioni, Sigafoos, *et al.,* 2013; Lenker, Harris, Taugher, & Smith, 2013). The technology solutions employed in these studies seem to satisfy those requirements. In fact, they appear rather straightforward for staff personnel to program and useas well as rather simple to handle. Participants may find sessions with the technology support largely agreeable and even pleasant given that they (a) can receive reliable and consistent guidance and reach high levels of successful performance (i.e., thus avoiding engagement- and mobility-related anxiety; Lancioni, Singh, O'Reilly, Sigafoos, Boccasini, *et al*., 2014), and (b) obtain preferred stimulation contingent on their performance in a very regular manner (Kazdin, 2001; Pierce & Cheney, 2008). The afore mentioned conditions plus an improvement in their social appearance and a possible/related increase in positive attention from staff may have beneficial implications for their quality of life (Brown, Schalock,

& Brown, 2009; Sunderland, Catalano, & Kendall, 2009; Verdugo, Gómez, Arias, Navas, & Schalock, 2014). Finally, the cost of the technology solutions (estimated at about US $2,500) seems affordable for an average care and rehabilitation context and thus would not represent a barrier against their adoption (Baxter, Enderby, Evans, & Judge, 2012).

Any technology solution may need to be considered as a basic flexible aid. The main reasons for this view are that (a) different characteristics of the participants may require adaptations of those solutions (i.e., as it was required for the two participants of Study II) and (b) the large and fast evolution of the technology field may make packages used today rather obsolete in a short time (Borg *et al.,* 2011; Hällgren *et al*., 2011; Foley & Ferri, 2012; Luckasson & Schalock, 2012; Lancioni, Sigafoos *et al.* 2013; Näslund & Gardelli, 2013; Lancioni, O'Reilly, *et al*., 2014). A third important reason for thinking of the technology solutions as transitory aids is the impact of new research evidence. Further evaluations of the technology solutions with new participants will eventually ascertain the robustness of those solutions and emphasize strengths and weaknesses that are at present not visible (Kennedy, 2005; Barlow *et al.*, 2009; Gibson, Carnevale, & King, 2012; Wehmeyer *et al.*, 2012; Lancioni, Singh, O'Reilly, Sigafoos, Alberti, *et al*., 2014).

In conclusion, the results of the two studies indicate that technology-aided programs can be effectively used to foster occupational engagement and mobility in persons with multiple disabilities.While these results are quite encouraging, caution is required given the small number of participants involved in these studies and previous ones in the area and the need to gather additional evidence to determine the strength of the present data. New research should deal with four points, that is, (a) extending the application of the programs to additional individuals, (b) verifying the possibility of expanding the participants' engagement time by using extra desks with activities/objects, (c) examining possible adaptations and innovations of the technology, and (d) interviewing staff and other service providers to gather their views about the solutions available and ways of improving them (Kennedy, 2005; Lancioni, O'Reilly, Singh, Groeneweg, Bosco, Tota *et al.*, 2006; Callahan, Henson, & Cowan, 2008; Barlow *et al.*, 2009; Borg *et al.*, 2011; Ripat & Woodgate, 2011; Näslund & Gardelli, 2013; Lancioni, O'Reilly, *et al*., 2014).

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