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Technology-aided options for helping persons with multiple disabilities engage in communication behavior

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Abstract

Efforts to promote communication in persons with multiple disabilities have largely focused on enabling them to make requests to their immediate caregivers and to exchange text messages or phone calls with distant partners. These two single-case studies extended the research in the latter area. Specifically, Study I targeted text messaging for a woman with visual and motor impairment and mild intellectual disability, teaching her to write her messages via microswitch, virtual keyboard, and word predictor. Study II targeted the use of phone calls for a post-coma adult male with motor impairment and mild to moderate intellectual disabilities, using a technology system that provided him with wide assistance through the process. The results of both studies were

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quite encouraging, showing an appropriate use of text messaging, including the writing of messages (Study I), and a successful performance of phone calls (Study II). The results were discussed in terms of their general relevance and implications for care and rehabilitation contexts.

Keywords: Communication; Text messaging; Phone calls; Multiple disabilities.

1. Introduction

Persons with congenital or acquired multiple disabilities are often unable to manage occupation and communication/interaction engagement in spite of their apparent interest in activities and people around them (Chantry & Dunford, 2010; Chung, Carter, & Sisco, 2012; Ball & Fazil, 2013; Iacono, Lyon, Johnson, & West, 2013; McNaughton & Light, 2013; Cockerill, Elbourne, Allen, Scrutton, Will, McNee *et al.*, 2014; Lancioni, Singh, O'Reilly, Sigafoos, Alberti, Perilli *et al.*, 2014; Lancioni, Singh, O'Reilly, Sigafoos, Oliva, Buonocunto *et al.*, 2014; Roche, Sigafoos, Lancioni, O'Reilly, Green, Sutherland *et al.*, 2014; Sutherland, van der Meer, Sigafoos, Mirfin-Veitch, Milner, O'Reilly *et al.*, 2014). Their failures may be due to neuro-motor impairments, speech and communication deficits, or combinations of these problems with social and intellectual disabilities (Bunning, Kwiatkowska, & Weldin, 2012; Lancioni, O'Reilly, Singh, Sigafoos, Buonocunto, Sacco *et al.*, 2013; Shih, 2013; Goldbart, Chadwick, & Buell, 2014). Such failures share a critically negative impact on the persons' life conditions (e.g., adjustment, participation, and status) and, consequently, on their quality of life (Hughes, Redley, & Ring, 2011; Alimovic, 2013; Verdugo, Gómez, Arias, Navas, & Schalock, 2014).

Given the importance of helping these persons improve in the aforementioned skill areas, a number of studies have been conducted introducing specific strategies and technology (Ramdoss, Lang, Mulloy, Franco, O'Reilly, Didden *et al.*, 2011; Sigafoos, Wermink, Didden, Green, Schlosser, O'Reilly *et al.*, 2011; Lancioni, Sigafoos, O'Reilly, & Singh, 2013; Lidström & Hemmingsson, 2014; Sutherland *et al.*, 2014). In the communication area, efforts have been largely concentrated on helping the persons to make requests to their immediate caregivers, and to exchange text messages or phone calls with distant partners (Lancioni, O'Reilly, Cuvo, Singh, Sigafoos, & Didden, 2007; Ramdoss *et al.*, 2011; van der Meer, Kagohara, Achmadi, O'Reilly, Lancioni, Sutherland *et al.*, 2012; van der Meer, Sutherland, O'Reilly, Lancioni, & Sigafoos, 2012; Gevarter, O'Reilly, Rojeski, Sammarco, Lang, Lancioni *et al.* 2013a, 2013b; Lancioni, O'Reilly *et al.*, 2013; Lancioni, Singh, O'Reilly, Sigafoos, Buonocunto, Sacco *et al.*, 2013; Lancioni, Singh, O'Reilly, Sigafoos, Oliva, & Campodonico, 2013; Sigafoos, Lancioni, O'Reilly, Achmadi, Stevens, Roche *et al.*, 2013; Bracken & Rohrer, 2014).

The use of text messaging has normally relied on the availability of a computer with specific software, a mobile communication modem, and a microswitch (Lancioni, O'Reilly, Singh, Green, Oliva, Buonocunto, *et al.*, 2012; Lancioni, O'Reilly, *et al.*, 2013; Lancioni, Singh, O'Reilly, Sigafoos, Oliva, *et al.*, 2014). The computer verbally listed (a) the partners among which a participant with multiple disabilities could choose the one to target for a message, and (b) messages among which the participant could choose the one to send to the target partner. The microswitch served to make selections and send the message by means of a small/minimal response. Lancioni, Singh, O'Reilly, Green, Ferlisi, Farrarese *et al.* (2013) also showed the possibility of enabling a participant with amyotrophic lateral sclerosis to write his messages through a virtual keyboard and a microswitch. To make the participant's writing process faster, a special word predictor was used.

Phone calls can serve as a means of communication as well as (or even more) as a form of social/emotional interaction (Lancioni, O'Reilly, *et al.*, 2013; Lancioni, Singh, O'Reilly, Sigafoos, Buonocunto, *et al.*, 2013; Lancioni, Singh, O'Reilly, Sigafoos, Oliva, *et al.*, 2013) and can occur through a technology package similar to that used for text messaging. For example, Lancioni, Singh, O'Reilly, Sigafoos, Buonocunto, *et al.* (2013) used the phone calls option with two post-coma participants with multiple disabilities who (a) were presented with the names of the partners available for their calls and (b) could choose the partner to call via a microswitch response. The participants were able to produce "yes" or "yes and no" sounds during the conversation with the partners, thus interacting with them and influencing the conversation.

The results of the aforementioned studies and other studies in the area suggest the possibility of teaching persons with multiple disabilities to exchange text messages or phone calls with relevant partners. Even so, caution is required in drawing conclusions because (a) the number of participants involved in the research is relatively small, and (b) adaptations of the programs/technology available may be needed to meet the requirements of participants differing in characteristics and/or interests from those involved in previous studies (Kennedy, 2005; Barlow, Nock, & Hersen, 2009; Posatskiy & Chau, 2012; McNaughton & Light, 2013). These two single-case studies' objectives were to extend research in this area. Specifically, Study I extended the research on text messaging by teaching a woman with visual and motor impairment and mild intellectual disability to write her messages via microswitch, virtual keyboard, and word predictor. Study II extended the research on the use of phone calls by involving a post-coma man with intellectual and motor disabilities and difficulties in linking names to persons. The technology used for him combined names with photos and provided wide assistance throughout the process (Perilli, Laporta, Campodonico, Oliva, & Groeneweg, 2013).

2. Study I

2.1. Method

2.1.1. Participant

The participant (Coleen) was 40 years old and had a diagnosis of congenital encephalopathy with mild intellectual disability, spasticity combined with hip and foot abnormalities, and severe visual impairment. She was able to speak but her utterances could be difficult to understand. Her level of intellectual disability was mainly estimated on the basis of her receptive language skills and her ability to write and read simple sentences (i.e., provided that the letter size was rather large, that is, about 2 cm x 2 cm). Her relative speech capacity could help her to make statements and requests within her immediate context, but was not necessarily helpful for communicating with distant partners via telephone. Yet, she liked to communicate/interact with those partners (i.e., family members and friends) and the idea of using text messaging technology to bridge that gap sounded exciting to her. She was therefore eager to participate in this study, which had been approved by a scientific and ethics committee. Her legal representative, moreover, had signed a consent form for her participation.

2.1.2. Setting and Technology

The study was carried out in the rehabilitation center that Coleen attended. The technology included a text messaging system and a pressure microswitch activated with a hand response. The text messaging system included a computer, a mobile communication modem, and specific software (Lancioni, Singh, O'Reilly, Green, *et al.*, 2013). Initial microswitch activation led the computer to verbalize the names of the12 partners available for text messaging, at intervals of 2-3 s from one another. Selecting a partner (i.e., microswitch activation after his or her name)turned on a scanning keyboard emulator on the computer screen for writing a message to him or her. Scanning/lighting started from the letters' rows(one at a time in succession for about 3 s). Microswitch activation in relation to a row caused the scanning of separate sections of that row in succession (as above). Microswitch activation in relation to a section caused the single keys of that section to be scanned for 1-2 s. Microswitch activation in relation to a key (letter) wrote that letter on the upper half of the computer screen and restarted the scanning process.

Writing the second letter of a word caused the appearance of three cells to the side of the screen. Two cells showed words starting with the same letter sequence, while the other was a “No-word cell” (Lancioni, Singh, O’Reilly, Green, *et al.*, 2013). Coleen would choose (a) a cell with the word matching the one she wanted to write (i.e., if this existed) or (b) the no-word cell. Choosing the no-word cell led her to resume the writing process. The vocabulary on which the word prediction worked was set up by research assistants and contained about 65 words often used by Coleen.

Once a message had been written, Coleen sent it out by activating her microswitch in relation to the “send” key. Incoming messages did not interfere with writing. In fact, the system signaled them either at the beginning of the session or immediately after the sending out of a message. Microswitch activation in relation to the signaling led the system to read the message and the name of the sender.

2.1.3. Experimental Conditions

The study consisted of an ABAB sequence, in which A and B represented baseline and intervention phases, respectively (Barlow *et al.*, 2009). Intervention sessions lasted 20 min or until any outgoing or incoming message started or opened before the 20-min mark had been sent or fully read. Baseline sessions lasted only 10 min because Coleen was not expected to manage the use of messages without technology. Data recording concerned the (a) number of messages sent and received (listened to) independently from the research assistant, and (b) the mean number of words and letters used per message sent. Interrater reliability was assessed in about 25% of the sessions. Agreement on each of the two measures (computed by dividing the number of sessions in which the two research assistants involved in data collection provided identical recordings by the total number of reliability sessions and multiplying by 100) was above 90%.

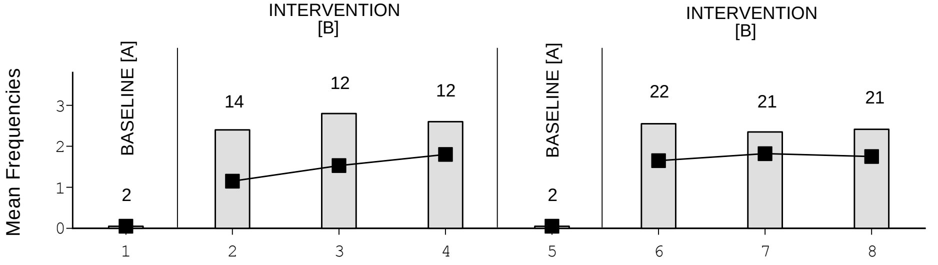
Baseline (A). Each of the two baseline phases included two sessions. Coleen was provided with (a) a computer system with regular keyboard and mouse to write and send out the messages and (b) a mobile phone to receive messages. If she did not progress in writing or reading a message for 30-60 s or asked for help with either of the two tasks, the research assistant provided the guidance required for a positive outcome (i.e., to minimize her frustration).

Intervention (B). During the intervention phases (which included 38 and 64 sessions, respectively), Coleen had the technology available, which worked as described above. The first intervention phase was preceded by six practice sessions with guidance from the research assistant. Subsequently, guidance was used only if she encountered a problem and asked for help.

2.2. Results

The bars and black squares of Figure 1 represent mean frequencies of messages sent and messages received (listened to) independently per session over blocks of sessions, respectively. The number of sessions included in the blocks is indicated by the numeral above the bars. During the two 10-min sessions of the first baseline phase, Coleen did not manage to send or receive/read any message independently. During the first intervention phase, she managed to independently send a mean of about two and a half messages and listen to a mean of about one and a half messages per 20-min session. Mean numbers of words and letters per message sent (not reported in the figure) were about 6 and 35, respectively. Virtually no guidance from the research assistant was needed. During the second baseline and the second intervention phases, data were comparable to those observed in the initial two phases.

Figure 1 - *Blocks of sessions (Coleen)*



Note: The bars and black squares represent mean frequencies of messages sent and messages received (listened to) independently per session over blocks of sessions, respectively. The number of sessions included in the blocks is indicated by the numeral above the bars.

3. Study II

3.1. Method

3.1.1. Participant

The participant (Marvin) was 54 years old and had incurred brain injury and coma following an aneurysm rupture several years prior to this study. He presented extensive motor impairment and reduced level of communication/interaction (i.e., he generally used one- or two-word utterances only when presented with a question). Psychological reports indicated mild to moderate levels of intellectual disability, but formal testing had not been carried out. He had adequate comprehension of simple statements and questions dealing with familiar persons and daily events (i.e., reacted appropriately about them). He enjoyed having direct or phone-mediated contact with family members and friends. However, he was not able to make phone calls on his own. He also presented occasional problems with names' discrimination/association and could be perplexed at the caregiver's question of whether he wanted to call a specific person identified by name. He appeared to be more confident and efficient in responding when the person's photo was presented. Given this situation, a technology-aided program to help him call family members and friends was thought to be a highly valuable solution for both communication and emotional purposes. To help him manage the aforementioned problems with names, the technology was set to use combinations of names and photos to guide him in selecting the persons to call. He seemed quite eager to use such technology. His legal representative had signed a formal consent for his involvement in the study, which had been approved by a scientific and ethics committee.

3.1.2. Setting and Technology

The study was carried out in the rehabilitation center that Marvin attended. The technology was a mixture of the versions used by Lancioni, Singh, O'Reilly, Sigafoos, Oliva, *et al.* (2013) and Perilli *et al.* (2013). It consisted of a computer, a mobile communication modem, a microswitch, and specific software. The microswitch was a simple touch/pressure layer fixed onto a telephone receiver that was activated as Marvin picked it up. At the start of the session, the computer (a) verbally asked Marvin whom he wanted to call and(b) listed eight relevant partners (e.g., brother, daughter, and old friends), one at a time. For each partner, the computer verbalized the name and showed the photo on the screen for 4-5 s. As suggested above, the addition of photos seemed to improve Marvin's responding. Lack of response within the 4-5 s during which the photo was on display led the computer to present the next name and photo. Marvin's responding to a name-photo combination (i.e., taking the telephone receiver) led the computer to select the telephone number of that partner and call him or her, while his or her photo remained on view. After the end of the communication with a partner or following the impossibility to establish contact (i.e., because of no response or busy signal), the computer asked Marvin to put down the telephone receiver. The computer started the sequence for a new call after 1-2 min from Marvin's putting down the receiver or from his failure to select a name for a call during a previous presentation of the names-photos available.

3.1.3. Experimental Conditions

The study was carried out according to an ABAB sequence, in which A and B represented baseline and intervention phases, respectively (Barlow *et al.*, 2009). Sessions lasted 10 min or until a call started before the 10-min limit had been completed. Data recording concerned the (a) number of phone calls made independently by the participant (i.e., without guidance from the research assistant; see below) and whether they were answered, and (b) conversation/interaction time. Interrater reliability was assessed in about 25% of the sessions. Agreement on each of the two measures (computed by dividing the number of sessions in which the two research assistants involved in data collection provided equivalent recordings by the total number of reliability sessions and multiplying by 100) was above 90%. Equivalent recordings implied identical numbers for phone calls made and answered and discrepancies of less than 30 s on the conversation/interaction time.

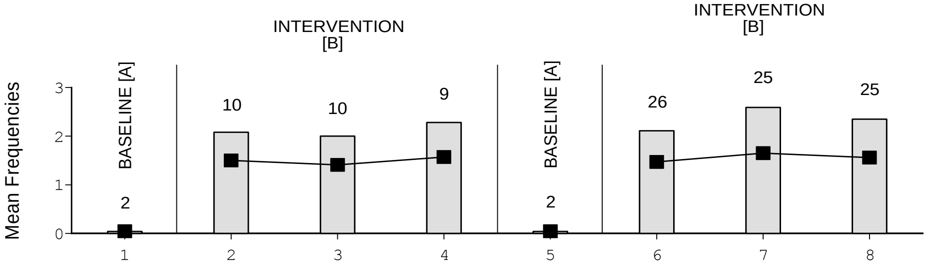
Baseline (A). Each of the two baseline phases included two sessions during which Marvin was provided with a desk telephone. The research assistant told him that he could use that telephone to make phone calls. If he did not take any initiative for about 3 min. or picked up the telephone receiver without progressing, the research assistant (a) asked him whom he wanted to call, (b) called that partner for him, and (c) allowed him to communicate with that partner, thus avoiding frustration.

*Intervention (B).*During the intervention phases (which included 29 and 76 sessions, respectively), Marvin had the technology available, which worked as described above. The first intervention phase was preceded by seven practice sessions in which Marvin received guidance from the research assistant. During the intervention sessions, guidance occurred only if Marvin failed to select a partner after three presentations of the list of partners had occurred (see above).

3.2. Results

The bars and black squares of Figure 2 represent mean frequencies of phone calls made independently and of phone calls answered per session over blocks of sessions, respectively. The number of sessions included in the blocks is indicated by the number above the bars. During the two sessions of the first baseline phase, Marvin did not manage to make any phone calls independently (and a zero score was provided for phone calls answered). During the first intervention phase, he made a mean of over two independent calls per session with about one and a half of them answered. The mean conversation/interaction time per session was about 4 min. The number of calls occurred after guidance from the research assistant (i.e., not reported in the figure) was virtually zero. The data of the second baseline and the second intervention phases were similar to those of the initial two phases.

Figure 2 - *Blocks of sessions (Marvin)*



Note: The bars and black squares represent mean frequencies of phone calls made independently and of phone calls answered per session over blocks of sessions, respectively. Data are plotted as in Figure 1.

4. Discussion

The results of Study I show that a woman with mild intellectual disability, severe visual problems and functional motor impairment successfully operated a technology package (a) to prepare/write text messages and send them out to persons she had previously selected, and (b) to receive (i.e., have the computer read out) incoming messages. The results of Study II indicate that a post-coma adult male with intellectual, motor, and language disabilities successfully operated a technology package to make phone calls. In light of these results, a number of considerations seem in order.

First, text messaging can be a relevant resource for participants who want to interact with distant partners and have speech problems. Given the difficulties that participants with multiple disabilities find in writing, research on text messaging has typically relied on the use of prearranged messages (Lancioni *et al.*, 2012; Lancioni, Singh, O'Reilly, Sigafoos, Oliva, *et al.*, 2014). That is, the participant was taught to choose among different groups of messages the correct one to send. This operation was relatively simple to accomplish, under careful computer guidance, and also rather fast. In this study, the participant was enabled to write her own messages and thus express her specific views to the communication partners (Lancioni, Singh, O'Reilly, Green, *et al.*, 2013). Two technology components were critical to make this possible, that is, (a) a scanning keyboard emulator with microswitch for letter selection, and (b) a special word predictor. The first component served to bypass the limits imposed by the participant's inability to use a keyboard of conventional or expanded size. In spite of this inability, she was rather effective in picking the letters required for the words/messages via the microswitch. The second component served to reduce the writing time. Given the relatively small vocabulary the participant used, many words could be predicted at an early stage and thus written with reduced time costs (Lancioni, Singh, O'Reilly, Green, *et al.*, 2013).

Second, although the word predictor can be considered a useful tool to reduce the overall writing time (which research assistants estimated to average about 6 min per message in the case of Coleen), additional efforts are necessary to make writing more practical/efficient. To pursue such a goal, two strategies might be applied. One strategy involves a revision of the scanning process and participant's possible inputs on such process. For example, (a) the letters could be divided into four sections, which are scanned in succession, and (b) the participant could be allowed to extend the scanning of a section if he or she needs more than one letter from that section. The other strategy concerns the use of a practical, fast response and matching microswitch to select letters and control the scanning process. For example, lip and eyebrow movements might be much faster and, thus, represent a better response than the hand movements adopted for Coleen (Lancioni, Singh, O'Reilly, Green, *et al.*, 2013).

Third, the results of Study II suggest that technology can be arranged to help participants with serious disabilities to communicate/interact with distant partners through the telephone. Indeed, the technology used in Study II helped the participant by (a) reminding him (at specific intervals)of the possibility of making a phone call, (b) presenting the partners available for the call, (c) activating such a call as soon as he selected a partner, and (d) instructing him to put down the telephone receiver at the end of a call or when a call failed. A conventional (old style) telephone was used as microswitch because such an apparatus was a natural link to phone calls for the participant. The participant's verbal behavior during the phone calls was rather poor. He generally used "yes" and "no" and few other words. Yet, he was reported to have expressions of interest and happiness (e.g., small smiles) during several phone calls. One could argue that the calls were not very intense in terms of sheer communication, but were highly useful in terms of interaction and emotional relation with the partners selected (Lancioni, O'Reilly, *et al.*, 2013; Lancioni, Singh, O'Reilly, Sigafoos, Buonocunto, *et al.*, 2013; Lancioni, Singh, O'Reilly, Sigafoos, Oliva, *et al.*, 2013; Hagan & Thompson, 2014).

Fourth, the technology solutions used in Studies I and II involved a computer system with specific software, a mobile communication modem, and a microswitch. Their use appeared fairly straightforward for participants and caregivers. Moreover, their cost (estimated at about US $ 2,500)seems affordable for most care and rehabilitation contexts (Hubbard Winkler, Vogel, Hoenig, Cowper Ripley, Wu, Fitzgerald *et al.*, 2010; Dahlin & Rydén, 2011; Wallace, 2011). Simplicity of use and affordable costs may be two critical elements in facilitating the adoption and continued use of technology solutions in applied contexts (Scherer, Craddock, & Mackeogh, 2011; Baxter, Enderby, Evans, & Judge, 2012; Fried-Oken, Beukelman, & Hux, 2012; Gibson, Carnevale, & King, 2012; Scherer, 2012; Lenker, Harris, Taugher, & Smith, 2013; Näslund & Gardelli, 2013).

In conclusion, the two studies showed ways of promoting communication/interaction for participants with different types of multiple disabilities. Each of the studies emphasized aspecific objective and a technology solution to attain it (i.e., technology packages for supporting active text messaging or phone calls). Albeit encouraging, the evidence available is still limited and new research with additional participants is needed in relation to each of the objectives and technology solutions to determine the strength and implications of the present findings (Kennedy, 2005; Barlow *et al.*, 2009. Other research initiatives could involve (a) assessments of participants' satisfaction with the technology solutions and communication opportunities offered to them (i.e., through preference checks or the recording of indices of happiness during and outside the sessions), (b) interviews of staff personnel to determine their opinion on the social value of the technology solutions used, their level of support for such solutions, and their suggestions for future developments and improvements in the area, and (c) updates and adaptations of the present technology solutions so as to make them more effective and also suitable for participants with different characteristics (Callahan, Henson, & Cowan, 2008; Ripat & Woodgate, 2011; Bauer & Elsaesser, 2012; Foley & Ferri, 2012; Gibson *et al.*, 2012; Lamontagne, Routhier, & Auger, 2013; Lancioni, Sigafoos, *et al.*, 2013; Lenker *et al.*, 2013; Näslund & Gardelli, 2013).

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