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Original Research

A Technology-Aided Program to Help People with Profound Intellectual and Multiple Disabilities Access Preferred Stimulation and Exercise Motor Responses and Visual Orientation

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Abstract

People with profound intellectual and multiple disabilities (PIMD) are generally isolated, with a high risk of reduced stimulation input and physical inactivity. One of the strategies available to mitigate this situation relies on using technology-aided programs delivering stimulation contingent on people's basic responses/activation. The two studies reported here were intended to extend the evidence available in this area. Specifically, Study I assessed whether a technology-aided program, which enabled participants to obtain preferred stimulation by touching an illuminated square (response target) changing position on a touch screen, would effectively increase their responding and, consequently, their stimulation input. Study II served as (a) a replication of Study I and (b) a means to assess whether responding in relation to a target changing position would increase the participants' visual orientation/attention compared to responding in relation to a static target. Seven participants were included, three

in Study I and four in Study II. Each study was conducted using a single-case research methodology. The results of both studies showed that the participants increased their responding and, thus, their stimulation input using the technology-aided programs. The program involving a response target changing position required differentiation of the response schemes (probably increasing the level of physical activation) and also tended to improve visual orientation, compared to the program using a fixed response target. Thus, the program involving a changing position of the response target may be considered a preferable tool for helping people with PIMD.

Keywords
PIMD; stimulation; physical activity; touching responses; visual orientation; technology-aided programs

1. Introduction

People with profound intellectual and multiple disabilities (PIMD) are typically characterized by intellectual disability combined with motor and/or sensory impairments, lack of speech, and minimal levels of non-verbal communication [1-5]. Given their complex condition, they tend to have serious problems interacting with their context and thus are generally isolated with a high risk of reduced stimulation input and physical inactivity [6-10].

The negative psychological and physical implications of such a situation have led to various intervention strategies aimed at increasing the people's stimulation input and possibly their physical activity level and/or communication occasions [7, 8, 11-15]. One of those strategies relies on providing people with extra opportunities for social contact with staff, family members and others to improve their stimulation input and activity level [1, 2, 5, 16]. Another strategy emphasizes the importance of using multisensory rooms, that is, environments in which people are exposed to various forms of stimulation that are expected to engage their senses and make them feel well [17-20]. A third strategy, known as multisensory storytelling, concentrates on the narration of simple stories and accompanies such narration with the presentation of stimulating events that underline the main aspects of the stories being narrated [21-25]. A fourth strategy relies on the systematic presentation of preferred common stimuli to ensure an enriched environmental input for the participants [11, 26-29]. A fifth strategy involves technology-aided delivery of brief periods of preferred stimulation contingent on the emission of simple responses (e.g., 10 s of preferred music for each object-touching response) [7, 14, 30-33].

While all those strategies are considered beneficial for the people's conditions, three considerations may be in order. First, the level of evidence available for the first three strategies is relatively limited and/or not always univocal [5, 19, 20, 24]. Second, those strategies are also relatively expensive to implement either in terms of staff time (i.e., increased social contact and multisensory storytelling) or in terms of environmental setup (i.e., multisensory rooms) [7, 18, 34]. Third, strategies based on the use of stimulation contingent on specific responses (a) may be considered much less demanding in terms of staff time or environmental setup than the first three strategies [7, 30, 35, 36], and (b) may be more effective in fostering people's self-determination,

satisfaction, and motor activation than a strategy based on environmental stimulation enrichment [7, 30, 36, 37].

Given the above, one could argue that the strategy relying on contingent stimulation may represent a viable and relatively advantageous/practical approach for helping people with PIMD. The two studies reported here were intended to extend the evidence available about this type of strategy by testing the possibility of using a response target that changed position across trials and thus required the participants to adjust their responses. Specifically, Study I assessed whether a technology-aided program, which allowed participants to obtain preferred stimulation by touching an illuminated square (response target) changing position on a touch screen, would effectively increase their responding and, consequently, their stimulation input. Using an illuminated square changing position (rather than a static illuminated square) was a practical means to foster the participants' exercise of different response schemes with possible benefits for their motor/physical activity [9, 15, 36]. Study II served as (a) a replication of Study I and (b) a means to assess whether responding in relation to a target (illuminated square) changing position would also increase the participants' visual orientation/attention compared to responding in relation to a static target [38-41]. Seven participants were included, three in Study I and four in Study II. Each study was conducted following a single-case research methodology.

2. Study I

2.1 Method

2.1.1 Participants

Table 1 lists the three participants involved in Study I with their pseudonyms (i.e., Leo, Lauren, and Rafael) and reports their chronological age, their visual and motor condition, and their Vineland age equivalents for Daily Living Skills (Personal Sub-Domain) on the second edition of the Vineland Adaptive Behavior Scales [42, 43]. Their chronological age ranged from 25 to 46 years. All three participants had a diagnosis of severe visual and motor impairments connected to congenital encephalopathy. They were credited with a positive score on five of the initial nine items of the Vision Assessment for People with Polyhandicap (VA-PLH) [44]. They were rated to have a functional residual vision that was adequate to see the response target (illuminated square) on the touch screen. The motor impairments impeded or hampered the participants' ambulation but did not interfere with their performance of the arm/hand movements required to touch the response target on the screen. The Vineland age equivalents were between 1 year and 2 months and 1 year and 8 months. No IQ scores were available. The care and rehabilitation centers the participants attended had rated them to be in the profound intellectual disability range.

Table 1 Participants' chronological age, visual and motor condition, and Vineland age equivalents for Daily Living Skills (Personal sub-domain).

Participants (pseudonyms)	Chronological Age (years)	Visual and Motor Condition	Vineland age equivalents [1, 2]
Leo	32	Functional residual vision; Brief ambulation with support	1;4

Lauren	25	Functional residual vision; Lack of ambulation	1;2
Rafael	46	Functional residual vision; Brief ambulation with support	1;8

[1] Age equivalents are based on the Italian standardization of the Vineland scales [42]. [2] Age equivalents are reported in years (number before the semicolon) and months (number after the semicolon).

The participants were selected for the study based on several conditions. First, they were known to be largely passive and detached and had no real opportunity to receive stimulation or engage in physical activity without staff/caregivers' support. Second, they possessed the visual and motor prerequisites for participating in the study (see above). Third, they were reported to enjoy music and other forms of auditory or auditory and visual stimulation (i.e., stimulation that could be made available contingent on their touching response). Fourth, staff and caregivers supported the program set up for the study, which had been presented to them in advance.

2.1.2 Ethical Approval and Informed Consent

The opinion of staff and caregivers was that the participants would enjoy their involvement in the study, given that they could access multiple instances of preferred stimulation during intervention sessions. Moreover, their practice of arm/hand response schemes during the sessions was considered beneficial to increase their level of physical activity. The staff and caregivers' favorable view of the study and its implications were shared by the participants' legal representatives, who signed a consent form authorizing their involvement in the study. The study complied with the 1964 Helsinki Declaration and its later amendments and was approved by an institutional Ethics Committee.

2.1.3 Setting, Sessions, Response, Stimuli, and Research Assistants

A quiet room of the centers that the participants attended served as the setting for the study. Intervention and baseline sessions (i.e., sessions with or without the presence of stimulation; see below) lasted 5 min and occurred 1 to 3 times a day, 4 to 6 days a week. The response selected for the participants to perform consisted of touching an illuminated square on a touch screen in front of them (i.e., pointing/moving with any part of their hand on any portion of the square). The square, illuminated (visible) for 15 s or until the participants touched it, appeared in different parts of the touch screen across different trials (see below).

The stimuli that followed the participants' touching response during the intervention sessions included various types of music and voices (for Leo and Rafael) and combinations of music, voices, and lights (for Lauren). These stimuli were used for the study after a stimulus preference screening had shown that the participants seemed to find them enjoyable. Specifically, three segments of every stimulus were presented (each for about 10 non-consecutive times) over successive screening sessions. A stimulus was considered enjoyable when the research assistants who conducted the screening agreed that its segments elicited positive reactions (e.g., orienting or smiling) in at least 50% of their presentations [45]. Two research assistants conducted the stimulus preference screening and implemented the baseline and intervention sessions. They held a Master's in

Psychology and had experience working with people with extensive disabilities and using technology-aided programs.

2.1.4 Technology System

The technology system included a touch screen of 27 × 48 cm and a computer fitted with specific software. A smart Wi-Fi plug supported by a smartphone application was added whenever the preferred stimuli following the touching response included lights (i.e., for Lauren). The software, which is freely available from the authors (https://osf.io/v4fj8/?view_only=93858398c5fa4c5ba56b58415e2edb2f), enabled the computer to run the session trials according to the conditions available during baseline and intervention. Each trial started with the appearance of an illuminated square of 7.5 × 10 cm in a specific position of the touch screen and the verbal cue "touch it". The square would be on for 15 s or until the participants touched it (i.e., touched any section of it).

Failure to touch the square within 15 s led the computer to switch it off for 5 s and then to start a new trial, that is, to switch the square on again in a different part of the screen while providing the verbal cue (i.e., "touch it"). Touching the square during baseline sessions led to the disappearance of the square for 5 s followed by the start of a new trial (i.e., reappearance of the square in a different part of the screen and of the verbal cue). Touching the square during the intervention sessions led to the disappearance of the square and the computer's delivery of 10 s of preferred stimulation, which was followed by the start of a new trial. The square's position on the screen changed according to a semi-random scheme with the restriction that the distance between two successive positions would never be greater than the median of the distances available.

2.1.5 Experimental Conditions and Data Analysis

The study used a non-concurrent multiple baseline design across participants [46, 47]. In line with the design requirements, participants were provided with different numbers of baseline sessions before the start of the intervention phase. The sessions were video-recorded, and the videos were made available to a study coordinator. Based on the videos, the study coordinator provided the research assistants with feedback about their performance during the sessions to ensure that such performance would be highly accurate (i.e., to ensure a high level of procedural fidelity [48]).

Baseline and intervention data were displayed in graphic form and compared using the "Percentage of data points Exceeding the Median" (PEM) method [49, 50]. This method (one of the most readily usable strategies for evaluating single-case research data) served to determine how many participants' intervention data points were above their baseline median.

2.1.6 Baseline

The baseline included five, seven, and nine sessions for Leo, Lauren, and Rafael, respectively. During the sessions, the participants sat in front of the touch screen and were presented with trials as described in the Technology System section (i.e., section 2.1.4.). Participant's failure to respond in the initial trials of a session led the research assistant to provide physical and verbal prompting, that is, to guide the participants to touch the illuminated square while repeating the verbal cue (i.e.,

"touch it"). Research assistant's prompting was provided again at the midpoint during the session if the participants continued to show failures to respond. No stimulation was scheduled for the responses.

2.1.7 Intervention

The intervention phase was introduced by four to six practice/familiarization sessions. During those sessions, the participants were provided with research assistant's prompting after every other trial in which they failed to respond. Responding was followed by 10 s of preferred auditory or auditory and visual stimulation (see section 2.1.3.). During the 61 (Leo), 45 (Lauren), and 70 (Rafael) intervention sessions that followed, the participants continued to receive 10 s of preferred stimulation contingent on each response. Research assistants' prompting could occur up to two times per session, and any prompting instance would follow the participants' failure to respond in two successive trials.

2.1.8 Data Recording

Data recording concerned the number of trials and the number of responses that occurred in the sessions. Both measures were recorded automatically via the computer. The research assistant was, however, to correct the number of responses recorded by the computer if research assistant's prompting had been used in the session. The correction consisted of subtracting the responses that occurred with prompting from the total number of responses recorded by the computer. Interrater agreement on the responses was assessed by having a reliability observer carry out independent recording over more than 20% of the sessions. The percentage of agreement (computed for each participant by dividing the number of sessions in which the same number of responses was reported by the total number of sessions in which agreement was checked and multiplying by 100%) ranged between 93 and 100%.

2.2 Results

The three graphs in Figure 1 report the participants' baseline and intervention data. The black triangles and the circles represent the mean frequency of trials and the mean frequency of responses that occurred over blocks of two sessions, respectively. Occasional blocks of three sessions (at the end of the phases) are marked with an arrow. The graphs do not include the practice/familiarization sessions introducing the intervention phase.

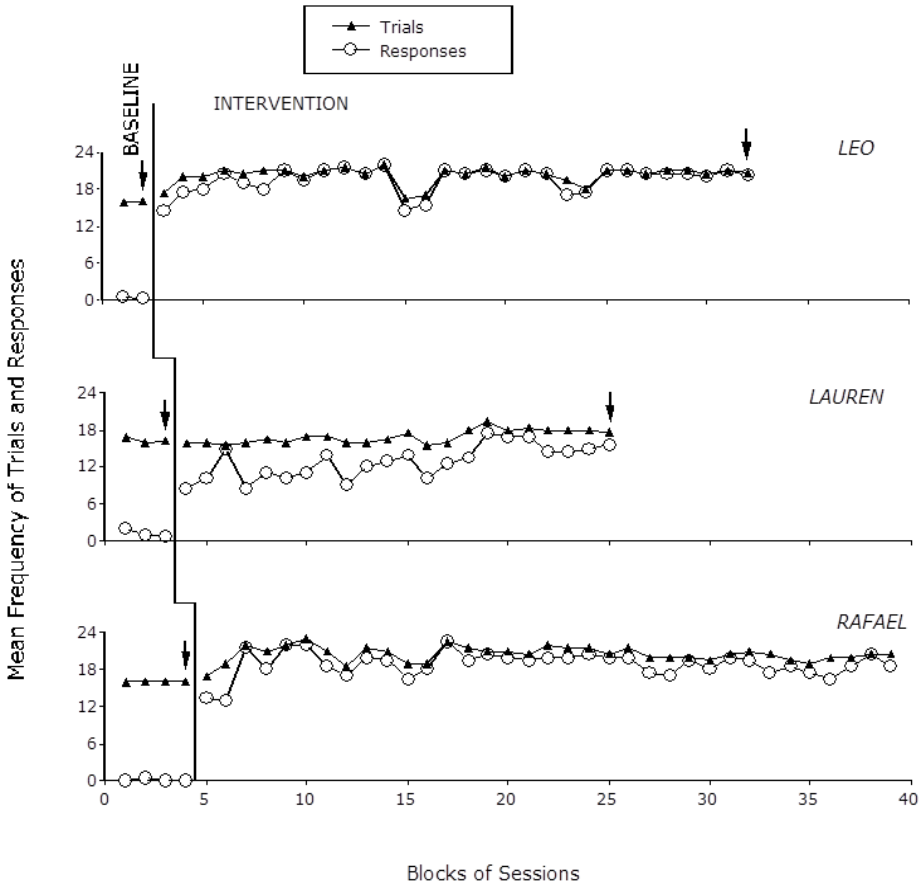

Figure 1 The black triangles and the circles represent the mean frequency of trials and the mean frequency of responses over blocks of two sessions, respectively. Occasional blocks of three sessions are marked with an arrow.

During the baseline sessions, the participants' mean frequency of trials per session was about 16, and their mean frequency of responses (i.e., responses independent of research assistant's prompting) was below two. During the intervention, the mean frequency of trials per session was nearly 17 (Laureen) and slightly more than 20 (Leo and Rafael). Higher numbers of trials were available when the participants responded rapidly following the appearance of the illuminated square with the verbal cue. The mean frequency of responses per session ranged from nearly 13 (Lauren) to about 19 (Leo and Rafael).

The PEM method used to compare the baseline and intervention response frequencies produced a score of 1 for all three participants. This score, which indicates that all intervention data points exceeded the baseline median value, confirms the strong impact of the intervention program [50, 51].

3. Study II

3.1 Method

3.1.1 Participants

The participants were four adults (two females and two males) who are here referred with the pseudonyms of Brynn, Logan, Kate, and Cole. Table 2 reports their chronological age, visual and

motor condition, and Vineland age equivalents for Daily Living Skills (Personal Sub-Domain) on the second edition of the Vineland Adaptive Behavior Scales [42, 43]. Their chronological age ranged between 27 and 42 years. All participants were diagnosed with visual and motor impairments linked to congenital encephalopathy. Brynn, Kate, and Cole (like the participants of Study I) (a) had a positive score on five of the initial nine items of the Vision Assessment for People with Polyhandicap (VA-PLH) [44], and (b) were rated to have a functional residual vision that was adequate to see the response target on the touch screen. Logan's visual condition was somewhat better than that of the other participants, and he had a positive score on six of the initial nine items of the VA-PLH. The motor impairments were as those described for the participants of Study I and did not interfere with the performance of the arm/hand movements required to touch the response target on the screen. The Vineland age equivalents ranged from below 1 year to 1 year and 10 months. No IQ scores were available. The care and rehabilitation centers that the participants attended rated their functioning to be in the profound intellectual disability range. The conditions for their recruitment were as in Study I.

Table 2 Participants' chronological age, visual and motor condition, and Vineland age equivalents for Daily Living Skills (Personal sub-domain).

Participants (pseudonyms)	Chronological Age (years)	Visual and Motor Condition	Vineland age equivalents [1, 2]
Brynn	32	Functional residual vision; Lack of ambulation	<1;0
Logan	33	Functional residual vision; Brief ambulation with support	1;4
Kate	42	Functional residual vision; Brief ambulation with support	1;10
Cole	27	Functional residual vision; Lack of ambulation	<1;0

[1] Age equivalents are based on the Italian standardization of the Vineland scales [42]. [2] Age equivalents are reported in years (number before the semicolon) and months (number after the semicolon).

3.1.2 Ethical Approval and Informed Consent

Ethical approval and informed consent occurred as in Study I.

3.1.3 Setting, Sessions, Responses, Stimuli, and Research Assistants

Conditions were as in Study I, with one exception. In addition to the touching responses, recording also concerned visual orientation (i.e., looking at the illuminated square right before and/or during the touching responses). Four research assistants were involved in the study (i.e., the two employed in Study I and two others with experience working with people with PIMD).

3.1.4 Technology System

The technology system was the same as that used in Study I, but it also included a second intervention module in which the illuminated square always appeared in the same position on the touch screen. Using the two intervention modules (i.e., the one in which the position of the illuminated square changed and the one in which it was fixed) served to determine whether the former module was functional to promote higher levels of visual orientation (see above).

3.1.5 Experimental Conditions and Data Analysis

The study started with a non-concurrent multiple baseline design across participants. A baseline phase with differing numbers of sessions across participants was carried out before the introduction of the first intervention phase [46, 47]. During this phase, the position of the illuminated square on the screen changed across trials (i.e., as in Study I). Once responding was consolidated, the second intervention phase began. During this phase, the position of the illuminated square on the screen was fixed. Eventually, a third intervention phase (identical to the first) occurred. During the final sessions of the first intervention phase and all sessions of the second and third intervention phases, the participants' visual orientation before and/or during their touching responses was also recorded (see Section 3.1.4.).

Conditions for fostering procedural fidelity were as in Study I. The PEM method [49, 50] was used to compare the frequencies of touching responses during the baseline and the intervention phases and the percentages of touching responses involving visual orientation under the two intervention modules.

3.1.6 Baseline

This phase included 5-10 sessions. Conditions were as in Study I.

3.1.7 First Intervention Phase

This phase included 36-57 sessions. Conditions were as in Study I, but recording also included visual orientation during the last 13-15 sessions (see above).

3.1.8 Second Intervention Phase

This phase included 14 or 16 sessions. Conditions were as in the first intervention phase except that (a) the illuminated square the participants were to touch appeared constantly in the same position on the screen and (b) visual orientation was recorded in all sessions.

3.1.9 Third Intervention Phase

This phase included 31-48 sessions. Conditions were as in the first intervention phase. Visual orientation was recorded in all sessions.

3.1.10 Data Recording

Data recording concerned the number of trials, touching responses, and touching responses involving visual orientation (i.e., looking toward the illuminated square right before and/or during the touching response). The first two measures were recorded as in Study I. Visual orientation was recorded by the research assistants utilizing the two videos available for each session. One video was obtained via a webcam, which was placed under or on the side of the touch screen to monitor the direction of the participants' eyes when responding (i.e., touching the illuminated square). The other video was obtained via a video camera, which was placed behind the participants to identify the position of the illuminated square on the screen at each session trial.

Interrater agreement on recording the touching responses was checked in more than 20% of the sessions with the involvement of a reliability observer, as described in Study I, and ranged between 95 and 100% across participants. Interrater agreement on visual orientation was also assessed over more than 20% of the sessions. The percentage of agreement (computed for each session by dividing the number of agreements on responses with and without visual orientation by the total number of responses and multiplying by 100%) ranged between 87 and 100%, with means exceeding 93% for each participant.

3.2 Results

The four graphs in Figure 2 report the participants' data during the baseline and intervention phases. The black triangles and the circles represent the mean frequency of trials and the mean frequency of touching responses over blocks of two sessions, respectively. Occasional blocks of three sessions (at the end of the phases) are marked with an arrow. The asterisks represent the percentage of touching responses involving visual orientation over the same blocks of sessions. The graphs do not include the practice/familiarization sessions introducing the first intervention phase.

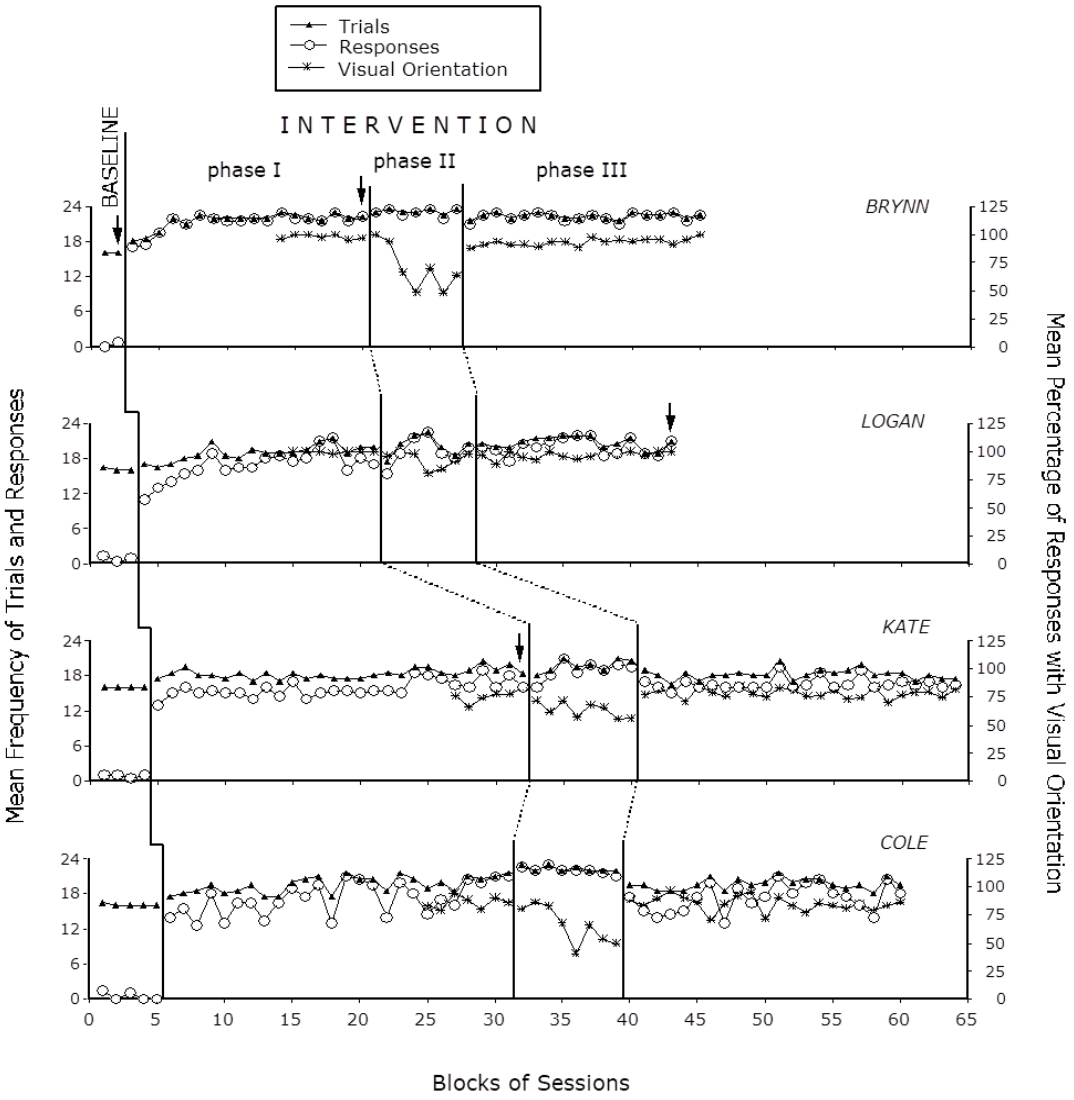

Figure 2 The black triangles and circles represent the mean frequency of trials and touching responses over blocks of two sessions. Occasional blocks of three sessions are marked with an arrow. The asterisks represent the percentage of touching responses involving visual orientation over the same blocks of sessions.

During the baseline, the mean frequency of trials per session was about 16. The mean frequency of responses per session was below two for all participants. During the first intervention phase (i.e., with the illuminated square changing position), the mean frequency of trials ranged between slightly over 18 (Kate) and close to 22 (Brynn) per session. The mean frequency of responses varied between about 16 (Kate) and 21 (Brynn) per session. During the second phase (i.e., with the illuminated square in a fixed position), the mean frequency of trials and touching responses was slightly higher than in the first phase. Indeed, the participants' responding times tended to be shorter without the need to organize different response schemes across trials. During the third intervention phase, the mean frequency of trials and the mean frequency of responses per session were comparable to or slightly higher than those recorded in the first intervention phase.

The mean percentage of touching responses involving visual orientation was about 94, 78, and 85 (Brynn, Kate, and Cole) and nearly 98 (Logan) per session during the first and third phases of the intervention (i.e., with the illuminated square changing position). The touching responses occurring

without visual orientation during these intervention phases tended to be characterized by the participants moving their hand across the touch screen until they found the illuminated square and the stimulation started. During the second phase of the intervention (i.e., with the illuminated square in a fixed position), the mean percentage of touching responses involving visual orientation declined to about 70, 63, and 66 per session for Kate, Cole, and Brynn, respectively, and to nearly 93 for Logan.

In comparing the baseline and intervention frequencies of touching responses, the PEM method produced a score 1 for all participants. In comparing the first- and third-phase with the second-phase's percentages of touching responses involving visual orientation, the PEM method produced (a) scores of 0.96 to 1 for Cole, Kate, and Brynn (i.e., scores confirming that the changing position of the illuminated square contributed to increasing the three participants' visual orientation [50, 51]) and (b) a score of nearly 0.76 for Logan. Logan's score, while visibly lower than that of the other participants, seemed still to suggest some impact of the changing position of the illuminated square on visual orientation [50, 51].

4. Discussion

4.1 Main Findings

The results suggest that intervention strategies involving basic technology and preferred stimulation for constructive responses may be highly successful in helping people with PIMD increase their stimulation input and physical activity [7, 14, 30-32]. Intervention strategies changing the position of the response target require the participants to exercise different (response) motor schemes. This may be more beneficial from a physical standpoint than exercising a single motor scheme (i.e., responding to a fixed target) [52, 53]. Strategies using a changing position of the response target may also promote a higher level of visual orientation during the touching responses. In light of these points, a few considerations may be in order.

First, the data obtained with the two types of intervention strategies (i.e., with a changing or fixed position of the response target) support previous evidence on the effectiveness of simple technology-aided programs to help people with PIMD practice their self-determination and improve/enrich their condition [7, 15, 30, 31, 33]. What the present two studies add to previous evidence concerns (a) the feasibility of an intervention program requiring the participants to produce different motor/response schemes in relation to the changing position of the response target and (b) the likely benefits of such a program in terms of increased/differentiated physical activity and visual orientation [36, 54, 55].

Second, the relatively high levels of touching responses observed throughout the intervention sessions of both studies suggest that the stimulation available for the responses was pleasant for the participants and, hence, capable of compensating them for their effort to perform such responses [50, 56-58]. One could argue that those sessions represented a practical condition for increasing the participants' motor activity, thus adding to other intervention approaches in the area [59, 60]. Those sessions also seemed to constitute a positive experience for the participants, that is, an experience which, due to the stimulation and activity benefits, might have contributed to improving their quality of life [61-64].

Third, promoting an increase in visual orientation, that is, eye gazing toward the response target in combination with reaching and touching such target, can be considered a relevant goal when

working with people with PIMD who have severe/extensive visual impairments. Many of these people, in fact, tend to make limited use of their residual vision, and this negative tendency may be accentuated and strengthened in situations where they are asked to interact with spatially static stimuli (i.e., as observed in Study II) [38-41]. An increase in visual orientation might ensure a potentially beneficial (as well as practical) exercise of the residual vision and eventually lead to increased accuracy of motor responses [38, 41].

Fourth, an intervention based on the use of fairly simple technology (as in the present studies) might be considered relatively accessible in terms of overall cost, environmental arrangements, and staff time demands. Indeed, a computer and a touchscreen cost about US $650. This cost could increase by $200-250 if a smart plug supported by a smartphone application is also included. Such costs are only a fraction of what is required for multisensory rooms. Unlike multisensory rooms, moreover, the present technology (a) is easily portable (usable across settings) and flexible concerning the types of response targets displayed on the touch screen, and (b) does not require specific environmental arrangements. The staff time needed for setting up and running sessions with a changing position of the response target, such as those used in Studies I and II, is minimal (as the computer regulates sessions' trials and stimulation for responding and does not require staff involvement). This makes those sessions much less demanding (and possibly more easily implementable within daily contexts) than sessions involving increased social contact, multisensory storytelling, and multisensory rooms [7, 65, 66].

4.2 Limitations and Future Research

The primary limitations of this study concern the small number of participants, the lack of generalization and maintenance data, and the absence of a social validation of the intervention and its impact. The first limitation asks for caution in making statements about the findings reported and calls for direct and systematic replication studies with additional participants [67-69]. These studies would help verify the generality of the present findings and their practical implications for professionals working with people with PIMD. The second limitation calls for new studies directed at (a) extending the data collection periods to determine whether the intervention effects are lasting/stable over time and (b) using various types of response targets (in addition to the illuminated square) to determine whether the participants' touching responses and visual orientation generalize across different visual stimuli [58, 69, 70]. The third limitation calls for the inclusion of education and care personnel in the assessment (i.e., social validation) of the program and its effects [71, 72]. This could be done by letting these personnel watch videos reporting the performance of different participants during intervention sessions and provide their opinion on whether (a) the participants are comfortable during the sessions, (b) the participants' touching responses are beneficial to increase their level of physical activity, (c) the visual orientation shown during the touching responses can be considered a relevant advancement in the participants' general behavior, and (d) the intervention approach is acceptable and applicable within daily contexts.

5. Conclusions

The results of the two studies corroborate previous evidence on the effectiveness of technology-aided programs involving contingent stimulation for increasing the stimulation input and

engagement/activity level of people with PIMD. The same results also add to previous evidence by showing that (a) it is possible to successfully arrange an intervention program that requires the participants to differentiate their response movements/schemes across trials and (b) the use of various movement schemes to reach and touch a target changing positions across trials is likely to increase the participants' level of physical activity and visual orientation (i.e., compared to a situation in which response schemes do not need variations because the position of the response target is fixed).

While these findings may be considered practically relevant, the aforementioned limitations of the studies prevent one from making general statements about their implications for daily intervention programs. Any such statement must wait until new research has determined the findings' robustness and replicability across individuals and settings. New research may also assess alternative technology solutions that would allow one to program the use of different response targets and multiple response schemes.

Author Contributions

GL was responsible for setting up the study, acquiring and analyzing the data, and writing the manuscript. GA, and CF collaborated in setting up the study (and in particular the technology system and related software), in acquiring and analyzing the data, and in editing the manuscript. MO'R, NS, and JS collaborated in setting up the study, analyzing the data, and editing the manuscript.

Competing Interests

The authors declare that they have no conflicts of interest. The software they set up for the study is freely available at (https://osf.io/v4fj8/?view_only=93858398c5fa4c5ba56b58415e2edb2f).

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