

# Persons with multiple disabilities exercise adaptive head responses with the support of microswitch-aided programs

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## Abstract

*The present two studies were aimed at extending evidence on the effectiveness of microswitch-aided programs for promoting exercise of head movements through contingent stimulation with three participants (i.e., a man and two children) with multiple disabilities. The man and the child involved in Study I were to exercise head rotation movements from a lying or sitting position. The child involved in Study II was to exercise brief head lifting movements from a supine and a prone position. Tilt, optic, and pressure microswitches were used for the three participants, respectively. Performance of the target movements led to brief periods of preferred stimulation during the intervention phases of the studies. Data showed that the intervention frequencies of those movements increased for all three participants. Implications of the studies were discussed.*

**Keywords:** Head responses; Technology; Response exercise; Multiple disabilities.

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## 1. Introduction

Persons with severe and profound intellectual disabilities and pervasive motor impairment are generally confined to a static position, in a wheelchair or bed, and have virtually no chances of facilitating their interaction with environmental stimuli and caring for their general condition (Mechling, 2006; Lancioni, O'Reilly, Singh, Sigafoos, Oliva, Smaldone *et al.*, 2009; Helton, 2011; Horn & Kang, 2012; Palisano, Chiarello, King, Novak, Stoner, & Fiss, 2012). In light of this situation, daily programs are mainly focused on providing them with general stimulation (environmental enrichment) and physiotherapy (Lancioni, O'Reilly, Singh, Sigafoos, Oliva, Antonucci *et al.*, 2008; Chen, Klein, & Minor, 2009; Lancioni, Singh, O'Reilly, Sigafoos, Didden, & Oliva 2009; Tam, Phillips, & Murdford, 2011). General stimulation is considered to be critical to ensure a sufficient level of sensory input and eventually improve their mood (Green & Reid, 1999; Dillon & Carr, 2007). Physiotherapy is considered critical to help them practice correct motor schemes and responses that could provide physical benefits and slow down the frequently inevitable degeneration of their condition (Bobath, 1980; Ketelaar, Vermeer, Hart, Van Petegem-van Beek, & Helders, 2001; Damiano & DeJong, 2009).

An alternative approach to increase stimulation and foster exercise of correct movements or body schemes might involve the use of microswitch-aided programs, in which microswitch technology serves to (a) monitor the persons' responses targeted for exercise and (b) ensure that the occurrence of those responses are followed by brief periods of positive stimulation (Lancioni *et al.*, 2008; Lancioni, Sigafoos, O'Reilly, & Singh, 2012). Such programs would (a) underline the persons' active role and (b) allow repeated periods of stimulation and response exercise with limited costs on staff time, provided that the technology available and the stimulation used are suitable to the persons' condition (Kazdin, 2001; Holburn, Nguyen, & Vietze, 2004; Chantry & Dunford, 2010; Borg, Larson, & Östergren, 2011; Shih, Shih, & Shih, 2011; Tam *et al.*, 2011).

Three recent studies have reported the use of microswitch-aided programs to provide stimulation for adaptive head movements with four participants with extensive multiple disabilities (Lancioni, O'Reilly, Singh, Sigafoos, Oliva, Campodonico *et al.*, 2012; Lancioni, Singh, O'Reilly, Sigafoos, Oliva, Campodonico *et al.*, 2012; Lancioni, O'Reilly, Singh, Green, Oliva, Campodonico *et al.*, 2013). The present two studies were aimed at extending the evidence on the effectiveness of microswitch-aided programs for combining stimulation input and exercise of head movements with three new participants (i.e., a man and two children) with multiple disabilities. The man and the child involved in Study I were to exercise head rotation movements from a lying or sitting position. The child involved in Study II was to exercise brief head lifting movements from a supine and a prone position.

## 2. Study I

### 2.1 Method

#### *Participants*

The participants (Glen and John) were 18 and 8 years old, respectively, had congenital encephalopathy with limited residual vision (Glen) or functional residual vision (John). Glen was affected by pervasive motor impairment with spastic tetraparesis, hip displacement and severe scoliosis, and had a diagnosis of epilepsy partially controlled through medication. John had a diagnosis of severe spastic tetraparesis with dystonic movements. Both participants lived with their parents at home. Glen's intervention program was supported by care and education staff, who provided him with physiotherapy sessions including head movements, sensory and tactile stimulation, and mild massage at his home. John attended a primary school, in which his daily program was similar to that described for Glen, except for a variety of physical and verbal interactions available from other children. Neither participant possessed specific forms of communication, and self-help skills or sphincteric control. They could not handle objects, and depended on others for any interaction with their surroundings. Their levels of intellectual disability had been estimated to be in the severe/profound range, and no formal assessments appeared feasible. Caution about their functioning was recommended, due to the fact that their motor condition prevented them from almost any form of expressed behavior. One of the goals of physiotherapy was to promote head movements/rotation to counter an increasing tendency to keep a static position. The participants, however, did not seem necessarily to enjoy the maneuvers required to ensure such movements/rotation, and could show signs of resistance and discontent. A technology-aided program that could motivate them to exercise their head and neck movements on their own (i.e., through contingent positive stimulation), rather than through external intervention was considered highly beneficial. Their families had signed an informed consent for their participation in this study, which had been approved by a scientific and ethics committee.

#### *Positions, responses, technology and stimuli*

Glen lay in bed throughout the sessions of the study while John sat in his wheelchair. Head rotation responses consisted of movements of the head of about 30 degrees (a) to the left (Glen) and (b) to the right or to the left (John). Rotations could start from a right head-turned position or other positions for Glen and from an approximately midway position for John. A series of tilt microswitches attached to a headband was used for Glen.

Optic microswitches (photocells) embedded in the wheelchair's headrest served for monitoring John's rotation movements. The microswitches were connected to a computer system, which served for recording the responses and regulating the presentation of preferred stimuli contingent on them during the intervention phases of the study (see below).

The stimuli selected for the study included songs, familiar voices, noises, lights, and vibratory inputs for Glen, and familiar voices, noises, lights, and vibratory inputs for John. The stimuli had been recommended by parents and staff and confirmed through a stimulus preference screening procedure (Lancioni *et al.*, 2013). The screening procedure involved 10-20 non-consecutive presentations of brief samples of the stimuli. The stimuli were selected when both research assistants involved in the screening agreed that positive reactions (e.g., orienting and smiling) occurred for more than 50% of the sample presentations.

#### *Experimental conditions*

The study was carried out according to an ABAB design in which A represented baseline phases and B intervention phases (Barlow, Nock, & Hersen, 2009). A 3-week post-intervention check was also available. Sessions lasted 5 min for Glen and 10 min for John, and were implemented 3 to 11 times a day, depending on the participants' availability conditions. The responses were automatically recorded through the computer system. Response prompting (i.e., verbal and physical guidance) was available prior to the start of the sessions as well as during the sessions if periods of non-responding of 30-60 s occurred. The responses performed during the sessions through prompting were subtracted from the computer count (i.e., by the research assistants in charge of the sessions). Interrater agreement on recording these prompt-related responses was checked in 15 sessions for each of the two participants. Agreement, which consisted of the two raters reporting the same number of prompting instances (which could also be zero), occurred in all sessions.

*Baseline I and II.* The baseline phases included four and eight sessions for Glen and four and nine sessions for John. The participants were provided with their microswitch and computer system, which recorded their responses, but did not present any stimulation contingent on them.

*Intervention I and II.* The intervention phases included 74 and 77 sessions for Glen, and 48 and 90 sessions for John. The first intervention phase was preceded by eight and seven practice sessions for the two participants, respectively. The practice sessions could involve frequent prompting from the research assistants to help the participants gain extensive experience of the responses and their stimulus consequences (i.e., 8-10 s of preferred stimulation). During the regular intervention sessions, (a) prompting occurred as indicated in the Experimental

conditions and (b) each response was followed by 8–10 s of preferred stimulation.

*Post-intervention check.* Both participants continued to receive sessions such as those available during the intervention phases. Fifteen of those sessions occurring 3 weeks after the end of the second intervention phase were used as post-intervention check.

## Results

Figures 1 and 2 summarize the data for Glen and John, respectively. The bars represent mean frequencies of head rotation responses per session over blocks of baseline and intervention sessions. The number of sessions included in each block/bar is indicated by the numeral above it. During Baseline I, the participants' mean frequencies of responses per session were below two and below five, respectively. During Intervention I, their mean frequencies of responses per session increased to approximately nine and 21. Baseline II showed a decline in responding, which was apparent for both participants. Intervention II showed mean frequencies of responses per session of about 10 and 24 for the two participants, respectively. The post-intervention check (not reported in the figures) showed that both participants maintained their intervention response levels. Response prompting was largely concentrated in the first intervention phase (and the first baseline).

Figure 1. *Glen's data. The bars represent mean frequencies of head rotation responses per session over blocks of baseline and intervention sessions. The number of sessions included in each block/bar is indicated by the numeral above it.*

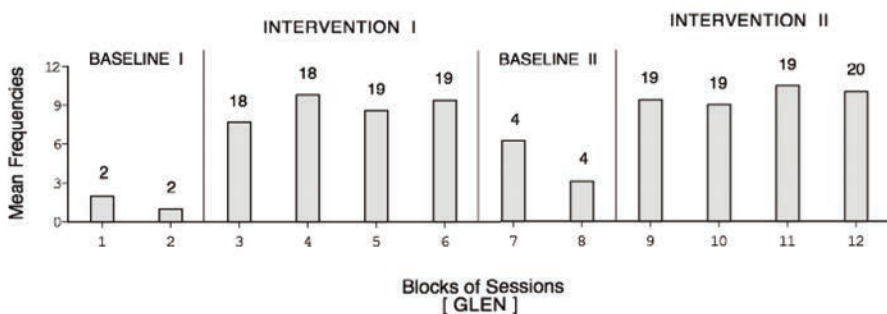
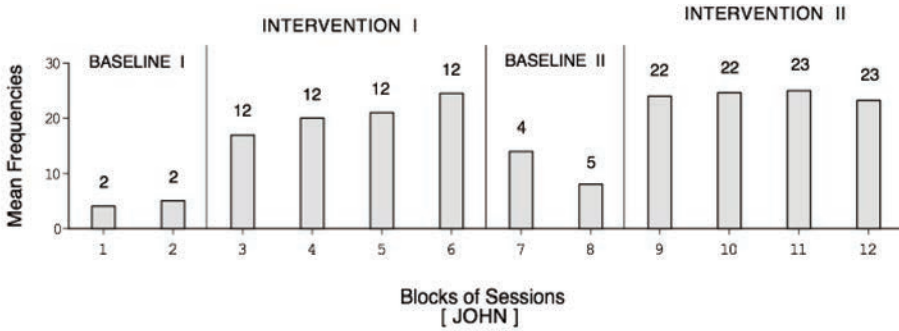


Figure 2 - John's data plotted as in Figure 1.



### 3. Study II

#### 3.1 Method

##### Participant

The participant (Vicky) was 7 years old, had a diagnosis of encephalopathy with minimal residual vision, and extensive motor impairment related to prenatal and perinatal hypoxia. She presented with spastic tetraparesis and hip displacement, had epilepsy that was largely controlled through medication, and was estimated to be functioning at the severe level of intellectual disabilities. As for the participants of Study I, caution was recommended in this area due to the impossibility of formal evaluation and the confounding motor conditions. She lived at home with her family and attended daily a regular school, in which she was provided with treatment strategies involving general stimulation, social interaction, and physiotherapy. Physiotherapy objectives for Vicky focused largely on head movements, and head-neck strengthening from supine and prone positions. A technology-aided program that could motivate her to exercise her head and neck movements on her own (i.e., through contingent positive stimulation) rather than through external intervention, was considered highly desirable and profitable. Her family had signed an informed consent for her participation in this study, which had been approved by a scientific and ethics committee.

##### Positions, responses, technology and stimuli

Vicky was in (a) a supine position with her head slightly lifted on a special pillow during the sessions in which head movements from such a position were targeted, and in (a) a prone position on the same special pillow, with her head slightly turned to her right, during the sessions in which her movements from such a position were targeted. The microswitch to monitor her responses in both

positions was a pressure device that was activated as soon as Vicky's head weight was momentarily lifted from such a device (i.e., due to the responses). The microswitch was connected to a computer system, which served for recording the responses and regulating the presentation of preferred stimuli contingent on them during the intervention phases of the study (as in Study I). The stimuli selected for Study II included songs, familiar voices, noises, lights, and vibratory inputs and were selected as in Study I.

#### *Experimental conditions*

The study was carried out according to a multiple probe design across responses (Barlow *et al.*, 2009). After the initial baseline, intervention focused on the head responses from a supine condition. Once the frequency of these responses had increased, a new baseline and intervention occurred on the head responses from a prone position. Increases of these latter responses led to alternating groups of intervention sessions focusing on one type of responses with groups of intervention sessions focusing on the other type of responses. Three weeks after the end of the intervention a post-intervention check was carried out. Sessions lasted 5 min and were implemented three to 12 times a day. The responses were automatically recorded through the computer system as in Study I. Conditions concerning response prompting (verbal and physical guidance of the responses) and interrater agreement on recording prompt-related responses matched those of Study I.

*Baseline I: responses from both positions.* Six sessions were carried out from the supine position and two sessions were carried out from the prone position. Each session included the microswitch for the responses targeted and the computer system that recorded the response occurrences. No stimulation was available for those occurrences.

*Intervention I: responses from the supine position.* Conditions were as in the baseline sessions carried out from the same position except that (a) each response occurrence was now followed by 10 s of preferred stimulation, and (b) five practice sessions were provided prior to the 68 regular intervention sessions (see Study I).

*Baseline II: responses from the prone position.* Three baseline sessions occurred. Conditions were as in Baseline I.

*Intervention II: responses from the prone position.* Conditions were as in the baseline sessions carried out from the same position except that (a) each response occurrence was now followed by 10 s of preferred stimulation, and (b) four practice sessions were provided prior to the 28 regular intervention sessions.

*Intervention III: responses from both positions.* This phase alternated Intervention I and Intervention II conditions (each lasting for a period of two to four



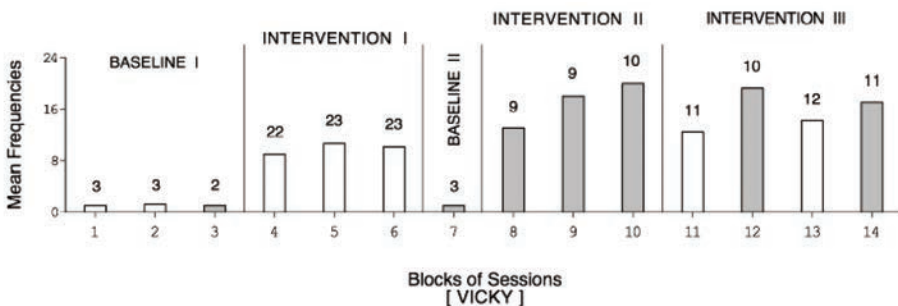
sessions). The phase included totals of 23 and 21 sessions for the two conditions, respectively.

*Post-intervention check: responses from both positions.* Vicky continued to receive sessions such as those available in Intervention III, after the end of that phase. Twenty-four of those sessions, occurring 3 weeks after the end of Intervention III, served as post-intervention check. Twelve of the sessions were carried out from the supine position and 12 were carried out from the prone position.

### 3.2 Results

Figure 3 summarizes Vicky’s data throughout the baseline and intervention phases of the study. White and gray bars represent mean frequencies of responses per session from the supine position and the prone position, respectively, over blocks of baseline and intervention sessions. The number of sessions included in each block/bar is indicated by the numeral above it. During Baseline I, Vicky’s mean frequencies of responses per session were below two from each position. During Intervention I, the mean frequency of responses per session from the supine position increased to nearly 10. During Baseline II, the mean frequency of responses per session from the prone condition remained low. During Intervention II, Vicky’s mean frequency of responses per session from the prone position increased to above 15. During Intervention III, the mean frequencies of responses per session from the two positions matched or exceeded those observed within the previous intervention phases. Comparable frequencies were also maintained during the post-intervention check (not reported in Figure 3). Response prompting was concentrated in the baseline phases and at the start of Intervention I and Intervention II.

Figure 3 - Vicky’s data. White and gray bars represent mean frequencies of responses per session from the supine position and the prone position, respectively, over blocks of baseline and intervention sessions. The number of sessions included in each block/bar is indicated by the numeral above it.





## 4. General discussion

The data of the two studies indicate that the use of the microswitch-aided programs enabled the participants to practice/exercise adaptive head responses independently. These data, which are in line with previous research outcomes in this area (Lancioni, O'Reilly *et al.*, 2012; Lancioni, Singh *et al.*, 2012; Lancioni *et al.*, 2013), may be considered very encouraging. Indeed, technology-aided programs with positive stimulation contingent on head responses may prove highly beneficial for persons with multiple disabilities to improve their motivation to independently exercise responses that they (a) do not find simple or enjoyable per se and (b) may resent practicing when forced by others to do so (Dunst, Raab, Hawks, Wilson, & Parkey, 2007; Ripat & Woodgate, 2011). The same programs may represent the only option to provide the participants sufficient exercise time without excessive burdens on physiotherapists and other staff personnel (Nicolson, Moir, & Millsteed, 2012).

The independent exercise data seem to underscore that the participants (a) found the enjoyment of the stimulation more appealing than the effort required for the responses, (b) changed from a condition of passivity and external control to a condition of self-determination and initiative, and (c) discovered a resource that could help them increase their chances of slowing down motor degeneration, and improving their social image and, probably, their level of acceptance and quality of life (Brotherson, Cook, Erwin, & Weigel, 2008; Brown, Schalock, & Brown, 2009; Carter, Owens, Trainor, Sun, & Swedeen, 2009; Sunderland, Catalano, & Kendall, 2009).

New research in this area may need to target four different goals. First, additional participants should be involved in studies matching those carried out to determine the reliability and robustness of the findings reported and thus the general applicability of the intervention approach used (Kennedy, 2005). Second, the participants' mood during the microswitch-aided sessions should be assessed to ascertain whether they display indices of happiness during their independent exercise (Dillon & Carr, 2007). Their mood during those sessions should then be compared with the mood they display during externally directed exercise sessions or physiotherapy sessions (Lancioni, Singh, O'Reilly, Oliva, & Basili, 2005; Dillon & Carr, 2007). Third, assessment of the possible benefits of independent exercise (e.g., in terms of the rates and ranges of movements produced) should be monitored over time within and across participants also in relation to the overall exercise time (Lancioni *et al.*, 2013). Fourth, the opinion of parents, staff, and service providers about this approach should be gathered through social validation assessments (Callahan, Henson, & Cowan,

2008). Such an opinion could become an important guideline in possible revisions of the approach aimed at improving the quality of its impact (Lancioni *et al.*, 2008; Lancioni, Singh, *et al.*, 2012).

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