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Fostering Recovery and Functional Engagement of Children With Traumatic Brain Injury through Technological Supports: A Mini Review

Viviana Perilli[1], Fabrizio Stasolla*[2], Dominga Laporta[3], Stefania Maselli[1] and Isabel Morelli[1]

[1]*Villa Apelusion Medical Care Center, Bari, Italy*

[2]*University "Giustino Fortunato" of Benevento, Italy*

[3]*The Other Home Day Center, Bari, Italy*

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***Corresponding author:** Fabrizio Stasolla, University "Giustino Fortunato" of Benevento, Italy

Abstract

We provide the reader with a mini review on the use of assistive technology-based interventions for recovering and fostering the functional engagement of children with traumatic brain injury. Traumatic brain injury, assistive technology, functional engagement, quality of life, recovery, and children were merged in Scopus database as keywords. The newest empirical evidences available were detailed and the clinical, educational, psychological, and rehabilitative implications of the findings were critically discussed. Some limitations and future research perspectives were additionally emphasized.

Keywords: Traumatic Brain Injury; Children; Assistive Technology; Quality of Life; Recovery; Engagement; Review

Introduction

Following a traumatic brain injury (TBI), children may experience significant communicative, intellectual, motor, and sensorial impairments with negative outcomes on their daily functioning, and deleterious consequences on their quality of life [1-3]. Additionally, they may encounter post-coma conditions, with a vegetative state, a minimally conscious state, or emerging from it [4-7]. Accordingly, they may be unable to positively interacting with the outside world. Enabling them with an adequate change of accessing to positive stimulation for promoting their independence and self-determination should be considered a crucial rehabilitative objective for parents and caregivers in daily settings [8-10]. However, enrichment programs may be at least only partially satisfactory. Thus, such interventions do not ensure the participant with an active role (i.e., independent) and do not guarantee that he/she will receive the preferable amount of stimulation [11-12]. To overcome this issue, one may envisage assistive technology-based (AT) rehabilitative programs [13-15]. An AT-based intervention may be viewed as an affordable and valid alternative capable of assessing and monitoring the participant's independent responding and use it purposefully for getting access to the positive stimulation [16-18].

Undoubtedly, AT-based interventions will allow the child to (a) acquire an active role, pursue self-determination, and independently choose among different options, and (b) can be implemented at a relatively low cost with a minimal involvement of staff members, parents, and/or caregivers. In fact, the AT-based approach may be evaluated as a basic modification of direction if compared to the stimulation sessions. Specifically, within the enrichment/stimulation approach, the participant is considered as a passive recipient of the delivered stimulation. A wide amount of literature has been developed on the use of AT for adults, and a relevant number of review papers has been published on this specific topic [19-25]. Conversely, few empirical evidences exist on the use of AT-based programs for children with TBI and post-coma outcomes [26-27]. To fill this gap, we carried out the current mini-review including the newest evidence available on the use of AT-based interventions for recovering and fostering functional engagement of children with TBI. The objectives of the current review were

a) To provide the reader with an overview of the literature available within this framework,

b) To emphasize strengths and weaknesses of te reviewed studies,

c) To critically discuss the outcomes, and

d) To suggest some useful future directions for both research and practice.

Method

A computerized search was performed in Scopus. Children, TBI, AT, quality of life, recovery, functional engagement, rehabilitation, post-coma, independence, and self-determination were merged as keywords. A manual search was additionally carried out as completion. Overall, twelve documents were found. The eligibility criteria concerned

a) At least an empirical contribution with an AT-based program,

b) At least a participant aged up to 19 years or less,

c) The English language for the published article, and

d) The last decade (i.e., 2008-2018) as publication range interval. Accordingly, four articles were critically reviewed. We detailed below a concise overview of the retained papers.

Literature Review

Stasolla et al. [28] exposed three children with TBI who were emerging from a minimally conscious state and aged between 9 and 12 years to an AT-based intervention aimed at promoting communication and leisure opportunities. First of all, though a computerized system an adapted software, the participants could communicate their needs among five basic categories (i.e., preferred songs, amusing videos, physical requests such as having cold, social contact with a parent, and pain) through small hand closures, which was recorded via a touch-sensitive double membrane microswitch. The microswitch was connected to the computer through an interface. Additionally, the participant could access to a literature program, with the opportunity to freely write their messages on a word processor. The intervention was conducted through a multiple-probe experimental design across behaviors and a one-month post-intervention check for each participant. Additionally, indices of positive participants were recorded as an outcome measure of participants' constructive engagement.

Finally, forty-eight under-graduated students of Educational Sciences were recruited for a social validation assessment as external raters. Results showed an increased performance for all the participants involved, who improved their positive participation during the intervention phases compared to the baselines. The participants maintained their performance over the time. Social raters favorably scored the use of the AT-based program. Stasolla and De Pace [29] implemented an AT-based intervention for two adolescents who were aged of 12 and 14 years, and who suffered of a road accident two and three years prior to the beginning of the study, respectively. They experienced a coma condition of two and three weeks, respectively and underwent to a condition of vegetative state and minimally conscious state. Both emerged from it exhibiting the acquisition of consciousness and understandable responding, although they presented extensive motor impairments. The AT-based intervention was focused on request and choose preferred items among four categories, namely

a) Songs,

b) Videos,

c) Social Contact and

d) Personal Needs.

Sixty under-graduated students of Education Sciences were enrolled as external raters for a social validation procedure. The study was carried out according to a non-concurrent multiple baseline design across participants. Results emphasized an increased performance for both participants during intervention phases. The external raters favorably scored the use of the technology.

Vincent et al. [30] presented a case report of a client with a serious TBI, who four years after the accident was exposed to a brain computer interface, finalized at examining the computer performance (i.e., keyboard and mouse tasks), and the degree of realization of three functional activities (i.e., written communication, interpersonal relations, and leisure). The training lasted 16 weeks. A three-month follow-up was conducted. The activation of the computer was evaluated through lateral eye movements, relaxation waves, facial musculature, and brain activity waves. Results evinced no significant improvements of the computer performance after 8 weeks, while the trial of a different interface (i.e., tactile screen) made the optimization of mouse functions possible. A long and flexible computer training was successful for increasing the participant' performance. Unsal et al. [31] assessed a prospective study with 25 TBI children, who were rehabilitated in a pediatric rehabilitation unit. Age, sex, duration of disease, duration of rehabilitation recovery, etiological factors, and medical complications of the patients were recorded. Functional status of the children was monitored as ambulatory and non-ambulatory at admission and discharge. ST devices were additionally recorded. Results showed that children with TBI who received an early or late rehabilitation program, both benefited of the intervention. The number of ambulatory patients increased after both rehabilitation program and motor recovery.

Discussion

Data of the reviewed studies emphasized the successful use of AT-based interventions for promoting functional engagement of children with TBI and extensive motor impairments. The active role and self-determination of the participants involved were fostered and their constructive engagement increased. The indices of positive participation as outcome measure of the participants' quality of life significantly augmented. The performances were consolidated over the time. The external raters recruited for the social validation assessments formally endorsed the use of the AT-based programs. The findings were consistent with previous contributions [32-36] and suggested the following considerations.

First, AT may be considered as affordable, effective, and suitable for enhancing the independence and self-determination of children with TBI and extensive motor disabilities. The participants could freely access to request and choice processes of preferred stimuli, literacy process, functional tasks, and/or occupation activities once equipped with the AT devices. Accordingly, the caregivers burden was relevantly reduced [37-38].

Second, the participants' positive participation as outcome measure of the quality of life and constructive engagement was improved. One may argue that the participants isolation and passivity were prevented, with positive consequences on their social image, desirability, and status. Consequently, the participants were capable of freely access to the positive stimulation by selecting and choosing the time and the amount of the stimulation [39-40]. Third, their performances were confirmed over the time. One may claim for the consolidation of the learning process. Thus, even if the intervention was suspended, the participants were able of favorably maintaining their performance, with beneficial effects on their functional opportunities [41-42]. Fourth, the external raters involved in the social validation procedures positively scored the use of the technology. In other words, the AT-based interventions were considered socially valid. One may argue that the clinical validity was empirically demonstrated [43-45].

Limitations and Future Research

Despite the aforementioned positive outcomes, our mini-review outlined some limitations. First, it was based only on the review of four studies. Further enlargement of the reviewed contributions were warranted. Second, the retained empirical contributions were based on single-subject experimental designs. Caution was mandatory for their generalization. Third, only 31 participants were considered. Accordingly, additional investigations were recommended. In light of the above, new research perspectives should deal with the following topics

a) Further empirical evidences involving new participants with TBI and extensive motor and/or communication delays,

b) New technological options finalized at responding to more sophisticated personal needs as consequence of their disabilities,

c) Generalization phases and

d) New social validation assessments, which should involve new external raters (e.g., psychologists, neurologists, physical, and/or speech therapists, parents of children with TBI).

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