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Mini Review

Enhancing Academic Performance of Children with Cerebral Palsy through Technological Aids: A Mini Review

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Abstract

Background: Children with cerebral palsy may have extensive motor impairments and intellectual disabilities, with negative outcomes on their academic performance and constructive engagement

Objectives: To assess the effects of assistive technology-based programs on self-determination and independence of children with cerebral palsy while dealing with academic activities. To evaluate the clinical validity of the implemented treatments. To carry out the effects of such interventions on positive participation and quality of life of children with cerebral palsy.

Method: A mini review was conducted on the empirical studies published during the last five years (i.e., 2013-2018 range period) within this framework. Four studies were critically discussed.

Results: Data were widely positive for all the participants. They improved their performance. Positive participation and constructive engagement as outcome measures of their quality of life increased as well.

Conclusion: Assistive Technology-based programs were helpful for enhancing academic performance of children with cerebral palsy. Their inclusion in daily settings was favorably fostered.

Keywords: Cerebral palsy; Assistive technology; Academic performance; Quality of life; Independence; Social validation; Positive participation; Constructive engagement

Introduction

Cerebral Palsy (CP) defines a group of non-progressive motor impairments caused by a defect in the fetus and/or in the immature brain (i.e., before, during or subsequently the infant birth), which may have negatives consequences on fine and gross-motor mobility, communication abnormalities, intellectual delays, learning difficulties. Four basic categories have been identified, namely (a) spastic, (b) dyskinetic, (c) ataxic, and (d) mixed. Accordingly, the greatest challenges once the rehabilitation is faced by children with CP deal with limitations in the main areas of humanities. Specifically, cognition, communication, locomotion, manipulation, and orientation are significantly affected. Thus, children with CP may experience relevant failures in the learning process and academic performances, with negative effects on their quality of life [1-4]. To overcome this issue, one may envisage assistive technology-based interventions (AT) [5-6].

AT refers to any equipment, device, tool, and/or technological solution/option enabling individuals with developmental disabilities with self-determination and independence towards the outside world. That is, by using an AT-based equipment a child with CP will profitably cope with his/her environment because the gap between his/her clinical conditions (i.e., developmental disabilities) and the environment requirements is removed [7-8]. In fact, the child with CP will be enabled to adequately communicate his/her personal needs through a computerized system [9], or to access to the literacy process independently [10], either to ambulate autonomously or to foster the locomotion fluency [11-12]. Furthermore, one may design microswitch-cluster technology implementation for promoting occupation and reducing challenging behaviors or inadequate postures (e.g., hand mouthing or biting, and head tilting) [13,14]. Nevertheless, few studies emphasize the role of AT-based programs for empowering the academic performance and constructive engagement of children with CP [15]. By searching in SCOPUS database, only seven documents were found once cerebral palsy, assistive technology, and academic performance or activities were used as keywords. No specific review paper was detected [16-22].

In light of the above, the current mini review was intended to provide the reader with a concise overview of the empirical contributions available in the literature on the use of AT-based programs for increasing and improving academic performance of children with CP. The second objective of the article was to assess the effects of the AT-based programs for academic performance on the constructive engagement, indices of happiness, and/or positive participation of the recruited participants. The third goal of the paper was to emphasize strengths and weaknesses of the reviewed studies. The fourth aim of this overview was to outline both learning consolidation through maintenance, generalization, or follow-up phases, and the intervention social and clinical validity via social validation procedures, whenever available. Finally, the fifth objective was to underline the limitations of the findings, suggesting some useful perspectives for future research and clinical practice.

Method

A computerized search was performed in SCOPUS. A manual search was added for completion. CP, AT, academic performance, academic activities, on-task behavior, indices of happiness, indices of positive participation, constructive engagement, and quality of life were used as keywords. The eligibility criteria were (a) at least an empirical contribution (i.e., conceptual, review, interview, and/or theoretical papers were excluded accordingly), (b) at least a child who was aged between 3 and 19 years old enrolled as participant (i.e., our interest was focused on children and adolescents rather than adults), (c) at least an AT-based intervention implemented, (d) English language of the contribution, and (e) publication year range comprised between 2013 and 2018. Consequently, four studies were retained with 19 participants involved. In the next section, a concise overview of the selected contributions was detailed, with the objectives of the interventions, the ages and the number of the participants involved, the adopted procedures, and the main results.

Literature Overview

Encarnaçao et al. [16] described the development and test of physical and virtual integrated augmentative manipulation and communication AT (i.e., IAMACATs) aimed at enabling children with motor delays and speech impairments to independently access to educational items by controlling a robot with a gripper, while communicating through a speech generating device. Nine children with CP were enrolled and compared to nine regular developed children. Teachers adapted academic activities so that they could be performed by children with CP using IAMACAT. An inductive content analysis of the teachers' interviews before and after the intervention was completed. According to the results, teachers considered the IAMACAT to be a successful educational resource to be integrated into the regular class dynamics respecting the curricular planning and fostering inclusion. It was demonstrated to have a positive impact on children with CP and on the educational community, although teachers emphasized the difficulties encountered along the class management, even if another adult was present, due to extra time required by children with developmental disabilities to complete academic activities. Consequently, AT-based program was useful for enabling children with CP to perform academic activities but full inclusion would need another adult in the class and specific strategies to deal with the additional time required by the children to complete the activities.

Adams & Cook [17] reported a 12-year-old girl with CP, complex communication needs, and severe motor impairments, who controlled a LEGO robot from a speech generating device (SGD) to do different hands-on academic activities. The basic assumption was that by controlling a robot the participant would be more motivated to use her SGD. A descriptive case study was adopted because the integration of communication and manipulation technologies was not yet completely understood. Target activities and goals were selected by the participant's teacher and AT team. The child performed several math activities and was engaged in an acting activity focused on increasing the message length. The competency skills needed to control a robot from the SGD and the stakeholder satisfaction with the robot system were evaluated. Results showed an increased performance for both the math activities and messages length, which improved significantly. The robot was useful for motivating the student to build SGD operational skills and learn educational concepts.

Stasolla et al. [18] extended the use of computer and microswitch (i.e., pressure sensor, interface, and laptop) with a new setup, allowing six children and extensive motor impairments to complete their academic activities during classroom. A second objective of the study was to assess a maintenance/generalization phase, occurred three months after the end of the intervention, implemented at participants' homes with their parents. A third aim was to evaluate the effects of the intervention on the indices of positive participation (i.e., constructive engagement), as an outcome measure of the participants' quality of life. The fourth rehabilitative purpose was to carry out asocial validation procedure involving 36 support teachers as external raters. A multiple probe design across behaviors was adopted for each participant, completed by a maintenance/generalization phase. Results evinced an enhanced performance for all the participants (i.e., both academic activities and positive participation increased), which was consolidated during the maintenance/generalization phase. Social raters favorably scored the use of the AT-based program.

Stasolla et al. [23] systematically compared a differential reinforcement of an alternative behavior (DRA) to a self-monitoring procedure implemented through technological supports (i.e., a pressure microswitch with a system control unit and an adapted software) for promoting the on-task behavior of three children with cerebral palsy during classroom while dealing with academic activities. Beside the effectiveness of each educational strategy, the study investigated the beneficial effects of both interventions on the participants' indices of happiness as outcome measure of their quality of life. Furthermore, the participants' preference checks were conducted. Finally, a social validation assessment involving 24 support teachers was carried out. The study was implemented through an alternating treatment embedded in a non-concurrent multiple baseline reversal design across participants. A maintenance phase occurred three months after the end of the intervention was realized. Results showed an increased performance for all the participants, which concerned (a) the on-task behavior, (b) the academic activities, and (c) the indices of happiness through both strategies. The self-monitoring, which was preferred by all the participants during the preferences assessment, evinced higher performances if compared to the DRA. Social raters scored the self-monitoring procedure more positively than DRA during the social validation, corroborating the clinical validity of the intervention.

Discussion

Data of the reviewed studies emphasized the effectiveness and the suitability of the AT-based interventions for promoting academic activities of children with CP and severe to profound developmental disabilities. In fact, all the recruited participants significantly increased the academic performance, improved their constructive engagement, indices of happiness, and positive participation with beneficial outcomes on their quality of life. Furthermore, the participants consolidated the learning process and favorably appreciated the use of the technology. External raters positively scored the use of such technology and conformed the validity (i.e., clinical and social) of the intervention. These findings were supported by previous contributions [24-27] and suggested the following considerations.

First, AT-based solutions can be suitable and effective for enhancing academic performance of children with CP and developmental disabilities. The participants' inclusion in daily settings and classrooms was additionally fostered. The gap between the participants' needs and environmental requirements was relevantly reduced, and the participants with CP were able of adequately cope with their outside world accordingly. Because no review papers up-to-date were available on the role of AT for supporting academic activities among children with CP, the current mini review positively extended the literature within this framework [28-30].

Second, the participants' positive participation and positive mood were improved. One may argue that their social image, desirability, and status were beneficially increased. The isolation and passivity were prevented with positive outcomes on their participants' quality of life. Consequently, both parents and caregivers burden was reduced since the children were more active and self-managed. Additionally, the classroom was more manageable because even the support teacher was aided by the technology and the child was more independent while coping with the academic tasks [31-32].

Third, the learning process was consolidated. Thus, even if the intervention was suspended, the participants were capable of confirming their performances during maintenance, generalization, and follow-up phases. One may argue that they acquired, maintained, and extended (i.e., in fact they generalized) the awareness of the causal association between their behavioral responses and the environmental events through the use of the AT options. That is, switching on a long period or different settings, children with CP were enabled to use their AT for correctly completing their academic activities. One may evaluate their adaptive responding as purposeful [33-35].

Fourth, social raters favorably endorsed the use of the AT-based interventions. Thus, they all considered the implementation of the technology useful and helpful for adequately achieving their academic tasks and activities. Irrespective of their group (e.g., teachers, parents, psychologists or caregivers),they highly scored the use of AT-based programs. Additionally, whenever available, the AT costs was evaluated as relatively cheap and not expensive, therefore the use of the AT-based systems were estimated as affordable [36-38].

Fifth, although not critical for the current review, challenging behaviors commonly exhibited by children with CP were fairly reduced during the intervention phases. Two considerations may be putted forward in this regard. One may argue that once constructively engaged and positively occupied, children with CP no longer requested to produce stereotypic movements or behaviors because the extrinsic motivation provide by the technological system was efficiently rewarding. Otherwise, one can consider that the participants re-directed their challenging behavior profitably in occupation and academic activities. Consequently, the challenging behaviors disappeared [39-40].

Limitations and Future Research

Despite the aforementioned encouraging outcomes, our review had some limitations. First, only four studies were reviewed with 19 participants involved. Further extensions were warranted accordingly. Thus, caution is mandatory while interpreting the data. Second, only few AT-based tools or devices were considered. For instance, technological devices aimed at promoting communication and/or leisure activities were not included (e.g., IPOD, IPAD, Tablets, VOCA). Third, the retained studies were implemented almost through single-subject experimental design (i.e., except for the contribution of Encarnaçao et al., 2011, who examined two small groups). Additional empirical evidences were needed consequently. Fourth, more long-term follow-up and/or generalization phases should be examined (e.g., one year follow-up). Fifth, although considered, the full inclusion of children with CP and developmental disabilities was not always completely realized.

In light of the above, new research within this topic should deal with (a) further extensions of the empirical contributions with new participants who present CP and developmental disabilities. Specific individualized solutions focused on both financial and human resources should be designed and planned. Second, to fill the gap of the weaknesses of the studies above detailed, new participants with developmental disabilities with different pathologies (e.g., autism, rare genetic diseases, encephalopathy) should be included, with more sophisticated technological solutions. Third, a systematic generalization of the results across settings, and more long-time follow-up phases should be carried out. Fourth, new groups of raters (e.g., practitioners and physiotherapists) should be included in further social validation assessments. Fifth, the challenging behavior and its functional assessment/analysis should be systematically examined.

Conclusion

Assistive Technology-based programs were helpful for enhancing academic performance of children with cerebral palsy. Their inclusion in daily settings was favorably fostered.

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None.

Conflict of Interest

No conflict of interest.

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