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Review

# New Technologies to Support People with Neurodevelopmental Disorders: A Selective Review

Donatella Ciarmoli, Fabrizio Stasolla*

University "Giustino Fortunato" of Benevento, Italy; E-Mails: d.ciarmoli1@studenti.unifortunato.eu; f.stasolla@unifortunato.eu

***Correspondence:** Fabrizio Stasolla; E-Mail: f.stasolla@unifortunato.eu

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**Abstract**

Neurodevelopmental disorders represent a cluster of conditions first diagnosed during childhood or adolescence (i.e., including intellectual disability, autism spectrum disorders, motor deficits, and communication deficits). The main characteristic of neurodevelopmental disorders is the presence of a deficit or a delay in the acquisition of skills that may affect different areas of evolution (e.g., cognitive, affective, and motor). These clinical conditions make the child or adolescent passive, isolated, and unable to carry out daily activities. Additionally, challenging behaviors and emotional disruption may be acknowledged. Accordingly, negative outcomes on personal well-being may be recognized. To enhance the well-being of those persons, assistive technology-based interventions (AT) may be useful. Among the new assistive technology are virtual reality, telemedicine, telerehabilitation, serious games, computer-brain interface, and other new technologies aimed at specific rehabilitation objectives. This document aims to give the reader a framework of reference to the literature on the most recent contributions available on the technology-based programs used to improve the well-being of individuals with neurodevelopmental disorders such as: serious games, virtual reality, wearable technologies, and telerehabilitation. The results were argued and several options were outlined. The studies reviewed on the eight classes of

new technologies showed the accessibility, effectiveness, and suitability of the implemented technologies to enable adaptive skills for participants with NDD. Some helpful solutions for both future research and practice have been evidenced.

**Keywords**
New technologies; neurodevelopmental disorders; quality of life; inclusion; review

## 1. Introduction

Different disabilities are included in neurodevelopmental disorders. Autism spectrum disorders, cerebral palsy, attention deficit hyperactivity disorders, and rare genetic diseases are commonly embedded [1, 2]. According to the DSM-5 [3], neurodevelopmental disorders encompass a wide variety of congenital disabilities or acquired brain injuries with a disruption in brain development such as those caused by conduct disorders, or due to other heavy metals [4-10], and Fetal Alcohol Spectrum Disorders (FASD). Neurodevelopmental disorders occur in the early stage of development and are involved in developmental deficits that cause compression in daily activities. The deficits are comprised of specific global domains. Neurodevelopmental disorders may co-occur. For instance, ASD children or adolescents may have intellectual disabilities, and individuals with attention-deficit/hyperactivity disorder may present specific learning difficulties. In some neurodevelopmental disorders (e.g., autism spectrum disorders, fragile X syndrome, Rett syndrome) the clinical features include symptoms of excess, difficulties and delays in reaching the standard milestones [3]. The chronic nature of the aforementioned clinical conditions represents a high cost for the health system, families and society, affecting the health of parents, causing absences from work and loss of wages [4]. Patients emphasize substantial delays in NDD assessment and care. Consequently, children would risk not achieving new goals from the intervention, experiencing a negative outcome on their school and social performance. Delivering poor NDD services includes a lack of qualified therapists [5], particularly in poor regions and short intervention sessions [6]. Technology offers the opportunity to provide automated and self-directed interventions, allowing improved access to therapy, even at a distance, to improve clinical efficacy and to individualize rehabilitation interventions as much as possible [7]. In addition to programs based on assistive technologies, one can rely on the use of virtual reality (VR) and/or wearable technology (WT) configurations [8]. Virtual reality makes it possible to achieve numerous goals such as data taking of behavioral responses, ecological validity and greater experimental control [9]. Additionally, wearable and mobile technologies may be considered as two practicable strategies for assessment and recovery [10].

Recent literature review studies have collected present contributions on specific technologies or disorders, such as the use of technology in ADHD to improve academic performance [5], technologies used to improve self-management [11], telerehabilitation or telemedicine [12], and serious games for persons with intellectual impairment [13]. The framework of evidence and research on individuals with autism spectrum disorders illustrates an overview of the use of new technologies [14]. From the considerations made so far, this study provided a selective review of empirical studies based on the use of AT for individuals with neurodevelopmental disorders over

the past two decades. Finally, practical outcomes were constructively discussed and some helpful tips were emphasized.

## 2. Background

Assistive technology has progressively been used within daily settings, including a wide range of technological solutions [15-17]. Assistive technology includes any electronic device, with a dual objective, namely (a) evaluation, and (b) rehabilitation of NDD individuals [18-22].

Several assistive technology tools are chosen based on the clinical condition and the objectives to be achieved. Although this framework can be considered promising and new developments can be highlighted in this topic, it should also be argued that the availability of technical support per se may not be adequate to pursue the expected objectives. Achieving the goals above is much more achievable when a rehabilitation intervention is carefully designed to (a) help and support participants in the use of technology and/or (b) enable participants to make optimal and daily use of technology [23].

## 3. Method

An electronic search was performed in the Scopus, ResearchGate, and PubMed databases. Keywords included assistive technologies, constructive involvement, communication skills, neurodevelopmental disorders, positive participation, quality of life, leisure and employment. The acceptance criteria of the studies were: (a) an empirical study based on the scientific evidence of interventions using AT, (b) studies involving participants with neurodevelopmental disorders; (c) studies carried out in the last two decades of publication interval (i.e., 2000-2020) and (d) English as the language used for publication. As a result, twenty-two studies were reviewed with 546 participants enrolled and grouped according to eight categories, namely: (a) academic performance, (b) communication, (c) daily activities, (d) locomotion, (e) occupational activities, (f) serious games, (g) telemedicine and (h) virtual reality (see Table 1). The selected studies were concisely detailed in the following section, and a synoptic table (i.e., Table 1) summarized the main results.

**Table 1** Reviewed studies arranged in alphabetic order.

| Authors | Group | N° Partecipants | Pathology | Aided Technology | Results |
|---|---|---|---|---|---|
| Cannella-Malone et al. [24] | Accademic performance | 2 partecipants | moderate intellectual disability | video-prompting via ipod-touch | all positive |
| Beer et al. [25] | Locomotion | 35 partecipants | sever walking disabilities | robot-assisted gait training | All positive |
| Carpinella et al. [26] | Daily activities | 2 partecipants | neurodevelopmental disabilities | braccio di ferro-robot | All positive |
| Davies et al. [27] | Accademic performance | 40 partecipants | intellectual disabilities | computer aided system | All positive |
| Di Palma et al. [28] | Occupational activities | 5 partecipants | ASD | Wt-based | All positive |
| Goldstein et al. [29] | Telemedicine | 6 partecipants | ASD | Telehealth technology | All positive |
| Hussan et al. [30] | Serious games | 23 partecipants | cognitive disabilities | CLES | All positive |
| Barlow et al. [31] | Daily activities | 20 partecipants | ALS | brain-computer interface | Two negatives |
| Kwon & Lee [32] | Serious games | 47 partecipants | Developmental disabilities | apple packaging and hydroponics | All positive |
| Lancioni et al. [33] | Occupational activities | 5 partecipants | Mild to moderate intellectual disability | Smartphone | All positive |
| Ledbetter-Cho et al. [34] | Accademic performance | 2 partecipants | intellectual disability and ASD | Ipod-touch | All positive |
| Myers et al. [35] | Telemedicine | 32 partecipants | Mild to moderate intellectual disability | Telehealth technology | All positive |
| Noel et al. [36] | Virtual reality | 14 partecipants | ASD | VR-technology | All positive |
| Ricci et al. [37] | Communication | 5 partecipants | intellectual and sensory or sensory-motor disabilities | Smartphone | All positive |
| Romero-Ayuso et al. [38] | Virtual reality | 24 partecipants | ADHD and ASD | VR-technology | All positive |
| Sellers et al. [39] | Communication | 6 partecipants | ALS | brain-computer interface | One negative |
| Selnder et al. [40] | Virtual Reality | 84 partecipants | ADHD and ASD | VR-technology | All positive |
| Sgandurra et al. [41] | Locomotion | 42 partecipants | Cerebral plasy | new medical device | All positive |
| Sigafoos et al. [42] | Communication | 11 partecipants | Severe communication impairment | Ipad-based communication | Four negatives |
| Singh et al. [43] | Telemedicine | 3 partecipants | developmetal disabilities | Teleheath technology | All positive |
| Tsikinas et al. [44] | Serious games | 136 partecipants | Intellectual disability and ASD | SGS | All positive |

## 4. Literature Overview

The selected empirical studies have been listed in alphabetical order in Table 1. The reader may note that reviews or theoretical articles have not been included according to the eligibility criteria (see above).

### *4.1 Academic Performance*

The improvement in academic performance certainly represents the first significant category. Children and adolescents with NDD can exhibit intellectual disabilities, leading to negative academic performance results. TA-based intervention programs may be suitable for school inclusion, positively impacting classroom management and organization. Such approaches can enhance their independence and self-determination while achieving academic goals [41, 45, 46]. In this section only three contributions from forty-four people were examined.

Cannella-Malone et al. [24], implemented an intervention program based on an iPod touch to improve and increase academic skills, in two participants with moderate intellectual disabilities. This AT tool made it possible to receive suggestions via video. The results obtained from this study highlighted an increase in academic performance in the participants as these technologies proved to be suitable for teaching new skills and useful for the generalization of the use of technology for learning further new skills without aids. Additional.

Davies et al. [27] conducted a computer-based intervention program to help persons with intellectual disabilities through an experimental test condition. The program allowed for (a) verbal rephrasing of the questions to be answered by the participants, (b) if the question was not understood by the participants, the system allowed for repetition, (c) to save the data of the actions of any participant (d) to allow participants to be fake the next question only when they had answered the previous question. The study involved a standard two-group design with 40 participants. One group used the written version, while the second was equipped with AT. The results showed that the TA-based version had better results.

Ledbetter-Cho et al. [34] conducted an empirical study using an iPod touch to provide an enhanced video presentation of the intended tasks for two participants with intellectual disabilities and autism spectrum disorders. Specifically, the task was divided into several phases and for each phase, the participant was provided with a video of a model to emulate from an image. Monitor to select. By touching the image, participants were able to view the video. This video-enhanced presentation mode was suitable for teaching both participants to perform various academic tasks independently. Generalization and retention measures were also registered.

### *4.2 Communication*

Communication is broadly defined as “any act by which a person provides or receives from another person information about his or her needs, desires, perceptions, knowledge or affective states” [47]. To communicate there is always a need for a linguistic code that is used as an arbitrary code by people in order to communicate with other people. By definition, AAC includes an intervention approach [48] that uses hand signs, communication cards with symbols and technological devices that allow the person to communicate [49]. Consequently, AAC is fully multimodal, allowing the user to benefit from every communication mode suited to the individual

need. AAC skills can vary over time. Consequently, is the AAC system used in a given period of life have to be remodeled as the person grows [50]. Three contributions were reviewed in this section, for a total of twenty-two participants involved in the studies.

Ricci et al. [37] conducted an empirical study using a new DGS to help prompt responses in five participants with intellectual and sensory or motor disabilities. A smartphone and a series of mini objects or chips with images with specific codes were used in the program. Once the participants placed one of the mini objects or chips with images on the smartphone, the device vocalized a verbal request related to the activity highlighted by the mini object or chip. All participants easily and successfully used the technology to make requests.

Sellers and Donchin [39] investigated the suitability of a brain-computer interface (BCI) technology that worked through the detection of an elicited P300 by one of the four randomly presented stimuli (i.e., YES, NO, PASS, END). They recruited two groups of participants. The first group enrolled three patients with amyotrophic lateral sclerosis (ALS) and different degree of disability, but all could communicate; the second group enrolled three non-SLA controls. Each participant was exposed to ten experimental sessions over approximately 6 weeks. During each session, the participant was requested to take care of one stimulus and ignore the three others. The stimuli were presented through auditory, visual, or combined modalities. Data indicated that two of the three classification measures of ALS participants were similar to those of non-ALS participants. Waveform morphology changed according to the presentation modality, but differently across participants. Event-related potentials produced by stimuli presentation could be identified if compared with non-target stimuli for non-ALS and SLA groups. Future studies should investigate an online classification. The results of the offline classification suggested that a P300-based BCI can be useful as a non-muscle communication device in both SLA and non-SLA groups.

Sigafoos et al. [42] conducted an empirical study using an iPad, involving 11 adults with developmental disabilities and severe communication delays. This empirical study demonstrated how leading participants achieved excellent results to increase their functional communication. Although the results were positive, the participants maintained these benefits for a short time.

### *4.3 Daily Activities*

It is known that single variables can influence the trend in the use of TA. Consequently, TA should improve personal well-being and constructive engagement throughout the day. Once the technologies are implemented in a real, everyday context, AT can meet personal needs [51]. Three contributions with a total of twenty-four participants were examined in this section.

Carpinella et al. [26] conducted an empirical study based on using a robot (called Popeye) to perform a task. The enrolled participants had an EDSS score of <9 with an average EDSS score of 6.7. Participants were given a cursor and a targeted setting for the task, while for the manipulative task, they were required to manipulate real objects such as LEGO constructions, plastic bottles and glass jars. The researchers found that the suggested robotic therapy strategy reduced arm tremors and improved arm kinematics and functional ability. They also discovered that people with MS can handle the disturbing forces produced by the robot. It was also shown that people with MS could not withstand the resistive forces before treatment, but this ability improved after the test.

Barlow et al. [31] designed and examined the use of a multifunctional BCI P300 with a dedicated graphical interface for configuration and control by non-experts, as the current brain-

computer interface (BCI) software was highly complex to use. The system included tools for spelling, web access, access to entertainment, access to cultural environments, and daily environmental control. The program also included new hardware for recording electroencephalographic (EEG) signals. The system was evaluated with a healthy sample. It targeted end-users of the BCI technology (i.e., people with varying degrees of motor disability tested the BCI in a series of individual case studies). The user-friendliness of the equipment was assessed by completing structured questionnaires. Twenty participants from two groups were involved in the study. The results suggested that all participants were overall satisfied with the new equipment.

### *4.4 Locomotion*

Physical disabilities related to movement and locomotion significantly reduce individuals' social participation or reduce it. People with disabilities have always been forced to use various devices, gadgets and tools to manage themselves through such aids, widely included as AT [52]. Two contributions were reviewed in this section, with seventy-seven registered participants.

Sgandurra et al. [41] projected a new tool to support children with congenital brain injuries. Forty-two children were recruited. An 8-week program with an 18-month follow-up was designed.

Beer et al. [25] evaluated using a 35 PwMS robot. The participants were divided into two groups, one using a robot and the other without. All participants underwent an hour-a-day intervention session five days a week over 3 weeks. The results reported and highlighted improved walking speed, distance, stride length and knee extensor strength.

### *4.5 Occupational Activities*

People with intellectual disabilities (ID) are significantly less employed than peers without intellectual disabilities, which can cause the risk of economic and social marginalization. The differentiated intervention of persons with intellectual disabilities in welfare and training policies supports the expectation that they are passive recipients of welfare rather than productive workers. [53, 54]. Two contributions were examined in this section, for ten people involved in the studies.

Di Palma et al. [28] included interactive serial games to assess the child's involvement during socio-cognitive tasks in their empirical study. Five children with high-functioning ASD aged between 6 and 8 years were included. An ECG monitoring instrument was used. The longitudinal observation lasted six months.

Lancioni et al. [33] explored the suitability of an intervention using two smartphones to help five participants with mild to moderate intellectual disability, visual and/or motor impairment and speech impairment to perform activities to entertain and develop communication skills. Participants could perform their activity requests by placing mini objects or pictures (which represented these activities and had frequency-coded labels) on one of the two smartphones. This smartphone read and recorded the relevant activity requests. The recording of the requests activated the S-voice of the second smartphone, which opened the files of the corresponding leisure opportunities or telephone contacts for the participants. All participants used the program successfully and spent most of the session time engaging in independently accessible recreational and communication activities.

### *4.6 Serious Games*

Serious games use strategies commonly implemented in special educational settings such as repetition, immediate feedback and context-based teaching-learning processes. Serious games are recognized for improving performance on the targeted task and related self-efficacy, using a cost-effective and safer method than traditional training [55]. In this section, three contributions were examined, for a total of two hundred and six participants involved in the studies.

Kwon and Lee [32] studied the impact of serious games on the practical skills of people with developmental delays. Forty-seven participants were divided into three groups. The two experimental groups completed two practice tests in a different order: apple packing and hydroponic cultivation (AH, HA). For the first round of testing, the AH group played the serious game of apple packing, while the HA group played the hydroponics game. The AH group played the Hydroponics game for the second round of practice tests, while the HA group played the Apple Packaging game. The control group did not play the practice tests. Finally, all three groups played a third round of practice tests. The results showed that the targeted activity game improved the speed and accuracy of the practical execution of the targeted activity. The results showed that serious games could be used to train simple working skills in people with developmental disabilities.

Hussaan et al. [30] analyzed key aspects of the Cognitive and Linguistic Element Stimulation (CLES) project designed to support serious play in assessing and intervening children with intellectual disabilities. In this study, their goal was to develop adaptive scenarios taking into account the user's profile, i.e., a series of educational activities that enable the student to achieve their academic goals. The system was designed to be as generic as possible (i.e., able to be used with a wide range of serious games). Therefore, they identified and highlighted different types of knowledge represented by the system: domain concepts, educational resources and serious gaming resources.

Tsikina et al. [44], examined whether SGs could represent the aids needed to apply for BL, particularly for people with ID or ASD who could benefit from tailored learning strategies. They examined 43 SGs available for persons with ID or ASD and the opinions of 93 special education professionals (SEPs) and teachers (SETs) working in schools and institutions for persons with ID or ASD regarding the role of TA and SGs in an educational context. They emphasized that SGs can improve the learning process of students with ID or SD in many skills. Furthermore, SEPs' and SETs' perceptions of the relevance of technology in the learning process of people with ID or ASD and familiarity with SGs suggest that BL could be effectively improved through SGs.

### *4.7 Telemedicine*

Telerehabilitation (TR) represents a subcategory of telemedicine that encompasses the set of tools and protocols for the design of remote rehabilitation [56], in different medical contexts. It supports positive outcomes for the healthcare system and patients regarding cost-effectiveness and feasibility for large-scale applications. TR can use multiple types of technologies, such as sensor-based technology, tele/videoconferencing, ad hoc specific development software or virtual reality [57]. This section examined 3 contributions for forty-one people involved in the studies.

Goldstein et al. [39] examined the effectiveness and cost-effectiveness of telehealth technology for children with autism spectrum disorder who do not have access to specialized care. The

authors concluded that telemedicine technology could make effective diagnosis, especially for those with ASD and ID. However, in other children with more clinical features (disorders), obtaining an accurate diagnosis requires direct and carefully planned examinations.

Singh et al. [43] evaluated in their empirical study the feasibility of implementing a telecare technology, introducing a simple mindfulness-based program to three teachers in a rural school district, assessing the teachers' loyalty in training students in the program, and determining the impact of the program on the students given their physical and verbal aggression. The participants were three children diagnosed with mild intellectual disabilities. The data show that telecare technology can be used effectively, enabling teachers to use the procedure and deliver it reliably to the students. The participants benefited from using the method by reducing their aggressive behavior, which practically disappeared.

Myers et al. [35] examined the suitability of telemedicine technology to instruct the parents of 32 adolescents or young adults in the mindfulness-based health wellness (MBHW) program they were to teach their children. The 32 participants (adolescents and young adults) were overweight or obese and had a mild intellectual disability. The results of the intervention on the children's body weight were evaluated using a variable criteria design. The program included exercise, healthy eating and nutrition, mindful eating, conscious response to thoughts of hunger and mindfulness practice to control the urge to eat. Participants were successfully exposed to the program, experienced an average weight reduction of 38.27 kilos at the end of the intervention and maintained their new weight for four consecutive years. Participants also expressed high satisfaction with the program's results in a social validity assessment.

### *4.8 Virtual Reality*

VR and augmented reality (AR) appear to be basic technological supports for appropriate program in different areas of public health, namely (a) assessment, (b) diagnosis, (c) rehabilitation and (d) health. About rehabilitation interventions, VR has been used in neurodevelopmental disorders. Virtual reality enables computer-mediated sensory experiences in artificial environments, enhancing virtual interactions like the real world. Virtual reality requires specific headsets, which people with NDD may not easily wear. In contrast, augmented reality can be considered easier as it relates to smartphones, tablets and I-PADs, which are more adaptable to real life [58, 59]. In this section, three contributions were reviewed, with one hundred and twenty-two participants involved in the studies.

Noel, et al. [36] used a visual nature trail task, including continuous active detection of actions and safe monitoring of participants' dynamic belief states. Nine participants were recruited and completed the firefly-catching task. Fourteen were adolescents aged 12-17 years with a diagnosis of autism and were matched with their peers. In both groups, a previously documented distortion pattern was used, which exceeded the radial distance and eccentricity of the target. A poor estimation of velocity signals biased both groups due to non-uniform velocity and imperfect integration. No statistical change was found in the participants' beliefs compared to the previous velocity, but the phenomenon was evident in the ASD group. Endpoint variance and speed irregularities were correlated with ASD symptom severity. With feedback, the variance decreased and ASD values were similar to the controls. Consistent with the data, the work highlighted the

need for more naturalistic tasks and a broad computational perspective to define the phenotype and pathology of ASD.

Romero-Ayuso et al. [39] assessed a study protocol to examine self-regulation ability in children with NDD (in particular, participants with ADHD and ASD were considered) aged between 6 and 11 years. A cluster randomised controlled trial was conducted based on a non-immersive virtual reality system in which children could handle virtual objects naturally using their hands. Two different groups (the experimental group and the control group) were considered. The procedure lasted ten weeks. The dependent variables included self-regulation and acceptance of the technology.

Selander et al. [40] examined a simulator driving test (SDT) and two neuropsychological tests (the Useful Field of View or UFV and the Variable Attention Test or TOVA) about the validity of fitness to drive in 51 young participants with ADHD, 33 of whom had ASD and 38 adolescents without a diagnosis of NDD. The data showed greater overall variability and lower performance on SDT and TOVA in subjects with ADHD and ASD. The results showed increased effort and susceptibility to motivational problems and decreased sustained attention on several tests. In conclusion, the SDT was significantly sensitive with good face validity. The TOVA was sensitive to the neuropsychological characteristics of safe driving. The SDT and TOVA were considered complementary, and the discrepancy between the test scores required specific considerations.

## 5. Discussion

The findings of the reviewed studies examined the eight classes of new technologies. They highlighted the convenience, effectiveness and appropriateness of the technologies implemented to enable the adaptive abilities of participants with NDD. In the first group, the issue of academic performance was addressed as individuals with disabilities often show significant difficulties in increasing academic performance because they lack strategies suited to their abilities [49, 50].

In the second category, the studies that presented new technology tools suitable for increasing the participants' communication skills were analyzed. Also, in this case the new technologies proved useful in order to increase the communication skills of individuals with disabilities and also to improve their social participation and quality of life [49, 50]. In the third category, using new assistive technologies, daily living activities were targeted with encouraging results [41, 52, 60].

In the fourth category, studies conducted on new technologies used to improve locomotion in people with neurodevelopmental disorders were analyzed and the results showed how the use of modern equipment allows for improving locomotion and therefore the quality of life allowing participants to be able to move freely [28].In the fifth category, occupational activities were analyzed using new technologies to decrease the poverty and social exclusion risk for people with neurodevelopmental disorders [48].In the sixth category, the results produced by experimental studies conducted on people with neurodevelopmental disorders through the use of a series of games were analyzed, that is, new strategies applied in special education in order to achieve objectives through the use of games [61].

In the seventh category, studies conducted on people with neurodevelopmental disorders through the use of telerehabilitation were analyzed, because especially where the participants had problems in locomotion, it was fundamental and important to adopt new and alternative opportunities in order to be able to achieve, even if virtually, basic health services [39]. In the

eighth and last category, studies based on new technologies such as virtual reality were analyzed, which can be used assess, diagnose and rehabilitate individuals with developmental disabilities [58].

Summarizing, the results were largely satisfactory even if conflicting results emerged [33, 46, 54]. Furthermore, some studies [62, 63] did not elucidate the NDD characteristics or the age of the participants. Both the evaluation and rehabilitation objectives were pursued positively. Behavioral and communication s, postural and motor behaviors have been widely investigated in children and adolescents with ADHD and ASD. In comparison, participants with cerebral palsy and rare genetic diseases (e.g., Rett syndrome) had not been studied yet [33, 63].

Recently, Bottiroli et al. [64] have supported Smart Aging. This serious gaming platform produces a 3D VR environment in which people can perform different screening activities for a broad and comprehensive cognitive assessment. An adequate extension could be suggested for individuals with NDD. For instance, a customer-tailored version may assess choice, demand, Internet access, and leisure opportunities.

## 6. Conclusion

The findings of this review highlight the importance of new technologies to support the independence of people with NDD. The data for the checked posts is positive. However, caution is advised about the empirical results of several studies. Thus, some future directions seem essential, such as (a) lack of control over time (maturity) underscoring some contributions, and (b) lack of interest in topics involving constructively engaged roles. Given the above criticisms and caution in interpreting some existing literature, the need for expanded empirical research seems reasonable. Furthermore, it is important to examine revised studies in terms of (a) the quantitative significance of the recorded changes and (b) the accessibility/reliability based on the methodological aspects contained in the intervention [31, 65]. Regarding the first point, it can be said that there is considerable variation between contributions. Many reported statistically and functionally significant behavioral changes in participants as measured by specific measures or response rates [66, 67]. Other studies (a) have shown that changes are not specifically associated with these variables or frequencies, but rather with behavioral assessments reported by caregivers and other representative individuals (e.g., parents) [68] participating in the intervention program [69] and/or Or part (b) or point out unwanted statistical evidence for formal variables [70]. The results of studies using single-subject designs might be considered more accessible, as these designs allow for control over the temporal variable (maturation) [69].

## 7. Future Research

Therefore, future research perspectives should address the following questions: (a) new tools, devices, and new technological solutions and options can be planned, responding to the characteristics of the participants on the one hand, and contextual resources on the other; (b) another topic might including recruitment, aftercare, program extension, and maintenance support within these methods in everyday settings such as home, rehabilitation, school, and/or medical centers; (c) assessing the extension of other techniques (such as serious play) beyond the studies studied developmentally disabled children, taking into account the large literature on the use of this intervention strategy in other areas of rehabilitation such as acquired rehabilitation or

pathology and the need to demonstrate the value of this approach concerning methodological complexity that any performance improvement can be observed with certainty.

**Author Contributions**

DC drafted the paper. FS edited and critically revised the manuscript. Both authors made a substantial contribution and approved the final version of the article.

**Competing Interests**

The authors have declared that no competing interests exist.

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