## Articles

# The psychological benefits and efficacy of computer-assisted training on competency enhancement in adults with intellectual disability. A systematic review

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## Abstract

The use of modern technologies as instructional tools is becoming increasingly prevalent in both general and special education. This systematic review examines the effects of computer-assisted and digital training on competency enhancement for adults with intellectual disabilities. As opposed to mere knowledge, "competency" was defined as the ability to apply and employ acquired knowledge to carry out tasks and solve problems in professional, social, and personal life domains. The PRISMA procedure was used to search for records dealing with competency enhancement using computerized training for intellectually disabled adults. Twenty-two articles met the inclusion criteria, showing that contemporary technology, computer-based tools, and digital instruments can positively affect the quality of life of adults with intellectual disabilities, and enhance their personal, professional, and social competencies. Ultimately, fostering computer-based technology to enhance competencies in adults with intellectual disabilities appears to be very promising, in that it allows these individuals to better integrate into society and live more independently, autonomously, and effectively.

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## 1. Introduction

The 5th edition of the *Diagnostic and statistical manual of mental disorders* (APA, 2013) defines Intellectual Disability (ID), also known as Intellectual Developmental Disorder (IDD), as a condition with onset during the developmental period, characterized by deficits in intellectual and adaptive functioning related to personal and social life-domains. ID significantly impacts knowledge acquisition and competency attainment. As to knowledge acquisition, most individuals affected by ID do not reach the level of academic learning, as they tend to quit school earlier than their peers. More generally, their competency acquisition appears to be harder for them to attain in different areas of their life, such as vocational environments, community and societal activities, and daily life. The greatest difficulties individuals with ID need to face are associated with deficits in intellectual functions involving "reasoning, problem solving, planning, abstract thinking, judgment, learning from instruction and experience, and practical understanding. Critical components include verbal comprehension, working memory, perceptual reasoning, quantitative reasoning, abstract thought, and cognitive efficacy" (American Psychiatric Association (APA), 2013, p. 37). Besides intellectual deficits, ID persons have problems in adaptive functioning, which refers to how the individual is able to meet social standards for independence and responsibility. According to the *DSM-5* (APA, 2013, definition of ID), adaptive functioning refers to three aspects of the individual's living, that is, conceptual, social, and practical domains.

The use of computer-based tools to enhance the education and training of ID individuals has witnessed increasing efforts in recent years (Torrado et al., 2020). The use of technological devices specifically targeting ID individuals means more favorable access to new tools and a greater need for educational service providers to be trained to identify and deploy appropriate digital supports (Ayres et al., 2013; Bochicchio et al., 2019). Few reviews have been written on the efficacy of computer-based tools in rehabilitation of ID subjects (Standen & Brown, 2005), as well as in competency enhancement in ID subjects' daily living (Mechling, 2007; Ramdoss et al., 2012), academic knowledge (Snyder & Huber, 2019), functional skills (Goo et al., 2019), and other important areas of functioning, such as communication, employment, and leisure (Kagohara et al., 2013). The use of modern technologies as instructional tools is becoming increasingly prevalent in both general and special education. The Covid-19 outbreak has forced the world-wide population to use online platforms to perform tasks that were previously done in person, such as attending school, working, making purchases, and contact others. Several educational programs have turned this dramatic situation into an opportunity to improve

technology-based tools in a way that appears to be a one-way journey. This is also why it is so relevant to implement new computer-based software to make them available to individuals with special needs, specifically to ID subjects.

The significance of assisted technologies has also been stressed by the World Health Organization (WHO), which focused on the use of info-communication technologies to facilitate the access to services for individuals with special needs and to remove the obstacles they encounter in social integration (WHO, 2012). However, existing technological devices only partially meet the needs of ID persons (Borblik et al., 2015). In fact, much still needs to be done in order for these individuals to be provided with appropriate technology, especially in the special centers they attend (Cuascota et al., 2019). To date, little literature exists as to how using technological tools specifically benefits competency enhancement of ID subjects (Peñaloza et al., 2016). This paper aims at filling this gap, by drawing attention on the topic and inviting scholars to prompt new experimental studies, as well as new types of technological tools to serve the needs of people with ID. More specifically, our aim is to review the impact of technology-based tools intended to enhance not only the dimensions of "knowledge" in ID individuals, but also the "competencies" they can use in everyday life.

As a premise, a crucial distinction ought to be made between the two notions of "knowledge" and "competency." Whereas *knowledge* can be described as the simple ability to "know" something, *competency* points to the capacity to "know how" to perform a certain task (Miller, 1990). In other words, *knowledge* is the range of an individual's information and/or understanding, that is, the sum of what s/he knows, whereas *competency* is the set of strategies an individual can put into practice if the opportunity is given. As opposed to simple *knowledge*, *competency* is the ability to apply knowledge and skills in practice (Sanford, 1989). In other words, *competency* is the integration of knowledge, skills, and attitudes required to perform a certain task in a specific setting (Spencer et al., 1994). Korossy (1999) extended the knowledge structures theory and integrated it into a competency-performance conception. The original theory stated that *knowledge* can be operationalized as an individual's solving behavior on a domain-specific set of problems. Korossy (1999) defined *competency* in terms of *performance*: in this view, the former is conceptualized in terms of what accounts for the latter, which is defined as the empirically observable solution behavior aimed at solving certain given problems: "*Performance* is conceived as the observable solution behavior of a person on a set of domain-specific problems. *Competency (ability, skills)* is understood as a theoretical construct accounting for the performance" (p. 103).

Finally, ESCO, the European multilingual classification of Skills, Competences and Occupations, applied the same definition of competency as the European Qualification Framework (EQF), which described competency in terms of responsibility and autonomy, as it refers to the capacity to use knowledge and skills for personal and professional development. As opposed to emotional intelligence, emotional competency involves the capacity to manage one's own emotions, to perceive one's well-being, and to be resilient towards stressful events (Amodeo et al., 2017, 2018; Maldonato et al., 2020; Saarni, 2000; Scandurra et al., 2018). As to psychology, according to Masterpasqua (1989) it ought to become the field where to identify and promote adaptationally relevant competencies, allowing for the individuals' well-being. According to Havaei et al. (2014), psychological competency is also positively associated to leadership-related empowering behaviors. Finally, academic competency refers to the ability to carry out appropriate school-related activities such as writing, reading, and solving mathematical problems (Van Wieren, 2011).

To sum up, whereas *knowledge* implies, as it were, to simply know the content of an activity, *competency* often requires dispositional abilities to put that activity into practice. Indeed, knowing *what* is required to carry out an action or to behave in a certain way is quite different from knowing *how* to do it. Here, we define "knowledge" as *the result of information acquisition through learning*. In contrast, we regard "competency" as *the ability to apply and utilize acquired knowledge to carry out tasks and solve problems in professional, social, and personal life domains*.

## 2. Methodology

We reviewed the existing literature on the impact of computer-based digital tools in the enhancement of ID individuals' competencies by carrying out a systematic search and selecting the relevant references in four electronic databases: PsycInfo, Educational Research Information Center (ERIC), PubMed, and Web of Science. We performed our search and analyzed the results using "PRISMA" (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) methodology (Page et al., 2021) (Figure 1). Search terms were chosen with the aim of satisfying all dimensions interested. The keywords we used for our research have been the following: "intellectual disability" AND "computer-assisted/based" AND "training/intervention." From March to May 2021, a systematic search was carried out in order to create a database of scientific articles relevant to our research. Three reviewers (SM, CS, and RFP) extracted the relevant data and assessed titles and abstracts identified in the literature search. They also excluded duplicates from the dataset. Disagreements between the three reviewers were solved through the involvement of three additional reviewers (NMM, IM, and

VB). All studies which matched the inclusion criteria were reviewed by the first three authors (SM, CS, and RFP) and any disagreement was settled through a discussion involving all other reviewers (NMM, IM, and VB).

Inclusion criteria consisted of selecting:

- experimental quantitative or qualitative studies

- studies involving samples of adult population (>18 years of age)

- studies involving samples of individuals affected by ID with no secondary comorbidities (e.g., ADHD, ASD, epilepsy, etc.)

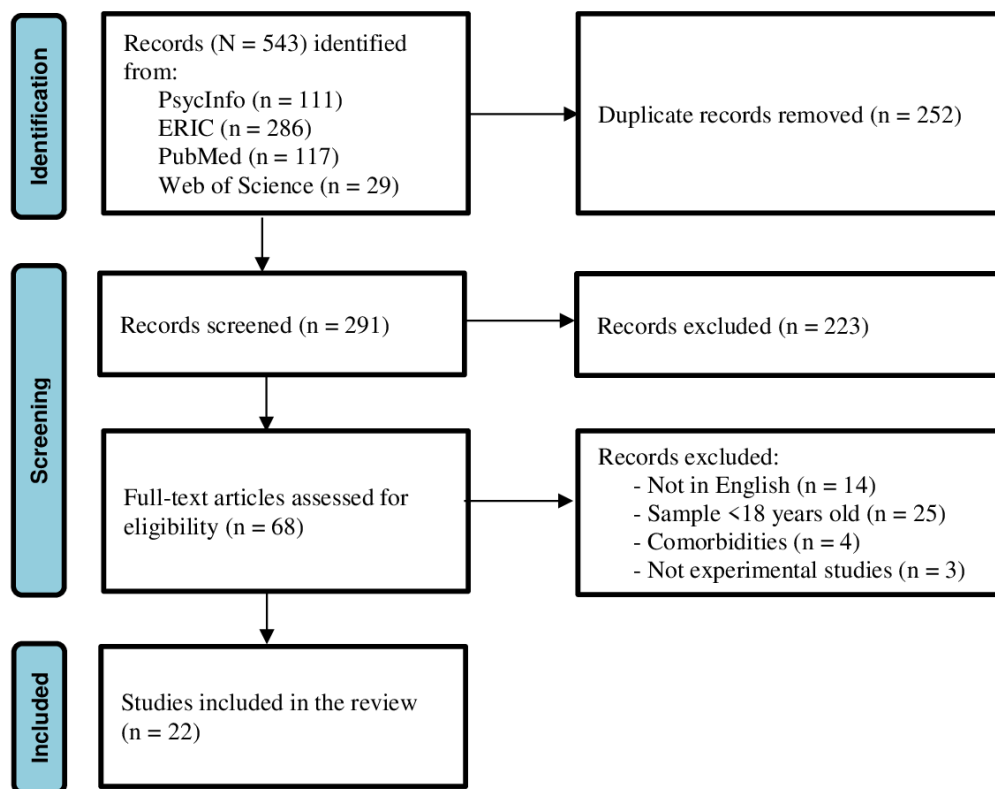To cover the largest range of publications, no temporal boundaries were set



**Figure 1.** PRISMA Flowchart of the Systematic Search

## 3. Results

A total of twenty-two articles were selected, as they met the inclusion criteria. Their sample (number of participants and diagnosis, gender, and age) and results are synthesized in Table 1. The issue addressed by the included articles were grouped and discussed by mixing a top-down and bottom-up approach. The latter refers to how we gathered and became aware of the relevant

topics the literature presents, the former more specifically refers to how our knowledge of the field allowed us to determine a grouping and separation of the issues at stake.

**Table 1.** Full Text Sources Retained

| Author(s), Year | Sample size | Gender | Age | Results |
|---|---|---|---|---|
| Cavkaytar et al. (2017) | 3 adults with mild ID | 3F | 19-32 | Tablet computers-based and Bluetooth headsets-assisted instructions are effective in teaching café waitering skills to ID individuals |
| Cazzell et al. (2016) | 3 young adults with ID | 2M, 1F | 20-25 | Computer-based flashcard instructions enhance word reading accuracy in young adult students with ID |
| Davies et al. (2002a) | 12 adults with ID | 8M, 4F | 19-46 | A palmtop computer with a schedule prompting software can increase ID individuals' independence in performing vocational and daily living tasks |
| Davies et al. (2002b) | 10 adults with ID | 8M, 2F | 18-70 | Using a multimedia training program on a palmtop PC enhances ID adults' self-direction in performing community-based vocational tasks |
| Davies et al. (2003a) | 19 adults with ID | 11M, 8F | 22-57 | Computerized technology can facilitate financial management skills in ID individuals |
| Davies et al. (2003b) | 9 adults with ID | 5M, 9F | 25-58 | Computer simulation is effective in teaching ATM use to ID individuals |
| Ivey et al. (2017) | 3 young adults with moderate ID | 3F | 19-20 | A "hands free" approach is effective in operating video prompts to complete multi-step tasks for people with moderate ID |
| Lancioni et al. (1999) | 4 adults with severe ID | 3M, 1F | 18-23 | ID subjects have a significantly higher level of correct performance on tasks presented with a computer-based system than on those presented using a card system |
| Larson et al. (2016) | 15 adults and older adults (8 IG; 7 CG) with mild to moderate ID | 8M, 7F | 22-71 | Computer-assisted instruction and one-on-one tutoring are both effective in teaching skills to individuals with ID |
| McMahon et al. (2015) | 6 young adult college students with ID | 4M, 2F | 19-24 | An augmented reality navigation app is more effective than a printed map and Google Maps in improving navigation skills in ID individuals |
| Mechling & O'Brien (2010) | 3 young adult students with moderate ID | 2M, 1F | 19-20 | Computer-based video instructions are effective in teaching young adult students with ID to locate landmarks and targeted bus stops |
| Mechling & Ortega-Hurndon (2007) | 3 young adults with moderate ID | 2M, 1F | 20-21 | Computer-based video instruction is effective in teaching generalized, multi-step job tasks to ID individuals |
| Moreno & Saldaña (2005) | 36 young adults (19 IG; 17 CG) with severe ID | 11M 8F in IG; 10M 7F in CG | 27.10 (mean) IG; 20.9 (mean) CG | Computer-assisted programs improve metacognitive processes in subjects with severe ID |

| | | | | |
|---|---|---|---|---|
| Morgan & Salzberg (1992) | 3 adults with severe ID | 1M, 2F | 34-37 | Video is a useful and efficient means to teach employment-related social skills to adults with severe ID |
| Peñaloza et al. (2016) | 50 adults with mild, moderate, or severe ID | 27M, 23F | 19-56 | "Armoni" (a computer-based cognitive training program for individuals with ID) is effective in teaching cognitive skills to ID individuals |
| Rehfeldt et al. (2003) | 3 adults with moderate to severe ID | 2M, 1F | 22-37 | Video modeling is an effective instructional tool to teach simple meal preparation skills to adults with moderate to severe ID |
| Siberski et al. (2015) | 32 individuals (11 IG; 11 $CG_1$; 10 $CG_2$) with ID | 7M, 4F in IG; 9M, 2F in $CG_1$; 8M, 2F in $CG_2$ | 44.18 (mean) IG; 37.27 (mean) $CG_1$; 39.89 (mean) $CG_2$ | ID individuals can successfully utilize computer programs to achieve cognitive enhancements |
| Smith et al. (2017) | 3 young adult college students with ID | 2M, 1F | 22-25 | An augmented reality iPhone app can improve navigation skills in young adult students with ID |
| Standen, Anderton, et al. (2009) | 16 individuals (8 IG; 8 CG) with severe ID | 5M, 3F in IG; 4M, 4F in CG | 37.5 IG; 35.5 CG (mean) | Playing computer games involves a significant decrease in choice reaction time in ID individuals |
| Standen, Rees, & Brown (2009) | 12 adults (6 IG; 6 CG) with ID | 3M, 3F in IG; 5M, 1F in CG | 41.25 (mean) | Computer games involving aspects of decision making improve performance in non-computer-based tests of decision-making in ID individuals |
| Tam et al. (2005) | 16 young adults (8 IG; 8 CG) with moderate ID | 4M, 4F in IG; 4M, 4F in CG | 17-23 | Virtual Reality programs are as effective as conventional training programs in training living skills to ID individuals |
| Tardif-Williams et al. (2007) | 39 individuals with ID | 19M, 20F | – | Computer-assisted and classroom-based training are equally effective in increasing human rights awareness in ID individuals |

Notes: ID = intellectual disability; IG = intervention group; CG = control group; M = male; F = female

### 3.1 Social competencies

ID individuals' social competencies include the quality of interpersonal relationships, self-confidence, problem solving, and practical skills, such as self-care and vocational skills (Schalock et al., 2010). The capacity to use effective social skills is crucial to the well-being of all individuals, and especially for persons with ID. Fostering social skills in these subjects is therefore extremely important to allow them to positively integrate in society. As a matter of fact, preparing individuals with ID for an independent social life after school is considered more and more important in the field of special education. Providing vocational education, employment, and job guarantee for these individuals is therefore crucial for their independency and autonomy.

### 3.1.1 Vocational competencies

One of the first studies that addressed the use of computer-based training to enhance the social skills of individuals with ID has been performed by Morgan and Salzberg (1992), who investigated the effects of video-assisted training on employment-related social skills in adults with severe ID. Video-assisted training consisted of viewing a model's behavior on videotape, making sure that the person correctly discriminated the behavior, and reinforcing the person's verbal responses to questions about the video-recorded scenarios. Since the participants were not used to ask for help when they needed it, and since request for assistance was determined as a high priority for them, the targeted social skill investigated in the study was requesting assistance from the work supervisor. The results showed that individuals with severe ID could learn the relevant features of requesting assistance, fixing problems, and reporting them to their supervisor when the related behaviors were presented on video-recorded scenarios. This showed that, therefore, videos can represent useful and efficient means of teaching relevant social skills to adult subjects with severe ID.

Video modeling has been also utilized by Rehfeldt et al. (2003) to evaluate whether adult individuals with moderate to severe ID would have acquired simple meal preparation skills by means of this computerized method. Participants were shown a video presenting a chained task of making a peanut-butter and jelly sandwich. The results supported the hypothesis that video modeling is an effective instructional tool to teach simple meal preparation skills to adults with moderate to severe ID, who were also able to generalize and maintain the acquired skills in other settings. Lancioni et al. (1999) further assessed the general task performance of adults with severe ID using a computer-based system capable of providing auditory and vibratory prompts in addition to pictorial instructions concerning the task steps. The results indicated that, when compared to those presented with a card system, the tasks presented on a computer-based system enabled ID subjects to perform significantly better than in the other condition.

### 3.1.2 Social responsibility

Based on the hypothesis that human rights awareness can prevent abuse on people with ID, Tardif-Williams's 3Rs (Rights, Respect and Responsibility) research team (2007) analyzed the usage of interactive technology aimed at allowing adults with ID to learn about their need to respect and be responsible for themselves and others. Human rights awareness was defined as the capacity (a) to identify human rights violations, (b) to understand their specific nature, and (c) to formulate possible solutions to resolve them. The goal was to compare the effectiveness of an interactive video-based CD-ROM to more traditional, classroom-based training intended

to teach individuals with ID to identify human rights violations and possible resolutions. Whereas the interactive CD-ROM training was based on computer-generated video scenarios focusing on respect for oneself and others, as well as on mutual responsibility, the classroom-based training consisted of traditional lessons comprised of previous class-review, role-play, discussions, and a review of the lesson. The order of the two types of training (computer-based training first, classroom-based training last, and vice versa) was not significant, as the two sequences equally yielded positive outcomes. In fact, the two programs were both effective in increasing human rights awareness in ID individuals. Most importantly, both types of training improved their ability to generalize the training to other non-trained scenarios. Finally, participants scored higher when presented with realistic video-presented scenarios ("action-test condition") than when a research assistant simply read a scenario on the video ("dictation test condition"), indicating that interactive computer-based technology is effective in competency enhancement for ID individuals.

Larson et al. (2016) compared the effectiveness of computer-assisted instruction to one-on-one tutoring in teaching people with mild and moderate cognitive disability. Participants received either computer-assisted instruction or one-on-one tutoring in three relevant domains: behavioral limitations, rights and responsibilities, and alphabetical sorting. Strong evidence of learning was found in both training method conditions, where learning equally increased linearly with repeated training. Furthermore, the two training methods gave rise to approximately equivalent rates of learning and general learning attainment, indicating that computer-assisted instruction applications do have the potential to be actually as effective as (but more cost efficient than) one-on-one tutoring.

### 3.1.3 Navigation skills

Since navigation skills are extremely important for the independence and autonomy of individuals with ID, McMahon et al. (2015) aimed at examining the effects of three different navigation aids (printed map, Google Maps on a mobile device, and an augmented reality navigation app) for young adult college students with ID to navigate a campus to an unknown location. The results showed that the augmented reality navigation application was functionally the most effective condition, indicating again that virtual reality can be more efficient than other methods in aiding young adults with ID to learn relevant daily skills. Similarly, Smith et al. (2017) examined the effects of using mobile technology in the improvement of navigation skills in young adult students with ID. Navigation skills involved an augmented reality iPhone app used to make correct "waypoint" decisions when traveling on foot to specific destinations on a

university campus. The results indicated that all participants improved their navigation skills thanks to this method. Mechling and O'Brien (2010) also investigated the effectiveness of a computer-based video instruction to teach young adults with moderate ID to push a "request to stop" bus signal and exit a city bus in response to target landmarks. The results indicated that computer-based video instruction was an effective tool to teach the bus route to all participants, most of whom were also able to generalize the acquired skill with no in-vivo instructions, and to maintain it over time.

### 3.1.4 Daily living competencies

Mechling and Ortega-Hurndon (2007) evaluated the efficacy of computer-based video instructions in training young adults with moderate ID to perform complex, multiple step job tasks in a generalized setting. All instructions were delivered through simulation that combined video- and computer-based instructions. Each job task was comprised of multiple steps of a task analysis, and was taught to participants using computer-based video instructions. The results indicated that computer-based video instructions were effective in teaching young adult students with moderate ID to carry out the required multiple step job tasks (i.e., watering a plant, delivering mail, and changing paper towels in a student restroom), and that the correctness of the performed steps progressively increased as the computer-based video instructions proceeded. Teaching vocational skills to ID individuals can be as challenging as important to the social integration of these persons. On this basis, Cavkaytar et al. (2017) aimed at determining the effectiveness of teaching café waitering to ID adults using contemporary pieces of audio-visual technologies, that is, tablet computers and Bluetooth headsets. The results indicated that both types of instructions were effective in teaching café waitering skills to ID adults. Also, most participants were able to generalize and perform the acquired skills in real workplaces after the training.

Virtual Reality (VR) has a great rehabilitative potential for individuals with ID, both as intervention and as assessment, as it provides a safer setting compared to the real world, where practicing skills might carry too many risks for vulnerable persons (Standen & Brown, 2005). More specifically, VR can facilitate learning processes of ID individuals by providing the chance to acquire knowledge and skills that may reduce the impact of their impairments (Standen & Brown, 2006). Tam et al. (2005) aimed at evaluating the effectiveness of a 2-D VR program intended to train persons with ID how to shop. Participants were divided into two groups: the first one received a shopping skills training through a 2-D VR-based computer program, the other was instructed traditionally, by means of a psychoeducational package using

demonstration, role-playing, and immediate feedback with verbal reinforcement. Both programs were effective in improving shopping skills in individuals with ID, because there was a significant difference between the pre- and post-assessment scores of both the 2-D VR training group and the conventional training group. Also, there were no significant differences between the two programs in levels of improvement; however, the 2-D VR program had a slightly greater effect. This showed how, although the VR program might be a positive substitute to a conventional community-based living skills program, it can nonetheless complement it, as it can be a very powerful tool in rehabilitation.

**3.1.5 Decision-making**

Decision-making consists of several components (Dell'Orco et al., 2019; Maldonato & Dell'Orco, 2011, 2015), including reaction time, which can be hard to measure in people with ID, as these frequently fail to search for all the relevant information and evaluate alternatives before making decisions; instead, they tend to transfer a narrow range of solutions from past experiences to actual situations (Jenkinson & Nelms, 1994). A study aimed at analyzing the benefits of continued use of a switch in order to play a computer game indicated that, when compared to the control group, which was instructed to spend the same amount of time playing a game without a time limited response, the study group showed a significant decrease in choice reaction time after some time spent playing the game (Standen et al. 2009). Since both groups sat in front of the computer screen for the same length of time, and had also similar rates of tutor interaction, these findings suggested that the time pressured nature of the task faced by the intervention group was the crucial factor of the decrease in choice reaction time.

Another study carried out by Standen et al. (2009) aimed at assessing the effect on decision-making of playing a computer game, which involved making a decision based on visual information. More specifically, the authors intended to discover if repeated sessions playing a computer game involving aspects of decision-making (e.g., collecting relevant information and controlling impulsivity), would have improved performance in non-computer-based decision-making tests. Participants were divided in two groups: a study group, who performed the study game, and a control group, who performed a control game involving simple reaction time only. After repeated sessions, the study group scored significantly higher in the game even though researcher assistance significantly decreased. This study confirmed previous findings (Standen et al., 2001) that showed how interactive computer-based programs are important in benefiting individuals with ID by helping them to make better decisions, have more self-confidence, and take charge of their life more effectively.

Davies et al. (2002a) aimed at examining the efficacy of a Schedule Assistant software package and the use of a palmtop PC to enhance personal schedule maintenance and time-management skills for ID individuals, who were asked to complete an eight-item schedule using both the Schedule Assistant system and a traditional written schedule. The results demonstrated that the use of an automated schedule prompting system could increase the ability of ID individuals to initiate scheduled activities independently and at appropriate times. The fact that using a multimedia training approach with a palmtop PC can enhance independence for adults with ID in performing community based vocational tasks has been demonstrated also by another study performed by Davies et al. (2002b), who showed that using the Visual Assistant prototype resulted in improved task accuracy and decreased use of external prompts from a support person on different vocational tasks (i.e., a pizza box assembly and a software packaging task) in ID individuals.

In a further study, Davies et al. (2003a) analyzed a management software system aimed at improving management of personal checking accounts in individuals with ID, by allowing them to store and retrieve common payees, automatic of checks to the register, automatic balancing, and check printing. Using a within-subjects experimental design, the authors were able to find that, when using the software, the number of errors made by adult users with ID in check writing, check recording, and checkbook balancing was significantly reduced as compared to the traditional manual method. This showed that the use of a money management software program can be effective in enabling ID individuals to perform financial management tasks more independently. Parallel to this study, Davies et al. (2003b) investigated the efficacy of computer simulation to teach ATM use to adults with ID. The small number of errors observed in the post-test condition showed that after the training participants were able to perform the task much more effectively. Therefore, these results sustained the usefulness of computer simulation in teaching independent living skills to adults with ID.

### 3.2 Cognitive competencies

Cognitive competences can be defined as the cognitive capacities that involve "creative" as well as "critical" thinking (Sun & Hui, 2006). Cognitive competencies are as important as social skills for all individuals, but especially for those affected by ID. In order to determine whether adult participants with ID would have enhanced cognitive performance on several domains after cognitive training, Siberski et al. (2015) compared a cognitive training group to 2 control groups: a first group performed computer games designed to act as a placebo but simulated a cognitive training program; a second group was a waitlist group that simply continued with its usual schedule and activities. Several cognitive abilities were targeted for assessment, such as divided

attention, hand-eye coordination, inhibition, monitoring, naming, planning, recognition, response time, shifting, spatial perception, updating, visual working memory, visual perception, visual scanning, working linguistic-auditory memory. Since an improvement in cognitive functioning was observed in the cognitive training group, the results supported previous findings – yet performed on children (Mastropieri et al., 1997) –, indicating that individuals with ID can successfully utilize computer programs to achieve various cognitive enhancements.

"Armoni" is a computerized cognitive training program designed to train a variety of cognitive competencies in individuals with ID. Peñaloza et al. (2016) aimed at finding the cognitive mechanisms underlying different activities included in Armoni, in order to validate its use with persons with ID and to explore how cognitive functions can predict these individuals' performance on the program activities. The results indicated that naming ability, visual memory, comprehension, and visuo-construction seemed to tap different aspects of visual perception, visual and verbal memory, verbal fluency, attention span, and motor function in adults with ID. Ultimately, these findings supported the validity of Armoni as an effective method of cognitive training for ID individuals. Similarly, Cazzell et al. (2016) evaluated the effects of a computer-based flashcard reading intervention on the ability to read health-related words within 3 seconds in young adult students with ID. Even though the dimensions of maintenance and generalization (i.e., the ability to read words embedded within passages) varied among participants, overall, computer-based flashcard instruction could enhance their word reading skills, confirming the efficacy and validity of computer-based flashcards for enhancing word reading accuracy in subjects with ID.

Among cognitive competencies, metacognition and self-regulation are specifically relevant to the well-being and integration of people affected by ID, for whom achieving a good-enough level of metacognition can be very difficult. Considering metacognition as an individual's ability to reflectively think upon his/her own behavior and cognition, Moreno and Saldaña (2005) aimed at assessing the efficacy of a computer-assisted version of an already existing thinking skills program developed in a non-computerized context. The results demonstrated that the computer-assisted program was a useful intervention procedure to improve metacognitive processes in individuals with severe ID, thus supporting the efficacy of computer-assisted programs in helping these subjects to improve important aspects of their cognitive functioning. Finally, Ivey et al. (2017) tested the effectiveness of a "hands free" approach for operating video prompts to complete multi-step tasks. Participants (young adults with moderate ID) advanced the video prompts by using a motion (hand wave) over a proximity sensor switch. The study showed that all participants could master operation of the proximity sensor switch to operate

the video prompts, independently complete the craft activities, and maintain their performance using the "hands free" approach.

## 4. Discussion

The aim of this review was to investigate the state of the art of the scientific literature exploring the impact of technology-assisted tools on the enhancement of cognitive, social, and interpersonal competencies of people with ID. We defined "competency" as the capacity to apply acquired knowledge to perform tasks and solve problems in different life domains, and we regarded "knowledge" as the result of information acquisition through learning. Whereas knowledge refers to the acquired information and/or understanding of it, competency represents the set of strategies that the individual can apply if given the opportunity. We preferred the term "competency" rather than "competence" because, even though both refer to the capacity to do something effectively, the former is associated more closely with the set of skills that are needed to do a job, whereas the latter refers more specifically to the ability to do something well (Moghabghab et al., 2018). The distinction between knowledge and competency is of crucial importance, as most of the literature dealing with computer-assisted training for ID individuals has focused on knowledge and not on competency. Our aim consisted precisely of filling this gap, by reviewing the existing literature based on digital training specifically focusing on competency enhancement of ID individuals. Overall, only 22 articles matched the criteria to be included in the present review. Except for two articles, which are dated back to the last century (Lancioni et al., 1999; Morgan & Salzberg, 1992), the rest of the articles has been published within the last two decades, probably thanks to the increasing use of technological tools in everybody's daily life, and especially in cognitive and social training for ID individuals.

The explored scientific literature is therefore relevant for the challenges that people with ID have to deal with in different environments, such as school, work, community, and everyday life. Technological devices have indeed proven useful in enhancing competencies in all these life domains. As to the treatment of ID, it might be hypothesized that technology can also be a relevant tool to deal with the problems faced by this population. The psychic processes involved in the studies included in this review involve different domains, such as working memory, short- and long-term memory, problem-solving abilities, cognitive and metacognitive competencies, and general daily life skills. The intervention outfits in which these types of training can be applied and implemented for these persons can vary from school-related environments, to laboratories, to more naturalistic environments, such as their home and the special centers they attend.

**5. Limitations**

This review has some limitations. First, the number of articles included is relatively small, and an extension of the research in this field would be required to extend this type of research. Second, the sample size of most articles included is also very small. Therefore, any study comprising a wider number of participants would be welcomed for scholars to consider. Third, most articles included have no control group. This is an issue insofar as a control group allows to compare the results with the core experimental group. Finally, there are still several areas not yet explored, such as the emotional and sociocultural components of social and cognitive competency, as well as educational and integrative capacities that allow ID individuals to more deeply learn from experience and be better integrated in societal activities.

**6. Recommendations for future research**

Given the relatively small number of articles dealing with experimental designs focusing on the effects of technology on personal and social competencies of ID individuals, our hope is that the present review will prompt scholars to extend and deepen this field of research. Furthermore, ever new technological devices ought to be set up to help this population to acquire crucial personal and social competencies to better integrate in society and be more independent and autonomous. Computer-assisted programs ought to serve as instructional tools to provide ID individuals with instruments to improve and enhance their personal and social competencies in daily life. As one can see in Table 1, the sample of the existing studies has been very small so far, so an extension of the number of individuals who take part of similar studies should also be considered. Finally, it appears that the socio-emotional component of everyday living has been widely underrated, and it is our hope that this aspect will be more deeply investigated in future researches. In spite of the challenges that computerized training present when applied to ID persons, our opinion is that fostering computer-assisted technology in training cognitive and social competencies to this population is very promising, in that these instruments allow these individuals to better integrate in society and live more independently and autonomously.

**7. Conclusions**

Computer-based technological tools have proved to be effective in training diverse personal, vocational, and intersubjective competencies to individuals with ID. However, as a matter of fact, the literature reviewed highlights a lack of studies addressing specific competencies that are crucial to the well-being of these individuals, such as emotion-regulation, interpersonal

relationships, and self-confidence. Ultimately, our hope is that future research will touch on these domains, as integration of disability is essential to a healthy and well-functioning society.

**Conflict of Interest Statement**

The authors declare that the research was conducted in the absence of any potential conflict of interest.

## References

1. American Psychiatric Association (2013). *Diagnostic and statistical manual of mental disorders (5th Ed.)*. Washington, DC: Author.

2. Amodeo, A. L., Picariello, S., Valerio, P., Bochicchio, V., & Scandurra, C. (2017). Group psychodynamic counselling with final-year undergraduates in clinical psychology: A clinical methodology to reinforce academic identity and psychological well-being. *Psychodynamic Practice, 23*(2), 161-180. https://doi.org/10.1080/14753634.2017.1308834

3. Amodeo, A. L., Picariello, S., Valerio, P., & Scandurra, C. (2018). Empowering transgender youths: Promoting resilience through a group training program. *Journal of Gay & Lesbian Mental Health, 22*(1), 3-19. https://doi.org/10.1080/19359705.2017.1361880

4. Ayres, K. M., Mechling, L. & Sansosti, F. J. (2013). The use of mobile technologies to assist with life skills/independence of students with moderate/severe intellectual disability and/or autism spectrum disorders: Considerations for the future of school psychology. *Psychology in the Schools, 50*, 259-271. https://doi.org/0.1002/pits.21673

5. Bochicchio, V., Maldonato, N. M., Valerio, P., Vitelli, R., Dell'Orco, S., & Scandurra, C. (2019). A review on the effects of digital play on children's cognitive and socio-emotional development. *9th IEEE International Conference on Cognitive Infocommunications, CogInfoCom 2018 – Proceedings*, 8639945, 261-266.

6. Borblik, J., Shabalina, O., Kultsova, M., Pidoprigora, A., & Romanenko, R. (2015). Assistive technology software for people with intellectual or development disabilities: Design of user interfaces for mobile applications. *6th International Conference on Information, Intelligence, Systems and Applications (IISA)*. Corfu, Greece, 2015, 1-6. https://doi.org/0.1109/IISA.2015.7387976

7. Cavkaytar, A. & Acungil, A. & Tomris, G. (2017). Effectiveness of teaching café waitering to adults with intellectual disability through audio-visual technologies. *Education and Training in Autism and Developmental Disabilities, 52*, 77-90.

8. Cazzell, S., Browarnik, B., Skinner, A., Skinner, C., Cihak, D., Ciancio, D., McCurdy, M., & Forbes, B. (2016). Extending research on a computer-based flashcard reading intervention to postsecondary students with intellectual disabilities. *School Psychology Forum, 10*(2), 191-206.

9. Cuascota, L., Guevara, L., Cueva, R., Tapia, F., & Guerrero, G. (2019). Assistance application of people with cognitive disabilities in tasks for their social inclusion. *14th Iberian Conference on Information Systems and Technologies (CISTI)*. Coimbra, Portugal, 2019, 1-7. https://doi.org/10.23919/CISTI.2019.8760732

10. Davies, D. K., Stock, S. E., & Wehmeyer, M. L. (2002a). Enhancing independent time-management skills of individuals with mental retardation using a palmtop personal computer. *Mental Retardation, 40*, 358-365. https://doi.org/10.1352/0047-6765(2002)040<0358:EITMSO>2.0.CO;2

11. Davies, D. K., Stock, S. E., & Wehmeyer, M. L. (2002b). Enhancing independent task performance for individuals with mental retardation through use of a handheld self-directed visual and audio prompting system. *Education and Training in Mental Retardation and Developmental Disabilities, 37*, 209-218.

12. Davies, D. K., Stock, S. E., & Wehmeyer, M. L. (2003a). Utilization of computer technology to facilitate money management by individuals with mental retardation. *Education and Training in Developmental Disabilities*, *38*, 106-112.

13. Davies, D. K., Stock, S. E., & Wehmeyer, M. L. (2003b). Application of computer simulation to teach ATM access to individuals with intellectual disabilities. *Education and Training in Developmental Disabilities*, *38*, 451-456.

14. Dell'Orco, S., Esposito, A., Sperandeo, R., & Maldonato, N. M. (2019). Decisions under temporal and emotional pressure: The hidden relationships between the unconscious, personality, and cognitive styles. *World Futures*, *75*(4), 260-273. https://doi.org/10.1080/02604027.2018.1560836

15. Falmagne, J.-C., Koppen, M., Villano, M., Doignon, J.-P., & Johannesen, L. (1990). Introduction to knowledge spaces: How to build, test, and search them. *Psychological Review*, *97*(2), 201-224. https://doi.org/10.1037/0033-295X.97.2.201

16. Goo, M., Maurer, A. L., & Wehmeyer, M. L. (2019). Systematic review of using portable smart devices to teach functional skills to students with intellectual disability. *Education and Training in Autism and Developmental Disabilities*, *54*(1), 57-68.

17. Havaei, F., Dahinten, V. S., & MacPhee, M. (2014). Psychological competence. *JONA: The Journal of Nursing Administration, 44*(5), 276-283. https://doi.org/10.1097/NNA.0000000000000067

18. Ivey, A. N., Mechling, L. C., & Spencer, G. P. (2015). Use of a proximity sensor switch for "Hands Free" operation of computer-based video prompting by young adults with moderate intellectual disability. *Education and Training in Autism and Developmental Disabilities, 50*, 278-289.

19. Jenkinson, J., & Nelms, R. (1994). Patterns of decision-making behaviour by people with intellectual disability: An exploratory study. *Australia and New Zealand Journal of Intellectual Disabilities, 19*(2), 99-109. https://doi.org/10.1080/07263869400035141

20. Kagohara, D. M., van der Meer, L., Ramdoss, S., O'Reilly, M. F., Lancioni, G. E., Davis, T. N., & Sigafoos, J. (2013). Using iPods and iPads in teaching programs for individuals with developmental disabilities: A systematic review. *Research in Developmental Disabilities, 34*, 147-156. https://doi.org/10.1016/j.ridd.2012.07.027

21. Korossy, K. (1999). Modeling knowledge as competency and performance. In D. Albert & J. Lukas (Eds.), *Knowledge spaces: Theories, empirical research, and applications* (pp. 103-132). Psychology Press.

22. Lancioni, G. E., Van den Hof, E., Furniss, F., O'Reilly, M. F., & Cunha, B. (1999). Evaluation of a computer-aided system providing pictorial task instructions and prompts to people with severe intellectual disability. *Journal of Intellectual Disability Research, 43*, 61-66. https://doi.org/10.1046/j.1365-2788.1999.43120165.x

23. Larson, J. R. Jr, Juszczak, A., & Engel, K. (2016). Efficient vocational skills training for people with cognitive disabilities: An exploratory study comparing computer-assisted instruction to one-on-one tutoring. *Journal of Applied Research in Intellectual Disabilities, 29*(2), 185-96. https://doi.org/10.1111/jar.12176

24. Maldonato, N. M., Bottone, M., Chiodi, A., Continisio, G. I., De Falco, R., Duval. M., Muzii, B., Siani, G., Valerio, P., Vitelli, R., & Scandurra, C. (2020). A mental health first aid service in an Italian university public hospital during the coronavirus disease 2019 outbreak. *Sustainability*, *12*(10), 4244. https://doi.org/10.3390/su12104244

25. Maldonato, N. M., & Dell'Orco, S. (2011). How to make decisions in an uncertain world: Heuristics, biases, and risk perception. *World Futures*, *67*(8), 569-577. https://doi.org/10.1080/02604027.2011.615591

26. Maldonato, N. M., & Dell'Orco, S. (2015). Making decisions under uncertainty emotions, risk and biases. In Basis S., Esposito A., & Morabito F. C. (Eds.), *Advances in neural networks: Computational and theoretical issues* (pp. 293-302). New York: Springer.

27. Masterpasqua, F. (1989). A competence paradigm for psychological practice. *American Psychologist, 44*(11), 1366-1371. https://doi.org/10.1037/0003-066X.44.11.1366

28. Mastropieri, M. A., Scruggs, T. E., Shiah, R.-L. (1997). Can computers teach problem-solving strategies to students with mild mental retardation? A Case Study. *Remedial and Special Education, 18*(3), 157-164. https://doi.org/10.1177/074193259701800304

29. McMahon, D. D., Smith, C. C., Cihak, D. F., Wright, R., & Gibbons, M. M. (2015). Effects of digital navigation aids on adults with intellectual disabilities: Comparison of paper map, google maps, and augmented reality. *Journal of Special Education Technology, 30*, 157-165. https://doi.org/10.1177/0162643415618927

30. Mechling, L. C. (2007). Assistive technology as a self-management tool for prompting students with intellectual disabilities to initiate and complete daily tasks: A literature review. *Education and Training in Developmental Disabilities, 42*, 252-269.

31. Mechling, L. C., & O'Brien, E. (2010). Computer-based video instruction to teach students with intellectual disabilities to use public bus transportation. *Education and Training in Autism and Developmental Disabilities, 45*, 230-241.

32. Mechling, L. C., & Ortega-Hurndon, F. (2007). Computer-based video instruction to teach young adults with moderate intellectual disabilities to perform multiple step, job tasks in a generalized setting. *Education and Training in Developmental Disabilities, 42*(1), 24-37.

33. Miller, G. (1990). The assessment of clinical skills/competency/performance. *Academic Medicine, 65*(9), S63-67. https://doi.org/10.1097/00001888-199009000-00045

34. Moghabghab, R., Tong, A., Hallaran, A., & Anderson, J. (2018). The difference between competence and competency: A regulatory perspective. *Journal of Nursing Regulation, 9*(2), 54-59. https://doi.org/10.1016/S2155-8256(18)30118-2

35. Moreno, J., & Saldaña, D. (2005). Use of a computer-assisted program to improve metacognition in persons with severe intellectual disabilities. *Research in Developmental Disabilities, 26*(4), 341-357. https://doi.org/10.1016/j.ridd.2004.07.005

36. Morgan, R. L., & Salzberg, C. L. (1992). Effects of video‐assisted training on employment‐related social skills of adults with severe mental retardation. *Journal of Applied Behavior Analysis, 25*, 365-383. https://doi.org/10.1901/jaba.1992.25-365

37. Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., McGuinness, L., et al. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ, 372*(71). https://doi.org/10.1136/bmj.n71

38. Peñaloza, C., Gutiérrez-Maldonado, J., Ferrer-García, M., Caqueo-Urizar, A., Reverter-Guimeso, A., Macías-Cajal, Y., Amela-Huemes, D., & Perales-Josa, S. (2016). Cognitive mechanisms underlying Armoni: A computer-assisted cognitive training program for individuals with intellectual disabilities. *Anales de Psicologia, 32*, 115-124.

39. Ramdoss, S., Lang, R., Fragale, C., Britt, C., O'Reilly, M., Sigafoos, J., Didden, R., Palmen, A., & Lancioni, G. E. (2012). Use of computer-based interventions to promote daily living skills in individuals with intellectual disabilities: A systematic review. *Journal of Developmental and Physical Disabilities, 24*, 197-215. https://doi.org/10.1007/s10882-011-9259-8

40. Rehfeldt, R., Dahman, D., Young, A., Cherry, H., & Davis, P. (2003). Teaching a simple meal preparation skill to adults with moderate and severe mental retardation using video modeling. *Behavioral Interventions, 18*, 209-218. https://doi.org/10.1002/bin.139

41. Saarni, C. (2000). Emotional competence: A developmental perspective. In R. Bar-On & J. D. A. Parker (Eds.), *The handbook of emotional intelligence: Theory, development, assessment, and application at home, school, and in the workplace* (pp. 68-91). Jossey-Bass.

42. Sanford, B. (Ed.). (1989). *Strategies for maintaining professional competency: A manual for professional associations and faculty*. Canadian Scholars Press, Inc.

43. Scandurra, C., Picariello, S., Scafaro, D., Bochicchio, V., Valerio, P., & Amodeo, A. L. (2018). Group psychodynamic counselling as a clinical training device to enhance metacognitive skills and agency in future clinical psychologists. *Europe's Journal of Psychology*, *14*(2), 444-463. https://doi.org/10.5964/ejop.v14i2.1528

44. Schalock, R. L., Borthwick-Duffy, S. A., Bradley, V. J., Buntinx, W. H., Coulter, D. L., Craig, E. M., & Yeager, M. H. (2010). *Intellectual disability: Definition, classification, and systems of supports*. American Association on Intellectual and Developmental Disabilities.

45. Siberski, J., Shatil, E., Siberski, C., Eckroth-Bucher, M., French, A., Horton, S., Loefflad, R. F., Rouse, P. (2015). Computer-based cognitive training for individuals with intellectual and developmental disabilities: Pilot study. *American Journal of Alzheimer's Disease and other Dementias, 30*(1), 41-48. https://doi.org/10.1177/1533317514539376

46. Smith, C. C., Cihak, D. F., Kim, B., McMahon, D. D., & Wright, R. (2017). Examining augmented reality to improve navigation skills in postsecondary students with intellectual disability. *Journal of Special Education Technology, 32*, 3-11. https://doi.org/10.1177/0162643416681159

47. Snyder, S., & Huber, H. (2019). Computer assisted instruction to teach academic content to students with intellectual disability: A review of the literature. *American Journal on Intellectual and Developmental Disabilities, 124*(4), 374-390. https://doi.org/10.1352/1944-7558-124.4.374

48. Spencer, L. M., McClelland, D. C., & Spencer, S. M. (1994). *Competency assessment methods: History and state of the art*. Hay/McBer Research Press.

49. Standen, P. J., Anderton, N., Karsandas, R., Battersby, S., & Brown, D. (2009). An evaluation of the use of a computer game in improving the choice reaction time of adults with intellectual disabilities. *Journal of Assistive Technologies, 3*, 4-11.

50. Standen, P. J., & Brown, D. J. (2005), Virtual Reality in the rehabilitation of people with intellectual disabilities. *Cyberpsychology and Behaviour, 8*(3), 272-282. https://doi.org/10.1089/cpb.2005.8.272

51. Standen, P. J., & Brown, D. J. (2006). Virtual Reality and its role in removing the barriers that turn cognitive impairments into intellectual disability. *Journal of Virtual Reality, 10*(3-4), 241-252. https://doi.org/10.1007/s10055-006-0042-6

52. Standen, P. J., Brown, D. J., & Cromby, J. J. (2001). The effective employment of virtual environments in the training and rehabilitation of people with intellectual disabilities. *British Journal of Educational Technology, 32*, 289-299. https://doi.org/10.1111/1467-8535.00199

53. Standen, P. J., Rees, F., & Brown, D. (2009). Effect of playing computer games on decision making in people with intellectual disabilities. *Journal of Assistive Technologies, 3*, 25-32. https://doi.org/10.1108/17549450200900011

54. Sun, R. C., & Hui, E. K. (2006). Cognitive competence as a positive youth development construct: Conceptual bases and implications for curriculum development. *International Journal of Adolescent Medicine and Health, 18*(3), 401-408. https://doi.org/10.1515/IJAMH.2006.18.3.401

55. Tam, S.-F., Man, D., Chan, Y.-P., Sze, P.-C., & Wong, C.-M. (2005). Evaluation of a computer-assisted, 2-D Virtual Reality system for training people with intellectual disabilities on how to shop. *Rehabilitation Psychology, 50*, 285-291. https://doi.org/10.1037/0090-5550.50.3.285

56. Tardif-Williams, C., Owen, F., Feldman, M., Tarulli, D., Griffiths, D., Sales, C., & Stoner, K. (2007). Comparison of interactive computer-based and classroom training on human rights awareness in persons with intellectual disabilities. *Education and Training in Developmental Disabilities, 42*(1), 48-58.

57. Torrado, J. C., Gomez, J., & Montoro, G. (2020). Hands-on experiences with assistive technologies for people with intellectual disabilities: Opportunities and challenges. *IEEE Access, 8*, 106408-106424. https://doi.org/10.1109/ACCESS.2020.3000095

58. Van Wieren, T. (2011) Academic competency. In J. S. Kreutzer, J. DeLuca, & B. Caplan (Eds). Encyclopedia of clinical neuropsychology. New York, NY: Springer. https://doi.org/10.1007/978-0-387-79948-3_1445

59. World Health Organization (2012). *International day of persons with disabilities*, 3 December 2012. Retrieved from http://www.un.org/disabilities/default.asp?id=1597