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REVIEW PAPER

Technology-Aided Interventions for Employment Skills in Adults with Autism Spectrum Disorder: A Systematic Review

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Abstract There is a growing body of research investigating the effects of technology on remediating the employment challenges experienced by individuals with autism spectrum disorder (ASD). The current study provides a focused systematic review of 18 studies identified within the literature to employ technology to teach employment skills to adults with ASD. The review included 13 single-subject research and 5 group designs. Reichow's (2011) criteria were employed to assess the interventions as evidence-based practice (EBP). Results showed that the use of technology-aided interventions to be effective on increasing employment outcomes for adults with ASD. Furthermore, the current study presented the ranges of employment skills targeted, as well as the focus of intervention towards those with higher functioning ASD. The review also highlights avenues for further research.

Keywords Technology · Autism spectrum disorder · Employment · Vocational skills

Individuals with autism spectrum disorder (ASD) are faced with significant barriers when it comes to employment and workplace participation (Chiang et al. 2013; Hurlbutt and Chalmers 2004). Being employed involves integration and social inclusion, contributing to society, and being less dependent on publically funded programs (Hendricks and Wehman 2009). However, employment outcomes for individuals with ASD are among the lowest when compared to individuals with other developmental disabilities (Roux et al. 2013; Wagner et al. 2005). Individuals with ASD are not considered a homogenous group (Tager-Flusberg and Joseph 2003) and the complex manifestations of the disorder present challenges in identifying employment goals as well as designing individualized employment interventions. It is approximated that 70 % of individuals with ASD have at least one comorbid disorder, with 41 % presenting with two or more disorders including epilepsy, attention deficit hyperactivity disorder (ADHD), gastrointestinal problems, anxiety, depression, and sleep problems among others (Leyfer et al. 2006; Mannion et al. 2013; Simonoff et al. 2008). In addition, studies have shown that 40 to 60 % of individuals with ASD have an intellectual disability (Baron-Cohen et al. 2009; Brugha et al. 2012; Emerson and Baines 2010; Fombonne 2003).

The most recent evaluation of the lifetime cost of supporting a person with ASD is estimated to be $1.4 million in the USA and the UK. The cost increases and ranges from $2.2 to $2.4 million when a person diagnosed with ASD also presents with an intellectual disability (ID), with the highest costs in adulthood associated with residential care/supportive living and loss of individual productivity (Buescher et al. 2014). It is estimated that 90 % of adults with ASD are unemployed or underemployed (Gerhardt and Lainer 2011). The high rate of unemployment highlights the requirement for clinical and empirical investigations to improve employment opportunities for individuals on the spectrum.

At present, there is a growing body of research investigating the effects of technology for teaching employment skills to individuals with ASD. Technology aided interventions have been used to teach a range of employment behaviors such as clerical skills (Bereznak et al.2012; Bennett et al. 2013a, b), cleaning skills (Kellems and Morningstar 2012; Van Laarhoven et al. 2012), shirt folding (Bennett et al. 2013c), and entertaining customers (Allen et al. 2010, 2012; Burke

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et al. 2010). Other factors have been found to impede an individuals' ability to complete work-related tasks and include poor time management, inappropriate commenting, poor hygiene, deviating from routine, and difficulties with reasoning and decision-making. These issues have been positively impacted within the literature, by the introduction of technological interventions such as the use of the iPad (Hill et al. 2013; Jones and Bucholz 2014).

A variety of technologies have been explored within the employment literature. Examples of technology-aided interventions within the literature include video based modeling (VBM; Alexander et al. 2013; Allen et al. 2010, 2012; Kellems and Morningstar 2012; Hill et al. 2013), audio cueing (Allen et al. 2012; Burke et al. 2010; Bennett et al. 2013b), video prompting (Bereznak et al. 2012; Bennett et al. 2013a), and the use of iPad applications (e.g., calendar, notepad lite, shopping list lite; Hill et al. 2013). Several software applications are available on iPads and handheld computer tablets to promote self-management and independence by providing structure and prompts to assist with organization, scheduling, time management, decision making, and task completion (Myles et al. 2007; Stock et al. 2006). The technology is arranged to facilitate the intervention, allowing instructors to work simultaneously with other students or focus on other work-related tasks (DiGennaro Reed et al. 2011). Furthermore, social validity data from individuals with ASD, employers, and job coaches have shown that using technology is an acceptable and an appropriate way to deliver an intervention within employment settings (Kellems and Morningstar 2012).

Within the literature, a broad array of employment skills have been targeted for individuals with ASD and can be categorized as specific on-the-job skills (e.g., folding, photocopying, sweeping) and generic employment-related skills (e.g., time management, interview skills, social skills). In a recent review of the literature, Odom et al. (2015) investigated the effects of technology-aided interventions on a variety of different behaviors for high school students with ASD. In their review, the authors identified six studies that had successfully employed technology to increase specific on-the-job skills (Allen et al. 2010, 2012; Bennett et al. 2013c; Kellems and Morningstar 2012; Mechling and Ayres 2012; Van Laarhoven et al. 2012) and one study that had increased generic employment-related skills (Strickland et al. 2013) for adolescents with ASD. While their review documented the benefits of utilizing technology in interventions and instruction for adolescents with ASD, it emphasized the importance of establishing methodological standards for research in the field (Odom et al. 2015). Furthermore, Nicholas et al. (2015) carried out an analysis specifically on the existing literature for employment support approaches for individuals with ASD across the lifespan. The authors identified two articles that cited the use of technology on increasing employment skills for individuals with ASD. This review was a synthesis-based analysis and the authors identified that a systematic review would yield stronger results (Nicholas et al. 2015).

Systematic reviews can be enhanced when methods for determining evidence-based practice (EBP) are used to evaluate the effectiveness of interventions. For example, Bennett et al. (2013c) questioned whether the existing literature in the area of technology-aided interventions meets the current standards of EBP proposed for the field. What constitutes EBP can vary contingent on different research areas. For interventions within the ASD population, Reichow (2011) established an evaluative method for identifying interventions that could be considered EBP. Reichow's (2011) evaluative method provides a three-step approach where research rigor and strength are rated, and criteria for EBP are applied. Previous research has shown the efficacy of using this approach to evaluate both single-subject research designs (SSRD) and group designs (McCoy et al. 2016; Lydon et al. 2013).

Together with the recent advances in technology, the rapid increase in emerging literature highlights the need for a systematic review that evaluates the applications of evidence base of research that applies technology to teach employment-related skills to adults with ASD. In addition, the review seeks to evaluate methodological rigor and the evidence base of technology-aided interventions in the area. The review also seeks to identify and differentiate the skills targeted across applications of technology and the varying presentation of ASD.

Method

Literature Search Procedures

Systematic searches were conducted in five electronic databases: Psych INFO, Education Resources Information Centre (ERIC), Scopus, Psychology and Behavioral Sciences Collection (EBSCO), and Medline. Across all databases, the following combination of keyword descriptors were used: "employment", or "vocational*", or "work", or "social*", plus "autis*", plus "technology*", or "virtual*", or "video*", or "computer*", or "tablet", or "iPad", or "iPod", or "iPhone", or "software", or "internet", or "electronic*", or "multimedia", or "pager", or "hardware", or "audio recorder" (i.e., employment AND autis* AND technology*). Following this, the title and abstract of returned studies were reviewed for inclusion using the criteria outlined below. Reference sections of studies meeting the inclusion criteria, along with reference sections from relevant reviews, were then reviewed to identify additional articles for inclusion. The searches were conducted from March to April 2015, and all articles from 1980 to 2015

were searched. The searches were limited to peer-reviewed studies written in the English language.

Inclusion Criteria

Studies were required to meet the following inclusion criteria: (a) the study must have included at least one participant diagnosed with ASD; (b) participants, with a diagnosis of ASD, must have been 18 years of age or older; (c) the study must have examined a technology-based intervention or package of interventions designed to increase vocational skills and/or social skills relevant to employment; (d) the examination of the technology-based intervention must have been conducted using an experimental design (i.e. a SSRD—or a group comparison design); and (e) the study must have been published or accepted for publication with online availability in English within a peer-reviewed journal. Technology was defined as "the use of an electronic or mechanical apparatus which can be programmed by the practitioner to automatically deliver visual, auditory or proprioceptive cues, discriminative stimuli, or to display the modelling of desired behaviors" (DiGennaro Reed et al. 2011). Studies that evaluated interventions implemented for skills other than work-related or vocational skills were excluded.

Data Extraction

Each study selected for inclusion was summarized in terms of (a) participant characteristics (i.e., age, co-occurring diagnosis, and cognitive functioning), (b) experimental design, (c) dependent variable, (d) technology aided-intervention, (e) maintenance and generalization, and (f) research strength. The type of technology used to deliver the intervention was also summarized in terms of (a) tablets or personal digital assistants (PDA), (b) virtual reality environment, (c) iPod/iPhone, (d) laptop computer (not a virtual reality environment), (e) video/DVD, (f) radio and headset, and (g) multiple technologies identified within a study. In addition, treatment integrity and social validity were further coded according to the type of procedures used.

Treatment integrity Each study was analyzed in terms of the methods used to evaluate and monitor treatment integrity. Each study was coded for the continuous assessment of treatment fidelity across participants, conditions, and implementers.

Social validity Each study was analyzed in terms of the method used to evaluate social validity. The different methods used to monitor social validity included (1) participant, parents, or teacher completed surveys or questionnaires; (2) social validity interviews; and (3) standardized assessments developed to evaluate social validity of an intervention.

Determining Treatment Efficacy

Evidence-Based Practice (EBP; Reichow 2011) Reichow's (2011) evaluative method for determining if an intervention constituted EBP was applied to all studies included. This method was selected because it was designed to evaluate research involving either single-subject or group comparison designs (Reichow 2011). The evaluative method involved a comprehensive protocol implemented across three stages. In the first stage, two rubrics, one for research conducted using group comparison designs and another for research conducted using SSRDs, were used to rate research report rigor. Within each rubric, methodological elements were categorized according to primary and secondary quality indicators. Primary quality indicators for both SSRD and group comparison designs include (1) information on participant characteristics and (2) operationally defined independent and dependent variables. Primary quality indicators for group comparison designs also include the inclusion of comparison/control conditions, the demonstration of the link between the research question and the data analysis, and the use of appropriate statistical analysis. In addition, primary quality indicators for SSRDs also include the demonstration of a stable baseline condition and the demonstration of experimental control. Across both rubrics, primary indicators were rated as "high quality" (H), "acceptable quality" (A), or "unacceptable quality" (U). Secondary quality indicators for both SSRD and group comparison designs include the use of interobserver agreement and blind raters, the measurement of treatment fidelity, reports of generalization and maintenance outcomes, and the demonstration of social validity. For group research method designs, a study also had to report if participants were randomly assigned, the details of participant attrition, and the reporting of treatment effect sizes. Across both rubrics, secondary quality indicators were rated on a dichotomous scale, where indicators were either present or absent.

In the second stage, ratings of primary and secondary quality indicators were then synthesized and a research report strength rating was assigned (i.e., "strong," "adequate," or "weak"). Similar to the primary and secondary quality indicators, the method for scoring the strength ratings differed according to the research design. For example, studies employing group comparison design required high-quality grades on all primary quality indicators and to show evidence of four or more secondary quality indicators to receive a "strong" strength rating, whereas studies employing SSRDs required high-quality grades on all primary quality indicators and to show evidence of three or more secondary quality indicators.

In the third stage, technology-aided interventions were aggregated based on their strength rating across studies to determine if the intervention had cumulated enough empirical support to be classified as EBP (Reichow 2011). According to

Reichow (2011), an established EBP is an intervention that has been shown to be effective across multiple methodologically sound studies carried out by a minimum of two independent research teams across different geographical areas. EBP was determined by examining the number of studies conducted in group comparison designs, and both the number of studies conducted and the number of participants for SSRD, that received "strong" and "adequate" strength rating. The following formula was then applied to determine EBP for each technology-aided intervention ("$Group_s$" equals the total number of group design studies with an overall "strong" rating, "$Group_A$" equals the total number of group design studies with an overall "adequate" rating, "$SSED_S$" equals the total number of single-subject studies with an "strong" rating, "$SSED_A$" equals the total number of single-subject studies with an "adequate" rating, and Z equals the total number of points for an intervention):

$$(Group_s*30) + (Group_A*15) + (SSED_s*4) + (SSED_A*2) = Z$$

A total of 60 points indicated an intervention that met the criteria for an "established EBP" and a score of 31 points indicated an intervention that met the criteria for "probable EBP."

Reliability of Search Procedures and Inter-rater Agreement

The first and third author of this review acted as raters. Both authors carried out initial searches in the five databases and screened the titles and abstracts of articles for inclusion and exclusion. The first author conducted a search that was independent of the third author who simultaneously searched all databases according to the inclusion criteria. Interobserver agreement for articles to be included was calculated for 100 % of the search procedures. Agreement was defined as both raters identifying the same number of articles to be included per database. Dividing the number of agreements by the number of agreements plus disagreements and multiplying it by 100 % calculated inter-rater scores. Initial agreement for articles included was calculated at 76 %, the 24 % disagreement related to the definitions of dependent variables, and identification of employment related skills within the studies initially identified by the title and abstract. When raters disagreed on articles to be included, the authors examined each study based on the inclusion criteria and reached agreement. This process was repeated for all studies where disagreement occurred until 100 % agreement was achieved. For the data extraction, both the first author and the third author independently extracted information from each study. Following this, the third author then reviewed the accuracy the data extracted and calculated the IOA. Initial inter-rater agreement on data extraction was 85 %. When the data extracted was considered inaccurate, the co-authors reached agreement through discussion. This process was repeated until 100 % agreement was achieved. Initial inter-rater agreement for Reichow's EBP for all included studies was 96 %. When primary and quality indicators and strength ratings were considered inaccurate, the first and third authors reached agreement through discussion of the indicators evaluated. This process was repeated until 100 % agreement was achieved.

Results

A total of 18 articles met the inclusion criteria for this review. Table 2 provides a summary of the participants, methodological characteristics, employment skills targeted, intervention, and the outcomes for each study.

Participants

There were a total of 159 participants included for analysis, across the 18 studies. The mean age of the participants was 21.10 years (range 16–60 years). A total of 146 (91.82 %) participants were diagnosed as having high-functioning autism (HFA) or Asperger's syndrome (AS). A total of six (3.77 %) participants were diagnosed with ASD and a co-occurring intellectual disability. Five (3.14 %) participants were described as having a diagnosis of ASD. Two (1.26 %) participants were reported as having two or more co-occurring diagnoses, which included one participant presenting with obsessive-compulsive disorder (OCD), attention deficit hyperactivity disorder (ADHD), and Tourette syndrome (Burke et al. 2013) and one participant presenting with OCD and Tourette syndrome (Burke et al. 2010).

Experimental Design

Table 1 provides a summary of the type of experimental design utilized by the studies reviewed. Thirteen studies employed SSRD. Of these, five studies (38.46 %) employed a multiple-baseline design across participants, four (30.76 %)

Table 1 Applications of technology used to increase vocational skills

Technology	Number of studies (%)	Number of participants
Tablet, PDA	4 (22.22 %)	7
Virtual reality	3 (16.67 %)	48
iPod, iPhone	3 (16.67 %)	55
Video, DVD	3 (16.67 %)	31
Radio and headset	2 (11.11 %)	2
Laptop computer	1 (5.56 %)	10
Multiple	2 (11.11 %)	6

employed a multiple probe design across behaviors, two (15.38 %) used an alternating treatment design, and one (7.70 %) employed a multiple baseline design across behaviors. The remaining study (7.70 %) used a multiple probe design across participants and stimuli. Of the five studies that employed group designs, four studies (80 %) used randomized controlled trials (RCT) and one study (20 %) used a pre-post design without a comparison group or random allocation to an experimental and/or control group.

Dependent Variables

The 18 studies were examined across a variety of dependent variables. The different skills targeted to increase employment outcomes for people with ASD were organized into the following two categories: specific on-the-job skills (e.g., folding, photocopying, sweeping, etc.) and more generic skills teaching (e.g., time management, organization, job interview skills, social skills, etc.). Twelve of the studies (66.67 %) targeted specific on-the-job skills. Specific on-the-job skills included sorting mail (Alexander et al. 2013), entertaining customers (Allen et al. 2010, 2012), using a washing machine (Bereznak et al. 2012), cooking (Bereznak et al. 2012), 104-step shipping task (Burke et al. 2013), fire safety training (Burke et al. 2010), clerical skills (Bereznak et al. 2012; Bennett et al. 2013a, b; Goh and Bambara 2013), T-shirt folding (Bennett et al. 2013c), cleaning (Kellems and Morningstar 2012), stocking and taking inventory (Kellems and Morningstar 2012), preparing silverware (Van Laarhoven et al. 2007), and clocking in and out (Van Laarhoven et al. 2007).

Six studies (33.33 %) targeted more generic skills teaching. Generic skills targeted included work performance (Gentry et al. 2014), reducing personal support needs on the job (Gentry et al. 2014), social skills (Kandalaft et al. 2013; Mason et al. 2012), and interview skills (Morgan et al. 2014; Smith et al. 2014; Strickland et al. 2013).

Technologies

This review focuses on identifying the different applications of technology used to teach employment skills to adults with ASD. Table 1 shows the range of technological devices used in employment skills interventions. Of the 18 studies, the most frequently used technology was Tablets or PDA ($n = 4$; 22.22 %). Of these, three studies used these devices with video modeling, and one study to deliver video prompts, with and without voice-over narration. Of the 18 studies, three studies used Virtual Reality as the main intervention ($n = 3$; 16.67 %). Three studies utilized iPods/iPhones ($n = 3$; 16.67 %). Of these, two studies used an iPod/iPhone to deliver video modeling and one to deliver video prompts. The application of video/DVD technology was employed for 16.67 % ($n = 3$) of studies. All three of these studies used this technology to model target skills. Two studies used the application of radio and headset technology ($n = 2$; 11.11 %). Radio and headsets were used to deliver covert audio coaching. One study employed a laptop computer to deliver video modeling ($n = 1$; 5.56 %) and the final two studies utilized multiple technologies in conjunction with video modeling and audio cueing ($n = 2$; 11.11 %).

Generalization and Maintenance

Of the 13 studies that employed SSRDs, four (30.76 %) included measures of generalized outcomes. With regard to the five group design studies, only two studies (40 %) included a measure of generalized social outcomes. No group comparison studies measured the maintenance of the skills across time; however, 10 of 13 SSRD studies (76.92 %) measured maintenance outcomes.

Treatment Integrity

With regard to the evaluation and monitoring of procedure fidelity, 9 of the 18 studies reviewed included continuous measurement of treatment integrity across participants, conditions, and implementers. Of these nine studies, technology-aided interventions evaluating video modeling and video prompting ($n = 4$; 44.44 %) included the majority of measures of treatment integrity compared to audio coaching ($n = 2$; 22.22 %), video feedback ($n = 1$; 11.11 %), virtual reality ($n = 1$; 11.11 %), and one study evaluating both video modeling and audio coaching ($n = 1$; 11.11 %).

Social Validity

Of the 18 studies reviewed, 8 studies (44.44 %) included a measure of social validity. Six of the thirteen SSRD studies (46.15 %) included a method to measure intervention satisfaction. Three of the six SSRDs (50 %) employed parent, teacher, or participant completed surveys, two studies employed satisfaction interviews (33.33 %), and one study (16.67 %) included a standardized measure of social validity (i.e., Treatment Evaluation Inventory-Short Form). Of the five studies that employed group designs, two studies (40 %) included a measure of social validity. One study (20 %) interviewed participants using the Functional Assessment Tool for Cognitive Assistive Technology and the remaining study ($n = 1$; 20 %) employed a follow-up questionnaire and participant feedback.

Research Strength

The research strength of all included studies was calculated in accordance with Reichow's (2011) criteria. Nine studies (50 %) received an "adequate" rating, eight studies (44.44 %) received a "weak" rating, and one study (5.56 %)

received a "strong" rating. Table 2 provides a summary of the strength ratings for each study included in this review. The evidence base for technology-aided interventions was calculated. This yielded a Z score of 54, indicating that technology-aided interventions could be categorized as probable in EBP (Reichow 2011).

The most common interventions delivered through the modality of technology included video modeling/video prompting ($n = 10$), audio cueing ($n = 4$), virtual reality ($n = 3$), and video feedback ($n = 1$). The evidence base for each of the interventions identified as part of the review was calculated using Reichow's criteria (2011). Video modeling and video prompting, as an intervention to teach employment skills, yielded a Z score of 18, which cannot at this time be considered EBP. Similar to this audio cueing ($Z = 8$), video feedback ($Z = 15$) and virtual reality ($Z = 15$) yielded Z scores below the criteria to be considered EBP.

Discussion

This systematic review aimed to examine the research on technology-aided interventions for teaching employment skills to adults with ASD. In addition, this review applied Reichow's (2011) evaluative method for determining EBP for teaching employment skills in ASD. Overall findings indicate that technology-aided interventions have been successful in teaching employment skills to adults with ASD, increasing both specific and generic employment skills and therefore improving performance in the work environment. In addition to this, the current study found that researchers employed a variety of different applications of technology with tablets, iPads, and PDAs emerging as the most frequent type of technology utilized in the literature. Tablets, iPads, and PDAs were most commonly used to deliver video modeling, with positive outcomes reported in all but one study (Allen et al. 2012).

The development and use of technology in autism research is expanding at a rapid rate (Shic and Goodwin 2015). The employment literature has demonstrated an increase in technology-aided interventions within the last 5 years, with 17 of the 18 studies included in this review published since 2010. This review examined the research rigor and the evidence base of the existing literature on technology-aided interventions for increasing employment skills for adults with ASD. Overall, findings from the current review show that technology-aided interventions that teach employment skills to the adult population with ASD have the accumulated evidence necessary to be classified as probable in EBP, according to Reichow (2011). In addition to this, technology-aided interventions identified as part of the review used to teach employment skills such as video modeling (Alexander et al. 2013; Allen et al. 2010; Burke et al. 2013; Gentry et al. 2014; Goh and Bambara 2013; Kellems and Morningstar 2012; Masonet al. 2012; Van Laarhoven et al. 2007), video prompting (Bereznak et al. 2012; Bennett et al. 2013a), audio cueing (Allen et al. 2012; Burke et al. 2010; Bennett et al. 2013b, c) video feedback (Morgan et al. 2014), and virtual reality (Kandalaft et al. 2013; Smith et al. 2014; Strickland et al. 2013) were also analyzed to determine EBP. Findings indicate that video modeling, video prompting, video feedback, audio cueing, and virtual reality could not at this time be considered EBP in teaching employment skills to adults with ASD. These findings highlight that further research is warranted to broaden the evidence base.

The current review extends upon previous reviews in the area, as it is the first to evaluate research rigor and evidence-based practice of technology-aided interventions for teaching employment skills to adults with ASD. The analysis of the primary and secondary quality indicators identified nine studies of adequate methodological rigor. Strong ratings were observed for a video-modeling and audio-cueing intervention that addressed job-specific skills (Allen et al. 2012). However, eight of the studies included in the review received a weak rating. This finding supports Odom et al. (2015), which found that a proportion of studies failed to meet the methodological and content criteria necessary for the review and were omitted. Both these reviews highlight the importance of methodological standards across the research base as findings indicate that the technology-aided employment skills literature contains a number of studies of inadequate rigor. Furthermore, the current and previous research points towards the necessity to continue with empirical work within this area.

Technology-aided interventions have been used to teach a range of employment behaviors to adults with ASD. The skills targeted to increase employment outcomes for people with ASD described in the review can be categorized according to specific on-the-job skills (e.g., folding, photocopying, sweeping) and more generic skills teaching (e.g., social skills, interview skills). It is also important to differentiate individuals with and without intellectual disabilities when examining the ASD literature, as it is possible to conclude that cognitive impairments may impact the employment skills targeted and the selection of interventions. For adults with ASD and an intellectual disability, majority of the existing studies have focused on improving specific "on-the-job" skills and have reported positive results. For young adults leaving school, learning specific work-related skills is important. However, interventions should not focus solely on specific job-related tasks but also on the social skills that will foster a positive work experience (Fast 2004).

Of the 159 participants included in the review, a total of 146 participants were diagnosed as having HFA or Asperger syndrome. This is consistent with previous research on employment that shows that of the individuals with ASD

Table 2 Summary of studies using technology-based interventions to increase vocational skills

Reference	*N*	Age Gender (M/F)	Number of patients incl. with diagnosis	Level of intellectual functioning	Setting	Experimental design and measures	Target behavior(s) (DV)	Technology	Behavioral intervention	Outcome	M and G	Strength rating
Alexander et al. (2013)	7	18.7 years M	1× ASD	Moderate ID	Classroom	SSRD, multiple probe design across participants and stimuli Direct observation of the TB (frequency of occurrence measured as percentage correct)	Sorting mail for three mail sets	iPad	Video modeling, positive reinforcement, error correction	Participant mastered Set A and B. Mastery was not met for set C	M and G	Weak
Allen et al. (2012)	3	18 years M	1× ASD	Mild ID	Factory/ warehouse	SSRD, interrupted time series withdrawal design Direct observation of the TB (frequency of target vocational skills was measured using partial interval recording—15-s intervals) Parental scale of employment experience	Wear WalkAround® mascot costume and entertain customers: (1) Head actions (2) Arm/hand actions (3) Leg/torso actions	Computer Radio and headphones	Video modeling delivered via computer and positive reinforcement Audio cueing delivered via radio and positive reinforcement	VM not effective—initially the TB increased, but this did not sustain Audio cueing highly effective—increases in the TB to 80 % correct responding following the introduction of the AC intervention	M and G	Strong
Allen et al. (2010)	4	18–25 years M	2× ASD	Mild/ borderline ID	Retail warehouse	SSRD, multiple baseline across participants Direct observation of the TB (frequency of TB was measured using partial interval recording—15-s intervals) Social validity measure	Wear WalkAround® mascot costume and entertain customers; (1) Head actions (2) Arm/hand actions (3) Leg/torso actions	Videotape	Video modeling	Both participants met performance criteria	M	Weak
Bereznak et al. (2012)	3	18.6 years M	1× ASD	Mild ID	School	SSRD, multiple probe across behaviors Direct observation of TB	(1) Using a washing machine (2) Making noodles (3) Using a copy machine	iPhone	Video prompting, error correction, positive reinforcement	Participant increased performance across all TB	M	Adequate
Burke et al. (2013)	4	19–28 years M	AS ($n = 3$) ASD, OCD, ADHD, and Tourette	Borderline ($n = 1$) No ID ($n = 3$)	Warehouse	SSRD, multiple baseline across participants design Direct observation of TB	104 step shipping task	*VideoTote* software delivered via Samsung Galaxy Tablet	Video modeling, prompting, and feedback	All participants reached the 100 % task accuracy criteria	NR	Weak

Table 2 (continued)

Reference	*N*	Age Gender (M/F)	Number of patients incl. with diagnosis	Level of intellectual functioning	Setting	Experimental design and measures	Target behavior(s) (DV)	Technology	Behavioral intervention	Outcome	M and G	Strength rating
			syndrome ($n = 1$)			Standardized measures: Universal Design Performance Measure for Productivity, Social Validity—Treatment Evaluation Inventory-Short Form						
Burke et al. (2010)	6	18–27 years M	AS ($n = 4$) ASD, OCD, and Tourette syndrome ($n = 1$)	No ID ($n = 4$) Borderline ($n = 1$)	Factory	(1) SSRD, multiple baseline design across participants (2) SSRD, multiple baseline design across participants Direct observation of TB Satisfaction surveys	63 scripted responses as part of fire safety training which involved: (1) Cues from the facilitator-following instructions, responding to facilitator questions, reinforcing key points, (2) Cues from audience—encourages participants, (3) Cues from script—initiates communication with facilitator, initiates actions per script	(1) DVD (2) iPhone and iPod	(1) Training script and video modeling via DVD, positive reinforcement (2) Cue system delivered through iPhone application	All participants reached criterion with cue system alone and 1 participant reached criterion with behavioral skills training	M and G	Weak
Bennett et al. (2013a)	5	18 years M	1× ASD	NR	School	SSRD, adapted alternating treatment design Direct observation of the TB Social validity measure	Clerical Skills (1) Photocopying (2) Making labels (3) Sending a fax	iPad	iPad 2 used to deliver video prompting with and without voice-over narration Positive reinforcement	Small differences between video prompting with or without voice-over narration	NR	Adequate
Bennett et al. (2013b)	3	22 years M	1× ASD	NR	School		Clerical skills (1) Photocopying	Radio and headphones	Covert audio coaching	Participants reached mastery of TB	M	Adequate

Table 2 (continued)

Reference	*N*	Age Gender (M/F)	Number of patients incl. with diagnosis	Level of intellectual functioning	Setting	Experimental design and measures	Target behavior(s) (DV)	Technology	Behavioral intervention	Outcome	M and G	Strength rating
						SSRD, multiple baseline design across participants Direct observation of the TB			delivered via radio and headphones Performance feedback			
Bennett et al. (2013c)	3	18 years F	1× ASD	NR	School	SSRD, multiple baseline design across participants Direct observation of the TB	T-shirt folding	Radio and headset	Covert audio coaching delivered via radio and headset Performance feedback	Job task accuracy and fluency improved for the participant	M and G	Adequate
Gentry et al. (2014)	50	18–60 year	ASD	HFA	Work setting	Group, delayed RCT Standardized assessments; Craig Handicap Assessment and Rating (Whiteneck et al. 1992) Supports Intensity Scale and Employment Subscale (Thompson et al. 2004) Employee Performance Evaluation Report Functional Assessment tool for Cognitive Assistive Technology (FATCAT) DARS vocational aptitude test Social validity	Reduce personal support needs on the job Work performance	iPod Touch applications (1) Task reminder (2) Task lists (3) Picture prompts (4) Video modeling (5) Self-management (6) Way-finding tools (7) Communicat-ion with job coach	Prompts, video modeling	Workers who received PDA training at the beginning of their job placement required significantly less hours of job couching support ($p = 0.013$) No difference between functional performance	NR	Weak
Goh and Bambara (2013)	3	28 years F	1× ASD	Mild ID	Quiet office space	SSRD, multiple probe design across targeted job behaviors Direct observation of TB	(1) Creating conference packets (2) Paper shredding (3) Photocopying	Videotape	Video-self modeling Performance feedback	Participant demonstrated an increase in task acquisition	M	Weak
Kandalaft et al. (2013)	8	18–26 years	AS or PDD-NOS	Average or above-average IQ	University	Group, pre-post design	Social skills; (1) Verbal and non-verbal recognition (2) Theory of Mind	Computer—Virtual Reality social skills intervention	Virtual Reality	Significant increases on social cognitive measures of theory of mind and emotion recognition. Social and occupational	G	Weak

Table 2 (continued)

Reference	*N*	Age Gender (M/F)	Number of patients incl. with diagnosis	Level of intellectual functioning	Setting	Experimental design and measures	Target behavior(s) (DV)	Technology	Behavioral intervention	Outcome	M and G	Strength rating
							(3) Conversational skills			functioning increased also post-intervention		
Kellems, and Morningstar (2012)	4	20–22 years	ASD ($n = 2$) AS ($n = 2$)	Average to below-average range	Work site	SSRD, multiple probe across behaviors design Direct observation of TB Social validity	Cleaning Stocking Taking inventory	iPod	Video modeling delivered through iPod	Substantial gains in the % of steps completed correctly	M	Adequate
Mason et al. (2012)	2	19 and 26 years	AS ($n = 2$)	NR	Classroom on-campus	SSRD, multiple baseline design across behaviors Direct observation of the TB	Social communicative skills; (1) Eye contact (2) Facial expressions (3) Turn taking	Laptop computer	Video modeling (video-model with other as a model)	Increases in all target behaviors for 1 participant and eye contact and turn taking for 1 participant were obtained	M	Adequate
Morgan et al. (2014)	28	18–36 years	AD ($n = 16$) ASD ($n = 12$)	HFA	NR	Group, RCT—waitlist control Standardized assessments; Stanford-Binet Intelligence Scale-Abbreviated Battery Autism Diagnostic Observation Schedule, second edition (ADOS-2) Vineland-II Adaptive behavior scales Depression Scale of the Health Questionnaire-9	Interview skills curriculum (1) Character, attitude, and persona (2) Small talk, non-verbal communication, and hygiene (3) Interview questions, closing the interview, and follow-up	Video	Discussion, role play, video feedback, peer review, and games	Increase in job interview performance	G—measured by distal outcomes (i.e., Vineland)	Adequate
Smith et al. (2014)	26	18–31 years	ASD	HFA	Office	Group, RCT Assessments: Role-play interview measure, Social Responsiveness scale, 2nd Edition (SRS-2) The repeatable battery for the assessment of neuropsychological status (RBANS) Bell-Lysaker emotion recognition task Emotional perspective taking task	Job interview skills	Virtual reality	Virtual reality job interview training via computer/internet	Improvement in real-life job interview role-play performance than control group Increase in self-confidence	NR	Adequate

Table 2 (continued)

Reference	*N*	Age Gender (M/F)	Number of patients incl. with diagnosis	Level of intellectual functioning	Setting	Experimental design and measures	Target behavior(s) (DV)	Technology	Behavioral intervention	Outcome	M and G	Strength rating
Strickland et al. (2013)	22	16–19 years	ASD	HFA or AS	Home and university for assessment	Group, RCT Assessments: Interview skills rating instrument Social Responsiveness Scale	Social skills related to job searching and job interviews	Virtual reality	Virtual reality environment	Significantly increases verbal content skills	NR	Weak
Van Laarhoven et al. 2007	2	18 years	AS ($n = 1$)	AS	Work site	SSRD, multiple probe design across behaviors Direct observation of TB	Rolling silverware Sorting and cleaning silverware Clocking in and out	PDA	PDA Video modeling Performance feedback	Participant met criterion on all 3 tasks	NR	Adequate

Participants meeting the age range requirements stated in the inclusion criteria were extracted from the studies

P participants, *M* male, *F* female, *Incl.* included, *ASD* autism spectrum disorder, *AS* Asperger syndrome, *HFA* high-functioning autism, *PDA* personal digital assistant, *VM* video modeling, *SSRD* single-subject research design, *MB* multiple baseline, *MP* multiple probe, *RCT* randomized control design, *G* generalization, *M* maintenance, *TB* target behavior, *NR* not reported

employed, the majority of individuals present with HFA or are described as having Asperger's syndrome with the lowest rates of employment among individuals who have both ASD and an intellectual disability (Howlin et al. 2004; Hofvander et al. 2009; Lin et al. 2012). There is a significant gap in both practice and research within the literature concerning individuals with ASD and co-occurring intellectual disabilities; therefore, the need for research to investigate employment outcomes for those with lower functioning profiles is imperative.

Generalized outcomes that can be applied to everyday workplace interactions are important aims of employment skills interventions. Studies included in the review reported various degrees of generalization and/or maintenance outcomes. Four studies reported both generalization and maintenance of skills taught (Alexander et al. 2013; Allen et al. 2012; Burke et al. 2010; Bennett et al. 2013c), ten studies reported maintenance (Alexander et al. 2013; Allen et al. 2010, 2012; Bereznak et al. 2012; Burke et al. 2010; Bennett et al. 2013b, c; Goh and Bambara 2013; Kellems and Morningstar 2012; Mason et al. 2012), and six studies reported generalization (Alexander et al. 2013; Allen et al. 2012; Burke et al. 2010; Bennett et al. 2013c; Kandalaft et al. 2013; Morgan et al. 2014). These findings highlight that generalized outcomes were largely underreported in the current employment literature. Further research is, therefore, required to explore the generalized outcomes of employment skills interventions and methods under which generalization outcomes can be achieved.

The review has limitations for consideration. One limitation lies in the omission of hand searches of the literature. The authors acknowledge the importance and relevance of including hand searches for identifying articles not yet available in the electronic databases. Applying this additional search strategy may have identified additional articles that were not yet available on databases; however, the authors felt that the databases utilized provided access to all and current relevant studies. This strategy is recommended for future reviews of the area. Further considerations to be taken should address the issue of keywords used to identify studies for inclusion. While every effort has been made to ensure the keywords selected in the current review encompass the research objectives and reflect the empirical base, future researchers should continue to pay careful attention to keyword selection to prevent the omission of studies.

Overall, the current review has indicated that technology-aided interventions can be classified as probable in evidence-based practice for teaching employment skills to adults with ASD. Together with the high unemployment rates and the high economic costs associated with the disorder, there is a pressing need for further exploration of evidence-based interventions that teach the necessary skills for workplace inclusion and productivity. There are many positive outcomes associated with employment for individuals with ASD, such as

increased cognitive functioning (García-Villamisar and Hughes 2007), improved social interaction opportunities, development of peer relationships, a general improvement in quality of life (García-Villamisar and Sala 2002; Hiller et al. 2011), and reduced anxiety and depression (Hiller et al. 2011). Technology has been shown to increase specific on-the-job skills (Alexander et al. 2013; Allen et al. 2010, 2012; Bereznak et al. 2012; Burke et al. 2010, 2013; Bennett et al. 2013a, b, c; Goh and Bambara 2013; Kellems and Morningstar 2012; Van Laarhoven et al. 2007) and generic employment-related skills (Gentry et al. 2014; Kandalaft et al. 2013; Mason et al. 2012; Morgan et al. 2014; Smith et al. 2014; Strickland et al. 2013) to adults with ASD. Furthermore, technology has become incorporated into daily life and devices can be discrete, offering interventions, which have social acceptability. However, this review highlights the additional need for high-quality research evidence to support the use of technology on increasing employment outcomes for adults with ASD.

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*An asterisk mark has been placed by each study in the reference section that met the inclusion criteria for the review

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