


# A Systematic Review of Interventions for Adults with Autism Spectrum Disorder to Promote Employment

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**Abstract** Adults with autism spectrum disorder are underrepresented in the workforce. This review examined single case design research investigating vocational interventions for this population. Reporting of generalization and social validity data was also assessed. Eighteen studies met inclusion criteria. They were categorized as Behavioral Skills Training, video-based instruction, or self-management procedures. Only Behavioral Skills Training meets replication standards to be considered effective and evidence-based for this population. Video-based instruction and self-management procedures are emerging with few studies completed and variable effects. Social validity was underreported and limited in focus. Future research should include considering error correction procedures and feedback in video-based instruction, trialing

self-management procedures, and greater attention to social validity.

**Keywords** Autism spectrum disorders · Adult · Behavior Skills Training · Vocational interventions · Self-management · Video-based instruction

Worldwide, the last two decades have seen staggering increases in the diagnosis of autism spectrum disorder (ASD). In Australia, for example, increases in diagnoses from 2009 to 2012 have been estimated at 79 % (Australian Bureau of Statistics 2012) and current prevalence rates from the USA indicate that one in 68 children are diagnosed with the disorder (Centers for Disease Control and Prevention 2014). Increasing numbers of these individuals are now approaching adulthood, and evidence regarding their quality of life is alarming.

Barneveld et al. (2014), in comparing young high-functioning adults with ASD in The Netherlands with age-matched adults diagnosed in childhood with other psychiatric disorders, found that those with ASD were more likely to be single, living with their parents or other family members, institutionalized, not in paid employment (51.9 %), and in receipt of social security payments than were those previously diagnosed with attention deficit/hyperactivity, disruptive behavior, or affective disorders. Similarly, Shattuck et al. (2012) in a nation-wide comparative study of post-secondary employment of young adults with ASD, speech/language impairment, learning disability, and mental retardation in the USA reported that those with an ASD had significantly lower rates of employment and higher overall rates of no workforce participation than all other groups. This pattern was particularly pronounced in the 2 years immediately after leaving school; the authors concluded that youth with an ASD are at uniquely high risk for failing to find employment on leaving high

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school. A potential financial and social crisis appears to be looming (Gerhardt and Lainer 2011).

Employment is associated with clear benefits to society and individuals, providing greater potential for independent living, greater life satisfaction, and general wellbeing. Vocational engagement has been shown to reduce autism-related symptoms and maladaptive behaviors (Taylor et al. 2014) and is tied to positive health outcomes, higher rates of self-esteem, and enhanced social wellbeing (Roux et al. 2013). Many adolescents make gains in functional independence with support throughout secondary school (Smith et al. 2012). However, without continued support, they often regress on leaving school (Shattuck et al. 2012).

Supported employment programs in mainstream workplaces, which enable individuals to be members of the workforce, to work as independently as possible and provide authentic career possibilities, have yielded positive outcomes for adults with ASD. Reported outcomes of such programs include improved quality of life (García-Villamizar et al. 2002), and cognitive performance (García-Villamizar and Hughes 2007), reduced anxiety and depression (Hillier et al. 2011), and increased and sustained employment (Wehman et al. 2012). Howlin et al. (2005) reported that 68 % of clients of such a program had maintained employment at an 8-year follow-up.

However, questions remain regarding the skills that need to be taught in vocational support schemes and how best to teach them. As well as job-specific skills, more generic problems with time management, task engagement, and low productivity have been identified as common with employees with ASD (Howlin et al. 2005). Similarly, deficits in social skills have been identified as a major barrier to their workforce participation. Addressing deficits in social, communication, and interpersonal skills, and enhancing task engagement and task completion, could be critical to improving employment outcomes for adults with ASD (Chen et al. 2015).

Since 2010, a number of reviews have been published on this topic, each addressing in different ways questions regarding increasing employment in adults with ASD, including how work-related skills might best be taught. Hendricks (2010) in a narrative review of research concerning the benefits of employment and the employment status of adults with ASD identified obstacles to employment, current employment, and support service options, together with a review of supports needed for successful vocational placement. Hendricks comments on the dearth of research on instructional procedures for use with adults with ASD in the vocational context but concludes that the available research supports the use of “strategies derived from the principles of applied behavior analysis and include modeling, structured reward systems, video modeling, errorless learning, graduated guidance, and systems of prompts” (p 130).

Taylor et al. (2012) undertook a systematic review of vocational interventions for young adults with ASD in which

they excluded all studies with fewer than 20 participants—thereby effectively eliminating all single case design (SCD) research. They located only five studies which met their inclusion criteria, all of which they rated as poor in quality. They concluded that although there was some evidence for successful outcomes from supported employment interventions, there was very little evidence available for specific vocational treatment approaches. Taylor et al. did not drill down into the methodologies used to identify specific instructional strategies that might contribute to skill acquisition.

More recently, Walsh et al. (2014) presented a broader systematic review of the extant research, which they assigned to categories: *Predictor*, *Impact* (of employment), and *Intervention* studies. Seventeen studies met the inclusion criteria for the latter category, 15 of which employed proper SCD designs, one an AB design, and one was a correlational study. Walsh et al. reported that, in these studies, a range of strategies were used including reinforcement-based procedures (in 16 of the 17 studies), video modeling (7/17), video modeling in combination with cuing and visual supports (2/17), antecedent prompts and feedback via covert audio coaching (2/17), a combination of instruction, modeling, prompting (which they termed a “performance cue;” 2/17), and graduated guidance. One study was reported to have explored a combination of self-monitoring, modeling, and response prompts and a final study used a combination of reinforcer assessment, written schedules, and simulation-based training. Walsh et al. concluded that all 17 studies reported participants achieving satisfactory performances in their target behaviors, and 13 reported maintenance 1 to 3 months post intervention. They did not however quantify the reported treatment effects nor did they assess the quality of the research designs. This report therefore leaves unaddressed questions regarding the strength of the evidence-base for these interventions and differential effectiveness of the procedures described.

The most recent systematic review on the topic of employment for individuals with ASD (Seaman and Cannella-Malone 2016) focused entirely on intervention studies, but it included pre-employment skills and school-based interventions for adolescents as well as employment retention skills. These authors reviewed 20 research papers that met their inclusion criteria, reporting on 21 separate intervention studies published between 2010 and 2015. Of these, 15 were single case design studies and six between group comparisons. Only the single case design studies were subjected to a quality assessment and nine of the 15 studies were rated as meeting WWC evidence standards (Kratichwill et al. 2010) with or without reservations. Though the authors then also allocated ratings of the strength of the evidence presented in these studies, they did so using visual analysis only rather than providing a quantified effect size. They also did not synthesize their findings nor reach any conclusions regarding which specific

practices and interventions might be considered *evidence-based*, though technology-based interventions (audio and video) emerge as strong contenders. Seaman and Canella-Malone discussed a number of limitations in the research they reviewed, including limited rigor in some studies—such that they are unable to contribute to the evidence-base, limitations in addressing generalization and maintenance, and limitations in addressing social validity, specifically whether the reported interventions actually led to important outcomes in real-life settings, such as real employment.

Useful interventions to support employment in adults with ASD need not only be effective but also have high social validity. It has long been argued that researchers should provide data to show that the goals of an intervention are socially significant or important, that the procedures are appropriate and acceptable, and that the outcomes are important for the participants concerned as well as society at large (Wolf 1978). Walsh et al. (2014) discussed the general usefulness of the skills targeted in the vocational interventions they reviewed. Some target skills were highly specific to a particular work role (e.g., wearing a mascot uniform), such that the social significance of the goals is questionable, while others were more general with wider potential applicability (e.g., photocopying). Social validity has been shown to be underreported in studies of adaptive skill interventions for adolescents with ASD (Palmen and Didden 2012). This may also be the case for vocational interventions with adults. Without these indices, it is uncertain whether interventions are used in ways that truly benefit the individuals concerned and society in general.

Although none of the reviews to date provide a clear result regarding evidence-based interventions to enhance employment in adults with ASD a number of common elements of procedures associated with positive outcomes are evident. This includes the use of technology (Seaman and Cannella-Malone 2016), and the use of basic behavioral strategies best described as Behavior Skills Training (BST), first researched many years ago (Baer et al. 1967). As a procedure, BST involves *instruction*, *modeling* (which Baer et al. termed *demonstration*), *prompting* if required, *rehearsal* or practice, and providing corrective *feedback* and/or *reinforcement* as appropriate. BST has been comprehensively evaluated, in teaching a broad range of skills to diverse populations, ranging from social skills (Bornstein et al. 1977) to pedestrian (Yeaton and Bailey 1978) and gun safety (Miltenberger et al. 2005), and abduction-prevention (Johnson et al. 2005). Systematic component analyses of the procedures (Kornacki et al. 2013; Yeaton and Bailey 1978) have demonstrated that the whole is better than the sum of its parts. Even though some of the promising approaches described above include elements of BST (for example, Walsh et al. 2014), its effectiveness has not to date been evaluated in relation to vocational skill training for adults with ASD.

The purpose of this paper was to systematically review intervention studies using SCDs that target improvements in skills likely to increase employment opportunities for adults with ASD. The What Works Clearinghouse (WWC) *Standards and Procedures Handbook* (Institute of Education Sciences 2014) (the *Standards*) was utilized to assess the quality of the studies reviewed and to determine whether the interventions used qualify as evidence-based.

Even though deficits in social skills have been identified as a barrier to employment (Hillier et al. 2007), few previous reviews of vocational skill interventions have considered social or other adaptive skills as target behaviors. Such skills may be pivotal to better vocational outcomes. As our aim was to investigate interventions likely to be associated with enhanced employment for individuals with ASD, our search strategy also sought to identify interventions for adults with ASD targeting more general skill development. Finally, we also examined the level of reporting of social validity and generalization data in these studies. It is important to know if those involved in interventions are satisfied with the goals, procedures, and effects, as well as if the skills taught maintain over time and generalize such that lasting benefits in the real world are likely.

## Method

### Literature Search

Studies included in this review were obtained through systematic searches of five electronic databases: EBSCO, ERIC, Scopus, PsycInfo, and Ovid Medline. Studies retrieved were published prior to May 16, 2016. Two searches were conducted within each database using the terms “autis\* AND adult,” in conjunction with “NOT child\*.” The first search combined these search terms with the keywords “employ\*,” “vocat\*,” and “work” to yield interventions in a vocational context. This search yielded 1864 studies. The second search combined the base search terms with the keywords “skill,” “training,” and “intervention” to identify a broader intervention literature. This search yielded 1434 studies. An ancestral search of existing ASD intervention and vocational intervention reviews was undertaken to identify additional articles that may not have been located through the database searches. The titles and abstracts of all identified studies were assessed to establish suitability for further review, and remaining articles were then retrieved for detailed evaluation.

The following inclusion criteria were applied: (a) the study implemented a single case research design, such as multiple baseline, alternating treatment, reversal, or withdrawal design; (b) participants were old enough to work or prepare for the transition to work (over 14 years old), and were diagnosed with ASD or previously recognized subtypes such as

Autism, Asperger's Syndrome, or Pervasive Developmental Disorder Not-Otherwise-Specified; (c) interventions were aimed at skill-building; (d) data were presented in graphical format for each participant to enable calculation of intervention effect sizes; and (e) articles were published in English in peer-reviewed journals. Studies were excluded if they were conducted in schools or if they were multiple baseline across participants studies where fewer than three participants had a diagnosis of ASD or other previously recognized subtypes of Autism. Seventy-seven articles met these criteria and were retrieved for review. Finally, in order to identify the most recent publications, all studies meeting criteria for inclusion in this review were subsequently entered into Google Scholar, and through use of the *cited by* function, recently published papers (2014–present) referencing these studies were identified and assessed for eligibility. This search yielded a total of 288 articles, of which 53 meet eligibility criteria based on titles/abstract screen and were downloaded for detailed evaluation. Hence, a total of 130 articles were retrieved and reviewed in detail.

A quality assessment was undertaken of the retrieved articles using the What Works Clearinghouse (WWC) standards (Institute of Education Sciences 2014). These standards stipulate that (a) the researcher systematically manipulated the independent variable and determined when independent variable conditions changed, (b) inter-assessor agreement was collected in each phase and in no less than 20 % of observations in each condition, and (c) there were at least the minimum number of phases and data points per phase as specified for the different research designs. The WWC standards classify research into three categories: *meets without reservations*, *meets with reservations*, or *does not meet standards*. One hundred and twelve studies were excluded from the review due to failing to meet the WWC criteria for quality research. Eighteen studies met the WWC standards, 11 with, and seven without reservation.

## Study Coding

Articles satisfying both the initial criteria and the design quality standards were coded for the following variables: intervention components, number of participants, participant characteristics (gender, age, and disability diagnosis), setting description, experimental design, targeted behavior, study findings, and social validity assessment. Studies were also coded for follow-up and/or response maintenance data.

## Classification of Studies

The studies that met the inclusion criteria were grouped according to their components. Components clustered into three intervention categories: Behavior Skills Training (BST),

video-based instruction (VBI), and self-management (SM) procedures. Studies classified as BST interventions included all of the following intervention components: instruction, provision of a model of the target response, opportunity for rehearsal, and corrective feedback or reinforcement as appropriate. The procedure could also include prompting and/or chaining where necessary. Studies categorized as VBI included some combination of video modeling, video prompting, or video feedback but did not meet the criteria for classification as BST. Similarly, the SM studies incorporated some combination of choice, goal setting, or self-management in the intervention procedure and did not otherwise meet criteria for classification as BST.

## Calculating Treatment Effect

The final stage of this review involved computing effect sizes for the 18 studies which met replication standards *with and without reservation* by calculating the percentage of non-overlapping data (PND; Scruggs et al. 1987). Although PND is not without its critics (Allison and Gorman 1993; Kratochwill et al. 2010), recent evidence indicates that this estimate is still broadly applicable and relatively conservative, an acceptable measure of treatment effectiveness which can provide valid summaries of SCD research (Busacca et al. 2015; Carr et al. 2014; Scruggs and Mastropieri 2013).

The PND calculation involved drawing a line through the highest baseline datum point, parallel to the *x*-axis, and calculating the proportion of treatment data points that exceed this line. For design types such as ABAB or reversal designs, calculations were based on combined data overlap across two AB phases, as described by Scruggs and Mastropieri (2013). PND scores over 90 % were interpreted as very effective, 70–90 % as effective, 50–70 % as questionable, and below 50 % as ineffective treatments (Scruggs and Mastropieri 1998).

## Replication Standards

The WWC recommendations for combining studies (henceforth the *replication standards*) were applied to ascertain whether sufficient evidence is available to consider any intervention processes evidence-based. The standards recommend that practices under review may be considered evidence-based if the dataset which demonstrated strong or moderate evidence (a) contained a minimum of five studies investigating the same intervention with a rating of either *meets standards* or *meets standards with reservation* for design quality, (b) were conducted by at least three research teams with no overlapping authorship at three different institutions, and (c) included at least 20 participants across the papers. This 5-3-20 threshold

was applied to each of the intervention categories identified above.

### Inter-Assessor Agreement

Reliability checks were conducted at each stage of the selection and quality assessment process. An independent researcher acquainted with the literature assessed 30 % of the studies at each stage of the selection process. Inter-assessor agreement for this process was calculated by dividing the number of agreements plus disagreements and multiplying by 100. An overall agreement of 97 % was observed. In cases of disagreement, the judgment of the first assessor was adopted. No assessment of inter-assessor agreement on the accuracy of the summaries of the studies was undertaken.

## Results

### Study Inclusion and Quality Appraisal

The search and selection process resulted in the inclusion of 18 studies, 11 derived from the vocational intervention search and seven from the broader intervention search. These studies were conducted by 14 research teams. Two studies were carried out in Australia, another two in The Netherlands, and the remaining studies took place in 10 states across the USA. The 18 studies were published in a total of nine journals: *Autism* ( $n = 1$ ), *Behavior Analysis in Practice* ( $n = 4$ ), *Career Development and Transition for Exceptional Individuals* ( $n = 1$ ), *Developmental Neurorehabilitation* ( $n = 1$ ), *Education and Treatment of Children* ( $n = 1$ ), *Focus on Autism and Other Developmental Disabilities* ( $n = 2$ ), *Journal of Applied Behavior Analysis* ( $n = 3$ ), *Journal of Autism and Developmental Disorders* ( $n = 1$ ), *Psychology in the Schools* ( $n = 1$ ), and *Research in Autism Spectrum Disorders* ( $n = 3$ ). There were a total of 62 participants across the 18 studies.

Seven of the studies were classified as meeting the WWC design standards *without reservations*, 11 met the standards *with reservations*, due in the main to inadequate sampling of inter-observer agreement or having too few data points in baseline phases. Summaries of each of the studies are presented in Table 1 which provides an overview of the research setting, target skills, intervention classification, research design, findings—including maintenance and generalization outcomes where reported, and a categorization of quality according to the WWC for each study.

### Participant and Study Descriptive Features

There was considerable variation in diagnostic categories across the studies. Among the 62 participants, two were

diagnosed with mental retardation without a comorbid diagnosis of ASD and consequently were excluded from further analysis. Twenty-nine participants were diagnosed with autism, 18 with ASD, seven with Asperger's Syndrome, six with PDD-NOS. Comorbid diagnoses were reported for 25 of the participants and included Tourette's syndrome ( $n = 1$ ), cerebral palsy ( $n = 1$ ), intellectual disability ( $n = 14$ ), intellectual impairment ( $n = 2$ ), Fragile X syndrome ( $n = 2$ ), and mental retardation ( $n = 5$ ).

The ages of the participants in these studies ranged from 14 to 42 years. Within this age range, nine were adolescents, 32 were young adults, and 21 were adults. One study (Palmen and Didden 2012) provided an average age only, so this figure was used to classify the age of all participants in the study. Only four participants were female. A summary of participant descriptive statistics is presented in Table 2.

The majority of the studies took place entirely in segregated settings ( $n = 8$ ) such as clinics or adult day centers (Boux sien et al. 2008; Goodson et al. 2007; Hua et al. 2012; Jerome et al. 2007; Nuernberger et al. 2013; Palmen and Didden 2012; Palmen et al. 2008; Watanabe and Sturmey 2003). Five studies were conducted in actual employment or other community settings (Aldi et al. 2016; Allen 2010a, b; Kellems and Morningstar 2012; Rausa et al. 2016). The remainder of the studies made use of authentic work/community environments in conjunction with segregated training sessions (Koegel et al. 2013; Lattimore, et al. 2006; Lattimore et al. 2008; Lattimore, et al. 2009).

A summary of the skills targeted for intervention is presented in Table 1. All target skills in studies in a vocational context were job-specific (e.g., answering telephone calls, book-keeping, cleaning, operating a WalkAround costume, packing, sorting) with the exception of on-task behavior (Watanabe and Sturmey 2003). The other studies targeted a broader set of skills supporting successful employment such as socialization (Koegel et al. 2013), conversation skills (Nuernberger et al. 2013; Palmen et al. 2008), question asking (Palmen et al.; Palmen and Didden 2012), task engagement (Palmen & Didden), and task completion (Boux sien et al. 2008).

### Classification of Studies and Treatment Effects

Of the 18 research reports, nine were classified as BST studies (Hoch et al. 2009; Hua et al. 2012; Jerome et al. 2007; Lattimore et al. 2006; Lattimore et al. 2008; Lattimore et al. 2009; Nuernberger et al. 2013; Palmen and Didden 2012; Palmen et al. 2008), five as VBI studies (Aldi et al. 2016; Allen et al. 2010a, b; Goodson et al. 2007; Rausa et al. 2016), and four as SM studies (Boux sien et al. 2008; Kellems and Morningstar 2012; Koegel et al. 2013; Watanabe and Sturmey 2003). Research teams associated with each study, number of participants, and PND scores are presented in Table 3.

**Table 1** Summary of studies

Author (year)	Intervention classification	Setting	Target skill	Research design	Findings incl generalization and maintenance	WWC
Aldi et al. (2016)	Video modeling	Home residence	Activities of daily living: cooking and various cleaning tasks	Multiple probe across behaviors	Intervention was effective in increasing multiple target behaviors for all participants. Skill gains were maintained at various levels, not all skills maintained at mastery level	Met standards with reservations
Allen et al. (2010a)	Video-based intervention	Retail warehouse store	Wearing and activating a walk around mascot costume to promote products (more than 1 target behavior per 15 s interval)	Multiple baseline across participants	Intervention was effective in increasing multiple target behaviors for all participants. Skill gains were maintained by 2 of 3 participants at 1-month follow-up and generalized by all participants to authentic work settings at 3 months.	Met standards
Allen et al. (2010b)	Video-based intervention	Retail warehouse store	Wearing and activating a walk around mascot costume to promote behaviors (multiple target interval)	Multiple baseline across participants	Intervention was effective for all 4 participants and in maintaining target behavior at 1-month follow-up for 2 participants. Generalization was not assessed.	Met standards
Bouxsiens et al. (2008))	Self-management	Day treatment center therapy room	Task engagement and completion	Multiple baseline across behaviors with embedded changing criterion design	Specific instruction was more effective than general instruction in increasing task engagement for all target behaviors. Generalization and maintenance were not assessed.	Met standards
Goodson et al. (2007)	Video-based instruction (with and without error correction and prompting)	Vocational training center dining room	Set a table	ABCD reversal within a non-concurrent multiple baseline across participants	Video prompting plus error correction was effective for 3 participants and 1 participant only required video prompting. Post intervention generalization and maintenance were not assessed.	Met standards
Hoch et al. (2009)	Behavior Skills Training	Community stores	Answer mobile phone and seek assistance when lost	Multiple probe across participants	Intervention was effective in increasing and generalizing target behavior for all 3 participants. Maintenance was not assessed.	Met standards with reservations
Hua et al. (2012)	Behavior Skills Training	Offices	Reading fluency and comprehension	Multiple baseline across participants	Intervention was effective in increasing target behavior for all 3 participants. Generalization (transfer) was evident. Maintenance was not assessed.	Met standards
Jerome et al. (2007)	Behavior Skills Training	Day-habilitation center	Internet skills	Multiple baseline across participants	Intervention was effective in increasing target behavior for all 3 participants. Behaviors maintained from 8 to 21 days post intervention and generalized to a second computer.	Met standards

Table 1 (continued)

Author (year)	Intervention classification	Setting	Target skill	Research design	Findings incl generalization and maintenance	WWC
Kellems and Moringstar (2012)	Self-management	Participants' current place of employment	Vocational tasks: c leaning, stocking, polishing, etc.	Multiple probe across behaviors	Intervention was effective in increasing target behaviors for all 4 participants. Intervention effects maintained 30 days post intervention for all participants. Generalization was not assessed.	Met standards with reservations
Koegel et al. (2013)	Self-management	University clinic room	Socialization skills	Multiple baseline across participants	Intervention was effective in increasing and maintaining target behaviors for all 3 participants. Generalization was not assessed.	Met standards with reservations
Lattimore et al. (2006)	Behavior Skills Training	Publishing company	Vocational tasks: prepare and fill envelopes, empty trash cans etc.	Multiple probe across participants and tasks	Job-site plus simulation training was more effective than job-site only training. Treatment effects maintained post intervention. Generalization was not assessed.	Met standards with reservations
Lattimore et al. (2008)	Behavior Skills Training	Publishing company	Vocational tasks: clerical tasks, office cleaning	Multiple baseline across participants and behaviors	Intervention was effective in increasing target behavior. Treatment effects generalized from training site to work place for all 3 participants and maintained 1–31 weeks post intervention.	Met standards with reservations
Lattimore et al. (2009)	Behavior Skills Training	Publishing company	Vocational tasks: Assembling boxes	Multiple probe across participants	Intervention was effective in increasing target behaviors for all 3 participants. Treatment effects generalized to criterion across settings and across tasks for 2 participants. Effects maintained 30 weeks post intervention.	Met standards with reservations
Nuernberger et al. (2013)	Behavior Skills Training	Residential rehabilitation facility	Conversation skills	Multiple baseline across participants	Intervention was effective in increasing target behavior for all 3 participants. Treatment effects were maintained up to 8 weeks post intervention.	Met standards with reservations
Palmen and Didden (2012)	Behavior Skills Training	Simulated work settings: office, catering, etc.	Off task behavior, requesting help	Non-concurrent multiple baseline across participants	Intervention was effective in increasing target behavior for all 6 participants. Training generalized across settings and maintained at 6 months follow-up.	Met standards with reservations
Palmen et al. (2008)	Behavior Skills Training	Therapy room, generalization settings	Conversation skills and question asking	Non-concurrent multiple baseline across groups	Intervention was effective in increasing target behavior for all 9 participants. Training generalized across settings and gains maintained at 1 month follow-up.	Met standards with reservations
Rausa et al. (2016)	Video modeling	Not-for-profit social enterprise based	Processing online orders; basic	Multiple baseline across behaviors	Intervention was effective in teaching complex vocational skills, including	Met standards

**Table 1** (continued)

Author (year)	Intervention classification	Setting	Target skill	Research design	Findings incl generalization and maintenance	WWC
Watanabe and Sturmey (2003)	Self-management	at a large commercial flower garden Adult services facility	book-keeping; answering telephone calls from customers On-task behavior	Multiple baseline across participants	listening and responding to orders and complaints from customer telephone calls, and using professional speech. All skill increases were maintained at follow-up. Intervention was effective in increasing target behavior for all 3 participants. Training maintained post intervention. Generalization was not assessed.	Met standards with reservations

**Table 2** Summary of participant descriptive statistics

	Descriptor	Participant numbers
Sex	Male	58
	Female	4
Age	Adolescent (13–17 years)	9
	Young adult (18–24)	32
	Adult (25 and over)	21
ASD diagnosis	ASD	18
	Autism	29
	Asperger’s	7
	PDD-NOS	6
	No ASD diagnosis*	2
Comorbidity	Intellectual disability	14
	Intellectual impairment	2
	Mental retardation	5
	Tourette’s syndrome	1
	Fragile X syndrome	2
	Cerebral Palsy	1

**Behavior Skills Training** The nine BST studies were undertaken by five different research groups, involved a total of 37 participants and have PND scores ranging from 72.2 to 97.2 % (Mean 87.7 %). Seven of these studies reported follow-up data (2 weeks–6 months after intervention ended); in all cases, the intervention effects were clearly maintained over time. Seven BST studies also reported generalization data: two reporting successful generalization across behaviors, four reporting generalization across settings, and one reporting generalization across both behaviors and settings for two of three participants. An important methodological feature of the intervention in all of these studies was a focus on preventing the practicing of errors, through the use of most to least prompting (e.g., Hoch et al. 2009; Jerome et al. 2007), interruption and physical guidance (Lattimore et al. 2006, 2008, 2009), error correction through least to most prompting (Hua et al. 2012; Palmen et al. 2008; Palmen and Didden 2012), or training with feedback to achieve 100 % correct performance (Nuernberger et al. 2013).

Four of the nine BST studies reported treatment acceptability data (Hoch et al. 2009; Lattimore et al. 2009; Palmen and Didden 2012; Palmen et al. 2008) using a variety of direct observation and questionnaire methodologies and informants. All reported positively on outcome acceptability, while Palmen and colleagues also reported their informants considered the intervention procedures themselves to be acceptable.

**Video-Based Instruction** The five VBI studies were undertaken by four research groups and involved 14 participants. Combined within-study PND scores ranged from 39 to 95 % (Mean = 76.7 %) for video-based instruction interventions



**Table 3** Research teams associated with each study, number of participants, and PND scores

Paper	Research team	<i>N</i>	PND score (%)	Summary	PND range	Mean
<b>Behavior Skills Training</b>						
Hoch et al. 2009	Alpine Learning Group, NJ, USA	3	95.2	Nine studies, five research groups, 37 participants	72.2–97.2 %	87.7 %
Hua et al. 2012*	University of Iowa, USA	3	75.2			
Jerome et al. 2007	City University of New York, USA	3	97.2			
Lattimore et al. 2006	Carolina Behavior Analysis and Support Center, USA	4	88			
Lattimore et al. 2008	Carolina Behavior Analysis and Support Center, USA	3	93.4			
Lattimore et al. 2009	Carolina Behavior Analysis and Support Center, USA	3	96.2			
Nuemberger et al. 2013	Southern Illinois University, USA	3	88.8			
Palmen and Didden 2012	Department of Special Education, Radboud University, The Netherlands	6	72.2			
Palmen et al. 2008**	Department of Special Education, Radboud University, The Netherlands	9	83.3			
<b>Video-based instruction</b>						
Aldi et al. 2016	International Institute for Behav Dev and Ed Design, USA	2	100	Five studies, four research groups, 14 participants	39.1–96.9 %	76.7 %
Allen et al. 2010a	Nebraska Medical Center, Omaha, USA	3	80.5			
Allen et al. 2010b	Nebraska Medical Center, Omaha, USA	4	39.1			
Goodson et al. 2007	University of Tasmania, Australia	4	70.8 (video prompting alone) 96.9 (video prompting plus error correction)			
Rausa et al. 2016	Monash University, Melbourne, Australia	1	93			
<b>Choice/goal setting/self-management</b>						
Bouxsien et al. 2008	University of Nebraska, USA	1	100	Four studies, four research groups, 11 participants	39.8–100 %	84.3 %
Kellens and Moringstar 2012	University of Oregon, USA	4	100			
Koegel et al. 2013	University of California Santa Barbara, USA	3	97.3			
Watanabe and Sturme 2003	City University of New York, USA	3	39.8			

\*With clearly improving trends in all cases

\*\*One participant had a single baseline observation so was excluded from PND analysis

though in one study (Goodson et al. 2007) a PND score of 70.8 % for a video prompting procedure increased to 96.9 % with the addition of an error correction process.

Aldi et al. (2016); Allen et al. (2010a, b), and Rausa et al. (2016) all reported maintenance data. Aldi et al. at 3 to 4 weeks post intervention had some performance degradation though both participants were performing well above baseline levels. Allen and colleagues reported follow-up data 1 month after the intervention ended with mixed results: two of three participants in the first study, and two of four in the second, maintained the new skills at criterion level at follow-up. Rausa et al. reported maintenance at or above intervention levels at 6 weeks post intervention for all behaviors. Allen et al. (2010a) was the only study in this set which reported on

generalization; they found clear generalization to an authentic work setting for all three of their participants. Three of the five VBI studies reported treatment acceptability data; both Allen et al. studies (2010a, b) reported that the participants considered the goals of their intervention acceptable. Rausa et al. (2016) reported that though their participant indicated that though he was satisfied with the effectiveness of the video modeling intervention, he would prefer to be trained via in vivo procedures in which he could “practice along side a model and receive instructional feedback” (p 272).

**Self-Management Oriented Interventions** The four studies categorized as self-management were undertaken by four different research groups and involved 11 participants in total.

PND scores ranged from 39.8 to 100 % (Mean = 84.3 %) and, for the three of these studies which reported maintenance data, at follow-up performance maintained at or above that achieved during intervention. None of these studies addressed generalization in any form, though regarding treatment acceptability, Kellems and Morningstar (2012) reported data confirming the acceptability of their procedures, and Koegel et al. (2013) reported their informants as finding their treatment outcomes acceptable. Watanabe and Sturmey (2003) also informally noted a generalized increase in productivity reflecting positively on their outcomes.

## Discussion

The purpose of this study was to systematically review SCD intervention studies targeting improvements in either work specific or more general adaptive and social communication skills required by adults with ASD in the workplace and to assess the quality of the identified studies using the What Works Clearinghouse *Standards* (Institute of Education Sciences 2014) to determine if the interventions used qualify as evidence-based for this population. In addition, this review examined the level of reporting of generalization and maintenance data in the identified studies.

Our search identified 18 empirical intervention studies targeting this population which met WWC quality criteria, seven without reservation, confirming the observation that this is at present an under-investigated area (Magiatia et al. 2014; Taylor et al. 2012), sorely in need of further research.

The participants in the reviewed studies included few females, about one to 15 males, suggesting that females are underrepresented in the current research cohort given the known ratio of males:females with ASD (Whiteley et al. 2010). Whether this is a reflection of a gender bias in their engagement with employment programs or in the participation of women with ASD in research studies is unclear and deserves further investigation. Other than that, participants were quite diverse, with 40 % reported to have diagnoses of comorbid conditions.

The 18 studies which met criteria for inclusion in this review clustered into three categories according to their intervention components; nine categorized as Behavior Skills Training, five as video-based instruction and four as self-management procedures.

Behavior Skills Training, with nine separate research studies meeting WWC design quality standards with or without reservation, undertaken by five different research groups, and involving a total of 37 participants surpasses the WWC replication standards 5-3-20 criteria. With an average PND effect size across these studies of 87.7 %, we can conclude that according to WWC criteria, BST is an established and effective intervention with this population and intervention target.

Importantly, all of these studies detailed prompting, feedback, reinforcement, or specified training performance criteria designed either to prevent or correct errors in target behaviors. In order to be truly effective, interventions should lead to lasting and generalized behavior change and target behaviors that are truly adaptive and useful in the workplace. Seven studies reported relatively robust data on behavior or setting generalization arising from BST interventions.

In 2003, Watanabe and Sturmey reported on the beneficial effects of choice-making opportunities in activity scheduling. Since then, a small number of researchers have explored the effects of self-management and of video-based intervention procedures in the skill training of adults with ASD in the workplace. This is important work. Even though there is substantial evidence in support of these procedures with other populations including regular elementary school students (Busacca et al. 2015) and school-aged adolescents with ASD (de Bruin et al. 2013), the extrapolation of these findings to adults with ASD cannot be assumed. Though not currently realizing evidence-based status—primarily because of the limited number of quality research studies available—both video-based instruction and self-management procedures deserve further research as promising approaches with strong efficiency prospects and with potential in maximizing independent functioning.

The mean PND score for the five VBI studies here indicate this may also be an effective procedure though the wide PND range observed suggests caution is warranted. In that regard, Goodson et al. (2007) reported data yielding a PND score of 70.8 % for their video prompting procedure, an effectiveness rating which increased to 96.9 % (“very effective”) with the addition of an error correction process. Given the importance of error correction in BST noted above, further research on the impact of combining video-based instruction with procedures to correct errors or to prevent their occurrence is clearly warranted. The absence of built-in error prevention or correction may well be a substantial limitation in current video-based intervention procedures with adults and children with ASD.

In order to be truly useful, interventions should lead to lasting and generalized change in behaviors that are highly adaptive and useful in the workplace. Seven of nine studies reported data on generalization effects (across behaviors or settings) arising from BST interventions, noting relatively robust findings. Conversely, social validity was underreported in this body of research with only half of the 18 studies addressing this at all. Furthermore, where social validity was reported, it tended to be limited to an examination of the acceptability of the treatment *outcomes*. Other components of social validity such as the appropriateness of the target behaviors and the acceptability of the intervention procedures were rarely considered in the studies reviewed.

Some of the skills targeted in the reviewed studies were highly specific and appear of limited adaptiveness or

*habilitative validity* (Hawkins 1991). More comprehensive reporting on these dimensions of social validity in future would be useful. In addition, it has been argued that it is relatively easy for individuals with ASD to acquire job specific skills and that a greater barrier to employment may lay in more general social communication difficulties (Mawhood and Howlin 1999; Reichow et al. 2012). Research exploring how best to address these skill needs is very limited.

In conclusion, though this review shows that Behavior Skills Training can be considered an evidence-based practice when providing vocationally related training for adults with ASD, it is clear that there is insufficient research seeking to identify other effective intervention procedures, including both self-management and video-based interventions, to best address the employment needs of adults with ASD. The research body is clearly limited in terms of scope and quality. Further research in this area is clearly warranted in order to be able to meet the needs of this growing population.

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