

Support for adults with autism spectrum disorder without intellectual impairment: Systematic review

Theo Lorenc, Mark Rodgers, David Marshall, Hollie Melton, Rebecca Rees, Kath Wright, Amanda Sowden

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### **Abstract**

Adults with autism spectrum disorder (ASD) without intellectual impairment may benefit from a range of support services. This paper presents the results of a systematic review assessing the effectiveness of supportive interventions for adults with ASD without intellectual impairment. Thirty-two studies were included; most focused on younger male participants. Although evidence was lacking for most types of intervention, employment programmes and social skills training were found to be effective for more proximal outcomes such as social skills. Evidence that any intervention improves mental health or wellbeing was very limited. Most interventions focused on mitigating specific deficits, rather than on providing broader support. Further research is needed on the effectiveness of supportive interventions such as advocacy and mentoring.

## Introduction

Approximately 1% of the population have autism spectrum disorder (ASD) (Brugha et al., 2011). While many people also have an accompanying intellectual impairment (defined as an IQ less than 70), many have normal or above-normal intelligence; under DSM-5 criteria (American Psychiatric Association 2013) this includes people who were previously diagnosed with Asperger's syndrome. Data from children suggest that between 45% (Baird et al., 2006) and 68% (Christensen et al., 2016) of those with ASD do not have accompanying intellectual impairment. These figures suggest that this proportion is increasing over time, probably due to changing practices in the diagnosis of ASD. If so, we can expect a substantial increase in the number of adults diagnosed with ASD without intellectual impairment over the coming years.

Adults with ASD without intellectual impairment often experience social isolation, difficulties with activities of daily living, unemployment, and mental and physical health problems (Balfe and Tantam, 2010; Kamp-Becker et al., 2010; Lai and Baron-Cohen, 2015; Magiati et al., 2014). They may therefore benefit from support which targets these challenges, while taking account of specific needs. Such support includes: assistance with finding and retaining employment; practical help with tasks of day-to-day living; social interaction, including mentoring or befriending, or peer support groups; and advice or advocacy relating to locating and accessing services, such as housing or welfare services, health services, and the criminal justice system. Short-term benefits may include practical and social skills, improved wellbeing, and employment, which might help to prevent mental health problems and enable people to live more independently.

Access to this kind of support has been limited. Although support is often available for children and young people, adults find it much harder to access appropriate support (National Audit Office, 2009). Young people who can access support up until they finish secondary education may face a 'services cliff' when eligibility for these services ceases abruptly (Roux et al., 2015). Mandated services for adults tend to focus on learning disabilities and mental health, and people with ASD without

intellectual impairment will generally not be eligible for these services, unless and until they develop serious health problems. Preventative services are rarely available, and adults only become eligible for support once serious problems have emerged.

More recently the support needs of adults with ASD have been recognised in policy circles. In the USA, the Autism CARES Act 2014 emphasizes community-based services, including social support and housing and employment services, to maximise independence and participation for adults with ASD. In England, guidance subsequent to the Autism Act 2009 requires local authorities to take action to prevent the development of more serious problems in adults with ASD without intellectual impairment, and recommends the provision of 'low-level' preventive services for people with unmet support needs, that is, low-intensity ongoing services such as advice and peer support (Department of Health, 2014). However, to what extent these legislative advances are reflected in improved service delivery at a local level is open to question.

Evidence supporting policy and practice in this area is also lacking. Adults with ASD are less well researched than children and adolescents (Shattuck et al., 2012). Some also argue that autism research priorities are skewed towards biomedical and neurological research, and studies of causation, at the expense of research on developing and evaluating supportive services. Service users and practitioners argue that 'real world' services aiming to support people in their daily lives are underserved by current research (Pellicano et al., 2014), and autism organisations have called for a greater allocation of resources to research on education, service delivery and community support (Autistic Self Advocacy Network, n.d.; Autistica and James Lind Alliance, 2016). The Interagency Autism Coordinating Committee's most recent audit of autism research found that community-based services and support for adults with ASD remain under-researched (Interagency Autism Coordinating Committee, 2014). Thus, while the specific needs of adults with ASD – and the potential benefits of supportive services – are becoming more widely recognised in policy and practice, the evidence which could support the provision of such services is not well understood.

Previous systematic reviews have focused on specific types of interventions for people with ASD without intellectual impairment, such as vocational services (Taylor et al., 2012) or social skills training (Palmen et al., 2012; Spain and Blainey, 2015). No previous review has covered the whole range of supportive strategies for this population. Therefore, we carried out a systematic review to assess the effectiveness of supportive interventions for adults with ASD without intellectual impairment.

## **Methods**

We followed CRD guidance (Centre for Reviews and Dissemination, 2009) and findings are reported according to the PRISMA statement ([www.prisma-statement.org](http://www.prisma-statement.org)). The review was registered on PROSPERO (registration number CRD42015029662). We set up a project advisory group who provided input and feedback on the review's draft protocol and at several additional stages throughout the review process.

### *Searching*

We searched ASSIA, EMBASE, ERIC, MEDLINE, PsycInfo, PubMed, Science Citation Index, Social Science Citation Index, and Social Policy and Practice. The strategy took the form:

(autism or Asperger's) AND (adults) AND (low-level support)

No date or language restrictions were used (i.e. databases were searched since inception). The search strategy used for MEDLINE is reported in web-only supplementary file 1; searches for other databases used a translated form of this strategy. Searches were conducted in November 2016. We also carried out web searches using Google and Google Scholar, scanned the lists of included studies of relevant systematic reviews identified by the searches (listed in supplementary file 2), and handsearched the following journals for the last five years: *American Journal on Intellectual and Developmental Disabilities*, *Autism*, *Autism Research*, *Journal of Autism and Developmental*

*Disorders, Journal of Intellectual and Developmental Disability, and Research in Autism Spectrum Disorders.* Our project advisory group were also consulted.

### *Screening*

Two reviewers independently screened an initial sample of 10% of records, and resolved any differences by discussion. A single reviewer screened the remaining 90%. We attempted to retrieve the full text of all records which met the criteria at abstract stage, or where it was unclear whether they met criteria. Two reviewers independently screened all full text records and resolved differences by discussion. We used EPPI-Reviewer 4 software for both screening and data extraction (Thomas et al., 2010). A list of studies excluded at full-text screening can be found in supplementary file 2.

The inclusion criteria were:

1. Does the study present quantitative data on the effectiveness of an intervention (including controlled and uncontrolled studies, as long as they either present pre-post data or use random allocation)?
2. Does the study include adults aged 18 or older with ASD without intellectual impairment (i.e. with  $IQ \geq 70$ ), or their families or carers, or focus on an intervention for people with ASD without intellectual impairment? (Studies where the sample mean age was 18 or over were included. Studies which included some participants with intellectual impairment ( $IQ < 70$ ), or where it was unclear whether such participants were included, were excluded.)
3. Does the study concern an intervention designed to support individuals in their daily lives?
4. Does the study report data on any outcome other than purely cognitive or task-following outcomes?
5. (Full-text screening only) Is the study published in English?

We interpreted criterion 3 broadly: we excluded clinical interventions and psychotherapy for specific morbidities (e.g. anxiety), but included any other intervention (including programmes informed by therapeutic or cognitive-behavioural approaches, but not directed to a specific morbidity, such as music interventions). Under criterion 4, we excluded studies which only measured cognitive outcomes such as the correct recognition of emotions, or correct task performance (e.g. on notionally job-related tasks), but included all other outcomes.

#### *Quality assessment, data extraction and synthesis*

We assessed the quality of studies using a version of the EPHPP tool

([http://www.ephpp.ca/PDF/Quality%20Assessment%20Tool\\_2010\\_2.pdf](http://www.ephpp.ca/PDF/Quality%20Assessment%20Tool_2010_2.pdf)) as modified by Thomson et al. (2009). We extracted data using a standardised form including information on: sampling and recruitment; sample characteristics; the content of the intervention and comparison (if applicable); methods of data collection and analysis; and the results. All quality assessment and data extraction were carried out by one reviewer and checked in detail by a second.

We synthesised the results narratively (Popay et al., 2006). We organised the studies inductively into broad categories of intervention types, and summarised each study in terms of its population, context, intervention content, design and findings. We then produced a summary of the findings within intervention categories, dividing the studies by type of outcome and prioritising studies using robust designs (randomised studies, followed by non-randomised controlled studies). We calculated effect sizes (standardised mean differences) and 95% confidence intervals for the comparative studies using the method of Hedges. We did not carry out meta-analysis due to the heterogeneity of intervention content, outcomes and outcome measures.

## **Results**

We identified 20,584 unique records. Thirty-two studies were included in the review. The flow of literature is shown in Figure 1. Most studies had a very small sample size (median N=13.5).

Participants included in the studies were predominantly male (80% overall) and in their twenties (mean age of 25 overall). Most studies were carried out in the USA (N=22).

The quality of the evidence was mixed, with equal numbers of studies receiving a high quality rating (A) and a medium or low quality rating (B or C). Nine studies used a randomised controlled trial design, eight used a non-randomised controlled design and fifteen used an uncontrolled (one-group) design.

The studies were divided into the following categories of intervention type:

- Social skills training and psychoeducation
- Job interview training
- Employment support
- Music and dance
- Support and mentoring for university students
- Safety training
- Specialist multidisciplinary teams

Table 1 provides a summary of the effectiveness evidence for these categories of intervention. In the following synthesis we consider each of the intervention categories in turn. For each intervention type we characterise the evidence, describe each study's findings and then present a summary statement for the evidence as a whole.

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### *Social skills training and psychoeducation*

Twenty-two studies evaluated group social skills training or psychoeducation, with programmes combining explicit skills training with more responsive, open-ended discussion, in varying proportions (Bonete et al., 2015; Cunningham, 2014; Eack et al., 2013; Gantman et al., 2012; Gracey,

2011; Hesselmark et al., 2014; Hillier et al., 2007a; Hillier et al., 2011; Howlin and Yates, 1999; Kandalaft et al., 2013; Koegel et al., 2016; Laugeson et al., 2015; McVey et al., 2016; Minihan, 2007; Newey, 2002; Palmen et al., 2011; Perdue, 2016; Pugliese and White, 2013; Shireman et al., 2016; Turner-Brown et al., 2008; White et al., 2015; White et al., 2016). Most interventions drew on cognitive-behavioural or social-cognitive principles. Some interventions consisted of structured, didactic educational curricula, such as the PEERS programme, which was evaluated in three studies (Gantman et al., 2012; Laugeson et al., 2015; McVey et al., 2016); others were more open-ended and emphasised participants' sharing of experiences over direct learning of content.

A range of outcomes were evaluated, the most common type being autism symptoms or empathy measured via questionnaires (e.g. Autism Spectrum Quotient, Empathy Quotient). Five studies (three RCTs and two one-group) showed significant positive impacts on these outcomes (Cunningham, 2015; Gantman et al., 2012; Hillier et al., 2007a; Laugeson et al., 2015; McVey et al., 2016). On questionnaire measures of social support, quality of socialisation or loneliness (such as the Social Provisions Scale, Quality of Socialization Questionnaire or Index of Peer Relations), four studies reported significant effects (three RCTs, one one-group) and four further one-group studies found non-significant positive effects (Cunningham, 2015; Eack et al., 2013; Gantman et al., 2012; Hillier et al., 2007a; Hillier et al., 2011; Koegel et al., 2016; Laugeson et al., 2015; McVey et al., 2016). There were also generally positive findings regarding social skills outcomes such as the Social Skills Rating System and Social Communication Skills Questionnaire (four RCTs, one nRCT, one one-group: Bonete et al., 2015; Gantman et al., 2012; Laugeson et al., 2015; McVey et al., 2016; Pugliese and White, 2013; Turner-Brown et al., 2008). Only four studies measured mental health or quality of life outcomes (such as the Beck Depression Scale, Hospital Anxiety and Depression Scale or Rosenberg Self-Esteem Scale), and the findings were mixed and inconclusive (Hesselmark et al., 2014; Hillier et al., 2011; Newey, 2002; Pugliese and White, 2013).



Evidence from RCTs suggests that social skills training may improve outcomes relating to autism symptoms or social life. However, most measures are questionnaire-based and may not translate to real-life situations. The data on quality of life and mental health outcomes are limited and inconclusive.

### *Job interview training*

Three RCTs evaluated specialist training intended to improve performance in job interviews (Morgan et al., 2014; Smith et al., 2014; Strickland et al., 2013). All included didactic educational elements, and some also included discussion and training on social skills.

The primary outcome in all three studies was job interview performance, measured immediately on completion of the programme using specially designed tools to evaluate participants' conduct in a mock interview. On this outcome, all three studies found significant time-by-group interactions indicating a positive effect of the intervention (Morgan et al., 2014; Smith et al., 2014; Strickland et al., 2013). One study found positive trends towards reduced depression (Patient Health Questionnaire) and social skills (Vineland Adaptive Behavior Scale) (Morgan et al., 2014), and one positive trends towards increased employment at six-month follow-up (Smith et al., 2015). These results failed to reach statistical significance.

Overall, the evidence suggests that interview training can produce a positive short-term impact on mock interview performance. However, it is unclear how this finding might generalise to real-world outcomes: one study finds indicative evidence of a trend towards increased employment, but this is inconclusive.

### *Employment support*

Two studies evaluated the effects of supported employment (Hillier et al., 2007b; Mawhood and Howlin, 1999). These interventions were designed as comprehensive programmes including training, job coaching, finding jobs and liaising with employers, plus ongoing support once a job is found.

One nRCT showed significant positive impacts on employment and earnings (Mawhood and Howlin, 1999), and one one-group study showed non-significant positive effects (Hillier et al., 2007b). However, one nRCT showed no improvement in self-esteem (Rosenberg Self-Esteem Scale) (Mawhood and Howlin, 1999).

This suggests that employment support has positive impacts on employment-related outcomes, but the evidence is limited.

#### *Music and dance interventions*

Two nRCTs evaluated dance and movement programmes (Koch et al., 2015; Koehne et al., 2016), and one one-group study a music therapy programme (Hillier et al., 2012). These programmes aimed to improve social functioning and general wellbeing. Two studies showed significant positive changes on outcomes relating to wellbeing and mental health (such as the State-Trait Anxiety Inventory and the Index of Peer Relations) (Hillier et al., 2012; Koch et al. 2015). This suggests that these interventions may have positive impacts on mental health and wellbeing, but the evidence is limited.

#### *University student support and mentoring*

Two one-group studies, both with very small sample sizes, evaluate support and mentoring interventions for university students (Koegel et al., 2013; Ness, 2013). The findings are mixed and, given that no controlled studies were located, the evidence is insufficient to support conclusions about the effectiveness of these interventions.

#### *Outcome measures*

More than 50 different outcome measures were used in the studies. The most widely used type of outcome related to social skills, either questionnaire instruments such as the Social Skills Rating System or measures of observed social performance (N=13). Eight studies used measures of social

interaction or social support, such as the Index of Peer Relations. Seven studies used measures of autism symptoms or empathy, such as the Social Responsiveness Scale or Empathy Quotient. Five studies used employment-related outcomes such as employment status or earnings. Ten studies used either measures of general wellbeing or quality of life or measures of mental health status (e.g. depression or anxiety).

## **Discussion**

Overall, evidence relating to adults with ASD without intellectual impairment suggests that: job interview training can be effective in improving interview performance; social skills training can be effective in improving self-rated social skills, autism symptoms and social relations; and supported employment programmes can be effective in increasing employment. The evidence on other interventions and outcomes is limited and inconclusive. Overall there is a lack of reliable evidence. Many studies are very small (only five studies had 50 or more participants) or do not use robust designs, and some test for multiple outcomes without adjusting significance levels, which may lead to results reaching significance by chance. However, the interventions highlighted above appear to be promising for certain outcomes.

The evidence base on adults with ASD without intellectual impairment appears very limited compared with the volume of research on interventions for children with ASD. For example, we located little or no evidence on: peer support; advocacy and advice programmes; mentoring; or interventions relating to services such as housing or criminal justice. In general, more supportive and responsive interventions are not currently underpinned by robust research evidence. This is problematic for a number of reasons. As noted in the introduction, current policy in a number of countries emphasises the role of support services for adults with ASD. However, there is a lack of research evidence to support policymaking in this area. Existing studies tend to reflect a directive, top-down model of service provision, where the aim is to mitigate specific deficits rather than to respond to individuals' diverse needs. The services evaluated are arguably better suited to

individuals with relatively less severe impairments and less complex needs (for example, who are in a position to apply competitively for employment). Service users and practitioners have also identified evaluation of supportive, responsive services as a research gap.

The outcomes evaluated also limit the value of the research for practice. Few studies focus on outcomes that would provide evidence of the impact of interventions on the lives of people with ASD, such as mental health, wellbeing, quality of life, or validated measures of social interaction or living independently. Many studies measure short-term outcomes and do not follow up participants to see if the effects are sustained; longer-term follow-up is needed in future research studies. Existing research provides very little information about the sampling or recruitment of participants, and in many cases participants were selected for their motivation to participate. This restricts the generalisability of findings outside of the research setting.

More robust outcome data on interventions would also help to provide a basis for evaluation of the cost-effectiveness of services. It is widely believed by practitioners that supportive interventions for people with ASD are cost-saving over the long term, because they enable people to live independently and find employment, and reduce the use of social care and health services (Department of Health, 2014). This belief has been given some support by previous cost-benefit modelling work (National Audit Office, 2009), but this is limited by the lack of reliable effectiveness data. Also, the intervention modelled in this study focused strongly on increasing rates of diagnosis of ASD in adults, and the modelled benefits were highly sensitive to the rates attained, suggesting that much of the value of the intervention comes from increased identification, enabling people to access services. The findings of this study are thus arguably tangential to the goal of supporting people who already have a diagnosis of ASD. It is also challenging to model the potential utility gains resulting from increased diagnosis rates, since those without a diagnosis may differ from those who have a diagnosis of ASD and who access specialist services. To what extent resources should be

devoted to proactively increasing identification rates of people with ASD living in the community remains an open question.

This review has some limitations. Screening of titles and abstracts was largely carried out by one reviewer due to time constraints. However, we adopted an inclusive approach: full texts of all potentially relevant study were retrieved, and each was screened by two reviewers independently, which reduces the chance of excluding relevant studies. Another limitation was that we included only English-language publications, again due to time constraints. The main strength of our review is its comprehensive coverage of supportive interventions for adults with ASD without intellectual impairment. Our findings are in line with the tentatively positive findings reported in previous reviews with a narrower focus on social skills training (Spain and Blainey, 2015) and employment support (Taylor et al., 2012). However, the broader scope of our review raises questions about the prioritisation of research for adults with ASD more generally. With a few exceptions, the majority of studies reflect a 'deficit model' of autism where the goal of interventions is to mitigate impairments, identified as such by researchers or clinicians, rather than a 'social model' in which the aim would be to empower individuals and address their needs in a responsive way. The paucity of research on programmes to improve the lives and wellbeing of adults with ASD has been frequently noted, but this observation has not previously been supported by a robust synthesis of the evidence. The findings of this review mirror the concerns of many stakeholders that the currently available evidence base does not adequately support current practice.

As already highlighted, a wide range of services for adults with ASD without intellectual impairment have been implemented in practice, including: peer support groups; advocacy programmes and assistance with accessing other services such as housing; mentoring; and drop-in centres or 'hubs' which function as a point of contact for individuals with ASD, helping to co-ordinate services and offer referrals to specialist services as appropriate. Such services offer flexible, person-centred support which aims to empower individuals to meet their own needs and challenges. However, the

available research evidence is of limited applicability to these more responsive services, and there is a need for more practice-relevant research which could help to inform the delivery of such programmes.

We recognise that evaluating these broader services is challenging, due to the complexity of the interventions, and the difficulty of identifying appropriate outcomes and outcome measures.

However, the focus of the studies included in our review appear distant from the stated goals of international policy and the views of autism advocates. While the funding and governance of research are becoming more responsive to the needs and wishes of people with ASD, carers and practitioners, this does not as yet seem to be reflected in the published evaluation evidence.

## **Conclusions**

We identified evidence in support of some interventions aimed at adults with ASD without intellectual impairment, particularly social skills training and, more tentatively, interventions relating to employment. Evidence is lacking on more responsive interventions such as emotional support, advocacy, and mentoring. For all interventions included in this review it is unclear how far the outcomes measured in the evaluation studies translate to improved wellbeing or quality of life for people with ASD. We identified a mismatch between the existing evidence base for adults with ASD without intellectual impairment, which is focused on narrow interventions relating to social skills and employment, and the broader goal of ensuring responsive support tailored to individuals' needs.

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Table 1. Characteristics of the included studies

| Reference   | Design | Sample size | % male | Mean age | Country | Intervention / control   | Follow-up from baseline (months) | Outcome  | Outcome type      | Direction of effect (within-group) | Direction of effect (between-group) | SMD (Hedges) |
|---|--------|-------------|--------|----------|---------|--|----------------------------------|--|-------------------|------------------------------------|-------------------------------------|--------------|
| <i>Social skills training and psychoeducation</i> |        |             |        |          |         |  |                                  |  |                   |                                    |                                     |              |
| Bonete et al. (2015)                              | nRCT   | 100         | 86     | NR       | Spain   | I Group social problem-solving training with focus on workplace environment<br>C No intervention | 2                                | Vineland Adaptive Behavior Scale (Sparrow et al., 2005)                    | parent report     | ↑*                                 |                                     |              |
|   |        |             |        |          |         |  |                                  | Evaluación de Solución de Conflictos Interpersonales (Calero et al., 2009) | self-report       | ↑*                                 |                                     |              |
|   |        |             |        |          |         |  |                                  | Osnabrück Ability to Work Profile (Wiedl and Uhlhorn, 2006)                | self-report       | ↑                                  |                                     |              |
|   |        |             |        |          |         |  |                                  | Osnabrück Ability to Work Profile (Wiedl and Uhlhorn, 2006)                | supervisor report | ↑                                  |                                     |              |
| Cunningham (2014)                                 | 1-G    | 38          | 79     | NR       | USA     | Social skills educational programme with focus on dating   | 2                                | Social Responsiveness Scale-2 (Constantino                                 | self-report       | ↑*                                 |                                     |              |

|  |  |  |  |  |  |   |  |  |             |    |  |  |
|--|--|--|--|--|--|---|--|--|-------------|----|--|--|
|  |  |  |  |  |  | and relationships<br>(Relationship Enhancement) |  | and Gruber, 2012)  |             |    |  |  |
|  |  |  |  |  |  |   |  | Autism Spectrum Quotient (Baron-Cohen et al., 2001)                                | self-report | ↑  |  |  |
|  |  |  |  |  |  |   |  | Dating and Assertion Questionnaire (Dating domain) (Levenson and Gottman, 1978)    | self-report | ↑* |  |  |
|  |  |  |  |  |  |   |  | Dating and Assertion Questionnaire (Assertion domain) (Levenson and Gottman, 1978) | self-report | ↑  |  |  |
|  |  |  |  |  |  |   |  | Empathy Quotient (Baron-Cohen and Wheelwright, 2004)                               | self-report | ↑* |  |  |
|  |  |  |  |  |  |   |  | Social Provisions Scale (Cutrona   | self-report | ↑  |  |  |

|                    |     |    |    |    |     |   |    |  |             |    |  |  |
|--------------------|-----|----|----|----|-----|---|----|--|-------------|----|--|--|
|                    |     |    |    |    |     |   |    | and Russell, 1987)   |             |    |  |  |
| Eack et al. (2013) | 1-G | 14 | 86 | 25 | USA | Cognitive enhancement therapy including structured social skills training and psychoeducation | 18 | Cognitive Style and Social Cognition Eligibility Interview (vocational ineffectiveness domain) (Hogarty et al., 2004)    | self-report | ↑* |  |  |
|                    |     |    |    |    |     |   |    | Cognitive Style and Social Cognition Eligibility Interview (interpersonal ineffectiveness domain) (Hogarty et al., 2004) | self-report | ↑* |  |  |
|                    |     |    |    |    |     |   |    | Cognitive Style and Social Cognition Eligibility Interview (adjustment to disability domain) (Hogarty et al., 2004)      | self-report | ↑* |  |  |

|                       |     |    |    |    |     |   |   |   |                  |   |    |                    |
|-----------------------|-----|----|----|----|-----|---|---|---|------------------|---|----|--------------------|
| Gantman et al. (2012) | RCT | 17 | 71 | 20 | USA | I Group social skills education (PEERS) including discussion, roleplays and homework<br>C No intervention | 3 | Social Responsiveness Scale (Constantino, 2005)                                       | caregiver report | ↑ | ↑* | 1.05 (0.02, 2.08)  |
|                       |     |    |    |    |     |   |   | Social Skills Rating System (Gresham and Elliott, 1990)                               | caregiver report | ↑ | ↑* | 1.48 (0.37, 2.59)  |
|                       |     |    |    |    |     |   |   | Social and Emotional Loneliness Scale for Adults (DiTommaso and Spinner, 1993)        | self report      | ↑ | ↑* | 1.00 (-0.03, 2.03) |
|                       |     |    |    |    |     |   |   | Empathy Quotient (Baron-Cohen and Wheelwright, 2004)                                  | caregiver report | ↑ | ↑* | 1.02 (-0.01, 2.05) |
|                       |     |    |    |    |     |   |   | Quality of Socialization Questionnaire (invited get-togethers) (Frankel et al., 2010) | caregiver report | ↑ | ↑* | 1.20 (0.14, 2.26)  |
|                       |     |    |    |    |     |   |   | Quality of Socialization Questionnaire (hosted get-                                   | caregiver report | ↑ | ↑* | 0.83 (-0.18, 1.83) |

|                             |     |    |    |    |        |  |    |   |                 |    |   |                          |
|-----------------------------|-----|----|----|----|--------|--|----|---|-----------------|----|---|--------------------------|
|                             |     |    |    |    |        |  |    | together)<br>(Frankel et al.,<br>2010)  |                 |    |   |                          |
| Gracey<br>(2011)            | 1-G | 9  | 56 | 31 | UK     | Stress<br>management<br>programme<br>using Palm Pilot<br>PDAs  | <1 | Subjective<br>anxiety (%<br>heightened<br>anxiety)  | self-<br>report | ↑* |   |                          |
|                             |     |    |    |    |        |  |    | Subjective<br>anxiety (mean<br>score)   | self-<br>report | ↑* |   |                          |
|                             |     |    |    |    |        |  |    | Hospital<br>Anxiety and<br>Depression<br>Scale – anxiety<br>(Zigmond and<br>Snaith, 1983)       | self-<br>report | ↑  |   |                          |
|                             |     |    |    |    |        |  |    | Hospital<br>Anxiety and<br>Depression<br>Scale –<br>depression<br>(Zigmond and<br>Snaith, 1983) | self-<br>report | ↓  |   |                          |
| Hesselmark<br>et al. (2014) | RCT | 68 | 55 | 32 | Sweden | I Group CBT-<br>based<br>psychoeducatio<br>n programme<br>for people with<br>ASC and<br>psychiatric<br>comorbidities | 8  | Quality of Life<br>Inventory<br>(Frisch et al.,<br>1992)  | self-<br>report | ↑* | ↑ | 0.20<br>(-0.31,<br>0.70) |
|                             |     |    |    |    |        |  |    | Sense of<br>Coherence<br>scale<br>(Antonovsky,<br>1993)   | self-<br>report | ↑  | ↑ | 0.29<br>(-0.22,<br>0.80) |



|                        |     |    |    |    |     |  |       |   |             |    |   |                     |
|------------------------|-----|----|----|----|-----|--|-------|---|-------------|----|---|---------------------|
|                        |     |    |    |    |     | C Unstructured recreational activity intervention    |       | Rosenberg Self-Esteem Scale (Rosenberg, 1962)         | self-report | ↑  | ↑ | 0.15 (-0.38, 0.69)  |
|                        |     |    |    |    |     |  |       | Symptom Checklist 90 (Derogatis and Cleary, 1977)     | self-report | ↑  | ↓ | -0.02 (-0.53, 0.49) |
|                        |     |    |    |    |     |  |       | Autism Quotient (Baron-Cohen et al., 2001)            | self-report | ↓  | ↓ | -0.15 (-0.74, 0.44) |
|                        |     |    |    |    |     |  |       | Beck Depression Inventory (Beck et al., 1996)         | self-report | ↓  | ↑ | 0.06 (-0.46, 0.58)  |
|                        |     |    |    |    |     |  |       | Adult ADHD Self-Report Scale (Kessler et al., 2005)   | self-report | ↓  | ↓ | -0.12 (-0.70, 0.46) |
|                        |     |    |    |    |     |  |       | Clinical Global Impression Scale–Severity (Guy, 1976) | self-report | ↓  | ■ | 0.00 (-0.55, 0.55)  |
|                        |     |    |    |    |     |  | 16-65 | Quality of Life Inventory (Frisch et al., 1992)       | self-report | ↑* | ↑ | 0.43 (-0.08, 0.95)  |
| Hillier et al. (2007a) | 1-G | 13 | 85 | 19 | USA | Social and vocational skills programme (Aspirations) | 2     | Index of Peer Relations (Hudson et al., 1993)         | self-report | ↑  |   |                     |

|                         |     |    |     |    |     |   |    |  |                |    |  |  |
|-------------------------|-----|----|-----|----|-----|---|----|--|----------------|----|--|--|
|                         |     |    |     |    |     | including education and supportive group discussion                     |    | Autism Spectrum Quotient (Baron-Cohen et al., 2001)      | self-report    | ↑  |  |  |
|                         |     |    |     |    |     |   |    | Empathy Quotient (Baron-Cohen and Wheelwright, 2004)     | self-report    | ↑* |  |  |
| Hillier et al. (2011)   | 1-G | 49 | 86  | 21 | USA | Same as Hillier 2007a   | 2  | Beck Depression Inventory (Beck et al., 1996)            | self-report    | ↑* |  |  |
|                         |     |    |     |    |     |   |    | State-Trait Anxiety Inventory (Spielberger et al., 1983) | self-report    | ↑* |  |  |
|                         |     |    |     |    |     |   |    | Index of Peer Relations (Hudson et al., 1993)            | self-report    | ↑  |  |  |
| Howlin and Yates (1999) | 1-G | 10 | 100 | 28 | UK  | Social skills groups including education, roleplays and team activities | 12 | Party scenario: total utterances                         | observer rated | ↓  |  |  |
|                         |     |    |     |    |     |   |    | Party scenario: % conversation maintaining / initiating  | observer rated | ↑* |  |  |

|                         |     |   |     |    |     |   |   |  |                   |    |  |  |
|-------------------------|-----|---|-----|----|-----|---|---|--|-------------------|----|--|--|
|                         |     |   |     |    |     |   |   | Party scenario:<br>% appropriate<br>responses                        | observer<br>rated | ↓  |  |  |
|                         |     |   |     |    |     |   |   | Party scenario:<br>%<br>inappropriate<br>utterances /<br>repetitions | observer<br>rated | ↑  |  |  |
|                         |     |   |     |    |     |   |   | Job enquiry<br>scenario: total<br>utterances                         | observer<br>rated | ↑  |  |  |
|                         |     |   |     |    |     |   |   | Job enquiry<br>scenario: %<br>appropriate<br>responses               | observer<br>rated | ↑* |  |  |
|                         |     |   |     |    |     |   |   | Job enquiry<br>scenario:%<br>inappropriate<br>utterances             | observer<br>rated | ↑* |  |  |
|                         |     |   |     |    |     |   |   | Job enquiry<br>scenario: %<br>social<br>utterances                   | observer<br>rated | ↓  |  |  |
| Kandalaft et al. (2013) | 1-G | 8 | 75  | 21 | USA | One-to-one social skills coaching and feedback using avatars in virtual reality environment | 1 | Social Skills Performance Assessment                                 | observer rated    | ↑  |  |  |
| Koegel et al. (2016)    | 1-G | 3 | 100 | 21 | USA | Communication skills training   | 4 | Empathic listening statements  | observer rated    | ↑  |  |  |

|                        |     |    |    |    |     |   |    |   |                  |    |    |                    |
|------------------------|-----|----|----|----|-----|---|----|---|------------------|----|----|--------------------|
|                        |     |    |    |    |     | using video feedback  |    | Empathic questions  | observer rated   | ↑  |    |                    |
|                        |     |    |    |    |     |   |    | Empathy Quotient (Baron-Cohen and Wheelwright, 2004)          | self-report      | ↑  |    |                    |
|                        |     |    |    |    |     |   |    | Socialisation satisfaction / confidence                       | self-report      | ↑  |    |                    |
|                        |     |    |    |    |     |   | 24 | Empathic listening statements                                 | observer rated   | ↑  |    |                    |
|                        |     |    |    |    |     |   |    | Empathic questions  | observer rated   | ↑  |    |                    |
| Laugeson et al. (2015) | RCT | 22 | 77 | 20 | USA | I Group social skills education (PEERS) including discussion, roleplays and homework<br>C No intervention | 4  | Social Responsiveness Scale (Constantino, 2005)               | caregiver report | ↑* | ↑* | 1.26 (0.19, 2.32)  |
|                        |     |    |    |    |     |   |    | Social Skills Rating System (Gresham and Elliott, 1990)       | caregiver report | ↑* | ↑* | 0.10 (-0.85, 1.05) |
|                        |     |    |    |    |     |   |    | Quality of Socialization Questionnaire (Frankel et al., 2010) | self-report      | ↑* | ↑* | 1.16 (0.11, 2.21)  |
|                        |     |    |    |    |     |   |    | Quality of Socialization Questionnaire                        | caregiver report | ↑* | ↑* | 2.58 (1.21, 3.96)  |

|                     |     |    |    |    |     |   |   |  |                  |    |    |                    |
|---------------------|-----|----|----|----|-----|---|---|--|------------------|----|----|--------------------|
|                     |     |    |    |    |     |   |   | (Frankel et al., 2010)   |                  |    |    |                    |
|                     |     |    |    |    |     |   |   | Empathy Quotient (Baron-Cohen and Wheelwright, 2004)   | caregiver report | ↑  | ↑  | 1.02 (-0.01, 2.05) |
| McVey et al. (2016) | RCT | 53 | 83 | 20 | USA | I Group social skills education (PEERS) including discussion, roleplays and homework<br>C No intervention | 3 | Social Skills Improvement System - Rating Scales (social skills domain) (Gresham and Elliott, 2008)                | parent report    | ↑* | ↑  | 0.21 (-0.37, 0.78) |
|                     |     |    |    |    |     |   |   | Social Skills Improvement System - Rating Scales (competing problem behaviours domain) (Gresham and Elliott, 2008) | parent report    | ↑* | ↑* | 0.57 (-0.01, 1.15) |
|                     |     |    |    |    |     |   |   | Social Responsiveness Scale (Constantino et al., 2003)   | parent report    | ↑* | ↑* | 0.41 (-0.17, 0.99) |

|  |  |  |  |  |  |  |  |             |    |    |                          |
|--|--|--|--|--|--|--|--|-------------|----|----|--------------------------|
|  |  |  |  |  |  |  | Liebowitz<br>Social Anxiety<br>Scale (Fresco<br>et al., 2001)  | self-report | ↑* | ↑  | 0.07<br>(-0.50,<br>0.64) |
|  |  |  |  |  |  |  | Social Phobia<br>Inventory<br>(Connor et al.,<br>2000)   | self-report | ↑  | ↑  | 0.07<br>(-0.50,<br>0.64) |
|  |  |  |  |  |  |  | Quality of<br>Socialization<br>Questionnaire<br>for Young<br>Adults<br>(Frankel et al.,<br>2010)   | self-report | ↑* | ↑* | 0.38<br>(-0.19,<br>0.96) |
|  |  |  |  |  |  |  | Empathy<br>Quotient<br>(Baron-Cohen<br>and<br>Wheelwright,<br>2004)  | self-report | ↑* | ↑* | 0.42<br>(-0.16,<br>1.00) |
|  |  |  |  |  |  |  | Social and<br>Emotional<br>Loneliness<br>Scale for<br>Adults<br>(emotion /<br>romantic<br>domain)<br>(DiTommaso<br>and Spinner,<br>1993) | self-report | ↑  | ↑  | 0.13<br>(-0.44,<br>0.71) |

|                |      |    |    |    |         |   |   |   |                |    |    |                        |
|----------------|------|----|----|----|---------|---|---|---|----------------|----|----|------------------------|
|                |      |    |    |    |         |   |   | Social and Emotional Loneliness Scale for Adults (family loneliness domain) (DiTommaso and Spinner, 1993) | self-report    | ↓  | ↓  | -0.06<br>(-0.63, 0.52) |
|                |      |    |    |    |         |   |   | Social and Emotional Loneliness Scale for Adults (social loneliness domain) (DiTommaso and Spinner, 1993) | self-report    | ↑  | ↓  | -0.20<br>(-0.77, 0.38) |
| Minihan (2007) | nRCT | 22 | 91 | 27 | Ireland | I Social skills training including roleplay, group discussion and feedback<br>C Unclear | 4 | Eye contact   | observer rated | ↑  | ↑  | 0.50<br>(-0.51, 1.51)  |
|                |      |    |    |    |         |   |   | Gesture   | observer rated | ↑* | ↑  | 0.26<br>(-0.74, 1.26)  |
|                |      |    |    |    |         |   |   | Attention   | observer rated | ↑* | ↑* | 0.95<br>(-0.10, 1.99)  |
|                |      |    |    |    |         |   |   | Feedback questions  | observer rated | ↑  | ↑* | 1.85<br>(0.69, 3.02)   |

|              |     |   |     |    |    |  |    |  |                |    |   |                        |
|--------------|-----|---|-----|----|----|--|----|--|----------------|----|---|------------------------|
|              |     |   |     |    |    |  |    | Conversation initiation  | observer rated | ↑* | ↑ | 0.20<br>(-0.80, 1.20)  |
|              |     |   |     |    |    |  |    | Conversation maintenance   | observer rated | ↑* | ↓ | -0.18<br>(-1.18, 0.82) |
|              |     |   |     |    |    |  |    | Conversation handover  | observer rated | ↑  | ↑ | 1.48<br>(-0.38, 2.59)  |
|              |     |   |     |    |    |  |    | Perseveration  | observer rated | ↑  | ↑ | 0.25<br>(-0.75, 1.25)  |
|              |     |   |     |    |    |  |    | No interaction   | observer rated | ↑  | ↑ | 0.24<br>(-0.76, 1.24)  |
|              |     |   |     |    |    |  |    | Inappropriate statements   | observer rated | ↓  | ↓ | -0.45<br>(-1.46, 0.56) |
| Newey (2002) | 1-G | 5 | 100 | NR | UK | Teaching theory of mind using discussion, modelling and homework | 12 | Symptom Checklist-90-Revised (Anxiety domain) (Derogatis and Cleary, 1977)                   | self-report    | NC |   |                        |
|              |     |   |     |    |    |  |    | Symptom Checklist-90-Revised (Interpersonal sensitivity domain) (Derogatis and Cleary, 1977) | self-report    | NC |   |                        |



|                           |      |    |     |    |             |   |   |   |                |    |   |                    |
|---------------------------|------|----|-----|----|-------------|---|---|---|----------------|----|---|--------------------|
|                           |      |    |     |    |             |   |   | Symptom Checklist-90-Revised (Phobic anxiety domain) (Derogatis and Cleary, 1977) | self-report    | NC |   |                    |
|                           |      |    |     |    |             |   |   | Psychopathology related to social functioning                                     | self-report    | NC |   |                    |
|                           |      |    |     |    |             |   |   | Social contacts   | self-report    | NC |   |                    |
| Palmen et al. (2011)      | nRCT | 12 | 83  | 21 | Netherlands | I Leisure programme including homework, skill development, behavioural practice and feedback<br>C No intervention | 6 | Need for leisure support  | self-report    | ↑* | ↑ | 0.58 (-0.60, 1.76) |
|                           |      |    |     |    |             |   |   | Engagement in leisure activities  | self-report    | ↑* | ↑ | 0.32 (-0.84, 1.48) |
|                           |      |    |     |    |             |   |   | Satisfaction with leisure lifestyle   | self-report    | ↑* | ↑ | 0.64 (-0.55, 1.83) |
| Perdue (2016)             | nRCT | 5  | 80  | NR | USA         | I Social skills training using video modelling<br>C Social skills training using lectures                         | 3 | Appropriate verbal engagement   | observer rated | ↑  | ↑ |                    |
|                           |      |    |     |    |             |   |   | Non-verbal engagement   | observer rated | ↑  | ↑ |                    |
|                           |      |    |     |    |             |   |   | Food etiquette  | observer rated | ↑  | ↑ |                    |
| Pugliese and White (2013) | 1-G  | 5  | 100 | 21 | USA         | Social problem-solving education programme  | 2 | Social Problem Solving Inventory  | self-report    | ↑  |   |                    |

|                            |     |    |    |    |     |  |   |   |                |   |   |                     |
|----------------------------|-----|----|----|----|-----|--|---|---|----------------|---|---|---------------------|
|                            |     |    |    |    |     |  |   | (D'Zurilla et al., 2002)  |                |   |   |                     |
|                            |     |    |    |    |     |  |   | Outcome Questionnaire (Lambert et al., 1996)                    | self-report    | ↑ |   |                     |
| Shireman et al. (2016)     | 1-G | 3  | 67 | 23 | USA | Training to deliver social play skills programme for children with ASD             | 4 | Frequency of social initiations                                 | observer rated | ↑ |   |                     |
|                            |     |    |    |    |     |  |   | % social reciprocations   | observer rated | ↑ |   |                     |
|                            |     |    |    |    |     |  |   | % social engagement   | observer rated | ↑ |   |                     |
|                            |     |    |    |    |     |  |   | Non-verbal interactions   | observer rated | ↑ |   |                     |
|                            |     |    |    |    |     |  |   | Verbal interactions   | observer rated | ↑ |   |                     |
|                            |     |    |    |    |     |  |   | Perceived effectiveness   | observer rated | ↑ |   |                     |
|                            |     |    |    |    |     |  |   | Rapport   | observer rated | ↑ |   |                     |
| Turner-Brown et al. (2008) | RCT | 11 | 91 | 36 | USA | I Group social-cognitive education programme using video cues<br>C Usual treatment | 4 | Social Communication Skills Questionnaire (McGann et al., 1997) | self-report    | ↑ | ↑ | 0.30 (-0.90, 1.50)  |
|                            |     |    |    |    |     |  |   | Social Skills Performance Assessment (Patterson et al., 2001)   | observer rated | ↓ | ↓ | -0.02 (-1.20, 1.17) |

|                     |     |   |     |    |     |  |   |   |                |   |  |  |
|---------------------|-----|---|-----|----|-----|--|---|---|----------------|---|--|--|
| White et al. (2015) | 1-G | 5 | 100 | 24 | USA | Group social skills education (PEERS) including discussion, roleplays and homework | 3 | Contextual Assessment of Social Skills (asking questions domain) (Ratto et al., 2011)           | observer rated | ↑ |  |  |
|                     |     |   |     |    |     |  |   | Contextual Assessment of Social Skills (topic changes domain) (Ratto et al., 2011)              | observer rated | ↑ |  |  |
|                     |     |   |     |    |     |  |   | Contextual Assessment of Social Skills (overall involvement domain) (Ratto et al., 2011)        | observer rated | ↑ |  |  |
|                     |     |   |     |    |     |  |   | Contextual Assessment of Social Skills (overall quality of rapport domain) (Ratto et al., 2011) | observer rated | ↑ |  |  |
|                     |     |   |     |    |     |  |   | Contextual Assessment of  | observer rated | ↑ |  |  |

|                           |     |    |    |    |     |  |   |   |                |   |    |                    |
|---------------------------|-----|----|----|----|-----|--|---|---|----------------|---|----|--------------------|
|                           |     |    |    |    |     |  |   | Social Skills (social anxiety domain) (Ratto et al., 2011)                |                |   |    |                    |
| White et al. (2016)       | RCT | 8  | 62 | 20 | USA | <b>I</b> Psychoeducation combined with social activities and coaching<br><b>C</b> Virtual reality social skills training using brain-computer bio-feedback interface | 3 | Barkley Deficits in Executive Functioning Scale (Barkley, 2011)           | self-report    | ↓ | ↑  | 0.18 (-1.21, 1.57) |
|                           |     |    |    |    |     |  |   | Student Adaptation to College Questionnaire (Baker and Siryk, 1999)       | self-report    | ↓ | ↑  | 0.05 (-1.34, 1.44) |
| <i>Interview training</i> |     |    |    |    |     |  |   |   |                |   |    |                    |
| Morgan et al. (2014)      | RCT | 28 | 94 | 25 | USA | <b>I</b> Social skills curriculum with focus on interviews including education, discussion and roleplays<br><b>C</b> No intervention                                 | 6 | Social Pragmatic Scale (mock interview) (Morgan, 2011)                    | observer rated | ↑ | ↑* | 0.44 (-0.37, 1.25) |
|                           |     |    |    |    |     |  |   | Vineland Adaptive Behavior Scale (social subscale) (Sparrow et al., 2005) | parent report  | ↑ | ↑  | 0.19 (-0.62, 0.99) |
|                           |     |    |    |    |     |  |   | Patient Health Questionnaire – Depression                                 | self-report    | ↑ | ↑  | 0.28 (-0.52, 1.09) |

|                           |     |    |     |    |     |   |    |  |                   |   |    |                    |
|---------------------------|-----|----|-----|----|-----|---|----|--|-------------------|---|----|--------------------|
|                           |     |    |     |    |     |   |    | (Spitzer et al., 1999)                               |                   |   |    |                    |
| Smith et al. (2014; 2015) | RCT | 26 | 77  | 24 | USA | I Virtual Reality job interview training programme with feedback<br>C Usual treatment                           | <1 | Mock interview performance                           | observer rated    | ↑ | ↑* | 0.35 (-0.45, 1.15) |
|                           |     |    |     |    |     |   |    | Self-confidence                                      | self-report       | ↑ | ↑  | 0.46 (-0.34, 1.26) |
|                           |     |    |     |    |     |   | 6  | Completed job interview %                            | self-report       |   | ↑  |                    |
|                           |     |    |     |    |     |   |    | Received job offer %                                 | self-report       |   | ↑  |                    |
|                           |     |    |     |    |     |   |    | Accepted position %                                  | self-report       |   | ↑  |                    |
| Strickland et al. (2013)  | RCT | 22 | 100 | 18 | USA | I Multimedia interview training including practice interview in VR environment with avatar<br>C No intervention | <1 | Interview Skills Rating Instrument (Content domain)  | observer rated    | ↑ | ↑* | 1.72 (0.71, 2.73)  |
|                           |     |    |     |    |     |   |    | Interview Skills Rating Instrument (Delivery domain) | observer rated    | ↑ | ↑  | 0.81 (-0.06, 1.69) |
| <i>Employment support</i> |     |    |     |    |     |   |    |  |                   |   |    |                    |
| Hillier et al. (2007b)    | 1-G | 9  | 88  | 22 | USA | Individualised supported employment including support with finding work, worksite evaluation,                   | 12 | Employment status                                    | routine data      | ↑ |    |                    |
|                           |     |    |     |    |     |   |    | Hourly income  | self-report       | ↑ |    |                    |
|                           |     |    |     |    |     |   |    | Assessment Worksheet (3 mo vs 12 mo)                 | supervisor report | ↑ |    |                    |

|                                      |      |    |    |    |     |  |    |  |                      |    |    |                           |
|--------------------------------------|------|----|----|----|-----|--|----|--|----------------------|----|----|---------------------------|
|                                      |      |    |    |    |     | job coaching,<br>ongoing support   |    | Socialization<br>Scale (3 mo vs<br>12 mo)                            | supervisor<br>report | ↑  |    |                           |
| Mawhood<br>and Howlin<br>(1999)      | nRCT | 50 | 94 | 30 | UK  | I Supported<br>employment<br>(Prospects) including<br>identifying jobs, job<br>coaching, ongoing<br>support<br>C No intervention | 24 | Employment<br>status   | unclear              | ↑* | ↑* |                           |
|                                      |      |    |    |    |     |  |    | Time spent in<br>work  | unclear              | ↑  | ↑  |                           |
|                                      |      |    |    |    |     |  |    | Hourly income  | unclear              |    | ↑  |                           |
|                                      |      |    |    |    |     |  |    | Rosenberg<br>Self-Esteem<br>Scale<br>(Rosenberg,<br>1962)            | self-<br>report      | ↑  | ↓  | -0.07<br>(-0.64,<br>0.50) |
| <i>Music and dance interventions</i> |      |    |    |    |     |  |    |  |                      |    |    |                           |
| Hillier et al.<br>(2012)             | 1-G  | 22 | 82 | 18 | USA | Music programme<br>(SoundScape)<br>including creative<br>sound exploration,<br>composition and<br>improvisation                  | 2  | Index of Peer<br>Relations<br>(Hudson et al.,<br>1993)               | self-<br>report      | ↑* |    |                           |
|                                      |      |    |    |    |     |  |    | Index of Peer<br>Relations<br>(Hudson et al.,<br>1993)               | parent<br>report     | ↑* |    |                           |
|                                      |      |    |    |    |     |  |    | Rosenberg Self-<br>Esteem Scale<br>(Rosenberg,<br>1962)              | self-<br>report      | ↑* |    |                           |
|                                      |      |    |    |    |     |  |    | State-Trait<br>Anxiety<br>Inventory<br>(Spielberger et<br>al., 1983) | self-<br>report      | ↑* |    |                           |

|                      |      |    |    |    |         |   |   |  |             |   |    |                    |
|----------------------|------|----|----|----|---------|---|---|--|-------------|---|----|--------------------|
| Koch et al. (2015)   | nRCT | 31 | 74 | 22 | Germany | I Dance movement therapy including dyadic mirroring, expressive movement and verbal discussion<br>C No intervention | 2 | Heidelberger State Inventory (Koch et al., 2007)                                   | self-report | ↑ | ↑* | 0.34 (-0.37, 1.05) |
|                      |      |    |    |    |         |   |   | Questionnaire of Movement Therapy (body awareness domain) (Gunther and Koch, 2010) | self-report | ↑ | ↑* | 0.43 (-0.28, 1.14) |
|                      |      |    |    |    |         |   |   | Questionnaire of Movement Therapy (social skills domain) (Gunther and Koch, 2010)  | self-report | ↑ | ↑* | 0.35 (-0.36, 1.06) |
|                      |      |    |    |    |         |   |   | Self-other awareness scale   | self-report | ↑ | ↑* | 0.44 (-0.27, 1.16) |
|                      |      |    |    |    |         |   |   | Emotional Empathy Scale (Caruso and Mayer, 1998)                                   | self-report | ↑ | ↑  | 0.29 (-0.42, 0.99) |
| Koehne et al. (2016) | nRCT | 51 | 63 | 33 | Germany | I Dance movement therapy focusing on imitation, synchronisation and interaction<br>C Movement training focusing on  | 2 | Multifaceted Empathy Test (empathic feelings domain) (Dziobek et al., 2008)        | self-report | ↑ | ↑  | 0.03 (-0.52, 0.58) |

|   |     |   |     |    |     |   |   |  |                                 |   |   |                     |
|---|-----|---|-----|----|-----|---|---|--|---------------------------------|---|---|---------------------|
|   |     |   |     |    |     | dexterity, balance and endurance                              |   | Interpersonal Reactivity Index (perspective taking domain) (Davis, 1983) | self-report                     | ↑ | ↑ | 0.05 (-0.50, 0.60)  |
|   |     |   |     |    |     |   |   | Interpersonal Reactivity Index (empathic concern domain) (Davis, 1983)   | self-report                     | ↑ | ↓ | -0.05 (-0.60, 0.50) |
| <i>University student support and mentoring</i> |     |   |     |    |     |   |   |  |                                 |   |   |                     |
| Koegel et al. (2013)                            | 1-G | 3 | 100 | 22 | USA | Mentoring and support to increase engagement in social events | 8 | N of social activities   | self-report + observer verified | ↑ |   |                     |
|   |     |   |     |    |     |   |   | Grade point average  | routine data                    | ↑ |   |                     |
|   |     |   |     |    |     |   |   | Satisfaction with socialisation  | self-report                     | ↑ |   |                     |
| Ness (2013)                                     | 1-G | 3 | 67  | 22 | USA | Peer mentoring focusing on academic work and goal setting     | 3 | Grade point average  | routine data                    | ↑ |   |                     |

\* Significant at  $p < 0.05$  in study authors' analyses

General abbreviations: C, control group; I, intervention group; NC, not calculable; NR, not reported; nRCT, non-randomised controlled trial; RCT, randomised controlled trial; SMD, standardised mean difference; 1-G, one-group study.

Direction of effect and effect sizes have been calculated with higher scores = improved outcome, i.e. outcome measures scored in the opposite sense (e.g. Autism Quotient) have been reversed.



Bonete: ES not calculable as measures only reported at one time point for control group.

Cunningham: Study designed as nRCT, but full comparative data not reported, so treated here as one-group

Hesselmark: within-group significance tests refer to whole pooled group (I+C).

Laugeson: Total follow-up was 32 weeks, but comparative change scores only reported at 16 weeks

Perdue: ES not calculable as standard deviations NR.

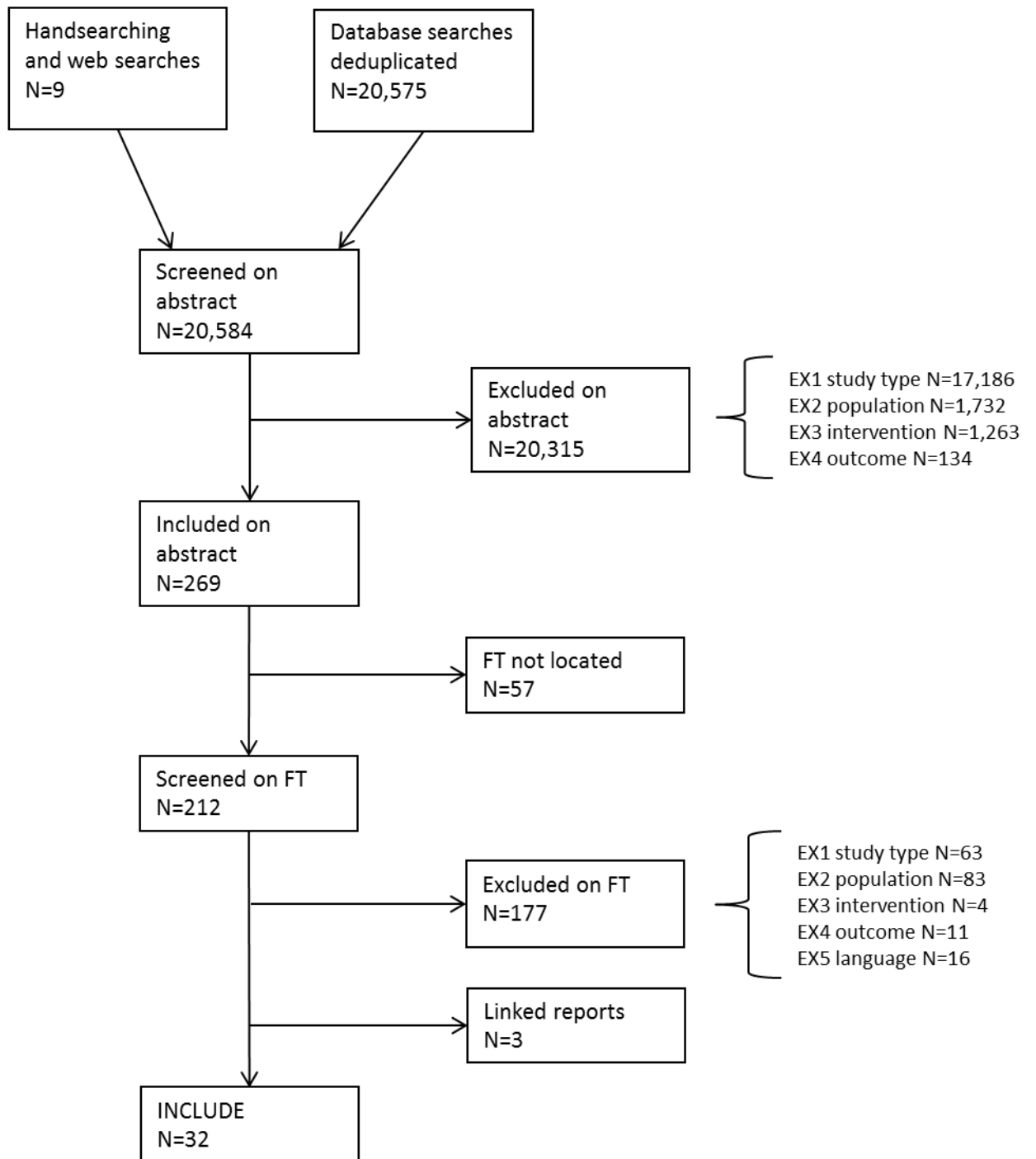


Figure 1. Flow of literature through the review

## Supplementary file 1: Medline search strategy

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- 1 Autistic Disorder/ (20812)
- 2 Asperger Syndrome/ (1881)
- 3 (autism or autistic or asperger\$).ti,ab. (40087)
- 4 1 or 2 or 3 (42826)
- 5 exp adult/ or middle aged/ or young adult/ (6972978)
- 6 (adult\$ or men or women or worker\$ or employee\$).ti,ab. (2317489)
- 7 (young people or young person\$).ti,ab. (25664)
- 8 5 or 6 or 7 (7993338)
- 9 4 and 8 (11631)
- 10 ((autism or autistic) adj2 (service\$ or treatment\$ or intervention\$ or support\$)).ti,ab. (1185)
- 11 (psychosocial adj2 (intervention\$ or treat\$ or therap\$ or prevent\$)).ti,ab. (8102)
- 12 (prevent\$ adj2 (intervention\$ or treat\$ or therap\$ or strateg\$ or approach\$ or program\$ or service\$)).ti,ab. (220328)
- 13 (targeted\$ adj2 (intervention\$ or treat\$ or therap\$ or strateg\$ or approach\$ or program\$ or service\$)).ti,ab. (69062)
- 14 (intervention adj2 (program\$ or strateg\$)).ti,ab. (29169)
- 15 Secondary Prevention/ (19465)
- 16 exp Cognitive Therapy/ (25382)
- 17 CBT.ti,ab. (8910)
- 18 ((cognitive or cognition) adj2 (therap\$ or treat\$ or program\$ or skill\$ or behavio\$ or intervention\$)).ti,ab. (48735)
- 19 Psychotherapy, Group/ (13807)
- 20 (group therapy or group psychotherapy or group psychoeducation or group intervention\$ or groupwork\$ or group work\$).ti,ab. (10766)
- 21 (low level intervention\$ or low intensity intervention\$).ti,ab. (209)
- 22 (brief adj2 intervention\$).ti,ab. (5555)
- 23 (model or models or modelling).ti,ab. (2442699)

- 24 (cue or cues or cueing).ti,ab. (81708)
- 25 (prompt or prompts or prompting).ti,ab. (67653)
- 26 applied behavior analysis.ti,ab. (382)
- 27 applied behaviour analysis.ti,ab. (29)
- 28 exp "Reinforcement (Psychology)"/ (55190)
- 29 social skills/ (764)
- 30 "Activities of Daily Living"/ (63446)
- 31 Occupational Therapy/ (12224)
- 32 (social skill\$ or life skill\$).ti,ab. (5543)
- 33 (independen\$ adj2 (live or lives or living)).ti,ab. (4879)
- 34 ((promot\$ or encourag\$ or support\$ or enhanc\$ or increas\$) adj2 (empathy or socialization or socialisation or interaction or friend\$)).ti,ab. (14494)
- 35 ((promot\$ or encourag\$ or support\$ or enhanc\$ or increas\$) adj2 (independen\$ or engagement\$ or involvement or inclusion or participation)).ti,ab. (35366)
- 36 Self Care/ (32143)
- 37 Self-Help Groups/ (9293)
- 38 (self help or selfhelp or self care or selfcare).ti,ab. (20879)
- 39 Social Participation/ or Friends/ (6074)
- 40 (social activit\$ or social group\$ or social involve\$ or social inclusion or social network\$).ti,ab. (24063)
- 41 (community activit\$ or community group\$ or community involve\$ or community inclusion or community network\$).ti,ab. (4344)
- 42 (games or leisure or sport or sports or hobby or hobbies).ti,ab. (79621)
- 43 exp Leisure Activities/ (221293)
- 44 community networks/ or social support/ (73709)
- 45 Mentors/ (10386)
- 46 (support\$ or coach\$ or mentor\$ or befriend\$ or broker\$ or advise\$ or advisor\$).ti,ab. (1442578)
- 47 Patient Advocacy/ (24809)

- 48 (advocacy or advocate\$.ti,ab. (59381)
- 49 "access to service\$.ti,ab. (3187)
- 50 (information adj2 (service or provid\$ or provision or give or gives or giving or gave)).ti,ab. (169709)
- 51 (advice adj2 (service or provid\$ or provision or give or gives or giving or gave)).ti,ab. (5680)
- 52 "advice and information".ti,ab. (351)
- 53 exp Self Concept/ (103386)
- 54 (self esteem or selfesteem or self-esteem or self confiden\$ or selfconfiden\$ or self-confiden\$).ti,ab. (21271)
- 55 person centred approach.ti. (22)
- 56 Patient-Centered Care/ (16159)
- 57 Caregivers/ (31213)
- 58 ((Carer\$1 or caregiv\$ or caretaker\$ or care taker\$ or custodian\$ or family or families of father\$ or mother\$ or parent\$ or sibling\$ or brother\$ or sister\$ or spouse\$ or wife\$ or husband\$ or partner\$ or peer or peers or friend\$ or online) adj2 (group\$ or support\$ or network\$)).ti,ab. (49241)
- 59 exp Self-Help Devices/ (10575)
- 60 ((assistive or enabl\$) adj2 (device\$ or technolog\$)).ti,ab. (10836)
- 61 exp Cell Phones/ (9805)
- 62 Mobile Applications/ (2009)
- 63 Communication Aids for Disabled/ (2532)
- 64 ((mobile or cell or cellular or personal or smart or android) adj (phone\$ or device\$ or technolog\$)).ti,ab. (13582)
- 65 computers/ or computers, handheld/ (57452)
- 66 (laptop\$ or PDA\$ or personal digital assistant\$ or iPAD\$ or IPOD\$).ti,ab. (17089)
- 67 ((computer or internet) adj (game\$ or simulat\$)).ti,ab. (25342)
- 68 exp Employment/ (81080)
- 69 ((employment or work or workplace or job or vocational) adj2 (train\$ or prepar\$ or opportunit\$ or skill\$ or rehabilitat\$ or support\$ or placement\$)).ti,ab. (20993)
- 70 "individual placement and support".ti,ab. (225)
- 71 (vocational adj (independence or engagement)).ti,ab. (20)

- 72 (autism adj2 champion\$.ti,ab. (0)
- 73 multidisciplinary team\$.ti,ab. (13086)
- 74 Patient Care Team/ (62130)
- 75 or/10-74 (4946934)
- 76 9 and 75 (4615)
- 77 exp adult/ or middle aged/ or young adult/ (6972978)
- 78 (adult\$ or men or women or man or woman or worker\$ or employee\$.ti. (782370)
- 79 (people or person\$.ti,ab. (926171)
- 80 77 or 78 or 79 (7733719)
- 81 76 and 80 (3666)
- 82 exp animals/ not humans.sh. (4859611)
- 83 81 not 82 (3615)

## Supplementary file 2: Further information on screening

Table 2. References excluded at full-text screening

| Reference   | Excl. code |
|---|------------|
| Alexander MGF, Dummer GM, Smeltzer A, et al. (2011) Developing the social skills of young adult Special Olympics athletes. <i>Education and Training in Autism and Developmental Disabilities</i> 46: 297-310.  | 2          |
| Allen KD, Burke RV, Howard MR, et al. (2012) Use of audio cuing to expand employment opportunities for adolescents with autism spectrum disorders and intellectual disabilities. <i>Journal of Autism &amp; Developmental Disorders</i> 42: 2410-2419.  | 2          |
| Allen KD, Wallace DP, Greene DJ, et al. (2010) Community-based vocational instruction using videotaped modeling for young adults with autism spectrum disorders performing in air-inflated mascots. <i>Focus on Autism and Other Developmental Disabilities</i> 25: 186-192.                            | 4          |
| Allen KD, Wallace DP, Renes D, et al. (2010) Use of video modeling to teach vocational skills to adolescents and young adults with autism spectrum disorders. <i>Education &amp; Treatment of Children</i> 33: 339-349.   | 4          |
| Ames ME, McMorris CA, Alli LN, et al. (2016) Overview and evaluation of a mentorship program for university students with ASD. <i>Focus on Autism and Other Developmental Disabilities</i> 31: 27-36.   | 1          |
| Arikawa M, Goto H and Mineno K. (2013) Job support by occupational therapists for people with developmental disabilities: two case studies. <i>Work</i> 45: 245-251.  | 1          |
| Ashburner J, Ziviani J, Rodger S, et al. (2015) Improving transfer of learning: An innovative co-mentoring program to enhance workplace implementation after an occupational therapy course on Autism Spectrum Disorders. <i>Journal of Continuing Education in the Health Professions</i> 35: 270-277. | 2          |
| Bailey DA. (2009) <i>Analysis of a social story intervention to increase appropriate social interactions in children with autism</i> . PhD thesis, Florida State University.  | 2          |
| Beadle D et al. (2013) The A Factor experience: enabling people with autism to have a voice. <i>Good Autism Practice</i> 14: 37-45.   | 1          |
| Begley J. (2014) Connect: the development of an online social network for people on the autism spectrum and their families. <i>Good Autism Practice</i> 15: 15-22.  | 1          |
| Bennett KD, Ramasamy R and Honsberger T. (2013) Further examination of covert audio coaching on improving employment skills among secondary students with autism. <i>Journal of Behavioral Education</i> 22: 103-119.   | 2          |
| Bennett KD, Ramasamy R and Honsberger T. (2013) The effects of covert audio coaching on teaching clerical skills to adolescents with autism spectrum disorder. <i>Journal of Autism &amp; Developmental Disorders</i> 43: 585-593.  | 2          |
| Beresford B et al. (2013) <i>Transition to adult services and adulthood for young people with autistic spectrum conditions: final report</i> . University of York. Social Policy Research Unit.   | 1          |
| Bereznak S, Ayres KM, Mechling LC, et al. (2012) Video self-prompting and mobile technology to increase daily living and vocational independence for students with autism spectrum disorders. <i>Journal of Developmental and Physical Disabilities</i> 24: 269-285.                                    | 2          |
| Berger HJ, van Spaendonck KP, et al. (1993) Cognitive shifting as a predictor of progress in social understanding in high-functioning adolescents with autism: a prospective study. <i>Journal of Autism &amp; Developmental Disorders</i> 23: 341-359.   | 1          |
| Bethune LK. (2016) <i>The effects of the self-advocacy and conflict resolution training on ability to request and negotiate academic accommodations with high school students with Autism Spectrum Disorders</i> . PhD thesis. Charlotte: University of North Carolina.                                 | 2          |

|  |   |
|--|---|
| Beyer S et al. (2014) <i>Regional SEN Transition to Employment Initiative (Real Opportunities): impact of the Real Opportunities project</i> . Cardiff: University of Cardiff.   | 2 |
| Bottema KM. (2013) <i>Adolescents with social disabilities and their peers: Intervention, identity, and judgments about exclusion</i> . PhD thesis, University of California.  | 2 |
| Brady MP, Honsberger C, Cadette J, et al. (2016) Effects of a peer-mediated literacy based behavioral intervention on the acquisition and maintenance of daily living skills in adolescents with autism. <i>Education and Training in Autism and Developmental Disabilities</i> 51: 122-131. | 2 |
| Buescher AV, Cidav Z, Knapp M, et al. (2014) Costs of autism spectrum disorders in the United Kingdom and the United States. <i>JAMA Pediatrics</i> 168: 721-728.  | 1 |
| Burckley E, Tincani M and Fisher Amanda G. (2015) An iPad™-based picture and video activity schedule increases community shopping skills of a young adult with autism spectrum disorder and intellectual disability. <i>Developmental Neurorehabilitation</i> 18: 131-136.                   | 2 |
| Burgess S and Cimera RE. (2014) Employment outcomes of transition-aged adults with autism spectrum disorders: a state of the States report. <i>American Journal on Intellectual &amp; Developmental Disabilities</i> 119: 64-83.   | 1 |
| Burke RV, Allen KD, Howard MR, et al. (2013) Tablet-based video modeling and prompting in the workplace for individuals with autism. <i>Journal of Vocational Rehabilitation</i> 38: 1-14.   | 4 |
| Burke RV, Andersen MN, Bowen SL, et al. (2010) Evaluation of two instruction methods to increase employment options for young adults with autism spectrum disorders. <i>Research In Developmental Disabilities</i> 31: 1223-1233.  | 4 |
| Burt DB, Fuller SP and Lewis KR. (1991) Brief report: competitive employment of adults with autism. <i>Journal of Autism &amp; Developmental Disorders</i> 21: 237-242.  | 1 |
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