

Interventions for children on the autism spectrum: A synthesis of research evidence

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November 2020



Australian Government Department of Industry, Science, Energy and Resources Business Cooperative Research Centres Program

autismcrc.com.au

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A synthesis of research evidence

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ISBN: 978-1-922365-14-9

Suggestion citation: Whitehouse, A., Varcin, K., Waddington, H., Sulek, R., Bent, C., Ashburner, J., Eapen, V., Goodall, E., Hudry, K., Roberts, J., Silove, N., Trembath, D. *Interventions for children on the autism spectrum: A synthesis of research evidence*. Autism CRC, Brisbane, 2020.

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Acknowledgements

The authors and Autism CRC acknowledge the financial support of the National Disability Insurance Agency in the development of this report, including funding to support the research activities conducted by six authors (Cathy Bent, Rhylee Sulek, David Trembath, Kandice Varcin, Hannah Waddington, Andrew Whitehouse) and an honorarium for other authors (Jill Ashburner, Valsamma Eapen, Emma Goodall, Kristelle Hudry, Jacqueline Roberts, Natalie Silove).

Details regarding the employment of each author, along with a summary of their declarations of interest, are provided below. Full declarations of interest are available at The Open Science Framework: https://osf.io/t7re9/

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Autism CRC

Autism CRC is the world's first national, cooperative research effort focused on autism. Taking a whole-of-life approach to autism focusing on diagnosis, education and adult life, Autism CRC researchers are working with end-users to provide evidence-based outcomes which can be translated into practical solutions for governments, service providers, education and health professionals, families and people on the autism spectrum.

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A note on terminology

We recognise that when referring to individuals on the autism spectrum, there is no one term that is preferred by all people. In our published material and other work, we use the terms 'autistic person', 'person on the autism spectrum', or 'person on the spectrum'. The term 'autistic person' uses identity first language, which reflects the belief that being autistic is a core part of a person's identity.

Autism Spectrum Disorder (ASD) is diagnostic terminology used by the healthcare sector, and is used in the context of a person being 'diagnosed with Autism Spectrum Disorder'.



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Executive Summary

Having access to effective intervention during childhood is an important element of the intervention pathway for children on the autism spectrum, providing an opportunity to support early development and promote longer-term quality of life. There are a large number of interventions available within clinical practice, which vary in their theoretical orientation and practical application. The current report had two broad aims: (1) to provide an overview of non-pharmacological interventions that have been developed for children on the autism spectrum, and the training pathways in Australia for clinical practitioners who provide these interventions; and (2) to review the scientific evidence for the therapeutic (and other) effects of interventions for children on the autism spectrum.

The first aim was addressed through a narrative review, which provided a rationale for clinical intervention, including a description of the medical, social, biopsychosocial, and neurodiversity models/perspectives of clinical intervention for children on the autism spectrum. A method for classifying clinical intervention practices was then discussed, categorising intervention practices into behavioural interventions, developmental interventions, naturalistic developmental behavioural interventions (NDBIs), sensory-based interventions, technology-based interventions, animal-assisted interventions, cognitive behaviour therapy (CBT), Treatment and Education of Autistic and related Communication-handicapped Children (TEACCH), and interventions that do not fit within these categories ('other' interventions). The theoretical premise for each of these interventions in clinical practice. The narrative review concludes by outlining the training pathways that are typically undertaken by clinical practitioners in Australia that ensure the effective and ethical delivery of these interventions.

The second aim was addressed through an umbrella review of the empirical evidence base examining interventions for children on the autism spectrum, focusing on those designed for use with children aged 0-12 years. The umbrella review used reproducible methods to identify, collate, and synthesise existing systematic reviews (including meta-analyses) of the intervention research literature, with a focus on group study designs that included a comparison group. The main findings corresponding to each specific research question are described in the Executive Summary Table.

Executive Summary Table. Summary of the main findings of the umbrella review. This is a replication of Table 11 presented in the Discussion in Chapter 3.



What non-pharmacological interventions have been examined in SRs?

- The umbrella review included 58 systematic reviews (SRs), drawing on 1,787 unique articles.
- Interventions were categorised into behavioural interventions, developmental interventions, NDBIs, sensory-based interventions, technology-based interventions, animal-assisted interventions, CBT, TEACCH, and other interventions that do not fit within these categories.
- Across these intervention categories, information was reported on at least 111 intervention practices.
- The SRs were of variable quality, and only 4 of the 58 SRs met all quality criteria.

What effects do non-pharmacological interventions have on child outcomes?

- When examined at a category level (i.e., systematic reviews of an assortment of related practices), there was evidence for positive effects on a range of child and family outcomes for behavioural interventions, developmental interventions, NDBIs, technology-based interventions, and CBT. Within these categories, the intervention effect on outcomes was variable (null, positive) across intervention practices.
- Positive intervention effects for sensory-based interventions were reported for certain intervention practices only, and in those cases, positive effects were limited to select child and family outcomes.
- A mix of inconsistent and null intervention effects on child outcomes were reported for both TEACCH and animal-assisted interventions.
- Among 'other' intervention practices, only social skills training had evidence for a positive intervention effect on child outcomes.
- Minimal information was provided on adverse effects.
- The effects were predominantly derived from systematic reviews with lowmoderate quality evidence.



What effects do non-pharmacological interventions have on family wellbeing?

- Minimal information was reported on the effect of interventions on caregiver outcomes.
- There were practices within the developmental and NDBI categories that were reported to have a positive intervention effect on caregiver communication and interaction strategies.
- A positive intervention effect on caregiver social and emotional wellbeing was reported for individual practices within the NDBI and sensory-based intervention categories, and a null effect was reported on this outcome within the behavioural category.

What are the optimal delivery characteristics of non-pharmacological interventions?

Amount of intervention

- The amount of intervention varied widely both between and within intervention categories and practices.
- Minimal information was reported on the influence of the amount of intervention (e.g., total hours) on intervention effects.
- Within the behavioural intervention category, there was evidence that a greater amount of intervention related to greater intervention effects. However, this effect on child outcomes varied between SRs, and null effects were also reported.
- For practices within the NDBI intervention category, the amount of intervention did not relate to intervention effects on most child outcomes examined.
- The effect of the amount of intervention on child and family outcomes was not reported for interventions within the developmental, sensory-based, technologybased, animal-assisted interventions, cognitive behaviour therapy, Treatment and Education of Autistic and related Communication-handicapped Children, and 'other' intervention categories.



- Intervention amount did not influence the effect of interventions targeting socialcommunication and communication outcomes.
- No evidence was reported on the amount of intervention that may maximise effects on child and family outcomes for any intervention category.

Intervention setting

- The majority of interventions were delivered in clinical, home or educational settings, with positive effects on a variety of child outcomes reported for all settings.
- Minimal information was reported comparing intervention effects between different intervention settings. In the few SRs that examined this, intervention effects on social-communication and play outcomes did not vary by setting.

Intervention format

- Evidence for a positive effect on child and family outcomes was reported for both individual and group interventions.
- Minimal information was reported comparing the effects of intervention when delivered in individual and group formats. In the few SRs that examined this, there was no difference between individual and group formats in the intervention effects on child outcomes.

Intervention agent

- Evidence for positive intervention effects on child outcomes were reported for interventions delivered by clinical practitioners, as well as for parent-mediated and peer-mediated interventions.
- Active caregiver involvement in intervention was reported to have a similar, and at times greater, intervention effect on child outcomes than those delivered by clinicians or educators alone.

Intervention mode

- The majority of evidence reported related to interventions delivered face-to-face.
- The few SRs that examined telepractice reported a positive intervention effect on select child outcomes, and a positive effect on a number of caregiver outcomes.



• No SR reported a comparison of intervention effects between telepractice and face-to-face delivery.

What child characteristics influence intervention effects?

- Minimal evidence was reported on the influence of child characteristics on intervention effects.
- The influence of child age on intervention effects was reported to be either inconsistent or null.
- There was no consistent evidence that other child characteristics (core autism characteristics, cognition, communication skills) influenced intervention effects.

This report is a comprehensive review of the evidence underpinning non-pharmacological interventions for children on the autism spectrum. The findings provide key insights into which interventions have research evidence for producing a positive effect on which child and family outcomes. This information is critical in informing clinical and policy decisions regarding interventions that may be most appropriate for children and their families. This information will also serve an important role in helping caregivers to make informed decisions regarding how best to support their children's learning and participation. The variability in the effects of interventions on child and family outcomes and the quality of the evidence reinforces the need for clinical decision making to take place within an evidence-based practice framework, which also draws on evidence from clinical experience and accounts for each child's and family's preferences and priorities. The near complete absence of evidence regarding the effects of intervention practices on quality of life outcomes highlights an urgent research priority. Understanding and measuring the desired outcomes of an intervention, as defined by individuals on the autism spectrum and their families, will advance the key research goal of how intervention practices can best be tailored to the strengths and support needs of children and their families. The information presented in this review will change as further scientific evidence emerges, and so it is recommended that this report becomes the foundation for a living guideline that is updated on a continuing basis.



Commonly used abbreviations

Abbreviation	Full description
ABA	Applied Behaviour Analysis
AHPRA	Australian Health Practitioner Regulation Agency
СВТ	Cognitive behaviour therapy
JBI	Joanna Briggs Institute
NDBIs	Naturalistic developmental behavioural interventions
NDIA	National Disability Insurance Agency
NDIS	National Disability Insurance Scheme
NHMRC	National Health and Medical Research Council
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
Quasi-RCT	Quasi-randomised controlled trial
RCT	Randomised controlled trials
SCEDs	Single case experimental designs
SR	Systematic review
TEACCH	Treatment and Education of Autistic and related Communication-handicapped Children



Chapter 1: General introduction

Autism Spectrum Disorder (herein referred to as autism) is the collective term for a group of neurodevelopmental conditions characterised by persistent difficulties in social-communication and interaction, and by restricted, repetitive patterns of behaviour, interests, or activities (American Psychiatric Association, 2013). The behavioural features that characterise autism are often present before 3 years of age, but may not become apparent until the school years or later in life. While these features can vary widely in nature and level between individuals, and in the same individual over time, there is evidence that autistic behaviours endure into adult life, though the impacts may change across the lifespan (Simonoff et al., 2019). A range of developmental, mental, and physical health conditions regularly co-occur with autism, including attention deficit hyperactivity disorder, intellectual disability, epilepsy, gastrointestinal issues, sleep disorders, language disorders, motor difficulties, and mental health problems. These comorbid conditions, in conjunction with the core autism characteristics, can create significant barriers to a person's ability to function independently in his or her environment, with longer-term implications for educational and vocational attainment and wellbeing (Lord et al., 2020). While approaches to supporting individuals on the autism spectrum vary, interventions share a universal goal of minimising the impact of developmental challenges and co-occuring conditions on functional abilities, participation, and quality of life, and maximising long-term independence and autonomy.

The provision of clinical intervention during the childhood years provides a significant opportunity to support early development, minimise disability, and maximise each child's strengths and opportunities over the long term (Whitehouse, 2017). These interventions are typically non-pharmacological and are designed to promote developmental skill acquisition across a range of domains, such as social-communication, language, cognition, and adaptive functioning. Individuals on the autism spectrum vary widely in their profiles of strengths, support needs, and behavioural characteristics, and it is recognised that there is no 'one size fits all' approach to intervention during childhood; that is, there is no one intervention that improves all developmental outcomes for all children (Lord et al., 2020). However, there are several core principles that are foundational to the delivery of appropriate services and supports to children on the autism spectrum. These core principles combine with the broader principles of ethical clinical practice – beneficence and nonmaleficence, honesty, justice and autonomy – to create a foundation upon which interventions are developed. These core principles are described in Table 1.



Table 1. Core principles that are important to interventions for children on the autismspectrum.

Core principles	Description
Holistic assessment	An initial assessment of an individual's strengths, challenges, goals, and preferences is critical to developing intervention targets that are meaningful to the child and family. By its very nature, an assessment requires an appraisal of the individual's difficulties, but should equally include identification of strengths and consideration of contextual and environmental barriers and enablers to learning and participation. Furthermore, assessment should be ongoing to understand the impact of interventions and evolving goals, and help ensure that the focus of the intervention remains meaningful to that individual and their family. The National Guideline for Autism Assessment and Diagnosis (Whitehouse, Evans, Eapen, & Wray, 2018) outlines the clinical assessment process in Australia.
Individual and family-centred	The person on the autism spectrum, and their family members, are the individuals receiving clinical services, and are to be considered equal partners with clinical practitioners in this process. There is considerable community diversity in socioeconomic resources, education, cultural background, language(s) spoken, and social-emotional factors that influence how individual people understand autism, what they desire from an intervention, and how they see their role in supporting the child on the autism spectrum. By placing the individual and family at the centre of clinical management, the aim is to understand and build the capacity of each individual and family to meet their unique needs.
Lifespan perspective	Autism is a lifelong condition, with long-term impacts for the individual and their family. A lifespan perspective acknowledges that people continue to grow and change throughout their lives as they are faced with new tasks, challenges, and opportunities. Accordingly, the types of supports that are most appropriate at each stage will change, as children move from early childhood settings into school, and ultimately adult life. At the same time, the capacity of those around the person will change over time as caregivers age, and siblings, partners, extended family, and friends play an increasing role. It is critical that clinical decision-making accounts for the current stage of life of the individual, as well as appropriate planning for both the short and longer term.
Evidence-based	Intervention is most effective and safe when it is based on the best available scientific evidence. While high-quality evidence is not currently available in relation to every aspect of intervention for children on the autism spectrum, it is an essential responsibility of clinical practitioners, educators and other service providers to be appropriately qualified, and to ensure the interventions they offer are underpinned by an evidence base to help ensure a safe and positive effect on the wellbeing of the individual on the autism spectrum and their family.



Evidence-based practices

While all of the principles described in Table 1 play an important role in the intervention pathway for children on the autism spectrum, the current report is primarily concerned with the selection and use of interventions within an evidence-based practice framework. Evidence-based practice is the conscientious, explicit, judicious and reasonable use of current best evidence in clinical decision making (Sackett, Richardson, Rosenberg, & Haynes, 2000). The framework does not impose a prescriptive approach on service provision, instead it focuses on the integration of the best available research evidence with appropriate clinical expertise and the values of the individual(s) receiving the services. At the core of the integrated model of evidence-based practice is an awareness of the evidence underlying a given intervention and a careful appraisal of that evidence as it applies to a particular individual and the context in which it is to be provided. Evidence-based practice fulfils an ethical obligation of clinical practitioners and educators to ensure that their decisions are informed by the best available evidence in order to maximise clinical benefit and minimise harm.

Not all research evidence is equal in quality, and central to the tenet of evidence-based practice is a critical appraisal of the quality of evidence underpinning a given research finding. Interventions can be tested using a range of different study designs, all of which incorporate a degree of methodological bias that can influence the study findings. A critical appraisal of study quality involves assessing the level of bias of the different study designs that have contributed to any given 'evidence base'. In Australia, the National Health and Medical Research Council (NHMRC) has developed a hierarchy for evaluating evidence in health and medical research (see Table 2). Towards the top of the hierarchy of evidence are randomised controlled trials (RCTs), which minimise potential methodological bias through the random allocation of study participants (and, indirectly, of potentially confounding variables) to different intervention conditions. The highest level of evidence is a systematic review of RCTs, which minimises methodological bias even further by evaluating evidence across the full breadth of the RCT literature using systematic and reproducible methods. Lower levels of evidence within the NHMRC hierarchy include non-randomised controlled trials, as well as case series and case reports. This hierarchy does not discount the evidence generated through these latter study designs, but rather contextualises the evidence in terms of its susceptibility to methodological bias and the capacity to generalise findings to the broader population. For further information about the NHMRC Evidence Hierarchy and methodological bias, please refer to NHMRC (2009).



Table 2. NHMRC Evidence Hierarchy. For further information, please refer to NHMRC(2009).

Level of evidence	Study design
I	Evidence obtained from a systematic review of all relevant randomised controlled trials.
н	Evidence obtained from at least one properly-designed randomised controlled trial.
III-1	Evidence obtained from well-designed pseudorandomised controlled trials (alternate allocation or some other method).
III-2	Evidence obtained from comparative studies (including systematic reviews of such studies) with concurrent controls and allocation not randomised, cohort studies, case-control studies, or interrupted time series with a control group.
III-3	Evidence obtained from comparative studies with historical control, two or more single arm studies, or interrupted time.
IV	Evidence obtained from case series, either post-test or pre-test/post-test.

It is important to note that there are other frameworks for evaluating the quality of research evidence, and that these may differ in the hierarchy of evidence assigned to a given study design. For instance, the Oxford Centre for Evidence-Based Medicine (2011) highlights the value of Single Case Experimental Designs (SCEDs) in evaluating treatment benefits and harms. SCEDs, which are also referred to as n-of-1 trials because they evaluate outcomes at the individual level, are often used to establish functional relationships between the delivery of an intervention and changes in an individual's skills or behaviour (Koegel, Koegel, Ashbaugh, & Bradshaw, 2014). The Oxford Centre for Evidence Based Medicine classifies both systematic reviews of RCTs and of SCEDs as the highest level of evidence, whereas the NHMRC reserves this highest rating for systematic reviews of RCTs only. The adoption of a particular framework for any given research project must be based on the specific research questions and the context in which the evidence is to be applied. The current report was commissioned by the National Disability Insurance Agency (NDIA) of Australia, which sought to understand the evidence base for interventions for children on the autism spectrum in the context of community-wide practice in Australia. While SCEDs provide important insights into the functional relation between a particular intervention and an outcome, group-based studies enable greater confidence in the generalisation of findings to the broader community. For this reason, evidence from group-based study designs with a control group was prioritised for this report. Studies with these designs align with the higher levels of evidence within the NHMRC Evidence Hierarchy. It is also important to state that the purpose of this review was to synthesise the research



evidence in such a way that may inform decision-making and the future development of a Guideline, not to recommend particular interventions or develop a Guideline. The development of a Guideline requires the completion of additional steps, including engagement with a broad group of stakeholders and the application of a system for rating the quality of evidence and developing recommedations, such as via the Grading of Recommendations, Assessment, Development and Evaluation (GRADE) approach (GRADE Working Group, 2013).

Interventions for children on the autism spectrum

Given the prominent role of intervention in the lives of children on the autism spectrum, it is critical that decisions about which interventions to provide are based on the highest quality evidence available. However, there are a range of challenges in synthesising the evidence base. First, a large number of interventions are currently used to support the early development of children on the autism spectrum. While a minority of these interventions are well documented through clinical protocols and manuals, the theoretical underpinnings and practical procedures of most are not clearly defined. Second, there is a degree of overlap in the theoretical underpinnings and practical applications of a number of widely-used interventions, which requires decisions around how to classify interventions and combine data across studies. Third, the systematic study of interventions is made more complex by the variety of ways through which a single intervention may vary, such as the delivery format (individual, group), the amount of intervention received (e.g., total intervention hours), the intervention agent (e.g., clinician, caregiver¹, peer/sibling, educator), the setting (e.g., clinic, home, school), and the delivery mode (e.g.., face-to-face, telepractice), as well as the many ways in which children on the autism spectrum may differ (e.g., age, core autism characteristics, cognition, communication skills). Combined, these challenges have contributed to an evidence base that is more piecemeal than systematic, and often reliant on evidence from lower quality study designs. Due to these combined challenges, the predominant issue facing clinical practitioners, educators, family members and policy makers is less a lack of evidence, and more the difficulty of evaluating a body of evidence that varies considerably in focus, quality, and relevance to everyday clinical practice.

¹ Please note that the current report uses the more inclusive term of 'caregiver' to refer to individuals who have primary responsibility for the care of a child (e.g., parents, grandparents, foster-carers, and other guardians). Where the report uses the term 'parent', this typically refers to well-established terminology within the literature (e.g., parent-mediated intervention). However, the use of these terms will also be applicable to other caregivers.



The last decade has seen a significant increase in the number of studies that have evaluated interventions for children on the autism spectrum using study designs that represent the higher levels of evidence within the NHMRC Evidence Hierarchy. A 2018 analysis found that 40 of a total of 48 RCTs of interventions to that date had been published since 2010 (French & Kennedy, 2018). In response to this expanding evidence base, there has been an increasing number of systematic reviews that have sought to collate these data and generate summarised findings. However, again, these reviews vary considerably across a range of factors: their focus on specific intervention practices or broad categories of intervention practices, the age range of the participants, the quality of the review methodology, the quality of included studies, and the detail of information extracted from the original studies and then reviewed. While these fundamental differences in study design mean that any one systematic review is unlikely to be entirely representative of the underlying evidence base on its own, the systematic review literature as a whole provides an important foundation from which the evidence base can be synthesised.

One method for collating and appraising evidence across different systematic reviews is known as an umbrella review. Umbrella reviews (also called meta-reviews, overviews of reviews, reviews of reviews, a summary of systematic reviews, and a synthesis of reviews) apply the same rigorous search method as systematic reviews but limit the included studies to research syntheses, such as systematic reviews, including meta-analyses (Aromataris et al., 2015). The aim of an umbrella review is not to duplicate the literature searches, study eligibility checks and quality assessments from the included reviews, but rather to provide an overall summary of evidence from a corpus of reviews across a broad topic area. Umbrella reviews are particularly helpful for the development of evidence-based policy because they facilitate a synthesis and appraisal of evidence across a broader topic area than is usually achieved through an individual systematic review. Given the current progression of the autism research field, an umbrella review provides the ideal study design to synthesise the current evidence base underpinning interventions for children on the autism spectrum.

The aims of the report

The current report has two broad aims: (1) to provide an overview of non-pharmacological interventions that have been developed for children on the autism spectrum, and the training pathways in Australia for clinical practitioners who provide these interventions; and (2) to review the scientific evidence for the therapeutic (and other) effects of interventions for children on the autism spectrum. These aims will be achieved through two literature reviews. The first is a narrative review (Chapter 2) that provides critical context in which the findings of the second review, the umbrella review (Chapter 3), can be interpreted. The narrative review describes the rationale for clinical



intervention, provides an overview of the theoretical premises and principles underpinning broad categories of interventions for children on the autism spectrum, and discusses the clinical training pathways that are typically required in Australia to ensure ethical delivery of these interventions. The umbrella review then provides a synthesis of the empirical evidence base for interventions for children on the autism spectrum. The review uses systematic and reproducible methods to identify, collate and summarise existing systematic reviews of the intervention literature, maintaining a focus on study designs that generate the highest levels of evidence according to the NHMRC Evidence Hierarchy (NHMRC, 2009). The narrative review provides key information regarding terminology and aspects of the methodology applied in the umbrella review, and we therefore recommend these chapters be read in combination.



Scope of review

The scope of the review was defined by the NDIA and included the questions addressed in the narrative review, as well as the study designs, interventions and outcomes that are the focus of the umbrella review. The protocol for the umbrella review was approved by the NDIA prior to the literature search commencing. Several key issues that are important to consider in the provision of supports for children on the autism spectrum, but that were beyond the scope of this report, include:

- The use of interventions primarily delivered by educators within school settings;
- A consideration of interventions that are primarily delivered to support the mental health outcomes of children on the autism spectrum;
- A consideration of interventions that primarily focus on supporting the needs of the family rather than those of the child on the autism spectrum;
- A consideration of pharmacological interventions;
- A consideration of interventions primarily designed for use with children with comorbid visual, hearing, or physical disabilities;
- An examination of the relative benefits of using interventions in isolation or combination to meet the needs of an individual child; and
- The capacity of the Australian workforce to deliver the interventions reviewed.

This research was undertaken to provide greater understanding about the variety of interventions for children on the autism spectrum in Australia, and the evidence base underpinning these. The classification and descriptions of autism interventions provided in this report, along with the summary of the associated evidence base for their use, may be useful to a range of stakeholders, including individuals on the autism spectrum, their families, clinical practitioners, scientists and policy makers. The findings can underpin evidence-based practice in Australia as the basis for greater choice, control, learning, and participation for children on the autism spectrum now, and into their adult lives.



Chapter 2: Interventions for children on the autism spectrum, and their application in the Australian community

Abstract

For children on the autism spectrum, effective intervention during childhood plays an important role in promoting their learning and participation in everyday life activities. However, navigating the range of interventions can be difficult for families, clinical practitioners, and educators due to the large number of interventions available, the diverse approaches they adopt, varying research evidence, and the range of clinical practitioners that may be involved in their delivery. The purpose of this narrative review was to provide an overview of the range of interventions for children on the autism spectrum and their use in Australia. The information presented in this chapter provides important context for the comprehensive review of research evidence for the effect of these interventions that is presented in the ensuing chapter (Chapter 3).

The review begins with the rationale for providing intervention, taking into consideration the medical, social, biopsychosocial, and neurodiversity models/perspectives of disability. Nine intervention categories are presented, reflecting different theoretical reasons for why an intervention may help support a child's development: (1) behavioural interventions; (2) developmental interventions; (3) naturalistic developmental and behavioural interventions (NDBIs); (4) sensory-based interventions; (5) technology-based interventions; (6) animal-assisted interventions; (7) cognitive behaviour therapy, (8) Treatment and Education of Autistic and related Communication-handicapped Children (TEACCH); and (9) other interventions that do not fit within these categories. The theoretical premises and the principles that underpin the use of these interventions in clinical practice are summarised. To conclude, the review outlines the training pathways and professional qualifications that are typically undertaken by clinical practitioners in Australia to ensure the effective and ethical delivery of interventions for children on the autism spectrum.



Introduction

This chapter provides an overview of non-pharmacological interventions that have been developed for children on the autism spectrum, and the training pathways in Australia for clinical practitioners who provide these interventions. The information is structured to answer the following questions:

- What is an appropriate method for categorising the broad range of interventions for children on the autism spectrum?
- What are the theoretical premises underpinning different intervention categories, and the principles guiding their practical application?
- What clinical competencies are typically required in the Australian context to deliver the interventions described in this report?

This chapter takes the form of a narrative review to support the information drawn from a variety of relevant sources including books, research articles, research commentaries, and professional practice documents that are relevant to the questions posed.

The rationale for intervention

All interventions share a common goal of improving a person's experience of the world, whether it be through modifying the person's skills and abilities (Sandbank et al., 2020a) or the environment around them (den Houting, 2019). Predominantly, interventions are designed and used in an attempt to help children develop new skills and reduce behaviours that are perceived to act as barriers to their learning and participation in home and community activities.

Interventions share the philosophy of advancing the human rights of the child (e.g., for justice, education, inclusion, participation), consistent with a disability rights perspective (United Nations, 2006). At a community level, there are also pragmatic and economic arguments for the importance of providing interventions and supports to children on the autism spectrum. These arguments focus on children's potential and the benefits of early investment in child development for promoting immediate and long-term gains in independence and participation in society, as well as cost savings to public spending associated with a reduction in the need for supports (Koegel et al., 2014). These rationales are additive rather than mutually exclusive; the savings in public spending that may be generated through effective and supportive intervention do not undermine the primary focus of increasing the participation of the individual receiving that intervention. It was in this context that the National Disability Insurance Scheme (NDIS) was created through a partnership between the Commonwealth and State Governments of Australia. The Productivity Commission provided recommendations that an insurance model for reasonable and necessary supports, including



investment in the provision of intervention during early childhood, may lead to both improved wellbeing and outcomes for children with disabilities and their families, as well as bringing savings to public spending in the long-term (Productivity Commission, 2017). Combined, these arguments provide a compelling case for public investment in intervention for children on the autism spectrum, particularly where there is empirical evidence that a given intervention may lead to the desired outcomes.

At an individual level, the rationale for applying and/or receiving intervention varies based on the lens through which disability and diversity are viewed. Within a medical model conceptualisation of disability (Gutkin, 2012; Sheridan & Gutkin, 2000), autism is a disorder to be treated, and so the goal of intervention will be primarily to address a child's underlying 'impairments'. These goals may be framed in terms of building new skills or reducing impairments and 'deficits', and the focus of intervention is primarily on the child, with disability seen as mostly arising from the child's impairments. From a social model perspective (Oliver, 1983, 2013), the disability associated with autism arises from the environment in which the child lives and learns, and so the focus of intervention is on making specific changes to the environment around the child, as well as broader changes to society. For example, intervention may focus on creating 'sensory safe' and predictable environments, reducing the social demands placed on the individual, or redesigning public spaces to support the individual's needs and their participation in those spaces. A biopsychosocial model (see World Health Organization, 2001) reconciles these two approaches, noting that aspects of children's development interact with the environment to influence their learning, inclusion, and participation. From this perspective, interventions should focus on aspects of both the child's development and the environment that are conducive to greater participation. Finally, a neurodiversity perspective (Singer, 1999) views autism as part of the natural variation in brain development and behavioural functioning (den Houting, 2019). This perspective rejects the notion of disorder, instead focusing on the unique skills and perspectives each person has to offer to the community and broader society. Here, goals for intervention will resemble those developed from a social model of disability, focusing on inclusion and participation and rejecting any notion of 'normalising' a child.



Classifying interventions

A variety of terminology has been used to describe interventions for children on the autism spectrum. Terms such as *therapy, treatment, intervention, support, approach, program, practice, technique* and *strategy* are often used interchangeably across disciplines (e.g., allied health, medical, education) and also by individual caregivers, clinical practitioners, educators and researchers. The current report uses the term *intervention* to denote a collection of clinical techniques, applied in combination, which aims to support the acquisition of developmental or educational skills, in order to promote well-being and community participation. The report then classifies intervention activities into three levels, ranging from the *intervention techniques* that combine to form *intervention practices*, which are in turn grouped together under the broader term of *intervention categories*. Definitions of these classification levels are provided in Table 3.

The current report maintains a focus on interventions for children on the autism spectrum at the practice and category levels. The rationale for excluding techniques as a focus of this review is related to the aim of the report – summarising the evidence base for the therapeutic and other effects of interventions – and a clinical understanding that the application of a single technique in isolation is unlikely to be sufficient to support the needs of children who, based on contemporary diagnostic criteria, have pervasive needs across multiple developmental domains.

Term	Description	Examples
Category	One or more practices that share similar theoretical underpinnings.	Behavioural interventions
Practice	A combination of techniques evaluated and implemented together to target the acquisition of one or more skills.	Early Intensive Behavioural Intervention, Discrete Trial Training, the Picture Exchange Communication System
Technique	A discrete clinical strategy, targeting the acquisition of a discrete skill.	Prompting, modelling, shaping, reinforcement

Table 3. Terms used to classify intervention activities in the current report along with an example of the classification system.



Intervention categories for autism: Theoretical premise, application, and principles

There are both scientific and clinical reasons for adopting a classification system for interventions for children on the autism spectrum, particularly at the category level. The category level groups together intervention practices that share common theoretical underpinnings; that is, there are similarities in the proposed reasons for why the intervention practices may have a positive effect on a child's development. While a large number of intervention practices are currently available within clinical practice, many of these share similar theoretical underpinnings. Without a classification system that enables the grouping of these interventions, a synthesis of the research findings would be both unwieldy to undertake and challenging to interpret. Clinically, an understanding of broad categories of intervention, about the range and types of interventions available, and also to support these consumers in making informed choices about which intervention may best suit the needs of their family. Category classifications can also help to orient clinical practitioners to different approaches that may benefit children and families, and provide both clinical practitioners and researchers with a framework through which new intervention practices can be developed and evaluated.

The intervention categories used in the current report are based on those described in a recent systematic review (Sandbank et al., 2020a). The use of these categories provides consistency with previous literature in this area, and the *a priori* selection of this taxonomy for use in the current review provides a degree of confidence that this classification system can support an appropriate research synthesis. However, there are two key issues to highlight in this regard. The first is that no method for classifying interventions will be entirely compatible with a broad and complex research literature that has evolved over many decades. Any incompatibility of the current classification system with previous literature will be documented in the umbrella review (Chapter 3). The second issue is that by focusing on intervention practices and categories – which is the typical method through which interventions are evaluated in the research literature – the umbrella review will not provide evidence regarding holistic service provision. Accordingly, terms such as occupational therapy, speech pathology/therapy, and psychology which are commonly used in the community do not feature, because these are clinical services that draw on a range of techniques and practices.

Table 4 provides an overview of the different intervention categories that are used to classify interventions in this report. The theoretical underpinnings, practical application, and principles that inform the use of interventions are outlined for each category. A more succinct summary of this information is provided in Appendix A.



Table 4. The theoretical premise, clinical application, and principles underpinning different categories of intervention for children on the autism spectrum.

Behavioural interventions		
Theoretical premise	Behaviourism proposes that children's behaviour, which includes the development of skills, is governed by their interactions with their environment. Central to this theory is the role of operant conditioning, which refers to the way intentional behaviours are shaped by one's environment, thus increasing or decreasing the likelihood of the same or a similar behaviour occurring again in the future (Skinner, 1953). From a behaviourism perspective, complex tasks (e.g., a child joining in a group activity at preschool) can be broken down into a set of specific behaviours, and systematically taught and supported through the application of teaching strategies. These include creating an environment in which the behaviour is likely to occur; cueing the behaviour; prompting, modelling, and shaping the behaviour; and reinforcing attempts toward successful use of the behaviour.	
Clinical application	Behavioural interventions for children on the autism spectrum have arisen primarily from Applied Behaviour Analysis (ABA). ABA is the scientific application of behavioural principles to, first, identify variables that are responsible for behavioural change, and second, to use these variables to improve 'socially significant' behaviours (Cooper, Heron, & Heward, 2020). ABA can involve the use of intervention techniques (e.g., modelling, prompting, reinforcement, shaping) and/or the combination of these in an intervention practice (e.g., Discrete Trial Training, Early Intensive Behavioural Intervention). ABA became a widely used intervention for children on the autism spectrum following the 1987 publication of a clinical trial that suggested positive developmental outcomes for children on the autism spectrum who received intensive ABA, compared to a control group (Lovaas, 1987). Although methodological limitations mean that the findings should be interpreted with caution, the publication of the study was followed by the development of a range of intervention practices that were based on behaviour theory. Behavioural techniques and practices may be used (a) in the delivery of ABA intervention (e.g., by people trained as Board Certified Behavior Analysts), and	



	(b) as part of other interventions, within and across intervention categories, and
	delivered by a range of professionals. To illustrate, behavioural principles have
	formed part of the evolution of a new category of intervention - Naturalistic
	Development Behavioural Interventions (NDBIs) – which is described below.
	These principles are also foundational to Positive Behaviour Support, which
	aims to address challenging behaviour through broadening an individual's skills
	and experiences, enhancing their environments, and improving quality of life
	(Carr et al., 2002). While the extent to which these different approaches reflect
	fundamentally different interventions has been debated (e.g., Johnston, Foxx,
	Jacobson, Green, & Mulick, 2006), at a practical level, behavioural principles
	and practices continue to be relevant to new and evolving interventions.
	Appendix B provides an illustration of the relevance of behavioural theory and
	practice across four intervention practices. Examples of intervention practices
	include Early Intensive Behavioural Intervention (Eikeseth, Smith, Jahr, &
	Eldevik, 2002), the Picture Exchange Communication System (Bondy & Frost,
	2001), and Positive Behaviour Support (Carr et al., 2002).
Principles	When behavioural interventions are used in the context of ABA, they reflect
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Developmental interventions

Theoretical premise	Developmental interventions draw primarily on cognitive (e.g., Piaget, 1951; Piaget & Inhelder, 1969) or social (e.g., Vygotsky, 1978) constructivist theories, which suggest that children construct knowledge and skills primarily through personal discovery. From a constructivist perspective, children acquire layers of knowledge, skills, and experience through their interactions with people and in everyday settings, and that this gradually improves their capacity to engage in increasingly complex tasks. Constructivist theories focus on children's acquisition of knowledge and skills over time and as part of typical stages of development (Piaget & Inhelder, 1969). This has led to the term 'developmental' being commonly used in the autism research literature to refer to interventions that have these elements at their core.
Clinical application	Developmental interventions focus on supporting children's learning through interactions with other people, particularly caregivers. These interventions target skills that are either delayed or not apparent in children on the autism spectrum, but that are assumed to be critical to learning. These skills include initiating interactions and sharing interest (e.g., use of gestures, joint attention), observing and then copying others' behaviour (e.g., imitation), and taking turns in play sequences as well as early conversations (Sandbank et al., 2020a). Developmental interventions are often described as being 'child-led', because they use children's intrinsic motivation to communicate, and 'naturalistic', because of the contexts in which they are delivered. Common techniques include modelling words and actions, imitating the child's actions to give them meaning, and using personal strategies (e.g., pausing, expectant looking) and environmental strategies (e.g., placing toys out of reach) to motivate communication. Caregivers are taught to use these techniques as part of everyday routines to increase the frequency, duration, synchrony, and reciprocity of interactions with their children (Sandbank et al., 2020a). Examples of developmental intervention practices include Developmental Individual- Difference Relationship-Based /Floortime; Hanen More than Words, and Paediatric Autism Communication Therapy.



Principles	 There is no set of universal principles that has been explicitly articulated for developmental interventions. However, specific intervention practices, such as Paediatric Autism Communication Therapy (Aldred et al., 2010), provide examples of principles that are often reflected in other developmental interventions. These principles include: The intervention is designed with a <i>developmental orientation</i>, such that intervention goals are organised in relation to a hierarchy of developmental learning stages. Intervention is delivered with a <i>focus on naturalistic interactions</i> involving caregivers and children. The intervention delivery, and are supported to build their own skills, independence and confidence in supporting their child(ren)'s learning.
Naturalistic developmental behavioural interventions (NDBIs)	
Theoretical premise	The intervention category of NDBIs was proposed in 2015 to describe several intervention practices that had recently emerged from the practical integration of behavioural and developmental theories (Schreibman et al. (2015). NDBI techniques are based on behavioural principles, but applied in a way that emphasises their delivery in the context of developmentally appropriate adult-child interactions, with a focus on learning in the context of play and routine activities (Schreibman et al., 2015). Skills are taught in a developmental sequence, with early skills (e.g., eye contact) considered pre-requisites for the development of more complex behaviours (e.g., joint attention).
Clinical application	NDBIs share similarities in terms of the nature of the learning targets, contexts, and strategies (Schreibman et al., 2015). First, in relation to the <i>nature of the</i> <i>learning targets</i> , skills in these interventions are taught across developmental domains (e.g., social, communication, motor, play), and with a focus on integration and generalisation across contexts and as part of daily activities, interactions, and routines with a variety of communication partners. There is a focus on helping children develop precursor knowledge and skills that lay the foundation for later development. For instance, intervention may focus on



	supporting a child who is not speaking to initiate joint attention with others, use
	destures, and imitate sounds, as a step towards the development of spoken
	language Second in terms of the <i>nature of the learning contexts</i> interventions
	are delivered in contexts that promote social engagement in particular dvadic
	caregiver-child interactions. Finally, with respect to the <i>nature</i> of the
	development ophancing strategies interventions bring together a range of
	behavioural strategies (o.g. medelling, chaping, differential reinforcement) as
	pert of intrinsically mativating routings that by id in complexity ever time and as
	part of intrinsically motivating routines that build in complexity over time and as
	part of daily routines and play. Examples of intervention practices include the
	Early Start Denver Model (Dawson et al., 2010), Pivotal Response Treatment
	(Koegel, Koegel, Harrower, & Carter, 1999), and Joint Attention, Symbolic Play,
	Engagement, and Regulation (Kasari, Gulsrud, Paparella, Hellemann, & Berry,
	2015).
Principles	Schreibman et al. (2015) described 13 features that are common to the
	intervention approaches classified as NDBIs:
	• Teaching incorporates the <i>three-part contingency</i> of antecedent, behaviour,
	consequence.
	• The use of a manual to guide implementation.
	• <i>Fidelity checks</i> to ensure the intervention is implemented accurately.
	Individualised intervention goals.
	Ongoing <i>measurement</i> of progress.
	Child-initiated teaching episodes.
	• Arranging the environment to promote children's interaction and learning.
	• A focus on <i>intrinsic reinforcement and natural contingencies</i> , over external
	reinforcement.
	• Use of prompting and prompt fading to teach skills leading to children's
	independent use.
	Helping children to learn to <i>take turns</i> in social and play routines.
	Adults modelling the skills children are being supported to learn.
	Adults imitating children's actions and attempts to communicate to motivate
	further communication attempts.
	 Systematic attempts to broaden children's repertoires of skills and interests
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Sensory-based interventions

Theoretical premise	Sensory-based interventions are based on the theoretical premise that sensory functions are a fundamental building block of all developmental skills, and that differences in how children on the autism spectrum process sensory information may produce cascading effects on skill acquisition and behavioural development across a range of domains, including core autism characteristics (Baranek, 2002; Sandbank et al., 2020a; Watling & Hauer, 2015). Based on this premise, sensory-based interventions are proposed to change how children on the autism spectrum process sensory stimuli on a temporary or permanent basis, with the aim of creating downstream therapeutic effects on skill acquisition and aspects of behaviour, such as attention and self-regulation (Watling & Hauer, 2015).
Clinical application	The clinical application of sensory-based interventions typically involves an assessment of the child's sensory functioning. In the case of intervention practices such as Ayres Sensory Integration Therapy, the information acquired from the assessment is then used to develop an individually-tailored intervention program of sensory-rich experiences that is hypothesized to promote the better future integration of sensory information and/or to support sensory processing on a permanent basis. By supporting the development of foundational sensory processing abilities, sensory integration therapies aim to facilitate greater and broader engagement of the individual with day-to-day activities (Baranek, 2002). Ayres Sensory Integration Therapy is typically conducted in a clinic-based setting with specialised equipment such as suspended equipment and scooter boards (Parham et al. 2007). Other interventions that are aimed at supporting sensory processing in a particular context are implemented in the child's natural environment, such as home, school or community settings (Watling & Hauer, 2015). A number of authors (e.g., Schoen et al., 2019; Watling & Hauer, 2015) distinguish between Ayres Sensory Integration Therapy and a broader group of sensory-based intervention techniques and practices that involve administering specific sensory stimuli, often targeting one modality. Examples of these latter techniques and practices include auditory integration-based approaches, music



	therapy, weighted blankets, swinging, brushing, deep pressure, massage, joint compression, vestibular stimulation (Baranek, 2002; Sandbank et al., 2020a). These techniques and practices may be combined into a 'sensory diet' delivered in specific activities or across the day by clinical practitioners, educators, and/or caregiver under supervision (Sandbank et al., 2020a; Watling & Hauer, 2015).
Principles	 There is no universal set of principles relating to sensory-based interventions for children on the autism spectrum. Parham et al. (2007) identified ten core elements that should be included in sensory integration therapies, such as Ayres Sensory Integration Therapy. The elements are: Providing sensory opportunities, such as tactile and proprioceptive experiences. Challenging children's sensory systems, but at a level that is 'just right' for each child. Collaborating on activity choice, including incorporating children's interests. Helping children learn to self-organise their play and behaviour. Supporting optimal arousal, such as by modifying the environment to support attention, engagement, and comfort. Using play as the context for learning. Maximizing children's physical safety. Arranging the room so that children are encouraged to interact and learn. Fostering therapeutic alliance with the child, such as through conveying positive regard.
Technology-based interventions	
Theoretical premise	Technology-based interventions predominantly use computer technology as the primary medium of intervention delivery. The theoretical underpinnings differ across practices, but generally centre on the premise that children on the autism spectrum may have an affinity with technology due to behavioural characteristics that are often observed in this population (Grynszpan, Weiss,




		technology may reduce the social demands of an intervention, complement a special interest a child may have in computers, and/or provide consistency in instruction that aligns with a child's preference for routine and sameness. These differences in intervention delivery may make learning through this modality equally, or even more, effective than via solely human interaction (Grynszpan et al., 2014; Sandbank et al., 2020a).
Clini	ical lication	Kientz, Goodwin, Hayes, and Abowd (2013) proposed eight categories of technology-based interventions: (a) personal computers and the internet; (b) video and multimedia; (c) mobile technologies; (d) shared active surfaces; (e) virtual reality and augmented reality; (f) sensor based and wearables; (g) robotics; and (h) natural user interfaces. These technologies may be used by children independently (e.g., to complete online social skills training), to support daily activities (e.g., using video modelling as one of several practices aimed at teaching dressing skills), or as an alternative modality for interacting with people (e.g., avatar based interaction in online environments). Examples of technology-based intervention practices include speech-generating devices, serious games, and computer-assisted instruction. The development of interventions in this category has occurred broadly in parallel with the emergence of these technologies as well as bespoke applications (Kientz et al., 2013). For the purpose of this review, augmentative and alternative communication interventions include both low-tech (e.g., picture boards) and high-tech (tablet-based communication apps) systems that are external to the person's body, which aligns with the classification as technology-based intervention. However, we note that augmentative and alternative communication also includes unaided gesture and sign language, which do not align well with this category classification.
Prin	ciples	There is no universal set of principles relating to technology-based interventions for children on the autism spectrum. However, where core principles have been articulated – such as with the use of augmentative and alternative communication interventions (Light & McNaughton, 2015) – key aspects have



	 been highlighted relating to the interaction of the technology, the individual and their environment. These principles include: The importance of an <i>individual's strengths</i> serving as the foundation for the intervention practice. Ensuring a <i>supportive alignment between the technology and the broader environment</i> around the child, including other aspects of an intervention program. Providing opportunities for learned skills to be <i>applied in real world contexts</i>.
Animal-assist	ed interventions
Theoretical premise	Animal-assisted interventions involve interactions with animals as the primary means for supporting skill development. These interventions are based on the premise that human-animal interactions may be motivating for children on the autism spectrum, and provide a calming and non-judgemental environment within which social abilities and general wellbeing may improve (Hill, Ziviani, Driscoll, & Cawdell-Smith, 2019; O'Haire, 2013; Sandbank et al., 2020a). While physiological benefits have also been proposed for certain animal-assisted interventions (Sandbank et al., 2020a; Trzmiel, Purandare, Michalak, Zasadzka, & Pawlaczyk, 2019), the primary focus has typically been on the promotion of psychosocial health and wellbeing.
Clinical application	The most prominent use of animal-assisted interventions for children on the autism spectrum has been through the use of assistance dogs (also called, canine assisted therapy), therapeutic horse riding (also called, equine-assisted therapy), and dolphin therapy (O'Haire, 2013). In some cases, intervention is delivered via the animal (e.g., therapeutic horse riding), whereas in other applications, animals form part of enrichment activities or education programs. Animal-assisted interventions are described using a variety of terminology and there is little standardisation in relation to intervention characteristics including the person delivering the intervention (e.g., therapist, animal handler) and consistency of procedures (O'Haire, 2017).



Principles

Because of the wide variety of uses of animal-assisted intervention, there is no universal set of principles that are shared across all practices. In Australia, the Delta Institute which acts as an accrediting body for dog trainers, has published Best Practice Guidelines (Delta Institute, 2016) that outline member expectations including, but not limited to:

- Appropriate training qualifications relating to the use of animals in therapy.
- Provision of appropriate and ethical services.
- The need for continuing professional development.

Cognitive behaviour therapy (CBT)

Theoretical premise

CBT is an intervention that is typically used to treat anxiety disorders and depression. The central premise of CBT is the interdependent relationships between how an individual thinks (cognition), acts (behaviour) and feels (emotion), and that unhelpful thoughts and thinking styles and their associated behaviours can perpetuate negative emotions. CBT intervention supports people to identify unhelpful thoughts about distressing stimuli, and develop alternative ways of thinking about and responding to these (Lang, Regester, Lauderdale, Ashbaugh, & Haring, 2010; Rachman, 2015). The application of CBT to children on the autism spectrum is based on findings that anxiety disorders and depression are commonly observed in this population. The use of CBT may lead to broad improvements in mood disturbances, and improve broader autism characteristics that may be subserved by these, such as a reduction in unhelpful routines or behaviours of concern, and an increase in social behaviours.

Clinical application

CBT may involve a variety of intervention components, but when used with children and adults on the autism spectrum, the intervention typically includes: (a) explaining the cause of anxiety, (b) discussing the impact of anxiety on daily life, (c) identifying situations that induce anxiety and ordering these, (d) gradually exposing the person to the situations from least to most confronting while managing anxiety as it arises, and (e) teaching the individual additional coping strategies such as relaxation.



Principles	There is no universal set of principles for CBT as it applies to children on the autism spectrum. In the broader context of childhood anxiety disorders, five	
	essential components of CBT have been highlighted (Gosch, Flannery-	
	Schroeder, Mauro, & Compton, 2006):	
	Assessment as the basis for case conceptualisation, treatment planning and monitoring change	
	Developed usertion to help shild up undeveloped the network of any job and here	
	Psychoeducation to help children understand the nature of anxiety and now treatment works.	
	• The development of <i>coping skills</i> related to (a) identifying and differentiating	
	feelings, (b) identifying and managing tension through relaxation exercises,	
	(c) identifying and challenging their own thoughts, and (d) problem solving in	
	a systematic manner.	
	• The use of <i>exposure tasks</i> to gradually desensitise the child to the	
	situation/s causing anxiety and build confidence for coping with these.	
	Contingency management involving the systematic use of extrinsic and	
	intrinsic reinforcement to support behaviour change.	
Treatment and Education of Autistic and related Communication-handicapped Children (TEACCH)		
Theoretical	TEACCH is a program based on structured teaching, which places an emphasis	
premise	on adapting tasks and environments to support a child's independence,	
	learning and participation. It has been used predominantly in classrooms but	
	may also be used in home or community settings. TEACCH is based on a	
	proposed profile of the strengths, preferences, and needs of children on the	
	autism spectrum, including a desire for routine, relative strength in processing	

	may also be used in home or community settings. TEACCH is based on a
	proposed profile of the strengths, preferences, and needs of children on the
	autism spectrum, including a desire for routine, relative strength in processing
	visual information, heightened attention to detail, and strong sensory
	preferences and aversions. Collectively, TEACCH describes this profile as the
	'culture of autism' (Mesibov & Shea, 2010), and seeks to adapt the learning
	environment to enhance learning opportunities.
Clinical	The TEACCH program was developed in North Carolina (USA) and involves
application	both a clinical service and professional training program (Mesibov & Shea,
	2010). Classrooms are organised to create structure and predictability through



Other little verticions

This category comprises interventions that do not demonstrate clear alignment with all three features (theoretical premise, clinical application, and principles) of one of the other eight categories described above.



Clinical training and the delivery of interventions described in the report

Children on the autism spectrum often have needs across multiple domains of learning, and physical and mental health. Accordingly, children and families may benefit from the expertise of a range of clinical practitioners spanning health, education and medical disciplines. For the purpose of this report, the term 'clinical practitioners' is used to refer to people who provide services in non-education roles, but may also include those with education qualifications. As per all areas of clinical practice, it is essential that clinical practitioners have acquired appropriate qualifications, are regulated (e.g., by a professional or government body), and deliver interventions that are within their scope of practice. In this section, we summarise the training pathways for clinical practitioners in Australia, and how these relate to the interventions that can be ethically delivered in the context of professional competencies and scope of practice. The information is intended to provide a broad overview of the typical training pathways in Australia. More detailed information can be obtained from the organisations that provide direct governance of these clinical qualifications and intervention practices, as described below.

The information presented will focus on clinical practitioners, and specifically those who have responsibility for all aspects of client management including assessment, intervention planning and delivery, and outcome measurement and reporting. While examples are provided in relation to four disciplines for illustrative purposes – ABA, occupational therapy, psychology, speech pathology – clinical practitioners from many disciplines are involved in the delivery of interventions to children on the autism spectrum, such as physiotherapy, social work, nursing and medicine as well as those with educational qualifications. While it is acknowledged that other people may work under the supervision of the clinical practitioners described below (e.g., allied health assistants), an overview of their roles and responsibilities is beyond the scope of this review.

Professional qualifications

Preparation to deliver interventions begins with attaining a set of competencies in a relevant discipline. In Australia, this is most commonly acquired through a tertiary undergraduate or postgraduate qualification in an allied health or related degree, such as psychology, occupational therapy, speech pathology, or ABA. These qualifications typically require the completion of theoretical and practical units related to the scope of practice of the particular discipline. The content of the degrees leading to the tertiary qualifications is regulated by the national or international professional bodies relevant to those disciplines.



The completion of a tertiary qualification is followed by professional registration, which differs between disciplines. For example, occupational therapy and psychology require formal registration through their national professional bodies and the Australian Health Practitioner Regulation Agency (AHPRA), while others that are not part of AHPRA (e.g., speech pathology) recommend but do not mandate registration with the professional body. Maintaining registration with professional bodies requires adherence to professional and ethical standards, which includes demonstrated engagement in continuing professional education. Professional practice is further regulated through commissions at both the State (e.g., Health Services Commissioners) and Federal (NDIS Quality and Safeguards Commission) levels that are able to receive complaints.

The one exception to national registration is behaviour practitioners, who are currently accredited internationally, predominantly by the Behavior Analyst Certification Board based in the United States of America. Certification is offered at the following levels, which differ based on degree and clinical practicum requirements: Registered Behavior Technician (RBT), Board Certified Assistant Behavior Analyst (BCBA), Board Certified Behavior Analyst (BCBA), and Board Certified Behavior Analyst – Doctoral² (BCBA-D). Practitioners must adhere to professional and ethical standards, engage in continuing professional education, and renew their Board membership on an annual basis, as per other disciplines in Australia. Behavioural practitioners who practice within Australia are also regulated through commissions at both the State (e.g., Health Services Commissioners) and Federal (NDIS Quality and Safeguards Commission) levels that are able to receive complaints. The Behavior Analyst Certification Board has announced plans to cease practitioner registrations outside of the United States of America and Canada from 1st January 2023 (Behavior Analyst Certification Board, 2020). The peak Australian professional body, the Association for Behaviour Analysis Australia, has published an intention to explore a national registration process for behavioural practitioners within Australia (Association for Behaviour Analysis Australia, 2020).

Table 5 provides examples of the professional training, regulation, competencies, and scope of practice for certain disciplines. Similar details for other professions, such as physiotherapy, social work, nursing, and medicine can be obtained from AHPRA or the relevant professional college or society. This table is for illustrative purposes only, and does not present information for all clinical practitioners or educators who are relevant to working with children on the autism spectrum.

² American spelling of behaviour is retained given these are trade-marked titles.



Table 5. Examples of clinical practitioners relevant to the delivery of interventions for children on the autism spectrum, including their tertiary education qualification, professional regulation, competencies, and scope of practice within Australia.

Psychologist				
Qualification	Bachelors/Masters degree			
Professional Association	Australian Psychological Society			
Regulated by AHPRA	Yes			
Accountable to complaints organisations	Yes			
Professional competencies	Professional competencies and scopes of practice depend on the type of registration and/or specialist practice endorsement. Further information can be obtained by the Psychology Board of Australia.			
Scope of practice				
Speech pathologist				
Qualification	Bachelors/Masters degree			
Professional Association	Speech Pathology Australia			
Regulated by AHPRA	No			

Regulated by AHPRA	No
Accountable to complaints organisations	Yes
Professional competencies	Speech Pathology Australia (2020). Professional Standards for Speech Pathologists in Australia. Melbourne: Speech Pathology Australia Ltd.
Scope of practice	



Occupational therapist

Qualification	Bachelors/Masters degree
Professional Association	Occupational Therapy Australia
Regulated by AHPRA	Yes
Accountable to complaints organisations	Yes
Professional competencies	Occupational Therapy Australia (2018a). Australian occupational therapy competency standards. Melbourne, Australia: Occupational Therapy Australia.
Scope of practice	Occupational Therapy Australia. (2018b). Occupational Therapy Scope of Practice Framework. Melbourne, Australia: Occupational Therapy Australia.

Board certified behavior analyst

Qualification	Masters degree
Professional Association	Behavior Analyst Certification Board
Regulated by AHPRA	Νο
Accountable to complaints organisations	Yes
Professional competencies	Behavior Analyst Certification Board (2014). Professional and Ethical Compliance Code for Behavior Analysts (updated 2019). CO, USA: Behavior Analyst Certification Board.
Scope of practice	Behavior Analyst Certification Board (2017). BCBA/BCaBA task list (5th ed.). CO, USA: Behavior Analyst Certification Board.



Delivering interventions within scope of practice

Fundamental to ethical practice is the delivery of interventions that are within a clinical practitioner's competency set and scope of practice. The main pathways through which these competencies are achieved, and the scope of practice defined for any given clinical practitioner, are described below, and in Figure 1:

- The first pathway relates to intervention techniques and practices that can only be ethically delivered with competencies that are specific to a particular discipline. Examples of interventions directly aligned to discipline-specific competencies include psychologists and the use of cognitive behaviour therapy, speech pathologists and the delivery of speech and language interventions, occupational therapists and strategies to support the development of fine-motor skills (e.g., handwriting), and Board Certified Behavior Analysts and the provision of ABA.
- 2. The second pathway relates to intervention techniques and practices that can be ethically delivered by a range of professionals within their scope of practice, without requiring any formal training beyond that required for professional registration. The method for delivering these techniques and practices may be described in journal articles, books, online training modules, and intervention manuals. Clinical practitioners will often learn to use these practices either during their tertiary education qualification or in the workforce through self-directed study and other professional development activities, such as attending workshops. There is no formal accreditation required to use these techniques and practices, and they can include approaches that are broadly relevant to supporting children's development in general (e.g., emergent literacy instruction) as well as to children with a range of neurodevelopmental conditions. Examples of techniques and practices that are not specific to a particular discipline and do not require any further formal training, include naturalistic teaching strategies, reinforcement, incidental teaching, social stories, and video modelling.
- 3. The third pathway relates to intervention techniques and practices that can be ethically delivered by a range of professionals within their scope of practice, but require additional training and assessment of competencies. Successful completion of the training will lead to accreditation to deliver the intervention within clinical practice. Training may take a variety of forms, but typically involves attendance at one or more workshops along with the completion of guided study materials. Assessment may involve one or both of a written or practical assessment to test knowledge of the intervention and fidelity to the practices and techniques. Examples of intervention practices that require additional competency accreditation includes, the Picture Exchange Communication System, the Early Start Denver Model, Hanen More Than Words, and Joint Attention, Symbolic Play, Engagement, and Regulation.



Figure 1. Professional training pathways typically required to deliver interventions for children on the autism spectrum in Australia.



AutismCRC

Delivering interventions in isolation and in combination

Children on the autism spectrum can vary considerably in terms of the functional impact of the core autism characteristics and other behaviours on their learning and participation in everyday activities. Some children require support in only one or a small number of activities, while others may require support across the majority of daily activities to be safe, to learn, and participate alongside their peers. In either case, clinical practitioners may deliver a single intervention practice, combine a small number of specific practices from the same intervention category, or select a broader range of techniques and practices across intervention categories. This latter, *technical eclectic* approach, involves the systematic selection of a range of intervention techniques or practices known to be evidence based, to build a comprehensive intervention program that is tailored to the needs of the child and their family (Odom, Hume, Boyd, & Stabel, 2012). For example, an eclectic program may include components that focus on the development of communication, the management of challenging behaviour and the understanding of emotions (Roberts and Williams, 2016). Depending on competencies and scope of practice, these interventions may be delivered by one professional, but are often delivered by a team of professionals spanning different disciplines.

In illustrating different ways in which interventions may be selected, combined, and delivered, it is important to emphasise that there is substantial overlap in intervention techniques, practices, and categories for children on the autism spectrum. This overlap will likely increase over time as the most effective intervention elements are identified and combined in evolving ways. Therefore, the identification of attributes for one intervention must not be inferred to mean that it is exclusive to that practice, but instead illustrative of key premises and principles.

Summary

This chapter provided background information to support the umbrella review presented in Chapter 3, which summarises the evidence base for interventions for children on the autism spectrum. A large number of interventions are available for children on the autism spectrum. There are a variety of terms used to describe interventions, various ways to define the elements that make up an intervention, and both distinct and shared theoretical premises underpinning different interventions. This complexity creates significant challenges in summarising the rapidly expanding evidence base in ways that are useful for individuals on the autism spectrum, family members, clinical practitioners, and policy makers. As a first step to achieving this aim, this chapter described a system for categorising the interventions for children on the autism spectrum, which is a key foundation of the umbrella review. This chapter also described the clinical competencies that are typically required in the Australian context to deliver the interventions included in the report. The description of the training pathways is intended to be a broad overview only, with more specific information available from the organisations that provide direct governance of the clinical competencies and intervention practices.



Chapter 3: A review of evidence for interventions for children on the autism spectrum

Abstract

There are numerous interventions that aim to support the early development of children on the autism spectrum. It is critical that decisions regarding the choice and use of interventions are informed by the best available research evidence. The aim of this umbrella review was to provide a synthesis of evidence, drawn from systematic reviews, regarding the effects of non-pharmacological interventions for children on the autism spectrum on a range of child and family outcomes. The umbrella review was conducted according to internationally recognised standards for the reporting of systematic reviews. We searched ten academic databases, as well as other sources (e.g., Google, conference abstracts, trial registry), to identify eligible systematic reviews. The umbrella review included data from systematic reviews with children on the autism spectrum up to 18 years of age, with a focus on those delivering interventions to children aged 0-12 years. Only systematic reviews that included at least one study with a controlled group design (i.e., randomised controlled trial, controlled clinical trial) were included. Data extraction from the systematic reviews was crosschecked by two reviewers, and quality ratings were conducted independently by two reviewers. A systematic and reproducible process was conducted to combine findings across systematic reviews and generate the overall summarised findings for this report. To synthesise the evidence, interventions were classified according to the following categories: (1) behavioural interventions; (2) developmental interventions; (3) naturalistic developmental behavioural interventions (NDBIs); (4) sensory-based interventions; (5) technology-based interventions; (6) animal-assisted interventions; (7) cognitive behaviour therapy (CBT); (8) Treatment and Education of Autistic and related Communication-handicapped Children (TEACCH); and (9) other interventions that did not fit within these categories.

A total of 58 systematic reviews (including narrative syntheses and meta-analyses), based on 1,787 unique studies, were included in the umbrella review. The systematic reviews were of variable quality, and only 4 of the 58 systematic reviews met all indicators of high methodological quality. Across the different categories of intervention, there was evidence for positive effects for behavioural interventions, developmental interventions, NDBIs, technology-based interventions, and CBT on a range of child and family outcomes. Within each of these categories, evidence at the individual practice-level was variable for child and family outcomes. Positive intervention effects for sensory-based interventions were reported for certain intervention practices only, and in those



cases, positive effects were limited to select child and family outcomes. A mix of inconsistent and null intervention effects on child and family outcomes were reported for both TEACCH and animalassisted interventions. Among 'other' intervention practices, only social skills training had evidence for a positive effect on child outcomes. Adverse effects were rarely considered in the systematic reviews, and so it was not possible to provide a comprehensive analysis of this information.

There was no consistent evidence as to whether the amount of intervention influenced child and family outcomes. Caregiver involvement in intervention was reported to have a similar, and at times greater, effect on child outcomes compared to interventions delivered by clinical practitioners alone. There was evidence that both parent/caregiver-mediated and peer-mediated interventions had a positive effect on a range of child and family outcomes. Very few studies directly compared the effect of interventions delivered in different settings (e.g., clinic, school, home), in different formats (individual, group), or via different modes (e.g., face-to-face, telepractice). As such, no conclusions could be drawn on intervention delivery characteristics that may maximise intervention effects. Similarly, minimal information was reported on the influence of child characteristics (e.g., age, autism characteristics, communication skills) on the effects of interventions.

The findings of the current review provide a summary of the best available evidence of the effects of a range of interventions across various child and family outcomes. The findings can also inform clinical and policy decision making regarding the most appropriate clinical supports for children on the autism spectrum and their families. The implications of the findings of the current review for future research and clinical practice are discussed.



Introduction

There are many interventions available for children on the autism spectrum. Like all aspects of clinical practice, it is critical that decisions regarding the choice and use of interventions are based on the best available research evidence, and considered within a broader evidence-based practice framework. Chapter 1 provided an overview of the different levels of research evidence, and how these may be used to inform intervention choice. Chapter 2 described the theory and principles underpinning the large range of interventions for children on the autism spectrum, as well as the clinical training pathways that typically support the use of these interventions within Australian clinical practice. This chapter presents a comprehensive review of the research evidence generated by systematic reviews (SRs) for the effects of interventions for children on the autism spectrum on a range of child and family outcomes. The objective was to generate a synthesis of evidence that can inform the use of the interventions at the individual, family, clinical, and policy levels in Australia and internationally.

The research questions that formed the basis for this umbrella review were:

- Question 1: What non-pharmacological interventions have been examined in SRs?
- Question 2: What effects do non-pharmacological interventions have on child outcomes?
- Question 3: What effects do non-pharmacological interventions have on family wellbeing?
- *Question 4:* What are the optimal delivery characteristics of non-pharmacological interventions, with a focus on the amount of intervention, setting, format, agent, and mode?
- *Question 5:* What child characteristics influence intervention effects, with a focus on child age, core autism characteristics, cognition, and communication skills?

Question 1 sought to identify the broad range of intervention practices for children on the autism spectrum that have been examined within the SR literature. The review focused on practices that could be classified within nine intervention categories described in a recent systematic review by Sandbank et al. (2020a). The rationale for adopting these categories, along with other critical background information, is provided in Chapter 2, and is intended to be read as background knowledge to this chapter.

Questions 2 and 3 were focused on understanding the research evidence for the effect of interventions for children on the autism spectrum on child and family outcomes. Many different child and family outcomes have been measured within the autism intervention literature, and so to provide a defined scope of the review, it was necessary to pre-specify outcomes of interest. The full list of the child and family outcomes of interest are provided in Appendix C, and relate to children's core autism characteristics, a range of related child skills and behaviours, their education and



participation, and broader measures of family wellbeing. Questions 2 and 3 also encompassed examination of any adverse effects of interventions. All interventions have potential negative impacts, either in the form of specific adverse effects, or potential costs of accessing one intervention and not another intervention that has a greater effect. The identification of any potential negative impacts of an intervention, and the evaluation of these alongside any potential benefits, is an essential element of the research evidence base underpinning any intervention.

Questions 4 and 5 examined whether there were intervention delivery characteristics or child characteristics that may influence the effects of interventions on child and family outcomes. No two children on the autism spectrum respond to intervention in the same way, and there is currently little research evidence to predict which children may benefit the most from which intervention practice. Further variability exists in the clinical application of intervention practices, such as the amount of intervention received (total intervention hours), setting (clinic, home, school), delivery format (individual, group), intervention agent (clinician, caregiver, peer, educator), and delivery mode (face-to-face, telepractice). A key research goal that has been repeatedly identified as a community research priority (Australian Autism Research Council, 2019; Autistica, 2016; Frazier et al., 2018) is to determine how best to tailor the range of intervention approaches available to a particular child and their environment; in essence: which interventions have a positive effect on which outcomes, and for which children? The current review specifically examined this question by seeking to understand whether there were optimal delivery characteristics for any given intervention, and whether there were child characteristics (e.g., age, core autism characteristics, cognition, communication skills) that may impact the effects of interventions on child and family outcomes.

The choice of methodology to address the study aim, an umbrella review, was a pragmatic decision based on the current state of autism intervention research. There has been a significant increase in the quantity and quality of intervention research published since 2010 (French & Kennedy, 2018), and this has led to an associated increase in the number of SRs available within the scholarly literature. The purpose of a SR is to provide a synthesis of original research study findings, which may take the form of a narrative synthesis (descriptive) or include a meta-analysis of quantitative data from the original studies (Aromataris & Munn, 2020). An umbrella review provides a transparent and reproducible way to combine and synthesise findings from these SRs, including accounting for the substantial variability in aims and methodologies that is often observed in SRs. Umbrella reviews are particularly suited to providing summary outcomes in a broad field of enquiry, such as interventions for children on the autism spectrum, and can provide a critical role in supporting the development of policy and practice recommendations (Aromataris et al., 2015).



A key element of the current umbrella review was to collate the highest quality of evidence available. The randomised controlled trial (RCT) design is the highest level of evidence in the NHMRC Evidence Hierarchy for individual studies (National Health and Medical Research Council, 2009) (see Chapter 1). Preliminary searches of the literature identified few SRs that included randomised controlled trials only. In order to identify the best evidence available within the existing research literature, it was necessary to broaden the focus of this umbrella review to SRs that included at least one study using a controlled-group design. While this protocol reduces the strength of conclusions that can be made, it ensures the review provides a more comprehensive summary of the available evidence.

The parameters of the umbrella review, including the interventions and outcomes of interest, were defined by the National Disability Insurance Agency, which commissioned this report. The findings of this review relate solely to the information considered within this scope, and the report provides no comment on those interventions or outcomes not included within the scope of the review.

Methods

The umbrella review was conducted according to the procedures outlined in the Joanna Briggs Institute manual for evidence synthesis (Aromataris et al., 2020) and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (Moher, Liberati, Tetzlaff, Altman, & Group, 2009). The protocol for the umbrella review is provided as Appendix D. The protocol was submitted to PROSPERO on June 12th 2020 and published on Open Science Framework on July 8th 2020 (https://osf.io/54vg8/). Minor variations to the protocol made during the process of completing the review are documented in Appendix E. The modified version is presented below.

Eligibility

SRs were eligible for inclusion in the umbrella review if they met all of the following inclusion criteria:

- The review was a SR, with or without meta-analysis. A review was considered "systematic" if it:

 included a clear statement of the purpose of the review;
 described the search strategy
 e.g., key search terms, multiple relevant databases, specification of search limits);
 indicated the criteria used to select studies for inclusion;
 presented all findings relevant to the main purpose of the SR, including those that did not favour the intervention; and
 used a method of quality appraisal for each included study.
- The SR included children on the autism spectrum. SRs that included children described as increased likelihood or suspected of autism were included if the SR also included children on the autism spectrum. SRs that included children on the autism spectrum and individuals with



other developmental conditions were included if outcomes were reported separately for children on the autism spectrum.

- The SR included children aged between 0 and 12 years. SRs that encompassed older individuals were included if outcomes were reported separately for children 18 years of age or younger.
- The SR reported on at least one non-pharmacological intervention that targeted the acquisition of developmental or educational skills.
- The SR included at least one RCT, quasi-RCT, and/or controlled clinical trial. SRs that included studies with other designs were included only if they also featured at least one RCT, quasi-RCT, and/or controlled clinical trial.
- There was no limit placed on comparison/control group.
- The SR reported summarised, quantitative data on the impact of the intervention on one or more of the umbrella review's main outcomes of interest. These outcomes were:
 - Core autism characteristics. Specifically, overall autism characteristics, socialcommunication, restricted and repetitive interests and behaviours, and sensory behaviours.
 - Related skills and development. Specifically, communication, expressive language, receptive language, cognition, motor, social-emotional and challenging behaviour, play, adaptive behaviour and general outcomes.
 - Education and participation. Specifically, school/learning readiness, academic skills, quality of life, and community participation.
 - Family wellbeing: Specifically, caregiver communication and interaction strategies, caregiver social emotional wellbeing, caregiver satisfaction, caregiver financial wellbeing, and child satisfaction.
 - Adverse effects.
- The SR was published in a peer-reviewed journal or as a publicly available scientific report.
- The SR had full-text copies available in the English language.

SRs were excluded if they met any of the following exclusion criteria:

- The review did not meet the criteria to be considered "systematic".
- It was an umbrella review, rapid review, or "review of reviews".
- SRs that report on interventions with children with developmental conditions other than autism, or where outcomes for children on the autism spectrum cannot be extracted; and those that only included children described as increased likelihood or suspected of autism.



- The SR did not include children under 12 and/or included individuals over the age of 18 without separate analysis.
- The SR did not include at least one RCT, quasi-RCT, and/or controlled clinical trial.
- The SR did not report on at least one non-pharmacological intervention that targeted the acquisition of developmental or educational skills.
- The SR focussed solely on dietary, sleep, exercise, chiropractic, massage, acupuncture, reflexology, kinesiology, shock therapy, neurofeedback, transcranial magnetic stimulation, or hyperbaric oxygen therapy interventions. While non-pharmacological, these interventions were beyond the scope of the umbrella review.
- The SR focused solely on techniques (defined as one specific strategy) rather than an intervention (i.e., a collection of techniques).
- The SR did not report summarised outcomes of interest relevant to the current umbrella review.
- The SR incorporated theoretical studies, text, and opinion as their primary source of evidence.
- The SR was limited by geographical region, that is, the search and/or inclusion/exclusion criteria were limited to specific countries, continents, or other geographical areas.
- The SR was a thesis, conference paper, newsletter, or protocol.
- The full-text was not available, or not available in English.

Key areas of focus

The inclusion/exclusion criteria reflect three pre-defined areas of focus for the current umbrella review.

First, the umbrella review maintained a focus on the intervention categories described by Sandbank et al. (2020a), and practices that fell within those defined categories. The specific categories were behavioural interventions, developmental interventions, naturalistic developmental behavioural interventions (NDBIs), sensory-based interventions, Treatment and Education of Autistic and related Communication-Handicapped Children (TEACCH), technology-based interventions, animal-assisted interventions, and cognitive behaviour therapy. Practices and categories that did not clearly align with those described by Sandbank et al. (2020a), but met criteria for inclusion in the umbrella review, were described as 'other' interventions. Please refer to Chapter 2 for further information.

Second, the umbrella review only examined child and family outcomes defined in the protocol and identified as per the operational definitions specified in Appendix C. Any outcome reported in a SR that did not correspond to one of these predetermined outcomes of interest was not reported in the umbrella review. The term used to describe outcomes occasionally differed across SRs (e.g.,



communication, language). In such cases, both the original term, and the categorisation used in this umbrella review, were reported.

Third, the umbrella review examined only the following predetermined intervention characteristics that may influence intervention effects: (a) the setting/context, (b) the delivery format, (c) the delivery agent, (e) the delivery mode, and (f) the amount of intervention. Further, the umbrella review only examined the following predetermined child characteristics that may influence intervention effects: (a) age; (b) core autism characteristics (overall autism characteristics; social-communication; restricted and repetitive behaviours and interests; and sensory behaviours); (c) related skills and development (communication, expressive language, receptive language, cognition, motor skills, social-emotional and challenging behaviour, play, adaptive behaviour, and general outcomes); and (d) comorbidities. The influence of other child/intervention characteristics on intervention effects, reported by SR authors, were not reported in this review.

Literature search strategy

A literature search was conducted on June 15th 2020 and updated on July 15th 2020 using the following databases: PsycINFO, Education Resources Information Centre (ERIC), Medline, PubMed, EMBASE, CINAHL, Cochrane Database of Systematic Reviewss, Scopus, EBSCO Education Source, and Epistemonikos. The search terms were: (Autis* OR ASD* OR Asperger* OR pervasive developmental disorder* OR PDD* OR pervasive child development disorder* OR pervasive childhood developmental disorder* OR PCDD* OR disintegrative disorder*) AND (intervention* OR therap* OR treat* OR teach* OR program* OR package*) AND (systematic review* OR systematic literature review* OR evidence synthes* OR meta-analy* OR meta-regression*). The search was limited to the year 2010 to present, as the vast majority of RCTs in this research area have been published post 2010 (French & Kennedy, 2018).

To collect 'grey literature' (i.e., SRs published as reports, or relevant SRs not yet published in peer reviewed journals) as recommended by the JBI manual (Aromataris et al., 2020) and PRISMA statement (Moher et al., 2009), additional searches were conducted using Google and PROSPERO, and of abstracts in the meeting archives (2015-2020) of the International Society for Autism Research) (INSAR, 2020). Corresponding full-text publications were accessed directly from the source (where available) or identified using Google. The search strategy for grey literature is provided as Appendix F.

Finally, ancestral searches were conducted using the reference lists of all included SRs and relevant umbrella reviews or 'reviews of reviews' identified by the database search.



Study selection

All studies retrieved from the database searches were imported into the Covidence software platform (Veritas Health Innovation, 2020). Duplicates identified by the software were removed prior to screening. Two reviewers (KV, HW) independently screened the titles and abstracts of the studies against the umbrella review inclusion/exclusion criteria. Articles were excluded if they met one or more exclusion criteria.

A systematic process was required to determine eligibility for inclusion in cases where it was not clear to the reviewers if the intervention would fall within the scope of the categories outlined by Sandbank et al. (2020a). Accordingly, immediately after independent title and abstract screening, a document (Appendix G) was created in which the reviewers could list interventions requiring a determination of eligibility, including a verbatim description of the intervention from the relevant SR. Four team members (DT, KV, HW, AW) independently determined whether the specific intervention should be included in the umbrella review based on the eligibility criteria. The same four team members then met to discuss each question of eligibility and resolved these via consensus.

Following this process, the two reviewers (KV, HW) independently screened the full-text reports of all potentially relevant articles. Where the design/s of included studies were not clearly specified, reviewers examined the SR reference list to determine if at least one study with an RCT, quasi-RCT, or controlled cohort design was included.

Following both independent title/abstract screening and independent full-text screening, the two reviewers (KV, HW) discussed and resolved any discrepancies. If an agreement could not be reached, another team member (DT and/or AW) was consulted. Prior to resolving disagreements, agreement was automatically calculated using Covidence software. Cohen's Kappa for the combined initial and updated title/abstract screening was 0.71 and the percentage of agreement [agreements/(disagreements + agreements) × 100] was 93%. Cohen's Kappa for the initial and updated full-text review was 0.69 and the percentage of agreement was 91%.

At the time of data extraction, it became apparent that additional SRs needed to be excluded to ensure that the umbrella review only contained articles that were not updated versions of earlier SRs and presented findings in a way that was relevant to addressing at least one umbrella review question. All reviewers (DT, KV, HW, AW) were independently responsible for identifying if a SR should be considered for exclusion on this basis and, if so, to present a rationale to the group. A second reviewer (of the four) then assessed the SR and recommendation, and either endorsed or refuted it. If both reviewers agreed, the SR was excluded from the review. All four authors reviewed all decisions. Additional reasons for exclusion at this stage included: (a) the SR had been



superseded by an updated version of the same review; (b) the same SR had been published in multiple forms (e.g., a report and a scholarly article); (c) the authors had categorised interventions in a different way to the current umbrella review, and consequently, it was not possible to map the intervention effects reported within the SR to the categories used in the current review; (d) the SR examined the combined intervention effect of a range of intervention practices/categories (meaning it was not possible to attribute intervention effects to the specific intervention categories/practices defined for the current review) and did not provide any information about potential child or intervention characteristics that may influence the intervention effect; and/or (e) closer reading of the SR revealed it violated one or more of the eligibility criteria.

Corrected covered area

A potential limitation of umbrella reviews is that they may inadvertently summarise data from one or more original studies on multiple occasions in cases where a study has been included in multiple SRs. Accordingly, the corrected covered area (CCA) was calculated to determine the overlap of primary, or index, publications across the included SRs. The CCA was calculated by dividing the frequency of repeated occurrences of an index publication in other SRs by the total number of index publications and reviews, reduced by the number of index publications (Pieper et al., 2014).

Data extraction

The reviewers conducted data extraction using a standardised data extraction form (Appendix H). Data extraction occurred in two stages. At each stage, reviewers were randomly assigned to extract data from the SRs using a random list generator. The first stage involved extraction of data related to the overall SR. Four reviewers (DT, KV, HW, AW) independently extracted data from each SR including: (a) the type of SR, (b) the objectives of the SR, (c) the number of studies included, (d) the design of included studies, (e) the quality of included studies, (f) sources of funding and conflicts of interest, and (g) the characteristics of included participants, interventions, comparison groups, and outcomes (PICO characteristics). The second stage involved extraction of data related to each individual practice or category included in the SRs and primarily involved two reviewers (DT, AW). The data extracted at this stage included: (a) the name of the category or practice; (b) the amount of intervention including, where stated, intensity (e.g., hours per week) and total duration of the intervention for each included study and for each practice/category; (c) the delivery setting (e.g., clinic, home, school), format (individual, group), agent (e.g., clinicians/researchers, parents/caregivers, peers/siblings), and mode (e.g. face-to-face, telepractice); and (d) the intervention effects reported, including any examination of the influence of child and intervention characteristics on intervention effects, for the predefined characteristics and outcomes of interest.



At this stage, five reviewers (CB, RS, DT, KV, and HW) also independently extracted information on the number of studies examining each intervention effect.

Coding of intervention effects

Intervention effects were extracted for outcomes of interest. In all cases, a positive intervention effect represented an increase in child skills/participation and family wellbeing (social-communication, communication, expressive language, receptive language, cognition, motor, play, adaptive behaviour, school/learning readiness, academic skills, quality of life, academic skills, community participation, caregiver communication and interaction strategies, caregiver social emotional wellbeing, caregiver satisfaction, and child satisfaction) and a reduction in certain autism characteristics (overall autism characteristics, restricted and repetitive interests and behaviours, sensory behaviours) and social-emotional/challenging behaviours.

The authors of the current review note that the term 'positive' refers to the intended effect of an intervention according to the SR authors, and not the authors' own subjective judgment about the benefit of an intervention.

Data extraction of intervention effects focused on recording one pooled (meta-analysis) or summary (for narrative review) effect for each relevant outcome reported in each SR. Effects derived from between-group and within-group analyses were eligible for extraction, with between-group analyses (i.e., between at least one intervention group and another group) prioritised where available. On occasions where meta-analyses reported more than one pooled effect for a specific outcome (e.g., main analyses and sensitivity analyses), we extracted the effect that was presented by the SR authors as the primary analysis. For meta-analyses, findings were recorded as either a positive pooled effect (90/95% confidence intervals of the pooled effect did not overlap with the null), a negative pooled effect (90/95% confidence intervals of the pooled effect did not overlap with the null), or a null effect (90/95% confidence intervals of the pooled effect overlapped with the null). Where a SR did not include a meta-analysis, the recording of an intervention effect focused on the summary provided by the SR authors in the Results section. Findings were recorded as either a summarised positive effect (60% or more of studies summarised reported a positive intervention effect), a negative summarized effect (60% or more of studies summarised reported a negative intervention effect), a null effect (60% or more of studies summarised reported a null intervention effect) or a summarized inconsistent effect (no direction of intervention effect meeting a 60% threshold).

The influence of child and intervention characteristics on intervention effects was summarised by coding the specific independent variable (intervention or child characteristic), the dependent



variable(s) (child and family outcomes), and the nature of the influence on the intervention effect (as reported by the SR authors, extracted verbatim). From these data, the two reviewers (DT, AW) independently generated statements to summarise the influence of each child or intervention characteristic on the intervention effect for any relevant outcomes, with each statement then checked by the second reviewer. Disagreements were resolved via consensus.

Reliability of extraction

Six strategies were used to ensure the reliability of data extraction. First, all reviewers worked from a pre-defined codebook (Appendix H) and entered data into a pre-prepared online spreadsheet. Second, each stage of extraction began with consensus coding to help ensure the accurate and consistent use of procedures. For this, those responsible for extracting data (SR level extraction: DT, KV, HW, AW; practice/category level extraction: DT, AW) independently extracted data for a set of SRs (6 for SR level extraction, 2 for practice/category level extraction) and then met to discuss any discrepancies and, if necessary, further clarify aspects of the data extraction form. Third, a random number generator was used to assign SRs to each reviewer. Fourth, a second reviewer independently extracted information for a randomly selected 20% of SRs. For the remaining 80% of SRs, a second reviewer cross-checked the first reviewer's extraction against the original article. Disagreements were identified and resolved via consensus. A third reviewer was not required on any occasion. Fifth, a third independent reviewer (CB, RS, KV, HW) independently checked each intervention effect reported in the current review against the original SR to ensure accurate transfer and interpretation. Sixth, to ensure independence, all reviewers worked from Covidence and centrally stored password protected spreadsheets that were only unlocked to other reviewers at the completion of each stage of extraction. For SR level extraction, the percentage of agreement was 90% for data independently extracted by two reviewers and 95% for the cross-checks. For the practice/category level extraction, the percentage of agreement was 98% for independently extracted data and 99% for the cross-checks. Occasions where one reviewer reported that an outcome (e.g. social-communication) was measured and a second reviewer reported that it was not measured were coded as one instance of disagreement, rather than a disagreement for all variables corresponding to that outcome. The consensus moderation articles were not included in these calculations.

Study quality assessment

Risk of Bias was assessed using the Critical Appraisal Checklist for Systematic Reviews and Research Syntheses (Appendix I) created by the Joanna Briggs Institute (2020). The form comprised 11 items related to the quality of: (a) the review question, (b) the inclusion criteria, (c) the sources and resources, (d) the criteria for appraising the studies, (e) agreement between raters on extraction and



quality appraisal, (f) the methods used to combine studies, (g) the likelihood of publication bias, (h) recommendations for policy and/or practice, and (i) directives for new research. Each item was rated dichotomously, with "yes" indicating a low risk of bias for that item, and "no" indicating a high risk of bias for that item. The item regarding the likelihood of publication bias was rated for meta-analyses only and was rated 'not applicable' for all other SRs. SRs were not excluded based on methodological quality.

Four reviewers (DT, KV, HW, AW) rated the quality of SRs. The process began with consensus moderation, involving two to four reviewers independently reviewing the same 6 SRs and then comparing their ratings with other reviewers and resolving any disagreements in interpretation. Next, the quality of each SR was independently rated by two reviewers. The percentage of agreement was 77%. Disagreements were resolved via consensus.

Data synthesis

A systematic process was conducted to combine findings across SRs and generate overall summarised findings for the umbrella review. The process is summarised in Figure 2.



Figure 2. Summary of the process undertaken for data synthesis.

Central to this process was combining the available evidence for intervention effects in a manner that would enable the synthesis of information within and across SRs, for multiple intervention practices, categories, and outcomes. The outcome of this process was a single categorisation for each intervention effect as either:

- Positive: coded when all available evidence for an intervention effect for a particular practice/category on a particular outcome of interest was positive.
- Null: coded when all available evidence for an intervention effect for a particular practice/category on a particular outcome of interest was null, or when rated as 'unestablished' (National Autism Center, 2015) or 'insufficient evidence' (Steinbrenner et al., 2020).



- Inconsistent: coded when all available evidence for an intervention effect for a particular practice/category on a particular outcome of interest was a mixture of positive and null, or when rated as 'emerging' evidence in the case of the National Autism Center (2015).
- Adverse effects were recorded in Table 7.

Please refer to Appendix J for full details of this process.

Interpretation and reporting

The raw, summarised, and synthesised data were shared and discussed within the project team, as the basis for presenting the results and interpreting the findings. All team members reviewed the documented findings and provided input into their interpretation via a formal feedback process which included procedures for resolving any differences of opinion via consensus moderation.

Results

Study selection

The PRIMSA flow diagram in Figure 3 represents the study selection process (Moher et al., 2009). The search process yielded 9,258 records, and 3,138 records once duplicates were automatically removed. This total comprised 3,090 records from the initial searches, 39 records from the updated searches 1 month later, 7 records from the grey literature searches, and 2 records from the reference list searches. Four hundred and seventy-eight articles proceeded to full-text review. Three hundred and ninety-three articles were excluded at this stage. The most common reasons for exclusion were: (a) the review did not meet criteria to be considered systematic; (b) the SR did not appear to include a study with an RCT, quasi-RCT, and/or controlled clinical trial design; (c) there were no individuals with an autism diagnosis or there was no separate analysis of individuals with an autism diagnosis; and (d) there was no relevant outcome or no useable summary of relevant outcomes. A further 27 SRs were excluded during the data extraction phase. The most common reason for exclusion in this phase was that the SR examined the combined intervention effect of a range of intervention practices/categories (and therefore, it was not possible to attribute intervention effects to the specific intervention categories/practices defined for the current review), and did not provide any information about potential child or intervention characteristics that may influence the intervention effect. A list of excluded SRs, and the reasons for their exclusion, is provided in Appendix K (studies excluded during full-text screen) and Appendix L (studiess excluded during data extraction).



Figure 3. PRISMA flow diagram





Study characteristics

Of the 58 SRs included in the umbrella review, 30 (52%) were meta-analyses with narrative synthesis, and 28 (48%) were narrative syntheses only. The majority of SRs (n=33; 57%) were published between 2018 and 2020, with the remainder (n = 25, 43%) published between 2010 and 2017. The number of studies included in SRs ranged from 3 (Schoen et al., 2019) to 972 (Steinbrenner et al., 2020), with a median of 17. All but 2 SRs specified the final year of the search, and 41 (71%) SRs mentioned the presence or absence (i.e., since database inception) of a starting year limit. Of these, 26 (63%) placed a limit on date, whereas 15 (37%) included all prior published research. The authors of 39 SRs (67%) provided information regarding sources of funding to conduct the SR and declarations of interest were reported in 37 SRs (64%). There were four instances in which authors identified a potential conflict of interest. A detailed outline of study characteristics is provided in Appendix M.

Corrected covered area (CCA)

The number of original publications across all SRs was 1,787. The overall CCA across these SRs was 0.65%. This is indicative of slight overlap (Pieper et al., 2014).

Focus of reviews

While all SRs included data on the effects of interventions for children on the autism spectrum, there were differences in the focus of the SRs. These differences divided the SRs into three groupings. First, *practice/category-focused reviews* had the aim of examining the intervention effects of a defined intervention practice/category on child and family outcomes. These SRs enabled the intervention effect for a given category and/or practice on child and family outcomes (Questions 2 and 3) to be readily synthesised. These SRs also provided insights into the potential influence of the amount of intervention and child characteristics on intervention effects for a given intervention practice/category (Questions 4 and 5).

Second, *outcome-focused reviews* examined the effect of interventions, combined across practices/categories, on an outcome of interest (e.g., social-communication). For SRs with this focus, it was not possible to delineate the effect of one intervention practice/category from another on any given outcome. However, these SRs provided insights into the potential influence of intervention delivery characteristics (Question 4) and child characteristics (Question 5) on the intervention effects relating to a given outcome.

Third, *intervention delivery-focused reviews* examined the effect of interventions with specific delivery characteristics (e.g., setting, format, agent, mode), combined across practices/categories, on child and family outcomes. These SRs also prevented the delineation of the effect of different



intervention practices/categories on outcomes. However, these SRs provided insights into the effects observed when interventions were delivered in a certain way (Question 4), as well as how differences in intervention (Question 4) and child characteristics (Question 5) may influence intervention effects.

There were 34 practice/category-focused reviews (summarised in Appendix N), 8 outcome-focused reviews (summarised in Appendix O) and 16 intervention delivery-focused reviews (summarised in Appendix P).

Study designs

Eligibility criteria for the umbrella review stated that each SR must include at least one study with a controlled-group design (either an RCT, quasi-RCT, or controlled clinical trial). Forty-seven SRs (81%) provided specific information about the designs of included studies in the results section. In the remaining SRs, there was evidence for the inclusion of at least one study with a controlled group design in other sections (e.g., title, abstract, methodology, and references). Fourteen SRs included only RCTs. Of these 47 SRs, 46 (98%) included at least one RCT, 26 (55%) at least one non-randomised group design study with a control, 14 (30%) at least one non-randomised group design study with a control, 14 (30%) at least one non-randomised group design study without a control, 20 (43%) at least one single case experimental design, and 10 (21%) included other designs such as case studies, post-test only, retrospective cohort studies, and qualitative studies. Comparison groups were described for each included study in 31 SRs (53%). Twenty of these (64.5%) included at least one study with a wait list control, 23 (74%) included at least one study with a treatment as usual control, and 30 (97%) included at least one study in which the comparison was another intervention.

Participants

Fifty-three (91%) SRs provided details about the total number of participating individuals. Across these SRs, a total of 41,374 individuals were identified as participants, with SRs ranging from 66 participants (Hardy & Weston, 2020) to 6,240 participants (Sandbank et al., 2020a). It was not possible to calculate the number of unique participants due to overlap between included SRs and non-specific reporting. Forty-four SRs (76%) provided information about the age range of included children. Within these SRs, the youngest child was aged 0.38 years old and the oldest individual was 65 years old. Twenty-two SRs (38%) provided the total number (rather than percentage or proportion) of participating females and males. Within these SRs 11,218/13,482 (83.2%) individuals were identified as male and 2264/13482 (17%) as female.

There was inconsistent reporting of diagnostic information, although there was evidence of broad representation of children on the autism spectrum with varying levels of functional needs. Authors



used terms such as autistic disorder, autism, autism spectrum disorder, Asperger's disorder, high functioning autism, child disintegrative disorder, and pervasive developmental disorders not otherwise specified (PDD-NOS). Children with increased likelihood for autism, but no formal diagnosis, were identified as being included in 3 (5% of) SRs. Only 24 SRs (41%) identified comorbid diagnoses of one or more included individuals. In the majority of these SRs, it was not clear if all comorbid diagnoses were identified or only particular comorbidities of interest. The most common comorbidity, where identified, was cognitive impairment (15 SRs, 62.5%) followed by attention deficit hyperactivity disorder (5 SRs, 21%).

Study location

Twenty-six SRs (45%) provided information about the geographical locations at which the original studies had been conducted. Of these, all included studies conducted in North America (100%), with Europe (19 SRs, 73%), Australia (19 SRs, 73%), Asia (14 SRs, 54%), South America/Caribbean (4 SRs, 15%) and the Pacific (1 SR, 4%) also represented. No studies were reported to have been conducted in Africa. Appendix Q describes the location of the included studies in each SR.

Risk of bias within studies

The quality of SRs, assessed using a modified version of the Critical Appraisal Checklist for SRs and Research Syntheses (Joanna Briggs Institute, 2020), yielded scores of 6 to 11 out of 11 (mode = 10) for meta-analyses with narrative synthesis, and 4 to 9 out of 10 (mode = 7) for narrative syntheses without a meta-analysis. Only 4 SRs (7%; all meta-analyses) scored maximum points (Geretsegger et al., 2014; Oono et al., 2013; Reichow et al., 2018; Tachibana et al., 2018). A full summary of item scores and totals for each SR is provided in Appendix R. Common areas of strength (criterion met for ≥80% of SRs) were in the inclusion of a clear statement of the review question (Item 1) along with appropriate inclusion criteria (item 2), search strategy (Item 3), the use of an appropriate critical appraisal tool (Item 5), recommendations for policy/practice (Item 10), and suggestions for future research (Item 11). Common areas of weakness (criterion met for < 80% of SRs) related to accessing appropriate sources including grey literature (Item 4), the use of independent reviewers to assess critical appraisal (item 6), adoption of methods to minimise extraction errors (Item 7), and a lack of appropriate methods for combining study findings (Item 8). Of the 30 SRs (52%) that included a meta-analysis, 23 (77%) included an assessment of potential publication bias.

The quality of studies included within SRs was assessed by the original review authors using a variety of tools (see Appendix S). The most common of these were the Cochrane Collaboration tool for assessing risk of bias (Higgins et al., 2011), the Evaluative Method for Determining Evidence-Based Practice in Autism (Reichow, Volkmar, & Cicchetti, 2008), and the Scientific Merit Rating Scale (SMRS; National Autism Center, 2015). Thirty-one SRs (53%) were identified as including at least one



study at high risk of bias, 5 (9%) as including at least one study with at least moderate risk of bias, and 2 (3%) as only including studies at low risk of bias. A determination regarding overall risk of bias for included original studies could not be made for 20 SRs (34%) due to insufficient data or the reporting of bias on an item-by-item level only.

Question 1: What non-pharmacological interventions have been examined in SRs

The 9 categories of intervention featured in the 34 practice/category SRs are as follows: behavioural interventions (8 SRs, 23.5%), developmental interventions (5 SRs, 15%), NDBIs (7 SRs, 21%), sensorybased interventions (9 SRs, 26%), TEACCH (2 SRs, 6%), Technology-based interventions (11 SRs, 32%), animal-assisted interventions (7 SRs, 21%), cognitive behaviour therapy (4 SRs, 12%), and 'other' interventions (2 SRs, 6%). Within these, at least 111 practices (and in some cases techniques) were examined, with a list provided in Table 6. It was not possible to determine exactly how many practices were examined, as some SRs only provided a broad description of the category of intervention.

As outlined in Appendices N, O and P, there was substantial variability in the setting, format, delivery, and agent across practices. Information about intervention setting for at least one included study was specified in 38 SRs (67%). Clinics were the most common intervention setting (29 SRs, 76%), followed closely by home (28 SRs, 74%) and education (26 SRs, 68%) settings. 'Other' settings were reported in 19 SRs (50%). These included a parent's office, non-specific 'natural contexts', hospitals, and summer camps. The use of equine-assisted therapy implied delivery in a community setting although this was not specifically stated.

All SRs were deemed to have included delivery of interventions to individuals, with group-based interventions reported in 22 SRs (38%). Parent-training (also known as caregiver-training) interventions often included a workshop component. Fifty-two SRs (90%) were judged to have included face-to-face delivery (i.e., in the absence of the SR authors stating otherwise), with telehealth featuring in 7 SRs (12%). Parents and other caregivers featured as intervention agents most often (30 SRs, 52%), followed by clinicians and researchers (28 SRs, 48%), educators (20 SRs, 34%), and peers/siblings (13 SRs, 22%). Riding instructors were involved in the delivery of equine-assisted interventions and several SRs referred to non-specific personnel (e.g., support staff, assistants).



Question 2: What effects do non-pharmacological interventions have on child outcomes?

Table 6 provides a synthesis of the research evidence, organised by intervention categories. In each case, findings from SRs that examined an assortment of practices within an intervention category are synthesised first, followed by findings from SRs of specific practices. A total of 279 different intervention effects across practices and categories are represented, drawn from the findings of 34 SRs. The effect sizes (for meta-analyses) and author statements (qualitative summaries) are provided in Appendix T.

The number of SRs considered, and the quality of evidence for SRs that contributed evidence for each effect, are also reported in Table 6. The quality of evidence is rated as low, moderate, or high based on the following criteria that reflect two key indicators of interest in the current review: the total score using the JBI quality appraisal tool (cut-off of 80%) and the nature of included studies (RCTs only; a mixture of designs/study designs not reported). A total of 27 SRs (47%) provided "low quality evidence" as they had scores of <80% on the JBI tool. A further 24 SRs (41%) provided "moderate quality evidence" as they scored \geq 80% on the JBI tool but included either a mixture of non-randomised designs or did not specify the designs of the included studies. Only 7 SRs (12%) were deemed to provide "high quality evidence" because they scored \geq 80% on the JBI tool and only included RCTs. Where more than one quality rating is provided (e.g., low and moderate), it indicates that findings from two or more reviews are reflected. In cases where an effect is based on a metaanalysis, only the single quality rating for that SR is provided.

Behavioural interventions

Three SRs (Makrygianni & Reed, 2010; National Autism Center, 2015; Sandbank et al., 2020a) examined an assortment of behavioural interventions at the category level. Positive effects were reported for 11 outcomes across core autism characteristics, related skills and behaviours, and education and participation. Practices included in the category level SRs included Behavioral Parent Training; Behavioural early intervention programmes; Discrete Trial Training with Motor Vocal Imitation Assessment; Early Intensive Behavioral Treatment; Functional Behavior Skills Training Home-based behavioral treatment; Home-based Early Intensive Behavioral Intervention (EIBI); Intensive ABA; Intensive Early Intervention; Low Intensity Behavioral Treatment; Managing Repetitive Behaviors; Peer-Mediated Intervention; Picture Exchange Communication System (PECS); Rapid Motor Imitation Antecedent; Regular Intensive Learning for Young Children with Autism; Schedules, Tools, and Activities for Transitions (STAT); Social Skills Group; Stepping Stones Triple P Positive Parenting Program; and Strategies for Teaching Based on Autism Research (STAR).



Six practices were further examined across 6 SRs (Flippin et al., 2010; National Autism Center, 2015; Reichow et al., 2018; Sandbank et al., 2020a; Steinbrenner et al., 2020; Virués-Ortega, 2010), with mix of effects across 14 outcomes. Consistently positive effects were reported for 2 practices: discrete trial training (8 outcomes) and language training (production; 1 outcome). A mix of effects across outcomes were reported for 4 practices: Early Intensive Behavioural Intervention (9 positive, 2 null), Functional Communication Training (6 positive, 1 inconsistent), Language Training (Production and Understanding; 1 inconsistent), and the Picture Exchange Communication System (1 positive, 1 inconsistent, 1 null).

Developmental interventions

Two SRs (Binns & Oram Cardy, 2019; Sandbank et al., 2020a) examined an assortment of developmental interventions at the category level. A positive effect was reported for core autism characteristics (social-communication), and a null effect for related skills and behaviours (communication). Practices included in the category level SRs included Child Talk; Developmental Individual-Difference Relationship-Based (DIR)/Floortime; Hanen More Than Words; Joint Attention Mediated Learning (JAML); Milton and Ethel Harris Research Initiative Treatment (MEHRIT) - DIR based; Parent-Mediated Communication Focused Treatment; Parent-mediated intervention for autism spectrum disorder in South Asia (PASS); Paediatric Autism and Communication Therapy (PACT); Play and Language for Autistic Youngsters (PLAY) project - DIR based; Scottish Early Intervention Program; Social Communication, emotion regulation, transactional support (SCERTS); and Video-feedback Intervention to Promote Positive Parenting adapted to autism (VIPP-AUTI).

Three practices were further examined across 3 SRs (Boshoff et al., 2020; National Autism Center, 2015; Steinbrenner et al., 2020). Consistently positive effects on a range of child outcomes were noted for naturalistic teaching strategies (9 positive). A mix of effects across outcomes was reported for DIR/Floortime (1 positive, 3 null), and an inconsistent effect for general outcomes was reported for Developmental Relationship-based Treatment.

NDBIs

Two SRs (Sandbank et al., 2020a; Tiede & Walton, 2019) examined an assortment of NDBIs at the category level. A mix of effects was reported across core autism characteristics (1 positive, 2 null), related skills and behaviours (5 positive, 2 null). Practices included in the category level SRs included Advancing Social-Communication and Play (ASAP); Caregiver-based intervention program in community day-care centres; Denver Model; Early Social Interaction Project (ESI); Early Social Interaction Project (SCERTS); Early Start Denver Model (ESDM); Focus parent training program; Home-based Building Blocks Program; ImPACT Online; Interpersonal Synchrony; Joint Attention,



Symbolic Play, Engagement, and Regulation (JASPER); Joint Engagement Intervention with Creative Movement Therapy; Joint Engagement Intervention; Learning Experiences Alternative Program (LEAP); Parent-Early Start Denver Model (P-ESDM); Pivotal Response Treatment (PRT); Reciprocal Imitation Training (RIT); and Social ABCs.

Two practices were further examined across 5 SRs (Fuller, Oliver et al., 2020; National Autism Center, 2015; Ona et al., 2020; Verschuur et al., 2014; Waddington et al., 2016). A mix of effects across child outcomes were reported for the Early Start Denver Model (3 positive, 4 null) and Pivotal Response Treatment (4 positive, 2 inconsistent, 1 null).

Sensory-based interventions

Three SRs (Lang et al., 2012; National Autism Center, 2015; Sandbank et al., 2020a) examined an assortment of sensory-based interventions at the category level. Null effects were reported for related skills and behaviours (communication, general outcomes). Practices included in the category level SRs were alternative seating; blanket or "body sock"; brushing with a bristle or a feather; chewing on a rubber tube; developmental speech and language training through music; family-centered music therapy; joint compression or stretching; jumping or bouncing; music therapy; playing with a water and sand sensory table; playing with specially textured toys; Qigong Sensory Treatment (QST); Rhythm Intervention Sensorimotor Enrichment; sensory enrichment; swinging or rocking stimulation; Thai traditional massage; Tomatis Sound Therapy; and weighted vests.

Five practices were further examined across 7 SRs (Geretsegger et al., 2014; National Autism Center, 2015; Naylor et al., 2011; Schaaf et al., 2018; Schoen et al., 2019; Steinbrenner et al., 2020; Weitlauf et al., 2017). A mix of effects across outcomes was reported for 3 practices: Ayres Sensory Integration (5 positive, 6 inconsistent, 1 null), music therapy (7 positive, 2 inconsistent), and environmental enrichment (1 positive, 1 null). Null effects were reported for Auditory Integration Training (2 null) and Sensory Diet (1 null).

TEACCH

Only one SR contributed data to TEACCH (Sandbank et al., 2020a) at the category level, reporting a null effect on social-communication outcomes. At the practice level, 1 further SR (National Autism Center, 2015) reported an inconsistent effect on general outcomes for structured teaching.

Technology-based interventions

Five SRs (Khan et al., 2019; Mazon et al., 2019; National Autism Center, 2015; Sandbank et al., 2020a; Steinbrenner et al., 2020) examined an assortment of technology-based interventions at the category level. A mix of effects was reported across child outcomes in relation to core autism



characteristics (1 null), related skills and behaviours (5 positive, 1 inconsistent, 1 null), and education and participation (2 positive). Practices in the category level SRs included ABRACADABRA; Apps; Computer-based interventions; FaceSay; Gaming Open Library for Intervention in Autism at Home (GOLIAH); Gaze-contingent attention training; Robot-based interventions; Serious games; Social Skills Training using a robotic behavioral intervention system; The Transporters animated series; Therapy Outcomes By You (TOBY) App; Transporters DVD; Transporters Program for Children with Autism; Videoconferencing; Virtual environment with playable games; and Web-based CBT intervention³.

Six practices were further examined across 8 SRs (Miguel-Cruz et al., 2017; Griffith et al., 2020; Knight et al., 2013; Logan et al., 2017; McCoy et al., 2016; Moon et al., 2019; National Autism Center, 2015; Steinbrenner et al., 2020). A mix of effects across outcomes was reported for 4 practices: Augmentative and Alternative Communication (5 positive, 2 inconsistent), computer-based instruction (1 positive, 1 inconsistent) and Apps (2 positive, 4 null). An inconsistent effect on general outcomes was reported for sign instruction (National Autism Center, 2015), and a null effect on general outcomes was reported for Facilitated Communication. The use of Robots was found to have an inconsistent effect on social-communication.

Animal-assisted interventions

Two SRs (National Autism Center, 2015; Steinbrenner et al., 2020) examined an assortment of animal-assisted interventions at the category level, both reporting a null effect for general outcomes. The specific practices included in these SRs were not specified. Five SRs (Hardy & Weston, 2020; Hill et al., 2019; Srinivasin et al., 2018; Trzmiel et al., 2019; Wiese et al., 2016) examined 2 practices. A mix of effects across outcomes was reported for equine-assisted therapy (1 positive, 5 inconsistent, 4 null), and an inconsistent effect on social-communication was reported for canineassisted therapy.

Cognitive behaviour therapy

Four SRs (Ho et al, 2014; National Autism Center, 2015; Steinbrenner et al., 2020; Weston et al., 2016) examined cognitive behaviour therapy at the category level. A mix of effects across outcomes was reported in relation to core autism characteristics (2 positive, 1 inconsistent), related skills and behaviours (4 positive), and education and participation (2 positive). The practice labelled exposure

³ Although cognitive behaviour therapy is a separate category, it is examined here in relation to technology-based delivery and it is not possible to separate the findings for individual practices in category level reviews.



package was examined in 1 SR (National Autism Center, 2015) and had an inconsistent effect on general outcomes.

Other

Nine practices were examined in 2 SRs (National Autism Center, 2015; Steinbrenner et al., 2020). A positive effect across a range of outcomes was reported for social skills training (7 positive). An inconsistent effect on general outcomes was reported for 5 practices: Imitation based training, multi-component package, reductive package, social communication intervention, and theory of mind training. A null effect on general outcomes was reported for 3 practices: social behavioural learning strategy, social cognition intervention, social thinking intervention.

Adverse effects

Adverse effects were considered in 8 (14%) of 58 SRs. As presented in Table 7, they were not considered for developmental interventions (5 SRs), NDBIs (7 SRs), TEACCH (2 SRs), cognitive behaviour therapy (2 SRs), or other interventions (2 SRs); nor for SRs focusing on child outcomes (8 SRs) or intervention characteristics (16 SRs). Adverse effects were considered in 1 of 8 SRs of behavioural interventions with none reported. Where effects have been identified below, the summary here is based on data from the SR (not directly from the original studies), consistent with the umbrella SR methodology. Furthermore, the categorisation of effects as negative (e.g., an increase in self-stimulatory behaviour) is based on the interpretation of the authors of the relevant SR. A further method for understanding potentially adverse effects of an intervention is to examine data on participation attrition. However, participant attrition was rarely reported at the SR level, and no further conclusions on adverse effects could be drawn from these data.

Adverse events were considered in 2 of 9 SRs of sensory-based interventions and reported in one. Specifically, Lang et al., (2012) identified 14 studies for which no benefit for any participant on any measure could be identified, and suggested that intervention may have contributed to an increase in 'stereotypy' and problem behaviour for participants in 4 studies. Adverse effects were considered in 3 of 12 SRs of technology-based interventions and reported in 2 of these. Mazon et al., (2019) in a category level SR noted that 6 participants in 1 included study had been excluded due to refusal or distress, although it is unclear if this was prior to enrolment in the study or in response to the intervention. Miguel-Cruz et al., (2017) noted that children who interacted with a robot during intervention showed a reduction in positive affect in interactions with humans. Adverse effects were considered in 2 of 7 SRs of animal-assisted interventions and reported in one. Hill et al., (2019) reported evidence from 3 different studies regarding an increase in tantrums, anxiety, and aggression for some children; an increase in anxiety towards a dog for one child; and increases in self-stimulatory behaviour for some children.


Table 6. Summary of the direction of intervention effects and quality of evidence relating to child and family outcomes.

			c	Core a	autism teristics	5			Relate	ed skill:	s and c	levelop	oment			E	ducati partici	ion and pation	i		Famil	y wellt	peing	
	Interventions	No. of systematic reviews	Overall autistic characteristics	Social-communication	Restricted and repetitive interests and behaviours	Sensory behaviours	Communication	Expressive language	Receptive language	Cognition	Motor	Social-emotional/ challenging behaviour	Play	Adaptive behaviour	General outcomes ^a	School/ learning readiness	Academic skills	Quality of life	Community participation	Caregiver communication and interaction strategies	Caregiver social emotional wellbeing	Caregiver satisfaction	Caregiver financial wellbeing	Child satisfaction
	Systematic reviews of assorted behavioural practices*	3	+ M	+ M	+ L	+ L	+ M			+ M	+ M	+ M	+ L	+ M		+ L	+ L							
	Discrete Trial Training	1		+ L			+ L			+ L		+ L	+ L	+ L		+ L	+ L							
_	Early intensive behavioural intervention	4	о М	+ M			+ M	+ M	+ M	+ M	+ L	о М		+ L		+ LM	+ L				0 M			
havioura	Functional Communication training	2		+ L			+ L					+ L	+ L	+ L	? L	+ L								
Be	Language Training (production)	1					+ L																	
	Language Training (production and understanding)	1													? L									
	Picture Exchange Communication System (PECS)	2		+ L				o L							? L									

+ Positive therapeutic effect

L = Low quality

? Inconsistent therapeutic effectM = Moderate quality

Null effect

H = High quality

Blank cell indicates no evidence available *Combines assorted interventions practices for this category. Please see page 79 for a full list.



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			c	Core a	autism teristics	S			Relate	ed skill	s and c	levelop	oment			E	Educati partici	ion and pation	i		Fami	y wellt	peing	
	Interventions	No. of systematic reviews	Overall autistic characteristics	Social-communication	Restricted and repetitive interests and behaviours	Sensory behaviours	Communication	Expressive language	Receptive language	Cognition	Motor	Social-emotional/ challenging behaviour	Play	Adaptive behaviour	General outcomes ^ª	School/ learning readiness	Academic skills	Quality of life	Community participation	Caregiver communication and interaction strategies	Caregiver social emotional wellbeing	Caregiver satisfaction	Caregiver financial wellbeing	Child satisfaction
	Systematic reviews of assorted developmental interventions*	2		+ M			0 M													+ Н				
lopmenta	Developmental relationship-based treatment	1													? L									
Deve	DIR/Floortime	2		+ M			о М				0 M				o L									
	Naturalistic teaching strategies	2		+ LL			+ LL			+ L	+ L	+ L	+ L	+ L		+ LL	+ L							
pmental vetions	Systematic reviews of assorted NDBIs*	2	0 M	+ M	0 M		+ M	+ M	+ M	+ M		0 M	+ M	0 M										
stic develo	Early Start Denver Model	2	0 M	0 M	0 M		+ M			+ M				0 M	+ M					+ M	+ M	+ M		
Naturali behavid	Pivotal Response Treatment	3		? L	+ L		o L	+ L					+ L		? L	+ L					? L			

L = Low quality

? Inconsistent therapeutic effectM = Moderate quality

Null effect

H = High quality

Blank cell indicates no evidence available *Combines assorted interventions practices for this category. Please see page 79 for a full list.



			c	Core a	autism teristic	s			Relate	ed skill:	s and c	levelop	ment			E	ducati partici	ion and pation	ł		Fami	y wellt	being	
	Interventions	No. of systematic reviews	Overall autistic characteristics	Social-communication	Restricted and repetitive interests and behaviours	Sensory behaviours	Communication	Expressive language	Receptive language	Cognition	Motor	Social-emotional/ challenging behaviour	Play	Adaptive behaviour	General outcomes ^ª	School/ learning readiness	Academic skills	Quality of life	Community participation	Caregiver communication and interaction strategies	Caregiver social emotional wellbeing	Caregiver satisfaction	Caregiver financial wellbeing	Child satisfaction
	Systematic reviews of assorted sensory- based interventions*	3					0 M								o LL									
entions	Auditory integration Therapy	3					0 M								o LL									
d interve	Ayers Sensory Integration (ASI)	4	? L	? LL		? LM	? LL			+ L	+ LM	+ L	o L	? LL	? M		+ L		+ L					
ory-base	Environmental enrichment	1						0 M		+ M														
Senso	Music therapy	4		+ M			+ M				+ L	+ L	+ L	? LL	? L	+ L		+ M			+ M			
	Sensory diet	1													o L									
ССН	Systematic review of TEACCH*	1		о М																				
TEA	Structured teaching	1													? L									

L = Low quality

? Inconsistent therapeutic effectM = Moderate quality

o Null effect

H = High quality

Blank cell indicates no evidence available *Combines assorted interventions practices for this category. Please see page 79 for a full list.



			c	Core a	autism teristics	5			Relate	ed skill	s and c	develop	ment			E	ducati partici	ion and pation	ł		Famil	y wellt	peing	
	Interventions	No. of systematic reviews	Overall autistic characteristics	Social-communication	Restricted and repetitive interests and behaviours	Sensory behaviours	Communication	Expressive language	Receptive language	Cognition	Motor	Social-emotional/ challenging behaviour	Play	Adaptive behaviour	General outcomes ^ª	School/ learning readiness	Academic skills	Quality of life	Community participation	Caregiver communication and interaction strategies	Caregiver social emotional wellbeing	Caregiver satisfaction	Caregiver financial wellbeing	Child satisfaction
	Systematic reviews of assorted technology- based interventions*	5		о М			+ L			+ L	+ L	0 M	+ L	+ L	? LL	+ L	+ L					? M		
suo	Apps	2		о Н			0 H	0 H	0 H	+ H	+ H													
interventi	Augmentative and Alternative Communication (AAC)	3		? LM			+ L				+ L	+ L	+ L		? L		+ L					? M		
y-based	Computer-based instruction	2		+ L													? L							
chnolog	Facilitated communication	1													o L									
Ę	Robots	1		? L																				
	Sign instruction	1													? L									

L = Low quality

? Inconsistent therapeutic effectM = Moderate quality

Null effect

H = High quality

Blank cell indicates no evidence available *Combines assorted interventions practices for this category. Please see page 79 for a full list.



			c	Core a	autism teristics	5			Relate	ed skill:	s and d	levelop	ment			E	ducati partici	ion and pation	ł		Famil	y welli	being	
	Interventions	No. of systematic reviews	Overall autistic characteristics	Social-communication	Restricted and repetitive interests and behaviours	Sensory behaviours	Communication	Expressive language	Receptive language	Cognition	Motor	Social-emotional/ challenging behaviour	Play	Adaptive behaviour	General outcomes ^a	School/ learning readiness	Academic skills	Quality of life	Community participation	Caregiver communication and interaction strategies	Caregiver social emotional wellbeing	Caregiver satisfaction	Caregiver financial wellbeing	Child satisfaction
sted ons	Systematic reviews of assorted animal- assisted interventions*	2													o LL									
mal-assi terventio	Canine-assisted intervention	2		? LM																				
Ani	Equine assisted therapy	3		o L		+ L	O L			o L	? L	? L		o L	? LM			? L	? L					
Initive aviour rapv	Systematic reviews of cognitive behavioural therapy	4	? M	+ L		+ L	+ L			+ L		+ LL		+ LL		+ LL	+ L							
Cog behi the	Exposure package	1													? L									

? Inconsistent therapeutic effect

o Null effect

Blank cell indicates no

*Combines assorted interventions practices for this category. Please see page 79 for a full list.



M = Moderate quality

H = High quality

evidence available

77



		c	Core a	autism teristics	5			Relate	ed skill:	s and d	levelop	ment			E	iducati partici	on and pation	i		Famil	y wellt	peing	
Interventions	No. of systematic reviews	Overall autistic characteristics	Social-communication	Restricted and repetitive interests and behaviours	Sensory behaviours	Communication	Expressive language	Receptive language	Cognition	Motor	Social-emotional/ challenging behaviour	Play	Adaptive behaviour	General outcomes ^ª	School/ learning readiness	Academic skills	Quality of life	Community participation	Caregiver communication and interaction strategies	Caregiver social emotional wellbeing	Caregiver satisfaction	Caregiver financial wellbeing	Child satisfaction
Imitation based training	1													? L									
Multi-component package	1													? L									
Reductive package	1													? L									
Social behavioural learning strategy	1													o L									
Social cognition intervention	1													0 L									
Social communication intervention	1													? L									
Social skills training	1		+ L			+ L			+ L		+ L	+ L	+ L		+ L								
Social thinking intervention	1													o L									
Theory of Mind training	1													? L									

? Inconsistent therapeutic effect

Null effect

Blank cell indicates no evidence available *Combines assorted interventions practices for this category. Please see page 79 for a full list.

L = Low quality

M = Moderate quality

H = High quality

AutismCRC

Combined practices for each category

Behavioural

Behavioral Parent Training; Behavioural early intervention programmes; Discrete Trial Training with Motor Vocal Imitation Assessment; Early Intensive Behavioral Treatment; Functional Behavior Skills Training Home-based behavioral treatment; Home-based Early Intensive Behavioral Intervention (EIBI); Intensive ABA; Intensive Early Intervention; Low Intensity Behavioral Treatment; Managing Repetitive Behaviors; Peer-Mediated Intervention; Picture Exchange Communication System (PECS); Rapid Motor Imitation Antecedent; Regular Intensive Learning for Young Children with Autism; Schedules, Tools, and Activities for Transitions (STAT); Social Skills Group; Stepping Stones Triple P Positive Parenting Program; Strategies for Teaching Based on Autism Research (STAR).

Developmental

Child Talk; Developmental Individual-Difference Relationship-Based (DIR)/Floortime; Hanen More Than Words; Joint Attention Mediated Learning (JAML); Milton and Ethel Harris Research Initiative Treatment (MEHRIT)-DIR based; Parent-Mediated Communication Focused Treatment; Parent-mediated intervention for autism spectrum disorder in South Asia (PASS); Pediatric Autism and Communication Therapy (PACT); Play and Language for Autistic Youngsters (PLAY) project - DIR based; Scottish Early Intervention Program; Social Communication Intervention for Children with Autism and Pervasive Developmental Disorder; Social communication, emotion regulation, transactional support (SCERTS); Video-feedback Intervention to Promote Positive Parenting adapted to autism (VIPP-AUTI).

Naturalistic developmental behavioural interventions

Advancing Social-Communication and Play (ASAP); Caregiver-based intervention program in community day-care centers; Denver Model; Early Social Interaction Project (ESI); Early Social Interaction Project (SCERTS); Early Start Denver Model (ESDM); Focus parent training program; Home-based Building Blocks Program; ImPACT Online; Interpersonal Synchrony; Joint Attention, Symbolic Play, Engagement, and Regulation (JASPER); Joint Engagement Intervention with Creative Movement Therapy; Joint Engagement Intervention; Learning Experiences Alternative Program (LEAP); Parent-Early Start Denver Model (P-ESDM); Pivotal Response Treatment (PRT); Reciprocal Imitation Training (RIT); Social ABCs.

Sensory-based

Alternative seating; Blanket or "body sock"; Brushing with a bristle or a feather; Chewing on a rubber tube; Developmental Speech and Language Training through Music; Family-Centered Music Therapy; Joint compression or stretching; Jumping or bouncing; Music Therapy; Playing with a water and sand sensory table; Playing with specially textured toys; Qigong (QST) Massage Treatment; Rhythm Intervention Sensorimotor Enrichment; Sensory Enrichment; Swinging or rocking stimulation; Thai Traditional Massage; Tomatis Sound Therapy; Weighted vests.

Technology-based

ABRACADABRA; Apps; Computer-based interventions; FaceSay; Gaming Open Library for Intervention in Autism at Home (GOLIAH); Gaze-contingent attention training; Robot-based interventions; Serious games; Social Skills Training using a robotic behavioral intervention system; The Transporters animated series; Therapy Outcomes By You (TOBY) App; Transporters DVD; Transporters Program for Children with Autism; Videoconferencing; Virtual environment with playable games; Web-based cognitive behavioural therapy (CBT) intervention.

Animal-assisted

Not specified

TEACCH

Not specified

Cognitive behaviour therapy

Building Confidence Family Cognitive behaviour therapy (FCBT); Cool Kids; Coping Cat CBT program; Facing your fears; Group Cognitive Behaviour Therapy (CBT); Social Skills Training for Children and Adolescents with Asperger Syndrome and Social-Communications Problems; Thinking about you, thinking about me.



Table 7: Information on adverse effects of interventions that was extracted from the systematic reviews

Focus of	Frequency of	Evidence for	adverse effects
Review	and identification	Systematic review	Author statement (verbatim quote)
Behavioural interventions	Considered in 1/8 systematic reviews (identified in 0)	-	-
Developmental interventions	Considered in 0/5 systematic reviews	-	-
Naturalistic developmental behavioural interventions	Considered in 0/7 systematic reviews	-	-
Sensory-based interventions	Considered in 2/9 systematic reviews (identified in 1)	Lang et al. (2012)	"The results of 14 studies (56%) were classified as negative because no benefit to any participant on any dependent measure was found. Of those 14 studies, 4 suggested that SIT may have contributed to increases in stereotypy and problem behavior (Carter, 2005; Davis et al., 2011; Devlin et al., 2011; Kane et al., 2004). Across the studies reporting negative findings, eight were rated as providing a suggestive level of certainty (e.g., Watling & Dietz, 2007), one was rated at the preponderance level (Devlin et al., 2011) and five were rated as providing a conclusive level of certainty. All five studies with a conclusive level of certainty and negative findings involved wearing a weighted vest. The results of eight studies were classified as mixed because some but not all participants improved or some but not all dependent variables improved. For example, Ayres and Tickle (1980) classified six participants as "good responders" to SIT and four as "poor responders". Across the studies with mixed results, six were classified at the suggestive level of certainty and two were classified at the conclusive level of certainty (Hodgetts et al., 2011b; Van Rie & Heflin, 2009). The results of three studies were classified as positive all with a suggestive level of certainty (Fazlioglu



			& Baran, 2008; Linderman & Stewart, 1999; Thompson, 2011)." (p.1015)
TEACCH	Considered in 0/2 systematic reviews		
Technology- based interventions	Considered in 3/11 systematic reviews (identified in 2)	Miguel- Cruz et al. (2017)	"Table 1. Summary of the included studies evaluating the level of evidence per diagnosis" indicates results were "Positive (47%), mixed (27.7%), negative (16.7%), NR (8.6%)." (p.434) "The highest level of clinical evidence in the papers involving children with ASD was an RCT that got a PEDro score of 5 [15]. According to the Sackett criteria [26], this paper offers a level of evidence of 3 that an intervention with a NAOTM robot did not have an effect on reducing repetitive and maladaptive behaviours in children with ASD. In contrast, a significant reduction in repetitive and maladaptive behaviours was observed in the group that received treatment based on interaction with a therapist. Similarly, the group that interacted with a human showed a significant reduction in negative affect and an increase in interested affect, whereas the robot group showed a reduction in positive affect." (p.436)
		Mazon et al. (2019)	"Sample sizes across studies ranged from 5 to 23 participants per group, with an average around 10 participants per group. According to the Jadad scale, 5 of out the 6 studies scored 0 and the remaining study scored 1, thanks to the inclusion of a statement about dropouts (6 participants were excluded due to refusal or distress; Bekele et al., 2014)." (p.243-244)
Animal- assisted interventions	Considered in in 2/7 systematic reviews (identified in 1)	Hill et al. (2019)	 The following statements appear under "undesirable behaviours"¹ in Table 5 of the systematic review: "↑ tantrums, anxiety, and aggression" (Mey 2017) "↑ Some anxiety expressed towards dog (student C)" (Stevenson et al., 2015) "↑ Self-stimulating behaviours (hand flapping) (frequency/-duration)" (Matin 2002)



Cognitive behaviour therapy	Considered in 0/4 systematic reviews	-	-
Other interventions	Considered in 0/2 systematic reviews	-	-
Child outcomes	Considered in 0/9 systematic reviews	-	-
Intervention characteristics	Considered in 0/16 systematic reviews	-	-

¹ The authors of the current review note that classification of these behaviours as 'undesirable' is based on the subjective judgement of the original authors and do not present a view in documenting these findings.



Question 3: What effects do non-pharmacological interventions have on family wellbeing?

Positive effects on caregiver communication and interaction strategies were reported for developmental interventions at the category level and for 1 practice within the NDBI category (Early Start Denver Model). Evidence for intervention effects on caregiver social-emotional wellbeing was reported for Early Intensive Behavioural Intervention (1 SR, null), the Early Start Denver Model (1 SR, positive), pivotal response treatment (1 SR, inconsistent), and music therapy (1 SR, positive). A positive effect on caregiver satisfaction was reported for the Early Start Denver Model. An inconsistent effect on caregiver satisfaction was reported at the category level for technology-based interventions (1 SR, inconsistent) and at the practice level for augmentative and alternative communication (1 SR, inconsistent). No evidence was presented in relation to caregiver financial wellbeing or child satisfaction across the 58 SRs.

Question 4: What are the optimal delivery characteristics of non-pharmacological interventions, with a focus on intervention amount, setting, format, agent, and mode?

Amount of intervention

Appendix U provides the full list of intervention amounts reported in each SR. The amount of intervention varied substantially between and within practices/categories, and there was considerable variability in how the amount was measured and reported.

The effect of the amount of intervention on intervention outcomes was examined in 5 practice/category-focused SRs (Table 8). Two SRs focused on behavioural interventions (1 at the category level, 1 for early intensive behavioural intervention practice). At the behavioural category level, Makrygianni and Reed (2010) reported that higher intensity (hours per week) related to greater intervention effect on cognition and adaptive behaviour, but not language. However, intervention duration (in months) was not related to effects on cognition, adaptive behaviour or language. At the practice level of behavioural interventions, Virués-Ortega (2010) reported that greater total hours of early intensive behavioural intervention was related to greater intervention effects on language and adaptive behaviour, but not cognition.

The other 3 practice/category-focused SRs examined NDBIs (1 at the category level, 2 for Early Start Denver Model practice). At the NDBI category level, Tiede and Walton (2019) reported that greater total hours was related to a greater intervention effect on joint attention, but not on outcomes relating to core autism characteristics, social-communication, expressive or receptive language, cognition, play, or adaptive behaviour. At the NDBI practice level, 2 SRs examined the possible effect the intervention amount for the Early Start Denver Model. One SR reported no influence on



intervention effects (Fuller, Oliver et al., 2020) and the other found inconsistent effects (Waddington et al., 2016).

The effect of the amount of intervention on intervention outcomes was not reported in any systematic reviews focusing on developmental, sensory-based, TEACCH, technology-based, animal assisted, CBT, or other interventions.

The influence of the amount of intervention on intervention effects was examined in 5 outcomefocused SRs. These SRs focused on social-communication outcomes (2 SRs), communication outcomes (1 SR), and motor outcomes (1 SR). The only consistent effect reported was for motor outcomes, in which greater total hours was related to greater effects on motor skills (Case & Yun, 2019).

Two intervention delivery-focused SRs examined potential effects of the amount of intervention. Naveed et al. (2019) examined the possible influence on intervention effects arising from nonspecialist mediated interventions (delivered by parents/caregivers, siblings/peers, educators), reporting null findings for both duration (weeks) and number of sessions. Nevill et al. (2018) reported similar null findings for parent-mediated interventions, noting that total hours did not influence intervention effects on autism core characteristics, socialisation, communication, or cognition.

Intervention setting

Two SRs focused specifically on interventions delivered in inclusive school settings (Appendix P). Tupou et al. (2019) reported positive effects across a range of outcomes including overall autism characteristics, social-communication, communication, cognition, social-emotional/challenging behaviour, adaptive behaviour, and general outcomes. Watkins et al. (2019) reported that interventions delivered in inclusive settings had a positive effect on social-communication, RRBs, social-emotional/challenging behaviour, and play.

Two outcome-focused SRs examined the influence of different intervention settings on intervention effects. Parsons, Cordier, Munro et al. (2017) reported that interventions delivered in the clinic, home, or school led to similar (positive) intervention effects on social-communication outcomes. Kent et al., (2020) reported similar (positive) effects on play for interventions delivered in the clinic and home.

Intervention delivery format

Two outcome-focused SRs reported no differences between individual and group intervention delivery formats in the (positive) intervention effect on social-communication (Parsons, Cordier, Munro et al., 2017) and play (Kent et al. 2020) outcomes (Table 9).



One intervention delivery-focused SR compared the intervention effects observed on a range of outcomes between individual and group formats (Tachibana et al., 2018). A mix of effects were reported for both individual and group interventions on a range of outcomes (individual delivery: 1 positive, 8 null; group delivery: 1 positive, 5 null; Appendix P). There was no difference between individual and group formats in the intervention effects on core autism characteristics, social-communication, expressive language, receptive language, cognition, or adaptive behaviour (Table 9).

Intervention agent

Six SRs examined the effects of parent-mediated interventions on child and family outcomes (Appendix P). Consistently positive effects across outcomes were reported by Nevill et al. (2018; 4 positive), Steinbrenner et al. (2020; 9 positive), National Autism Center (2015; 5 positive), and Postorino et al. (2012; 1 positive). A mix of effects across outcomes were reported by Oono et al. (2013; 4 positive, 1 inconsistent, 8 null) and Tarver et al. (2019; 3 positive, 1 null). A synthesis of these SRs identified positive intervention effects of parent-mediated interventions on child overall autism characteristics, social-communication, RRB, communication, cognition, motor, social-emotional/challenging behaviour, play, school/learning readiness and academic skills outcomes, and for caregiver communication and interaction strategies and satisfaction. There were null effects for expressive language, receptive language, and adaptive behaviour, and an inconsistent effect for caregiver social-emotional wellbeing. Appendix V presents the synthesised findings for the effects of parent-mediated interventions on child and family outcomes. The method for indicating the quality of evidence in Appendix V is the same as that used in Table 6.

Four SRs examined the effects of peer-mediated interventions on child outcomes. Consistently positive effects across outcomes were reported: Chang and Locke (2016; 1 positive), Zagona and Mastergeorge (2018; 1 positive), Steinbrenner et al. (2020; 7 positive), and National Autism Center (2015; 4 positive). A synthesis of these SRs identified positive intervention effects of peer-mediated interventions for child social-communication, RRB, communication, cognition, social-emotional/challenging behaviour, play, school/learning readiness and academic skills outcomes (see Appendix V for the presentation of synthesised findings for peer-mediated interventions).

Naveed et al. (2019) examined the effects of 'non-specialist' implemented interventions (parents/caregivers, peers, teachers, school staff, childcare workers), reporting mixed outcomes across child and family outcomes (13 positive, 3 null).

Six outcome-focused SRs examined whether the type of intervention agent (e.g., clinician/researcher, parent/caregiver, peers) exerted an influence on the magnitude intervention effects. Hampton and Kaiser (2016) reported greater intervention effects on spoken language



outcomes from those that involved clinicians and caregivers compared to those delivered by clinicians or caregivers alone. Parsons, Cordier, Munro et al. (2017) reported positive intervention effects on social-communication outcomes for clinician-delivered interventions that included caregiver involvement, but not for interventions that focused on caregiver education alone. Four further SRs reported no differences in the magnitude or direction of the (positive) intervention effects on social-communication (Bejarano-Martín et al., 2020; Fuller & Kaiser, 2020; Murza et al., 2016) or communication (Sandbank 2020b) outcomes, for a range of different intervention agents (Table 9).

Two intervention-delivery-focused SRs compared the influence of different intervention agents on intervention effects (Table 9). Naveed et al. (2019) reported that parent-implemented interventions had a greater effect on children's joint engagement (but not autism core characteristics) than those delivered by other "non-specialists" (peers, teachers, school staff, childcare workers). Watkins et al. (2019) reported that delivery of interventions within an inclusive setting by teachers had a greater intervention effect than interventions delivered by researchers or peers.

Intervention delivery mode

Four SRs examined delivery of interventions via telepractice (Appendix V). Ferguson et al (2019) reported a positive effect on general outcomes and Akemoglu et al. (2020) reported an inconsistent effect on social-communication outcomes. Parsons, Cordier, Vaz et al. (2017) reported positive effects for communication, caregiver satisfaction, caregiver communication and interaction, and caregiver social-emotional wellbeing. An inconsistent effect was reported for social-communication. Sutherland et al. (2019) reported inconsistent effects for communication, but positive effects for social-emotional/challenging behaviour, caregiver satisfaction, and caregiver communication and interaction and interaction and interaction and interaction. A synthesis of these SRs identified positive intervention effects for telepractice on certain child (general outcomes) and caregiver (caregiver communication and interaction strategies, caregiver social emotional wellbeing, caregiver satisfaction) outcomes, with inconsistent effects for social-communication and communication. See Appendix V for the presentation of synthesised findings for interventions delivered via telepractice). No SRs reported outcomes related to the influence of delivery mode on intervention effects, such as a comparison of telepractice with face-to-face delivery.



Table 8. Information on the influence of the amount of intervention on intervention effects.

Systematic review	Focus of systematic review	Summary of evidence
	(specific focus)	
Makrygianni & Reed (2010)	Practice/category (Behavioural category)	Summary: Higher intensity (hours per week) related to greater intervention effect on cognition and adaptive behaviour, but not language. Intervention duration (months) not related to intervention effect on cognition, adaptive behaviour, or language.
Virués-Ortega, et al. (2010)	Practice/category (Early intensive behavioural intervention practice)	Summary: Greater total hours related to greater intervention effect on language and adaptive behaviour, but not cognition.
Tiede & Walton (2019)	Practice/category (NDBI category)	Summary: Greater intervention effect on joint attention, but not on outcomes relating to core autism characteristics, social- communication, expressive or receptive language, cognition, play, or adaptive behaviour.
Waddington et al. (2016)	Practice/category (Early Start Denver Model practice)	Summary: Total hours of intervention inconsistently related to intervention effects.
Fuller, Oliver, et al. (2020)	Practice/category (Early Start Denver Model practice)	Summary: Duration of intervention (total weeks) not related to child outcomes. Intensity of intervention (hours per week) not related to child outcomes. Total hours of intervention not related to child outcomes.
Bejarano- Martín et al. (2020)	Outcomes (Social-communication)	Summary: Total hours inconsistently related to intervention effects on social-communication.
Fuller & Kaiser (2019)	Outcomes (Social-communication)	Summary: Total hours not related to intervention effects on social-communication. Intervention duration (weeks) not related to intervention effects on social-communication.
Sandbank et al. (2020b)	Outcomes (Communication)	Summary: Total hours not related to intervention effects on communication.
Hampton & Kaiser (2016)	Outcomes (Communication)	Summary: Total hours not related to intervention effects on expressive language (spoken language).



Case & Yun (2019)	Outcomes (Motor skills)	Summary: Greater total hours related to greater intervention effects on motor skills.
Naveed et al. (2019)	Intervention delivery characteristics (Non-specialist mediated)	Summary: Intervention duration (weeks) not related to intervention effects. Number of intervention sessions not related to intervention effects.
Nevill et al. (2018)	Intervention delivery characteristics (Parent-mediated)	Summary: Total hours not related to intervention effect on autism core characteristics, socialisation, communication, or cognition.

Note: The effect of the amount of intervention on child and family outcomes was not reported in any systematic reviews focusing on developmental, sensory-based, TEACCH, technology-based, animal-assisted, CBT, and other interventions.

Table 9. Information on the influence of different intervention delivery characteristics on intervention effects.

Characteristic	Systematic review	Summary of evidence
Setting	Parsons, Cordier, Munro et al. (2017)	Intervention setting not related to intervention effects on social- communication.
	Kent et al. (2020)	Intervention setting (clinic, home) not related to the intervention effect on play.
Format	Parsons, Cordier, Munro et al. (2017)	Intervention format (individual, group) not related to intervention effects on social-communication.
	Kent et al. (2020)	Intervention format (individual, group) did not relate to intervention effects on play.
	Tachibana et al., (2018)	Intervention format (individual, group) did not relate to intervention effects on overall autism characteristics, social-communication, expressive language, receptive language, cognition, or adaptive behaviour.
Agent	Bejarano-Martín et al. (2020)	Interventions involving caregivers or teachers had a similar positive effect to those involving clinicians alone.



	Fuller & Kaiser (2020)	Intervention agent (clinicians, caregivers, school staff) not related to intervention effects on communication.
	Parsons, Cordier, Munro et al. (2017)	Positive intervention effect for interventions with active caregiver involvement, but not for interventions with parent education alone.
	Murza et al., (2016)	Intervention agent (caregiver, non-caregiver) not related to intervention effects on social-communication.
	Sandbank et al. (2020b)	Intervention agent (clinician, caregiver, educator, technology, combination, other) not related to intervention effects on communication.
	Hampton & Kaiser (2016)	Interventions involving clinicians and caregivers related to greater intervention effect on expressive language (spoken language) than clinicians or caregivers alone.
	Naveed et al. (2019)	Intervention agent (caregivers, peer, teacher, school staff, childcare worker) not related to intervention effects on autism core characteristics (including joint attention). Parent-implemented interventions related to greater effect on child joint engagement than peer/educator-implemented interventions.
	Watkins et al. (2019)	Interventions delivered by teachers had a greater intervention effect than interventions delivered by researchers or peers.



Question 5: What child characteristics influence intervention effects, with a focus on child age, core autism characteristics, cognition, and communication skills?

Three practice/category-focused SRs examined the influence of child characteristics on intervention effects (2 category, 1 practice; Table 10). At the category level for behavioural interventions, children's age, cognition, and communication skills prior to intervention were reported to not influence intervention effects (Makrygianni & Reed, 2010). Greater adaptive behaviour prior to the commencement of intervention was related to greater intervention effects on certain outcomes (adaptive behaviour, communication), but not others (cognition). At the category level for developmental interventions, there was an inconsistent relationship between the level of autism core characteristics and intervention effects on social-communication outcomes (Binns & Oram Cardy, 2019). A SR focusing on the Early Start Denver Model (NDBI category) reported that child age and greater levels of pre-intervention imitation were inconsistently related to intervention effects (Waddington et al., 2016). In this same SR, cognition prior to the commencement of intervention did not influence intervention effects, but greater abilities in certain skills (functional use of objects, goal understanding) was related to greater intervention effects.

The influence of child characteristics on intervention effects was examined in 6 outcome-focused SRs (Table 10). One SR reported that a younger age related to greater intervention effects on socialcommunication outcomes (Fuller & Kaiser, 2020). The other 5 SRs reported an inconsistent influence of age on intervention effects for social-communication (Bejarano-Martin et al., 2020; Parsons, Cordier, Munro et al., 2017) or no effect for communication (Sandbank et al., 2020b), expressive language (Hampton & Kaiser, 2016) and motor (Case & Yun, 2019) outcomes. Bejarano-Martin et al. (2020) reported no influence of child cognition or expressive language on intervention effects for social-communication outcomes. Sandbank et al. (2020b) reported that greater language skills prior to intervention related to greater intervention effects on communication outcomes. The level of core autism characteristics did not influence intervention effects on communication outcomes.

One intervention-delivery focused SR reported no influence of child age on the intervention effects of non-specialist mediated interventions (Naveed et al., 2009).

There was insufficient data to examine the influence of child comorbidities on intervention effects.



Table 10. Information on the influence of different child characteristics on intervention effects.

Child characteristic	Systematic review	Summary of evidence
Child age	Makrygianni & Reed (2010)	Behavioural intervention (category): Child age not related to intervention effect on communication, cognition, or adaptive behaviour.
	Waddington et al. (2016)	NDBI Practice (Early Start Denver Model): Child age inconsistently related to intervention effects.
	Bejarano-Martín et al. (2020)	Social-communication outcomes: Age inconsistently related to intervention effects on social-communication.
	Fuller & Kaiser (2020)	Social-communication outcomes: Age related to intervention effects on social-communication. Intervention effects increased from 2 to 4 years of age, but then diminished as children got older. Greatest intervention effects at around 4 years of age.
	Parsons, Cordier, Munro et al. (2017)	Social-communication outcomes: Age not related to intervention effects on social-communication.
	Sandbank et al. (2020b)	Communication outcomes: Age not related to intervention effects on communication.
	Hampton & Kaiser (2016)	Expressive language: Age not related to intervention effects on expressive language (spoken language).
	Case & Yun (2019)	Gross motor: Age not related to intervention effects on motor skills.
	Naveed et al. (2019)	Effect of non-specialist mediated intervention: Age not related to intervention effects.
Core autism characteristics	Binns & Oram Cardy (2019)	Developmental interventions (category): The level of pre- intervention core autism characteristics inconsistently related to intervention effects on social-communication.
	Waddington et al. (2016)	NDBI Practice (Early Start Denver Model): Greater pre- intervention imitation was inconsistently related to intervention effects. Functional use of objects, and goal understanding related to greater intervention effects.



	Sandbank et al. (2020b)	Communication outcomes: Level of overall autism characteristics prior to intervention not related to intervention effects on communication.
Communication	Makrygianni & Reed (2010)	Behavioural intervention (category): Pre-intervention communication (language abilities) not related to intervention effect (behavioural intervention) on communication, cognition, or adaptive behaviour.
	Bejarano-Martín et al. (2020)	Social-communication outcomes: Child communication skills prior to intervention not related to intervention effects on social-communication.
	Sandbank et al. (2020b)	Communication outcomes: Greater language skills prior to intervention related to greater intervention effects on communication.
Cognition	Makrygianni & Reed (2010)	Behavioural intervention (category): Pre-intervention cognition (intellectual abilities) not related to intervention effect (behavioural intervention) on communication, cognition, or adaptive behaviour.
	Waddington et al. (2016)	NDBI Practice (Early Start Denver Model): Pre-intervention cognitive ability and social attention not related to intervention effects.
	Bejarano-Martín et al. (2020)	Social-communication outcomes: Child cognitive ability prior to intervention not related to intervention effects on social-communication.
Adaptive behaviour	Makrygianni & Reed (2010)	Behavioural intervention (category): Greater pre-intervention adaptive behaviour skills related to greater intervention effects on communication and adaptive behaviour, but not on cognition.



Discussion

The current umbrella review provides a synthesis of evidence regarding the effects of interventions for children on the autism spectrum on a range of child and family outcomes. The research findings are presented in Tables 6-10, and the full data set is provided in Appendices M, N, O, P and T. A broad summary of the findings is presented in Table 11.

Table 11. Summary of the main findings of the umbrella review.

What non-pharmacological interventions have been examined in SRs?

- The umbrella review included 58 SRs, drawing on 1,787 unique articles.
- Interventions were categorised into behavioural interventions, developmental interventions, NDBIs, sensory-based interventions, technology-based interventions, animal-assisted interventions, CBT, TEACCH, and other interventions that do not fit within these categories.
- Across these intervention categories, information was reported on at least 111 intervention practices.
- The SRs were of variable quality, and only 4 of the 58 SRs met all quality criteria.

What effects do non-pharmacological interventions have on child outcomes?

- When examined at a category level (i.e., systematic reviews of an assortment of related practices), there was evidence for positive effects on a range of child and family outcomes for behavioural interventions, developmental interventions, NDBIs, technology-based interventions, and CBT. Within these categories, the intervention effect on outcomes was variable (null, positive) across intervention practices.
- Positive intervention effects for sensory-based interventions were reported for certain intervention practices only, and in those cases, positive effects were limited to select child and family outcomes.



- A mix of inconsistent and null intervention effects on child outcomes were reported for both TEACCH and animal-assisted interventions.
- Among 'other' intervention practices, only social skills training had evidence for a positive intervention effect on child outcomes.
- Minimal information was provided on adverse effects.
- The effects were predominantly derived from systematic reviews with lowmoderate quality evidence.

What effects do non-pharmacological interventions have on family wellbeing?

- Minimal information was reported on the effect of interventions on caregiver outcomes.
- There were practices within the developmental and NDBI categories that were reported to have a positive intervention effect on caregiver communication and interaction strategies.
- A positive intervention effect on caregiver social and emotional wellbeing was
 reported for individual practices within the NDBI and sensory-based intervention
 categories, and a null effect was reported on this outcome within the behavioural
 category.

What are the optimal delivery characteristics of non-pharmacological interventions?

Amount of intervention

- The amount of intervention varied widely both between and within intervention categories and practices.
- Minimal information was reported on the influence of the amount of intervention (e.g., total hours) on intervention effects.
- Within the behavioural intervention category, there was evidence that a greater amount of intervention related to greater intervention effects. However, this



effect on child outcomes varied between SRs, and null effects were also reported.

- For practices within the NDBI intervention category, the amount of intervention did not relate to intervention effects on most child outcomes examined.
- The effect of the amount of intervention on child and family outcomes was not reported for interventions within the developmental, sensory-based, technologybased, animal-assisted interventions, cognitive behaviour therapy, Treatment and Education of Autistic and related Communication-handicapped Children, and 'other' intervention categories.
- Intervention amount did not influence the effect of interventions targeting socialcommunication and communication outcomes.
- No evidence was reported on the amount of intervention that may maximise effects on child and family outcomes for any intervention category.

Intervention setting

- The majority of interventions were delivered in clinical, home or educational settings, with positive effects on a variety of child outcomes reported for all settings.
- Minimal information was reported comparing intervention effects between different intervention settings. In the few SRs that examined this, intervention effects on social-communication and play outcomes did not vary by setting.

Intervention format

- Evidence for a positive effect on child and family outcomes was reported for both individual and group interventions.
- Minimal information was reported comparing the effects of intervention when delivered in individual and group formats. In the few SRs that examined this, there was no difference between individual and group formats in the intervention effects on child outcomes.

Intervention agent

 Evidence for positive intervention effects on child outcomes were reported for interventions delivered by clinical practitioners, as well as for parent-mediated and peer-mediated interventions.



 Active caregiver involvement in intervention was reported to have a similar, and at times greater, intervention effect on child outcomes than those delivered by clinicians or educators alone.

Intervention mode

- The majority of evidence reported related to interventions delivered face-to-face.
- The few SRs that examined telepractice reported a positive intervention effect on select child outcomes, and a positive effect on a number of caregiver outcomes.
- No SR reported a comparison of intervention effects between telepractice and face-to-face delivery.

What child characteristics influence intervention effects?

- Minimal evidence was reported on the influence of child characteristics on intervention effects.
- The influence of child age on intervention effects was reported to be either inconsistent or null.
- There was no consistent evidence that other child characteristics (core autism characteristics, cognition, communication skills) influenced intervention effects.



What the review was able to answer

The findings from the current review fill an important knowledge gap in the evidence base regarding which interventions are more likely to have a positive effect on which child and family outcomes. These data (presented in Table 6) can be used in combination with the information presented in Chapter 2 to inform decision making around intervention choice, based on both the match between the principles of an intervention and the desires of the child and family, and the evidence for positive effects. This information is critical to the ethical and effective clinical service provision to children on the autism spectrum, affording families and clinical practitioners the greatest opportunity to make informed decisions when choosing interventions. The rigorous and consistent process for collating and synthesising the broad evidence base provides confidence and clarity to all stakeholders that the information presented within this report is supported by the highest-quality evidence available.

What the review was unable to answer

Table 6 provides a comprehensive summary of the current evidence base regarding which interventions have a positive effect on which child and family outcomes. What is apparent in this summary is the breadth of knowledge regarding interventions for children on the autism spectrum that remains unknown. Each blank cell in Table 6 represents an absence of high-quality empirical evidence, as it was defined in the current umbrella review (based on the NHMRC Evidence Hierarchy). Particular gaps in research evidence were noted for outcomes relating to education and participation, and family wellbeing. Critically, however, there has been an observable increase in the quantity of intervention research over the past decade (French and Kennedy, 2018), and so it is likely that further evidence will emerge in the coming years to build on the findings presented here.

While the review was able to report findings at a broad level (i.e., *which interventions have a positive effect on which outcomes*), the current body of research evidence does not afford an understanding of the effect of interventions at the individual level (i.e., *which interventions have a positive effect on which outcomes, for which children*). This limitation is driven by several aspects of the research literature. There is often inconsistency in how child characteristics are reported, and in some cases, these details are not reported at all. In part, this may reflect the exclusion of children with co-morbid conditions commonly associated with autism in some of the studies included in the reviews. Furthermore, the effect of child characteristics on intervention outcomes was rarely examined within individual SRs. Where these characteristics were examined, such as the effect of a child's age or autism characteristics on intervention outcomes, results were often inconsistent between SRs (Table 10). The majority of effects were derived from systematic reviews with low-moderate quality evidence, indicating the need for caution in interpreting the findings.



Similar challenges were experienced in the examination of the effect of intervention characteristics, such as the relationship between the amount of intervention provided to children and families and intervention outcomes. There was a lack of consistency in how the total amount of intervention was measured and reported both within and between SRs, which is likely a reflection, at least in part, of the reporting of the original intervention studies included in the SRs. The few studies that did examine whether the amount of intervention was related to child and family outcomes yielded no consistent evidence on the direction or strength of this relationship. Because of the absence of data, it would be incorrect to interpret these findings as there being no relationship between the amount of intervention and the effects on child and family outcomes. There was a broad range when it came to the amount of intervention reported for most intervention categories and practices (Appendix U), often with levels (e.g., hours per week, total hours) at the high and low extremes of the distribution, as well as a cluster of broadly similar amounts in between. It is likely that there will be a minimum and a maximum amount of intervention at which a positive effect is observed for any given practice, though this may differ for each child on the autism spectrum. The current research literature does not provide clear information on this minimum or maximum amount, nor how this is distributed in terms of intensity (e.g., hours/week) and total duration of the intervention program.

The delivery of any particular intervention practice can also vary by setting, format, agent, and mode. While there were more data available on intervention characteristics than for child characteristics and intervention amount, no greater clarity in findings emerged. The lack of clarity was driven primarily by a lack of relevant data, with an insufficient number of intervention studies that would enable SRs to compare different methods of intervention delivery. We urge particular caution in interpreting the findings relating to intervention setting, format and mode, for which few SRs were identified that had examined and compared the influence of these different characteristics on intervention effects.

It is important to highlight that the current review was designed specifically to examine and summarise intervention effects reported by SRs, and did not provide an examination of why these effects were observed. Chapter 2 describes, for each intervention category, the theoretical reasons that have been proposed as to why an intervention may have an effect on a child's development. While some theories have a well-established empirical evidence base (e.g., behavioural, developmental, NDBI), the empirical evidence underpinning the theoretical rationale for other intervention categories is less robust. An understanding as to why a particular intervention may have a positive effect on child development is critical to the goal of individualised service provision, and will further contextualise the findings presented in the current review. For example, it is important to understand if it is the purported causal mechanism or "active ingredient" of the intervention (e.g., the sensory input provided during sensory interventions, or the child's interactions with horses provided



during equine therapy) that leads to positive outcomes, rather than the impact of other variables such as regular interactions with a playful and engaging clinician.

Quality of SRs

The SRs included in the current umbrella review were of variable quality (Appendix R), and only 4 of 58 studies met every criterion on the Critical Appraisal Checklist for SRs and Research Syntheses (Joanna Briggs Institute, 2020). Common methodological areas where quality ratings were downgraded included the sources of the literature search (no search of grey literature), data extraction (not conducted by two independent reviewers), and the appropriate combining of studies (lack of detail reported). Further areas of potential bias include small sample sizes in a minority of SRs (as low as 66 participants), poor-reporting of study attrition, and inconsistent reporting of child and intervention characteristics.

One notable aspect of study quality was a lack of consideration of adverse effects, with only 8 of 58 studies making explicit mention of this critical aspect of intervention research. It is unclear whether this is a result of poor reporting in the original intervention study or at the SR level. The lack of reporting on adverse effects may reflect an assumption that non-pharmacological interventions carry a negligible risk of harm. However, this is an assumption that requires constant testing in order to meet the ethical obligations of intervention research. Explicit collection and reporting of data relating to adverse effects is a critical and urgent recommendation for further research in this area.

Limitations of the methodology

The findings of this review need to be interpreted in light of the strengths and limitations of the study methodology. Strengths of the study design included the systematic and reproducible approach to selecting, extracting, and synthesizing data from SRs. Independent data coding and complete data checks were conducted at each step of the review process. Furthermore, the publication of a publicly available study protocol (and author disclosures of interest) prior to the commencement of the review process provides transparency around the research processes undertaken.

As described in Chapter 2, the current review made two key methodological decisions *a priori* to facilitate the synthesis of a large and complex body of literature. The first was to focus on intervention categories and practices, and not techniques. The rationale for this decision was that application of intervention techniques alone are unlikely to support the needs of children on the autism spectrum across multiple developmental domains. However, we note that there is evidence for certain intervention techniques to have a positive effect on discrete developmental domains (National Autism Center, 2015; Steinbrenner et al., 2020), and that the application of these



techniques in combination, and in a way that is tailored to the abilities of an individual child, is fundamental to 'technical eclectic' approaches across a range of disciplines. The second decision was to adopt a particular method for categorising intervention practices that was based on shared theoretical underpinnings and principles (Sandbank et al., 2020a). While the categories applied in the current umbrella review were suitable for extracting and synthesising information from the vast majority of SRs, 6 SRs were excluded from review because a different approach to categorisation was used that made it impossible to summarise the findings. These SRs are identified in Appendix L.

A further limitation of the current review related to the mix of study designs incorporated within the included SRs. The highest level of evidence within the NHMRC Evidence Hierarchy are SRs of RCT designs. There are a limited number of SRs in this research area that meet these standards, and only 14 of the 58 SRs included in the current umbrella review included RCTs only. To circumvent the potential issue of limited data being available for review, the pre-defined study protocol expanded inclusion criteria to SRs that included at least one clinical trial (RCT), quasi-RCT, and/or controlled clinical trial. Single Case Experimental Designs were included, where accompanied by at least one controlled-group trial. While this method ensured that each SR included data from a controlledgroup study, the summaries and conclusions from a given SR may have been drawn from a broader pool of studies of varying designs. There were differences between SRs in how data from individual studies were reported, and so it was not possible to apply a consistent and accurate method for extracting and summarising data from controlled-group designs only. The inclusion of broader study designs increases the risk of methodological bias of the data included in this review. While the current umbrella review represents a summary of best available evidence of interventions for children on the autism spectrum, this is an important limitation to consider in interpreting the conclusions of this report.

The purpose of an umbrella review is to summarise findings, but that does not negate the importance of reading the systematic reviews and original studies from which the findings have been derived. The current umbrella review summarised the nature of effects and contexts in which they were derived, but readers are also directed to the original studies for information about the specific tools and the way effects were analysed (e.g., within the intervention group only, comparing two different interventions, comparing an intervention with treatment as usual). It is also critical to acknowledge the challenges of translating research findings into broader clinical practice. The research evidence presented in the current report was generated predominantly through studies conducted in well-controlled settings, which is often very different to real-world clinical practice. Real-world clinical practice encompasses many challenges including, but not limited to, staff training costs to deliver evidence-based interventions, and the equitable provision of services to diverse client groups, including those with multiple co-morbidities, and those from different cultural



backgrounds or remote geographical locations. In recent years, there has been an increase in the amount of research being conducted within routine clinical practice, such as through the Autism Specific Early Learning and Care Centres (ASELCCs) supported by the Australian Government, and other community clinics. The continued integration of research into clinical services will likely be key to bridging the gap between scientific research and real world outcomes.

Implications for clinical practice

The current review fills an importacnt knowledge gap in our understanding of interventions for children on the autism spectrum. The findings are a summary of the best available evidence of the effects of a range of intervention categories and practices, and on which child and family outcomes. This information is critical to support clinical and policy decision making regarding the most appropriate clinical supports for children on the autism spectrum and their families. The information also serves an important role in supporting caregivers to make informed decisions regarding the interventions they access to support their child(ren)'s learning and participation in all aspects and activities of their lives.

A key finding of this review was the variability in outcomes observed both between and within intervention categories. This finding emphasises the need for clinical decision making to be embedded within an evidence-based practice framework. Evidence-based practice is not a 'cookbook' approach, which mandates strict adherence to a recipe of ingredients. Rather, the approach endorses the application of the best scientific evidence available in combination with an appraisal of contextual factors, such as clinical experience and child and family preferences and priorities. The current report represents an important step forward in promoting this approach.

Implications for future research

The umbrella review also provides a foundation for future research into interventions for children on the autism spectrum. Table 6 outlines a summary of the current evidence base linking intervention practices with child and family outcomes. Each blank cell in this table represents knowledge that could not be obtained through the current review process. Future research of the intervention categories and practices included in the current review can be informed by this information to determine research gaps and priorities.

A clear shortcoming of the current evidence base is a lack of understanding of how the effect of interventions may differ according to child characteristics (e.g., child age, core autism characteristics, cognition, communication skills) and intervention characteristics (e.g., intervention amount, setting, format, agent, mode). Individuals on the autism spectrum vary widely in their profiles of strengths, support needs, and behavioural characteristics, and it is often observed that there is no 'one size fits



all' approach to intervention during childhood. The findings of the review provide empirical evidence supporting this clinical observation. A related consideration is that not all interventions are specifically designed to cater for all children, and this may affect the suitability of an approach for a particular child (e.g., CBT for a preschool aged child with minimal functional language) and the nature and consistency of effects. It is possible, for instance, that interventions that are designed specifically for children with the most complex needs, who typically have co-morbid conditions (e.g., intellectual disability, hearing and vision impairment, epilepsy) and greater variability in support needs, will yield more inconsistent results than interventions that are designed for children with fewer comorbidities. For this reason, we have focused on the direction of effect (positive, null, inconsistent) in reporting the findings in Table 6 and Appendix V, rather than the magnitude of effect (although see Appendix T for effect sizes). Nevertheless, when interpreting the findings, it is important that readers avoid simplistic comparisons of the effects of intervention categories and practices, without also considering for whom the interventions have been designed and in what populations they have been evaluated. Equally important is an understanding that each child and caregiver will vary widely in their individual goals, preferences, perspectives, and priorities. While the findings of the current review provide key information that can inform intervention selection for children on the autism spectrum, the existing research literature does not provide a clear indication as to how these interventions can then best be tailored to the individual child to optimise the intervention effect. Studies that systematically examine different intervention characteristics, or compare intervention responses across children with different characteristics, are critical to advancing knowledge beyond the findings of the current review.

The majority of intervention research to date has taken place in North America, Europe and Australia, which have populations with a majority White/Caucasian background. The lack of cultural diversity in intervention research is particularly salient to the provision of services to Australia's First Peoples: Aboriginal and Torres Strait Islander communities. A recent report highlighted the stark absence of research in this area, and the urgent need to better understand the life experiences of individuals on the autism spectrum in these communities (Lilley, Sedgwick & Pellicano, 2019). A community-directed research strategy that identifies the needs, priorities and preferences of the Aboriginal and Torres Strait Islander communities is critical to meeting the obligation for ethical clinical practice in Australia (see Chapter 1).

Another aspect to highlight for future research is how intervention effects are defined and measured. In the current review, a 'positive effect' represented the desired effect of an intervention on a child or family outcome as defined by the authors of the SR. Most commonly, the measured effects were improvements in developmental skills and abilities, or reductions in autism characteristics (see Table 6). Notably, there were a paucity of studies that recorded measures of



child and family wellbeing, particularly in the area of quality of life. For all models of disability, the primary purpose of intervention is to increase participation in daily life (see Chapter 2). To test interventions against this goal, it is critical to not just measure developmental outcomes that may contribute to this goal, but also the goal itself. Understanding how intervention outcomes may generalise to improvements in child and family wellbeing and participation, and whether any improvements are sustained over time, are critical areas of focus for future intervention research. Central to this recommendation is the involvement of autistic individuals and their families in each phase of the research process. Grounding research in the lived experience of the autistic community provides the greatest opportunity for research to generate outcomes that are meaningful to, and have a positive impact on, the lives of children on the autism spectrum and their families.

This report is published at a crucial period of evolution within the Australian disability community. Australia is part of a worldwide shift in community expectations regarding the role of early intervention in the lives of children on the autism spectrum and their families (see Chapter 2), including a clear recognition of the importance to the clinical and research landscapes of consumers who are informed and equal partners in decision making. Furthermore, the introduction of the NDIS has created sector-wide change in the choice and control exerted by individuals on the autism spectrum and their families over their own clinical management, and presented increased opportunities for the development of policies that are consistently applied across Australia. This report can play an important role in maintaining this momentum, and provides a robust foundation of evidence upon which consumers and policy-makers can combine efforts to develop guidelines that ensure the delivery of evidence-based supports to children on the autism spectrum within the Australian community.

The findings presented in this report reflect the best available evidence, as defined by the review, as of the date of publication. However, the current review highlighted a rapidly developing intervention research literature, with more than half of the included SRs published in the previous 3 years (2018-2020). To maintain relevance and impact, it is critical that the information contained in this report is updated regularly. It is recommended that this report becomes the basis for a living review that is continually updated as new evidence emerges.



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Appendix A: Overview of intervention categories

	Theoretical premise	Intervention examples	Examples of principles from particular intervention practices
Behavioural	Children learn new skills based primarily on the consequences of their behaviour (operant learning)	EIBI, DTT, PECS, PBS	ABA. <i>7 Dimensions:</i> Applied; Behavioural; Analytic; Technological; Conceptually systematic; Effective; Generality
Developmental	Children learn new skills primarily through interactions with people and environments (cognitive and social constructivist theories)	DIR Floortime; PACT	PACT. <i>General Principles:</i> Developmental orientation; Focus on naturalistic interactions; Caregiver directed.
Naturalistic Developmental Behavioural Interventions	Children learn new skills, through interactions with other people and environments (behavioural and constructivist theories)	ESDM, PRT, JASPER	ESDM. <i>Core features:</i> three-part contingency; manualised practice; fidelity; individualised goals; progress monitoring; child-initiated teaching; environmental arrangement; natural contingencies; prompting and prompt fading; balanced turns; modelling; adult imitation; broadening child's attentional focus.
Sensory-based	Children's learning can be enhanced by addressing neurophysiological impairments in sensory processing	ASI, sensory diets, weighted blankets, swinging, AIT, music therapy	Sensory Integration. <i>Core Process Elements:</i> Sensory opportunities; challenges; choice; self-organisation; optimal arousal; play; success; safety; therapeutic alliance



Technology-based	Technology use complements children's diagnostic characteristics thus supporting learning and participation	AAC, computer- based instruction.	AAC. <i>Principles:</i> Strengths-based approach to intervention; technology as a component of a broader approach to supporting learning and participation; learning should occur in real world contexts.
Animal-assisted	Human-animal interactions may be particularly motivating and provide a context for learning and improved wellbeing	Assistance dogs, THR, dolphin therapy	Canine-based approaches. <i>Best Practice Guidelines:</i> People providing services must have appropriate qualifications, ensure services are appropriate and ethical, and engage in professional development.
Cognitive behaviour therapy	People can learn to identify and replace unhelpful thoughts, leading to positive effects on emotions and behaviour	A discrete intervention	<i>Essential components:</i> Appropriate assessment; psychoeducation; development of coping skills; use of exposure tasks; contingency management.
TEACCH	Children learn new skills most effectively when the environment is adapted to their learning characteristics.	A discrete intervention	<i>Essential mechanisms:</i> structured environment; use of visual supports; utilise special interests; support self-initiated communication.
Other	Interventions in this category do not alig specific categories identified.	gn directly with the featu	res (theoretical premise, clinical application, and principles) of one of the eight



(AAC) Augmentative and Alternative Communication; (AIT) Auditory Integration Training; (ASI) Ayres Sensory Integration; (DTT) Discrete Trial Training; (EIBI) Early Intensive Behavioural Intervention; (ESDM) Early Start Denver Model; (EMT) Enhanced Milieu Teaching; (JASPER) Joint Attention, Symbolic Play, Engagement, and Regulation; (PECS) Picture Exchange Communication System; (PRT) Pivotal Response Training; (PBS) Positive Behaviour Support; (SI) Sensory Integration (SI); (TEACCH) Treatment and Education of Autistic and related Communication-Handicapped Children; (THR) Therapeutic Horse Riding.



Appendix B: An illustration of the relevance of behavioural theory and practice across four intervention practices.





Broad category	Specific outcomes	Operationalised definition	Examples of terms used to describe these outcomes in included systematic reviews	Examples of measures used to examine these outcomes in included systematic reviews
Core autism characteristics	Overall autism characteristics	This outcome was coded where authors provided a global measure of autism symptoms or characteristics.	ASD/autism symptom severity; autism general symptoms; diagnostic characteristics of autism; general symptoms; severity of autism; symptoms associated with autism/ASD.	Autism Diagnostic Interview; Autism Diagnostic Observation Schedule; Autism Screening Questionnaire.
	Social-communication	The following definition was used to guide coding for measures of social-communication (Volkmar, 2013): "Social communication is a broad term that describes the vast amount of verbal and nonverbal behaviors used to interact with other people. Examples of the verbal and nonverbal behaviors are (but are not limited to) speech, prosody, gestures, and facial expressions. These behaviors can be used to initiate or respond to joint attention, to share emotion with others, or to signal when an individual wants the attention of another person, along with many other uses." The term 'social-communication' emphasises the pragmatic (functional) use of language. Accordingly, variables that relate primarily to	Child initiations; interpersonal; joint attention; non-verbal behaviours; pragmatic language; qualitative impairment in social interaction; reciprocity of social interaction towards others; shared engagement; socialisation; social- communication; social and emotional development; social adaptation; social skills.	Early Social Communication Scales; Vineland Adaptive Behaviour Scales (Socialisation); Observational measures of initiation and response to joint attention.

Appendix C: Outcomes included in the umbrella review



	Stereotypies: "Stereotypies are repetitive, persistent, non-goal, and apparently purposeless		
	Restricted interest: "A limited set or limited number of interests and/or activities Restrictive interests may be repetitious (i.e., spinning a wheel) and/or limited in scope or range (i.e., a narrow or limited range of items that hold the individual's interest)."		
Restricted and repetitive interests and behaviours	The following definition was used to guide coding for measures of restricted and repetitive interests and behaviours (Volkmar, 2013): Repetitive behaviours: "The term "repetitive behaviors" refers to abnormal behaviors that are characterized by repetition, rigidity, inappropriateness, and lack of adaptability. They include motor stereotyped behaviors, self- stimulatory behaviors, self-injurious behaviors, compulsive or sameness behaviors, and verbal repetitive behaviors such as echolalia."	Repetitive behaviours; Repetitive and maladaptive behaviours; Restrictive and repetitive behaviours; Restricted, repetitive, non-functional patterns of behaviour, interests, or activity.	Repetitive Behaviour Scale; Autism Diagnostic Observation Schedule (Restricted and Repetitive Behaviours).
	children expressing a pragmatic function (e.g., requesting, commenting, sharing) were coded as 'social-communication'. Measures were coded under other communication related categories ('communication', 'expressive language', 'receptive language'), where: (a) these terms were used explicitly and/or (b) the outcome emphasises the proficiency of expressive or receptive language (e.g., syntax, grammar, morphology) in comparison to other children of similar age.		



		 motor actions and speech patterns which are carried out in a rhythmic and uniform way that serves no obvious adaptive functioning." A separate category for social-emotional/challenging behaviours was also included in the current review. Measures were coded according to the context in which the authors of a systematic review used the term. 		
	Sensory behaviours	The following definition was used to guide coding for measures of sensory behaviours (Volkmar, 2013): Sensory seeking: "Sensation-seeking is the tendency to pursue sensory stimulation and excitement. Sensory avoiding: "Sensation avoiding is the	Sensory or emotion regulation; sensory skills; sensory-related outcomes.	Sensory Profile; Sensory Integration and Praxis Test; Test of Sensory Integration Function.
		tendency to avoid sensory stimulation."		
Related skills and development	Communication	Please note the differentiation between 'social- communication' and 'communication' categories described in the 'social-communication' entry. 'Communication' was coded where: (a) the term was used to describe the outcome; and/or (b) The outcome refers to a set of behaviours that together enhance the child's capacity to understand, and/or be understood by others. This latter definition was based on that described in Volkmar (2013).	Child communication; communication; communication- language; communication and language skill; composite language; general language; gestures; joint language; language; qualitative impairment in communication;	MacArthur Bates Communicative Development Inventory (Composite); Mullen Scale of Early Learning (Language); Vineland Adaptive Behaviour Scale (Communication).
	Expressive language	Please note the differentiation between 'social- communication' and 'expressive language'	Expression; expressive language; speech or vocalisation; speech	MacArthur Bates Communicative Development



	categories described in the 'social- communication' entry. 'Expressive language' was coded where: (a) the term was used to describe the outcome; and/or (b) The outcome referred to a skill that enhances a child's capacity to be understood by others via a range of modalities such as vocalisations, speech, gesture, and augmentative communication. This latter definition was based on that described in Volkmar (2013).	outcomes; spoken language; words produced.	Inventory (Vocabulary Produced); Vineland Adaptive Behaviour Scale (Expressive Language).
Receptive language	Please note the differentiation between 'social- communication' and 'receptive language' categories described in the 'social- communication' entry. 'Receptive language' was coded where: (a) the term was used to describe the outcome; and/or (b) The outcome referred to a skill that enhances a child's capacity to be understood by others via a range of modalities such as vocalisations, speech, gesture, and augmentative communication. This latter definition was based on that described in Volkmar (2013).	Comprehension; receptive language.	MacArthur Bates Communicative Development Inventory (Vocabulary Produced); Vineland Adaptive Behaviour Scale (Expressive Language).
Cognition	The following definition was used to guide coding for measures of cognition (Volkmar, 2013): "The term "cognition" refers to mental processes or forms of information processing. These processes include attention, memory, learning, decision making, reasoning, and problem solving. In the study of autism, a distinction often	Child cognitive or educational strengths; cognition; cognitive; cognitive development; developmental quotient; developmental/ intellectual gains; full scale IQ; higher cognitive functioning; non-verbal cognitive	Bayley Scales of Infant Development; Mullen Scale of Early Learning (Developmental Quotient); Wechsler Preschool and Primary Scale of Intelligence.



	is drawn between social and/or nonsocial forms of cognition given the presumed centrality of social deficits to the disorder."	skills; non-verbal IQ; visual reception.	
Motor	The following definition was used to guide coding for measures of motor (Volkmar, 2013): "Fine motor skills are also termed hand skills, fine motor coordination, object manipulation, or dexterity. Components of fine motor development include reach, grasp, release, in- hand manipulation, and bimanual coordination" "Gross motor abilities entail the use of large muscle groups that coordinate body movements to perform activities such as maintaining balance, walking, sitting upright, jumping, throwing objects, etc."	Fine motor; gross motor performance; motor; motor and fine motor; motor skills.	Mullen Scale of Early Learning (Gross Motor/Fine Motor); Vineland Adaptive Behaviour Scale (Fine Motor/Gross Motor).
Social- emotional/Challenging behaviour	The following definition was used to guide coding for measures of social- emotional/challenging behaviour: Social-Emotional: "Behavioural and emotional strengths and ability to adapt and deal with daily challenges (resilience and coping skills) and respond positively to adversity while leading a fulfilling life" (AIHW 2012). Challenging behaviour: "Challenging behavior refers to certain behaviors that a person engages in which negatively affect his/her daily functioning. These behaviors are often recognized as being culturally abnormal and	Adaptive/maladaptive behaviour; behaviour; behavioural skills; challenging/interfering behaviour; classroom behaviour; disruptive behaviour; hyperactivity; maladaptive behaviour; problem behaviour; self-regulation; social emotional/challenging behaviour.	Aberrant Behaviour Checklist (Irritability); Eyberg Child Behaviour Inventory (Intensity of problem behaviour).



		that the safety of the person and/or others is placed in jeopardy. Challenging behaviors may be related to social, academic, communicative, cognitive, vocational, or physical domains, may serve various functions, and should be examined systematically in order to identify these functions." (Volkmar, 2013)		
	Play	The following definition was used to guide coding for measures of play skills: A set of behaviours referred to as 'play' by the study authors and encompassing various characteristics including exploratory, functional, parallel, sensorimotor, and pretend. The investigators of the current review formulated this definition based on definitions for a range of play activities provided in Volkmar (2013).	Play.	Structured Play Assessment.
	Adaptive behaviour	The following definition was used to guide coding for measures of adaptive behaviour (Volkmar, 2013): "The collection of conceptual, social, and practical skills that have been learned by people in order to function in everyday lives. Adaptive behavior is best understood as the degree to	Adaptive behaviour; adaptive/self- help; daily living skills; functional skills; personal responsibility.	Vineland Adaptive Behaviour Scale (Composite); Vineland Adaptive Behaviour Scale (Daily Living Skills).



		which individuals are able to function and maintain themselves independently and meet cultural expectations for personal and social responsibility at various ages."		
	General outcomes	This outcome was coded where authors did not specify a specific outcome, but provided a global measure of the effect of an intervention.	Condition specific outcomes; child behavioural functioning and development; efficacy outcomes; functioning and participation; outcomes.	N/A
Education and participation	School/learning readiness	The following definition was used to guide coding for measures of school/learning readiness (UNICEF, 2012): "School readiness is a combination of three domains: learned behaviours such as knowing colours and shapes, counting numbers and saying letters of the alphabet; attitude and emotional competence, as in listening to directions, being interested in learning and behaving in a socially acceptable manner; and developmental maturation, including fine and gross motor development and sitting still for an appropriate period of time." "Placement" was also included under school/learning readiness. The definition was created by the investigators of the current review: Provisions required to support a child in educational (e.g., specialist school versus mainstream, in classroom support), residential	Academic placement; learning readiness; placement; school readiness.	Non-specific measures of following instructions, sitting skills, attending to environmental sounds; placement in mainstream settings.



		(e.g. home versus out of home care), or community settings.		
Academ	nic skills	The following definition was used to guide coding for measures of academic skills (Volkmar, 2013): "Academic skillsrefer to skills in subject areas that form the academic curriculum, available to all children in that country."	Academic/s.	Non-specific, observational and/or self-created measures of fluency, latency, reading, writing, mathematics, science, history, or skills required to study or perform well on exams.
Quality	of life	The following definition was used to guide coding for measures of quality of life (WHO, 2020): "An individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns."	Joy; quality of life.	Pediatric Quality of Life Generic Core Scales; General Activities Subscale of the Quality of Life Enjoyment and Satisfaction Questionnaire.
Commun	nity participation	The following definition was used to guide coding for measures of participation: A child's ability to participate in activities within the community. The investigators of the current review formulated this definition.	Academic placement; functional participation.	Percentage of time spent with typically developing peers.



Family wellbeing	Caregiver communication and interaction strategies	The following definition was used to guide coding for measures of caregiver communication and interaction strategies: Caregiver behaviour proposed by the authors to be beneficial to promoting communication and interaction abilities in children on the autism spectrum. The investigators of the current review formulated this definition.	Fidelity; knowledge acquisition; parental responsiveness; parental synchrony; parents' use of intervention strategies	Observational and/or self- created measures of fidelity, parent use of communication strategies, parental responsiveness, and parent synchrony.
	Caregiver social emotional wellbeing	The following definition was used to guide coding for measures of caregiver social emotional wellbeing (AIHW, 2012): "Behavioural and emotional strengths and ability to adapt and deal with daily challenges (resilience and coping skills) and respond positively to adversity while leading a fulfilling life".	Parent behaviours; Parenting efficacy; parental stress; parental distress; parental self-efficacy; parent-child relationship; parents' confidence; quality of family relationships.	Maternal Behaviour Rating Scale; Parenting Sense of Competence; Questionnaire of Resources and Stress.
	Caregiver satisfaction	The following definition was used to guide coding for measures of caregiver financial impact: Caregivers' views regarding the appropriateness and acceptability of intervention goals, methods, and/or outcomes. The investigators of the current review formulated this definition.	Customer satisfaction; satisfaction and acceptability; social validity.	Various surveys of parent satisfaction and perceptions of social validity.



	Caregiver financial wellbeing	 The following definition was used to guide coding for measures of caregiver financial impact: Direct or indirect consequence to caregivers of accessing an intervention measured in monetary terms. The investigators of the current review formulated this definition. 	Cost of intervention; reduced costs.	Not specified
	Child satisfaction	The following definition was used to guide coding for measures of child satisfaction with intervention: Children's' views regarding the appropriateness and acceptability of intervention goals, methods, and/or outcomes. The investigators of the current review formulated this definition.	Child distress.	Not specified.
Adverse effects	Child related adverse effects	The following definition was used to guide coding for measures of child-related adverse effects Undesired and/or harmful effects of the intervention on the child. These can be immediate effects or longer-term effects. The investigators of the current review formulated this definition.	Adverse effects; deterioration; increases in stereotypy and problem behaviour.	Participants excluded due to refusal or distress; deterioration on measures of tantrums, anxiety, and aggression.



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Appendix D: Umbrella review study protocol

Title

An umbrella review of non-pharmacological interventions for children on the autism spectrum.

Study aim

To generate a synthesis of evidence from systematic reviews regarding the therapeutic and other effects of non-pharmacological interventions for children on the autism spectrum.

Review questions

- What non-pharmacological interventions have been examined in systematic reviews?
- What effects do non-pharmacological interventions have on child outcomes?
- What effects do non-pharmacological interventions have on family wellbeing?
- What are the optimal delivery characteristics of non-pharmacological interventions?
- What child characteristics impact on intervention outcomes?

Searches

- 1. We will conduct electronic searches of the following databases for peer-reviewed systematic reviews published in English.
 - a. PsycINFO
 - b. Education Resources Information Centre (ERIC)
 - c. Medline
 - d. PubMed
 - e. EMBASE
 - f. CINAHL
 - g. Cochrane Database of Systematic Reviews
 - h. Scopus
 - i. EBSCO Education Source
 - j. Epistemonikos
- 2. We will conduct a search for grey literature by searching:
 - a. Google advanced search (limited to first 100 results per search)
 - b. PROSPERO
 - c. Abstracts submitted to International Society for Autism Research (INSAR) conferences, and identification of corresponding full text publications.



3. We will also conduct ancestral searches using the reference lists of all included systematic reviews and relevant umbrella reviews or "reviews of reviews" identified by the search.

Search terms

We will conduct a search of subject headings (using corresponding MeSH terms related to autism in each database) and keywords using the terms:

Autis* OR ASD* OR Asperger* OR "pervasive developmental disorder*" OR PDD* OR "pervasive child development disorder*" OR "pervasive childhood developmental disorder*" OR PCDD* OR "disintegrative disorder*"

AND

intervention* OR therap* OR treat* OR teach* OR program* OR package*

AND

"systematic review*" OR "systematic literature review*" OR "evidence synthes*" OR "meta-analy*" OR "meta-regression*"

It is known that the vast majority of RCTs in this research area have been conducted post 2010 (French & Kennedy, 2018). Because of this (and to ensure currency), we will limit the search to systematic reviews published from 2010 to present.

Types of studies to be included

Inclusion criteria:

Systematic reviews will be included in the umbrella review if they meet the following inclusion criteria:

- The review was a systematic review, with or without meta-analysis. A review will be considered "systematic" if it: (1) includes a clear statement of the purpose of the review; (2) describes the search strategy (i.e., key search terms, multiple relevant databases, specification of search limits); (3) indicates the criteria used to select studies for inclusion; (4) presents all findings relevant to the main purpose of the review, including those that did not favour the intervention; and (5) uses a method of quality appraisal for each included study.
- The systematic review reports on at least one non-pharmacological intervention that targets the acquisition of developmental or educational skills.



- The systematic review includes at least one clinical trial (RCTs), quasi-RCT, and/or controlled clinical trial. Systematic reviews that include studies with other designs will be included only if they also feature at least one randomised controlled trial (RCTs), quasi-RCT, and/or controlled clinical trial.
- The systematic review reports summarised, quantitative data on the impact of the intervention on one or more of the main outcomes of interest (described below).
- The systematic review is published in a peer-reviewed journal or published as a publicly available scientific report.
- The systematic review has full-text copies available in the English language.

Exclusion criteria:

- Systematic reviews that do not meet the criteria to be considered "systematic".
- Umbrella reviews, rapid reviews, or "reviews of reviews".
- Systematic reviews that did not include at least one RCTs, quasi-RCT, and/or controlled trial.
- Systematic reviews that did not report on at least one non-pharmacological intervention that targets the acquisition of developmental or educational skills.
- Systematic reviews focussing solely on dietary, sleep, exercise, chiropractic, massage, acupuncture, reflexology, kinesiology, shock therapy, neurofeedback, transcranial magnetic stimulation, or hyperbaric oxygen therapy interventions. While non-pharmacological, these interventions are beyond the scope of the review.
- Systematic reviews focusing solely on techniques (defined as one specific strategy) rather than an intervention (i.e., a collection of techniques).
- Systematic reviews that did not report summarised outcomes of interest relevant to the current umbrella review.
- Systematic reviews that incorporate theoretical studies, text, and opinion as their primary source of evidence.
- Theses, conference papers, newsletters.
- Systematic reviews where full-texts are not available in English.

Conditions or domain being studied

Autism.

Participants

Inclusion criteria:



- Systematic reviews that report on interventions that were trialled in children on the autism spectrum (0-12 years of age). Systematic reviews that include children described as increased likelihood or suspected of autism will be included only if the review also included children on the autism spectrum. Systematic reviews that specify in the aims and/or search criteria that studies including children with developmental conditions other than autism (e.g., Down syndrome, global developmental delay) were specifically targeted, will only be included if outcomes were reported separately for children on the autism spectrum. Data will also be extracted from reviews which report on caregiver outcomes as described in the outcomes section.
- Priority for inclusion will be given to systematic reviews that are either limited to, or report
 outcomes separately for younger children (within the age range of 0-12 years). Where there are
 no systematic reviews identified for a specific intervention that meets this criterion, we will
 include systematic reviews that report outcomes for children both within and beyond the 0-12
 age range.

Exclusion criteria:

- Systematic reviews that report on interventions with children with other developmental conditions that are not autism, or where outcomes for children on the autism spectrum specifically cannot be extracted and those that only include children described as increased likelihood or suspected of autism.
- Systematic reviews that do not involve children ≤12 years of age and/or include individuals over 18 without a separate analysis of younger children. If a systematic review for a specific intervention is identified that reports outcome separately for children 0-12 years of age, then we will exclude systematic reviews of the same intervention that involved children over 12 years of age without a separate analysis of younger children.

Intervention(s), Exposure(s)

This umbrella review will focus on non-pharmacological interventions that target the acquisition
of developmental or educational skills, such as developmental (e.g., Preschool Autism
Communication Therapy), behavioural (e.g., early intensive behavioural intervention), sensory
(e.g., sensory integration therapy), technological (e.g., alternative and augmentative technology),
naturalistic developmental and behavioural interventions (e.g., Early Start Denver Model),
cognitive behaviour therapy, TEACCH, and animal-assisted interventions (Sandbank et al,
2020a). For the purpose of the umbrella review, an *intervention* is defined as a collection of
techniques, applied in combination, in an attempt to support the acquisition of developmental or
educational skills. *Intervention* details will be extracted, and findings summarised, based on and
using the intervention labels used by the systematic review authors, whether it be for a specific



practice or a broader category of practices. There will be no limits on intensity, duration, or setting in which the intervention is provided.

Comparator(s)/controls

Systematic reviews reporting on any comparison/control group will be included. Comparison/control groups could include:

- 1. Individuals receiving no intervention (e.g., wait-list control) and/or minimal intervention support (e.g., general parent/caregiver education).
- 2. Individuals who receive treatment-as-usual (including 'eclectic intervention'/treatment) or another intervention approach.
- 3. In the case of single case experimental designs within/across participants, control is implicit in the designs.

Outcomes:

The following list includes all outcomes of interest; no additional outcomes will be included in the umbrella review. All measurement tools will be included and there will be no minimum follow-up time.

- Core autism characteristics. Specifically, social-communication skills, restricted and repetitive interests and behaviours, sensory behaviours.
- Related skills and behaviours. Specifically, expressive language, receptive language, cognition, motor, social-emotional/challenging behaviour, play skills.
- Adaptive behaviour.
- Education. Specifically, school/learning readiness, academic skills, placement/support.
- Community participation.
- Parent/caregiver experience. Specifically, caregiver communication and interaction strategies, attrition, caregiver social emotional wellbeing, financial support, caregiver satisfaction with intervention.
- Child experience. Specifically, child satisfaction, child related adverse effects, attrition.

Data extraction

The studies retrieved using the search strategy will be screened for eligibility according to the inclusion criteria based on title and abstract. Titles and abstracts will be screened by two reviewers. Full texts will then be retrieved for all potentially eligible studies and reviewed by two reviewers. Screening of titles and abstracts, and full texts will be managed using Covidence software. The



reviewers will independently determine inclusion based on the study meeting all inclusion criteria. The two reviewers will discuss and resolve any discrepancies. If an agreement cannot be reached, a third reviewer will be consulted. Inter-rater reliability for study screening will be calculated using Cohen's kappa coefficient.

The review will follow the PRISMA-style flow chart.

Information relating to specific variables for data extraction is included in Appendix C.

For a randomly selected 20% of included systematic reviews, two authors will independently extract the data into a spreadsheet. For the remaining 80%, one reviewer will extract the data and a second reviewer will crosscheck the extraction. Agreement will be determined by reviewing the systematic review and data entered in the spreadsheet on a cell by cell (e.g., participant characteristics, intervention description) basis. The two reviewers will discuss and resolve any discrepancies. If an agreement cannot be reached, a third reviewer will be consulted. Inter-rater reliability for data extraction will be calculated separately for the independently extracted data and the crosschecked data using Cohen's kappa coefficient.

To determine the degree of overlap between systematic reviews, the specific primary publications included in each review will be presented in a table. The "corrected covered area" will be calculated (Pieper et al., 2014) based on the contents of this table. This will be reported across all systematic reviews, and for each specific practice and broader category of intervention.

Types of studies to be included:

Please refer to inclusion/exclusion criteria above.

Risk of bias (quality) assessment

Two reviewers will independently assess each included systematic review using the Critical Appraisal Checklist for Systematic Reviews and Research Syntheses created by the Joanna Briggs Institute (Aromataris et al., 2015). The two reviewers will discuss and resolve any discrepancies. If an agreement cannot be reached, a third reviewer will be consulted. Inter-rater reliability for risk of bias assessment will be calculated using Cohen's kappa coefficient. All reviews will be included regardless of methodological quality.

Strategy for data synthesis

Systematic narrative review (see data extraction) structured around the current umbrella review's main outcomes for all included intervention practices and/or categories of intervention. Systematic



reviews will first be collated into a table providing a broad overview of the study details (author, date, range of diagnoses, age range, number of included studies etc.), along with corresponding quality assessment ratings. Summary tables will then be created that synthesise the extracted data across systematic reviews and will be structured to focus on the key research questions of the umbrella review.

References

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French, L., & Kennedy, E. M. M. (2018). Annual Research Review: Early intervention for infants and young children with, or at-risk of, autism spectrum disorder: a systematic review. *Journal of Child Psychology and Psychiatry*, *59*(4), 444-456. doi:10.1111/jcpp.12828

Pieper, D., Antoine, S. L., Mathes, T., Neugebauer, E. A., & Eikermann, M. (2014). Systematic review finds overlapping reviews were not mentioned in every other overview. *Journal of Clinical Epidemiology*, 67(4), 368-375.

Sandbank, M., Bottema-Beutel, K., Crowley, S., Cassidy, M., Dunham, K., Feldman, J. I., Crank, J., Albarran, S. A., Raj, S., Mahbub, P., & Woynaroski, T. G. (2020). Project AIM: Autism intervention meta-analysis for studies of young children. *Psychol Bull,* 146(1), 1–29. doi.org/10.1037/bul0000215



Appendix E: Variations to protocol

Protocol submitted of Open Science Framework	Variation to protocol	Rationale
Eligibility criteria Not included	Eligibility criteria SRs excluded if: "The SR was limited by geographical region, that is, the search and/or inclusion/exclusion criteria were limited to specific countries, continents, or other geographical areas."	The reviewers determined that it was not appropriate to include SRs limited by geographical region, as it was not possible to draw generalised conclusions about intervention effects.
 Outcomes Outcomes were categorised as follows: Core autism characteristics. Specifically, social-communication skills, restricted and repetitive interests and behaviours, sensory behaviours. Related skills and behaviours. Specifically, expressive language, receptive language, cognition, motor, social-emotional/challenging behaviour, play skills. Adaptive behaviour. Education. Specifically, school/learning readiness, academic skills, placement/support. Community participation. 	 Outcomes Outcomes were categorised as follows: Core autism characteristics. Specifically, <u>overall autism</u> <u>characteristics</u>, social-communication, restricted and repetitive interests and behaviours, and sensory behaviours. Related skills and development. Specifically, <u>communication</u>, expressive language, receptive language, cognition, motor, social-emotional and challenging behaviour, <u>play adaptive</u> <u>behaviour</u>, and general outcomes. Education and participation. Specifically, school/ learning readiness, academic skills, <u>child quality of life</u> and community participation <u>Family wellbeing</u>: Specifically, caregiver communication and interaction strategies, caregiver social emotional wellbeing, caregiver satisfaction, <u>caregiver financial wellbeing</u>, and child satisfaction with intervention. Adverse effects. 	Outcomes were added, renamed, or re-categorised to align with common terminology or categorical groupings within the extant literature. All outcomes in the original protocol remained in the revised protocol.



 Parent/caregiver experience. Specifically, caregiver communication and interaction strategies, attrition, caregiver social emotional wellbeing, <u>financial support</u>, caregiver satisfaction with intervention. Child experience. Specifically, child satisfaction, child related adverse effects, <u>attrition</u>. 		
Study Selection Not included	Study selection "Immediately after independent title and abstract screening, a document was created in which the reviewers could list interventions requiring a determination of eligibility, including a verbatim description of the intervention from the relevant SR. Four team members (DT, KV, HW, AW) independently determined whether the specific intervention should be included in the umbrella review based on the eligibility criteria. The four team members then met to discuss each question of eligibility and resolved these via consensus."	"Given the vast number of different intervention techniques and practices reported in the literature, it became apparent that a systematic process was required to determine eligibility for inclusion in cases where it was not clear to the reviewers if the intervention falls within the scope of the categories outlined by Sandbank et al. (2020a)."
Study selection Not included	Study selection "All reviewers (AW, DT, HW, KV) were independently responsible for identifying if a SR should be considered for exclusion on this basis and, if so, to present a rationale to the group. A second reviewer (of the four) then assessed the SR and recommendation, and either endorsed or refuted it. If both reviewers agreed, the SR was excluded from the review. Additional reasons for exclusion at this stage included: (a) the SR had been superseded by an updated version of the same review; (b) The same review had been published in multiple forms (e.g., a report and a scholarly article); (c) the authors had categorised interventions in a different way to the	"At the time of data extraction, it became apparent that additional SRs needed to be excluded to ensure that the umbrella review only contained articles that were not updated versions of earlier SRs and presented findings in a way that was relevant to addressing at least one umbrella review question."



	current umbrella review, and consequently, it was not possible to map the intervention effects reported within the SR to the categories used in the current review; (d) the review examined the combined intervention effect of a range of intervention practices/categories (meaning it was not possible to attribute intervention effects to the specific intervention categories/practices defined for the current review) and did not provide any information about potential child or intervention characteristics that may influence the intervention effect; and/or (d) closer reading of the SR revealed it indeed violated one or more of the eligibility criteria."	
Corrected covered area "The "corrected covered area" will be calculated (Pieper et al., 2014) based on the contents of this table. This will be reported across all systematic reviews, and <u>for each</u> <u>specific practice and broader category of</u> <u>intervention."</u>	Corrected covered area CCA was only reported across all SRs and was not reported for each specific practice and broader category.	Many practices were only covered by a single SR, meaning that calculations of CCA at this level were not possible.
Coding of intervention effects Not included	Coding of intervention effects "Data extraction of intervention effects focused on recording one pooled (meta-analysis) or summary (for narrative review) effect for each outcome reported in each SR. On occasions where meta- analyses reported more than one pooled effect for a specific outcome (e.g., main analyses and sensitivity analyses), we extracted the effect that was presented by the SR authors as the main analysis. For meta-analyses, findings were recorded as either a positive pooled effect (90/95% confidence intervals of the pooled effect did not overlap with the null), a negative pooled effect (90/95% confidence intervals of the pooled effect did not overlap with the null), or a null effect (90/95% confidence intervals of the	It was necessary to categorise intervention effects as there was significant variation in the way in which effects were reported across SRs.



Reliability of extraction	pooled effect overlapped with the null). Where a SR did not include a meta-analysis, the recording of an intervention effect focused on the summary provided by the SR authors in the Results section. Findings were recorded as either a summarised positive effect (60% or more of studies summarised reported a positive intervention effect), a negative summarized effect (60% or more of studies summarised reported a negative intervention effect), a null effect (60% or more of studies summarized reported a null intervention effect) or a summarized inconsistent effect (no direction of intervention effect meeting a 60% threshold)."	
Not included	"Each stage of extraction began with consensus coding to help ensure the accurate and consistent use of procedures. For this, those responsible for extracting data (stage 1: AW, DT, HW, KV; stage 2: AW, DT) independently extracted data for a set of SRs (6 for SR level extraction, 2 for practice/category level extraction) and then met to discuss any discrepancies and, if necessary, further clarify aspects of the data extraction sheet."	This was conducted to increase consistency of coding and interpretation of the codebook.
Reliability of extraction "Inter-rater reliability for data extraction will be calculated separately for the independently extracted data and the crosschecked data using Cohen's kappa coefficient."	Reliability of extraction Percentage of agreement between reviewers was calculated instead of Cohen's kappa for both independently extracted data and the crosschecked data.	All four reviewers (AW, DT, HW, KV) participated in data extraction in order to meet the current project's required timeline (as opposed to just to two reviewers). Due to the multiple combinations of reviewer agreement, percentage of agreement was considered a more applicable measure of reliability.
Study quality assessment "Two reviewers will independently assess each included systematic review using the	Study quality assessment "Risk of Bias was assessed using a quality assessment form based on the Critical Appraisal Checklist for SRs and Research Syntheses	The checklist was modified to suit the specific purposes of this umbrella review.



Critical Appraisal Checklist for Systematic Reviews and Research Syntheses created by the Joanna Briggs Institute (Aromataris et al., 2015)."	created by the Joanna Briggs institute (2020). The form, <u>modified</u> in consultation with JBI staff, comprised 11 items"	
Reliability of study quality assessment "Inter-rater reliability for risk of bias assessment will be calculated using Cohen's kappa coefficient."	Percentage of agreement between reviewers was calculated instead of Cohen's kappa for both independently extracted data and the crosschecked data.	Four reviewers (AW, DT, HW, KV) participated in the assessment of study quality/risk of bias (as opposed to just two reviewers) in order to meet the current project's required timeline. Due to the multiple combinations of reviewer agreement, percentage of agreement was considered a more applicable measure of reliability.

Note: Underlined phrases indicate aspects which were added, altered or removed after submission to Open Science Framework.



Appendix F: Grey literature search strategy

Google search

Using Advanced Search on Chrome platform:

(Autism OR ASD OR Asperger OR Aspergers OR "pervasive developmental disorder" OR PDD OR "pervasive child development disorder" OR "pervasive childhood developmental disorder" OR PCDD OR "disintegrative disorder") AND (intervention OR interventions OR therapy OR therapies OR treatment OR treatments OR teach OR program OR programs OR package OR packages) AND ("systematic review" OR "systematic reviews" OR "systematic literature review" OR "systematic literature reviews" OR "evidence synthesis" OR "evidence syntheses" OR meta-analysis OR metaanalyses OR meta-regression OR meta-regressions)

Limited to:

- English language
- First 100 results

For google search results, the person conducting the search will review the first 100 search results. Within each page, the website search function will be initially used to identify (a) a relevant document or (b) a citation for a relevant document. If there is no search function, the person completing the search will click a maximum of five times within any one webpage to identify a (a) a relevant document or (b) a citation for a relevant document.

The person responsible for searching these sources will exercise judgement in selecting search results (web pages) to investigate, as well as subsequent pages for review within a website based on the umbrella review eligibility criteria. In each case, the URL of the primary webpage selected for review will be recorded.

The grey literature search will be conducted in duplicate, by two reviewers in real time by screen sharing.

Prospero search

We will search trial Prospero for any potentially relevant completed reviews https://www.crd.york.ac.uk/PROSPERO/.

We will search Prospero using the following MeSH terms and keywords, combined with "OR":



MeSH DESCRIPTOR Child Development Disorders, Pervasive EXPLODE ALL TREES

Autis* OR ASD* OR Asperger* OR "pervasive developmental disorder*" OR PDD* OR "pervasive child development disorder*" OR "pervasive childhood developmental disorder*" OR PCDD* OR "disintegrative disorder*"

Of the search results, protocols marked as 'Review completed, published' or 'Review completed, not published' will be screened for potential eligibility. Those that pass screening will be followed up to identify a full-text by first reviewing the protocol entry for a reference to the published paper. Where the reference is not available, a search will be conducted using Advanced Search on the Chrome platform using the following search terms:

[First author's name] AND "systematic review" OR "meta-analysis" OR "evidence summary" OR "autism" OR "ASD" OR "autistic" OR "pervasive developmental disorders" OR PDD OR intervention OR therapy OR treatment

Where the Advanced Google search does not return any full-text articles, we will then search Google using the exact title from PROSPERO for that particular protocol.

The Google Chrome search will be limited to:

- English language
- First 10 results

Within each page, the website search function will be initially used to identify (a) a relevant document or (b) a citation for a relevant document. If there is no search function, the person completing the search will click a maximum of five times within any one webpage to identify a (a) a relevant document or (b) a citation for a relevant document.

The person responsible for searching these sources will exercise judgement in selecting search results (web pages) to investigate, as well as subsequent pages for review within a website based on the umbrella review eligibility criteria. In each case, the URL of the primary webpage selected for review will be recorded.

In the event that the Google searches (of author's surname and keywords and the exact title search) do not return any full-text results, we will then conduct an author search in Scopus (based on the protocol lead author) for publications for the year of protocol registration up to 2020.

The grey literature search will be conducted in duplicate, by two reviewers.



INSAR Abstract search

Abstracts for presentations at meetings of the International Society for Autism Research (2015-2020) will be searched via online programs available at: <u>https://www.autism-</u> insar.org/page/MeetingArchives?&hhsearchterms=%22abstracts%22

The search was limited to the years 2015-2020 to identify only more recent bodies of work that are less likely to be detected in the database searches.

The search terms ("systematic review" OR "meta-analysis" OR "systematic reviews" OR "metaanalyses") will be entered into the search function for each program.

Abstracts will be screened for potential eligibility independently by two reviewers. Any discrepancies will be resolved through discussion. Those that pass the title and abstract screening phase will be followed up to identify a full-text by first cross-checking against the results of the database searches. Where a full-text article is not identified in the database searches, we will complete a Google search using Advanced Search on the Chrome platform using the following search terms:

[First author's surname] AND "systematic review" OR "meta-analysis" OR "evidence summary" OR autism OR ASD OR autistic OR "pervasive developmental disorders" OR PDD OR intervention OR therapy OR treatment

Where the Advanced Google search does not return any full-text articles, we will then search Google using the exact title from the INSAR Program Booklet for a particular abstract.

The Google searches will be limited to:

- English language
- First 10 results

Within each page, the website search function will be initially used to identify (a) a relevant document or (b) a citation for a relevant document. If there is no search function, the person completing the search will click a maximum of five times within any one webpage to identify a (a) a relevant document or (b) a citation for a relevant document.

The person responsible for searching these sources will exercise judgement in selecting search results (web pages) to investigate, as well as subsequent pages for review within a website based on the umbrella review eligibility criteria. In each case, the URL of the primary webpage selected for review will be recorded.



In the event that Google searches (of author's surname and keywords and the exact title search) do not return any full-text results, we will then conduct an author search in Scopus (based on the abstract lead author) for publications for the conference year up to 2020.


Appendix G: Consensus on intervention eligibility

Intervention	Explicitly listed for exclusion	Not an intervention i.e. assessment	Not an intervention i.e. technique	Does not meet eligibility criteria	Include
Acupuncture	~				
Animal-assisted Therapy					√
Antecedent-Based Interventions (ABI)			1		
Art therapy				\checkmark	
Auditory Integration Training					√
Augmentative and Alternative Communication (AAC)					√
Behavioral intervention					√
Behavioral Momentum Intervention (BMI)			~		
Chelation	√				
Child-centred play therapy					√
Chiropractic	1				
Client Feedback			~		
Cognitive bias modification				1	
Cognitive Behavioral/ Instructional Strategies (CBIS)					~



Comprehensive Behavioral Treatment for Young Children				V
Computer-based intervention				√
Concept Mapping		\checkmark		
Creative arts programs			\checkmark	
Dance	\checkmark			
Developmental Relationship-based Treatment				V
Differential Reinforcement of Alternative, Incompatible, or Other Behavior (DR)		V		
DIR/Floor Time				\checkmark
Direct Instruction (DI)		✓		
Discrete Trial Training (DTT)				\checkmark
Emotion Recognition Training			\checkmark	
Exercise and Movement (EX)	\checkmark			
Exposure Package				\checkmark
Extinction (EXT)		√		
Facilitated Communication-				V
Feeding			V	



Fluency intervention				✓
Functional Communication Training (FCT)				√
Functional Behavioral Assessment (FBA)		√		
Gamification/Serious games				√
Gluten-free/Casein-free diet	\checkmark			
Holding therapy				√
Hydrotherapy	\checkmark			
Hyperbaric oxygen therapy interventions	\checkmark			
Imitation-based Intervention				\checkmark
Inclusion of circumscribed/special interests			V	
Initiation Training				√
Intensive Interaction				√
Joint control training/Joint stimulus control			√	
Kinesiology	√			
Language Training (Production & Understanding)				√
Language Training (Production)				~



Martial arts	√			
Massage Therapy	~			
Matrix training		√		
Mind-body therapies (yoga, meditation, Nei Yang Gong, acceptance and commitment therapy)	V			
Mindfulness				\checkmark
Modelling		\checkmark		
Motivating Operations		\checkmark		
Multi-component Package				\checkmark
Music-Mediated Intervention (MMI)				\checkmark
Naturalistic Intervention (NI)				\checkmark
Neurofeedback	\checkmark			
Oral health			\checkmark	
Parent Child Interaction Therapy				\checkmark
Parent verbal responsiveness		\checkmark		
Parent-Implemented Intervention (PII)				\checkmark
Peer-Based Instruction and Intervention (PBII)				\checkmark
Picture Exchange Communication System				~



Pivotal Response Treatment®				~
Precision teaching				\checkmark
Prompting (PP)		\checkmark		
Psychodynamic psychotherapy			\checkmark	
Psychomotor therapy				\checkmark
Punishment		\checkmark		
Rapid Prompting Method (RPM)				\checkmark
Reductive Package				\checkmark
Reflexology	\checkmark			
Reinforcement (R)		\checkmark		
Response Interruption/Redirection (RIR)		V		
Role play		\checkmark		
Schedules		√		
Scripting		✓		
Self-controlled technology				~
Self-Management (SM)		✓		
SENSE Theatre Intervention			~	
Sensory Integration [®] (SI)				√



Shared reading			√
Shock Therapy	√		
Sign Instruction			\checkmark
Social Behavioral Learning Strategy			\checkmark
Social Cognition Intervention			\checkmark
Social communication intervention			√
Social Narratives (SN)		\checkmark	
Social Robots			✓
Social Skills Training (SST)			~
Social Thinking Intervention-			\checkmark
Speaker/Listener instruction			\checkmark
Structured teaching			\checkmark
Systemic therapy			\checkmark
Task Analysis (TA)		\checkmark	
Task interspersal		\checkmark	
Technology-Aided Instruction and Intervention (TAII)			V
The listening programme			\checkmark
Theory of Mind Training-			√



Therapeutic surfing	\checkmark			
Time Delay (TD)		\checkmark		
Toileting			\checkmark	
Transcranial magnetic stimulation	\checkmark			
Video Modeling (VM)		\checkmark		
Video-based instruction		\checkmark		
Virtual/augmented/mixed reality				\checkmark
Visual Supports (VS)		\checkmark		
Water Safety			\checkmark	
Weighted vests				\checkmark



Appendix H: Codebook for data extraction

The following variables were extracted from the systematic reviews where available and without further analysis within the systematic review or review of the original study sources. This approach ensured consistency, reliability, and replicability within the data extraction process. Simple addition, subtraction, multiplication, and division was used to synthesise information during extraction (e.g., sum of individual study samples).

Data entry

Survey Question	Variable	Label	Fields/options	Explanation/Rules
Data extracted by	Ext_Name	Extracted by	String	
Date data extracted	Ext_Date	Date extracted	Number	

Variables extracted for the systematic review

Survey Question	Variable	Label	Fields/options	Explanation/Rules
1. Title	SR_Title	Title	String	Copied verbatim from SR.
2. Author(s)	SR_ Authors	Authors	String	First name/initial, last name for all authors.
3. Year of publication	SR_Year_Published	Year	Number	Copied verbatim from SR.
4. Type of review	SR_Type_Review	Type of review	 1 = Narrative synthesis only 2 = Meta-analysis with narrative synthesis 	To be completed based on author description within the SR.



5.	Objectives/aims of the review	SR_Aim	Aims/objectives	String, 777 = Not specified	Copied verbatim from abstract only. If not in abstract, then first place in article mentioning aim/purpose/objective.
6.	Databases searched	SR_Search_Database	Databases searched	String	Copied verbatim from search strategy.
7.	Range (years) of search	SR_Search_Year_Start	Search start year	Number Inception – authors explicitly state that there was no limit on search year, 777 = Not specified	Copied verbatim from search strategy.
		SR_Search_Year_End	Search end year	Number 777 = Not specified	
8.	Number of included studies	SR_Number_Studies	Number of included studies	Number	Copied from text in abstract/method. This should reflect the number of studies included for analysis rather than the number of studies initially included, if these numbers differ.
9.	Type(s) of eligible studies	SR_Eligible_RCT	RCT eligible	1 = Yes, 0 = No, 777 = Not specified	To be completed based on SR inclusion/exclusion criteria.
		SR_Eligible_NR_cont	Non-randomised with control eligible	1 = Yes, 0 = No, 777 = Not specified	Mark yes if this type of design is
		SR_Eligible_NR_No_cont	Non-randomised without control eligible	1 = Yes, 0 = No, 777 = Not specified	'yes' for 'Other study types included', list.



	SR_Eligible_SCED SR_Eligible_Other SR_Eligible_Other_Desc	Single case experimental designs eligibleOther study types eligibleOther study types eligible description	1 = Yes, 0 = No, 777 = Not specified 1 = Yes, 0 = No, 777 = Not specified String, N/A 777 = Not specified	_
	SR_Eligible_Spec	Eligible studies specified	1= Yes, 0 = No,	
10. Type(s) of included studies	SR_Inc_RCT	Included RCT	1 = Yes, 0 = No, 777 = Not specified	To be completed based on SR: • Method
	SR_Inc_NR_cont	Included non-randomised with control	1 = Yes, 0 = No, 777 = Not specified	Results (including tables)Supplementary information
	SR_Inc_NR_No_cont	Included non-randomised without control	1 = Yes, 0 = No, 777 = Not specified	Mark yes if this type of design is
	SR_Inc_SCED	Included single case experimental designs	1 = Yes, 0 = No, 777 = Not specified	mentioned on at least one occasion. If 'yes' for 'Other study types included', list.
	SR_Inc_Other	Other study types included	1 = Yes, 0 = No, 777 = Not specified	summary and table will prioritise extraction from the summary.
	SR_Inc_Other_Desc	Other study types included description	String, 777 = Not specified	



	SR_Inc_NS	Included studies specified	1 = Yes, 0 = No,	
11. Type(s) of comparison groups	SR_Comp_WLC	Included Comparison Wait list control	1 = Yes, 0 = No 777 = Not specified	To be completed based on SR: • Method (including eligibility
	SR_Comp_TAU	Comparison Treatment-as- usual	1 = Yes, 0 = No, 777 = Not specified	criteria)Results (including tables)
	SR_Comp_Interv	Comparison Another intervention (includes minimal support and eclectic)	1 = Yes, 0 = No, 777 = Not specified	• Supplementary information Mark yes if this type of control group is
	SR_Comp_SCED	Comparison The individual's own baseline (single case experimental designs)	1 = Yes, 0 = No, 777 = Not specified	mentioned on at least one occasion. If 'yes' for 'SR Comparison Other', list.
	SR_Comp_Other	Comparison Other	1 = Yes, 0 = No, 777 = Not specified	
	SR_Comp_Other_Desc	Comparison Other description	String	
	SR_Comp_None	Comparison No comparison group	1 = Yes, 0 = No, 777 = Not specified	
	SR_Comp_Spec	Comparison specified	1 = Yes, 0 = No	
12. Country of origin of included studies	SR_Cont_Africa	Included Africa	1 = Yes, 0 = No, 777 = Not specified	To be completed based on SR: • Method (including eligibility
represented)	SR_Cont_Asia	Included Asia	1 = Yes, 0 = No, 777 = Not specified	criteria)Results (including tables)



	SR_Cont_Australia	Included Australia	1 = Yes, 0 = No, 777 = Not specified	Supplementary information
	SR_Cont_Pacific	Included Pacific	1 = Yes, 0 = No, 777 = Not specified	Mark yes if at least one study was identified as being conducted in a country in this continent.
	SR_Cont_Europe	Included Europe	1 = Yes, 0 = No, 777 = Not specified	
	SR_Cont_S_Amer	Included South America/Caribbean	1 = Yes, 0 = No, 777 = Not specified	
	SR_Cont_N_Amer	Included North America	1 = Yes, 0 = No, 777 = Not specified	
	SR_Cont_Spec	Continent specified	1 = Yes, 0 = No	
13. Eligible autism diagnosis/es	SR_Eligible_Diag_Autism	Diagnosed with autism eligible	1 = Yes, 0 = No, 777 = Not specified	To be completed based on SR: Method (including eligibility criteria)
	SR_ Eligible_Diag_Susp_Autism	Increased likelihood/suspected autism eligible	1 = Yes, 0 = No, 777 = Not specified	 Results (including tables) Supplementary information
	SR_Eligible_Diag_Spec	Eligible diagnosis specified	1 = Yes, 0 = No	Mark yes if at least one study was identified as including participants meeting the criteria.



14. Types of eligible autism diagnosis/es	SR_Eligible_Diag_Type	Eligible autism diagnoses	String, 777 = Not specified	 To be completed based on SR: Method (including eligibility criteria) Supplementary information
15. Eligible autism diagnosis system(s)	SR_Eligible_Diag_System	Eligible autism diagnostic system (e.g. ICD, DSM)	String, 777 = Not specified	 To be completed based on SR: Method (including eligibility criteria) Supplementary information
16. Included autism diagnosis/es	SR_Inc_Diag_Autism	Included children diagnosed with autism	1 = Yes, 0 = No, 777 = Not specified	To be completed based on SR: Results (including tables) Supplementary information
	SR_ Inc_Diag_Susp_Autism	Included children with increased likelihood of/suspected autism	1 = Yes, 0 = No, 777 = Not specified	Mark yes if at least one study was identified as including participants meeting the criteria.
	SR_Inc_Diag_Spec	Diagnosis of included children specified	1 = Yes, 0 = No	
17. Types of included autism diagnosis/es	SR_Inc_Diag_Type	Autism diagnoses of included children	String, 777 = Not specified	To be completed based on SR: • Results (including tables) • Supplementary information



18. Description of other population groups/diagnoses	SR_Inc_Pop_Oth	Other included population groups	String, 777 = Not specified	To be copied verbatim from: • Title/abstract • Method (inclusion)
19. Total participants across studies	SR_Total_Part	Participants (total sample)	Number, 777 = Not specified	To be completed based on information provided by SR authors in:
	SR_Total_Part_Int	Participants (total intervention)	Number, 777 = Not specified	AbstractResults (including tables)
	SR_Total_Part_Cont	Participants (total control)	Number, 777 = Not specified)	• Supplementary information Must be reported by study authors. No calculations to occur. If total included in studies, and total included in analyses
	SR_Total_Part_ASD	Participants (total ASD)	Number, 777 = Not specified	are both reported, we will select the number included in analysis.
	SR_Total_Part_Other	Participants (total other populations)	Number (across groups), 777 = Not specified	Where a study provides a number for pre-test and for analysis, use the pre-test number of participants.
20. Participant age range across studies (search)	SR_Age_Min_Search	Minimum search age	Number, 777 = Not specified	To be completed based on search/eligibility criteria
	SR_Age_Min_Search_Unit	Unit for minimum search age	1 = Years; 2 = Months, 777 = Not specified	



	SR_Age_Max_Search SR_Age_Max_Search_Unit	Maximum search age Unit for maximum search age	Number, 777 = Not specified 1 = Years; 2 = Months, 777 = Not specified	If reported in years, months in SR, select 'Years' as unit and transfer to extraction form as X(years);Y(months) e.g., 4;2.
21. Participant age range across studies (Actual)	SR_Age_Min_Unit	Unit for minimum actual age	1 = Years; 2 = Months, 777 = Not specified	To be completed based on information provided by SR authors in: • Abstract
	SR_Age_Max_Unit	Unit for maximum actual age	1 = Years; 2 = Months, 777 = Not specified	Results (including tables)Supplementary information
	SR_Age_Min_Actual	Minimum age (total sample)	Number, 777 = Not specified	
	SR_Age_Max_Actual	Maximum age (total sample)	Number, 777 = Not specified	
22. Participant mean age across studies	SR_Age_Mean_Unit	Unit for mean age	1 = Years; 2 = Months, 777 = Not specified	Must be reported by study authors. No calculations during extraction to occur.
	SR_Age_Mean_Int	Mean age intervention ([mean age] (of studies reporting age)	String, 777 = Not specified	
	SR_Age_Mean_Cont	Mean age intervention ([mean age] (of studies reporting age)	String, 777 = Not specified	



	SR_Age_Mean_Comb	Mean age intervention ([mean age] (of studies reporting age))	String, 777 = Not specified	
23. Participant sex across studies	SR_Male_Total	The number of males in the total sample ([number of males] out of total number of participants for which gender is known)	String, 777 = Not specified	To be completed based on information provided by SR authors in: • Abstract • Results (including tables)
	SR_Female_Total	The number of females in the total sample ([number of females] out of total number of participants for which gender is known)	String, 777 = Not specified	• Supplementary information. Total males and females can be summed from the tables. Do not do any calculations for the number of males or
	SR_Male_Int	The number of males receiving intervention	Number, 777 = Not specified	females in intervention or control groups
	SR_Female_Int	The number of females receiving intervention	Number, 777 = Not specified	
	SR_Male_Cont	The number of males in the control groups	Number, 777 = Not specified	
	SR_Female_Cont	The number of females in the control groups	Number, 777 = Not specified	
24. Comorbidities in SR	SR_Comor_ADHD	ADHD included in SR	1 = Yes, 0 = No 777 = Not specified	Included comorbidities extracted from the results section, excluded



SR_Comor_Sleep	Sleep included in SR	1 = Yes, 0 = No 777 = Not specified	comorbidities extracted from the inclusion/exclusion criteria or when explicitly stated in the results section
SR_Comor_Anxiety	Anxiety included in SR	1 = Yes, 0 = No 777 = Not specified	(e.g. "there were no participants with ADHD").
SR_Comor_Depress	Depression included in SR	1 = Yes, 0 = No 777 = Not specified	
SR_Comor_Lang	Language delay included in SR	1 = Yes, 0 = No 777 = Not specified	
SR_Comor_MinV	Minimally verbal (descriptive term, used with language delay) included in SR	1 = Yes, 0 = No 777 = Not specified	
SR_Comor_Cog	Cognitive impairment (including ID, IQ <70) included in SR	1 = Yes, 0 = No 777 = Not specified	
SR_Comor_GDD	Global developmental delay included in SR	1 = Yes, 0 = No 777 = Not specified	
SR_Comor_Genetic	Genetic syndrome (e.g. Down Syndrome, Fragile X) included in SR	1 = Yes, 0 = No 777 = Not specified	
SR_Comor_CBeh	Challenging behaviour included in SR	1 = Yes, 0 = No 777 = Not specified	



	SR_Comor_Physical SR_Comor_Other SR_Comor_Spec	Physical disability included in SR Other comorbidity included in SR Comorbidity Specified	1 = Yes, 0 = No 777 = Not specified 1 = Yes, 0 = No 777 = Not specified 1 = Yes, 0 = No	
25. Included categories and practices	SR_Cat_Prac	Included categories and practices	String, 777 = Not specified	 To be completed based on information provided by SR authors in: Abstract Results (including tables) Supplementary information Name(s) used by SR authors to be copied verbatim.
26. Appraisal instrument	SR_App_Inst	Appraisal instrument used	String, 777 = Not specified	To be completed based on information provided by SR authors in: Abstract Method Results Supplementary information
27. Appraisal ratings	SR_App_Rating	Appraisal ratings	1 = Included low quality/high risk of bias and above	To be completed based on information provided by SR authors in: • Abstract



			2 = Included moderate quality/moderate risk of bias and above 3 = Included only high quality/low risk of bias 777 = Not specified	 Method Results (including tables) Discussion Supplementary information Refers to overall quality and risk of bias in included studies.
28. Heterogeneity	SR_Hetero_Clinical	Clinical heterogeneity	 1 = Low (age range ≤6 years and no comorbidities) 2 = Moderate (age range >6 years OR no comorbidities are identified) 3 = High (age range >6 years AND comorbidities are identified) 4 = Insufficient information 	To be completed based on information provided by SR authors in: Abstract Method Results (including tables) Discussion Supplementary information AND after other data has been extracted.
	SR_Hetero_Method	Methodological heterogeneity	1 = Low (SR included only ONE of the following eligible designs: RCT, Quasi- RCT, or controlled trial)	variability in participants/study populations, interventions, and outcomes. Level to be determined by a combination of participant ages and presence of comorbidities. Assign according to the following:



	2 = Moderate (SR included TWO or THREE of the following eligible designs: RCT, Quasi- RCT, or controlled trial) 3 = High (SR included at least one of the following eligible designs: RCT, Quasi- RCT, or controlled trial AND one or more other study designs) 4 = Insufficient information	 Low: Age range if less than 6 years and no-comorbidities are specifically identified Mod: Age range if greater than 6 years OR no-comorbidities are specifically identified High: Age range is greater than 6 years AND co-morbidities are identified Methodological heterogeneity: refers to variability in study designs, outcome measurements, study quality/risk of bias. Assign according to the following: Low: SR included only ONE of the following eligible designs (RCT, Quasi-RCT, or controlled trial) Mod: SR included TWO or THREE of the following eligible designs (RCT. Quasi-RCT. or
		 the following eligible designs (RCT, Quasi-RCT, or controlled trial) Mod: SR included TWO or THREE of the following eligible designs (RCT, Quasi-RCT, or controlled trial)
		 High: SR included at least one of the following eligible designs (RCT, Quasi-RCT, or controlled trial) AND one or more other study designs



29. Sources of funding	SR_Funding	Sources of funding	String, 777 = Not specified	To be copied verbatim from SR.
30. Conflict of interest	SR_Conflict	Conflict(s) of interest reported by the author(s)	1 = yes, 0 = No/None 777 = Not specified	To be completed based on information provided by SR authors in: • Conflict of interest statement
31. PC level extraction	SR_Relevant_Table	Table for extraction	1 = P/C table 2= Outcome table 3= Format/agent/setting table	 Practices/categories must be analysed separately within the review, must meet intervention inclusion criteria and contain: A relevant design (group with control) – see decision tree Relevant age (no individuals over 18) Only children with autism diagnoses A relevant outcome

Variables extracted separately for each category/practice, or "non specific"/generic category

Survey Question	Variable	Label	Fields/options	Explanation/Rules
1. Author(s)	PC_ Authors	Authors	String	Copied verbatim from SR
2. Year of publication	PC_Year_Published	Year	Number	Copied verbatim from SR



3. Name of category	PC_Cat_Name	Name of category (NDBI, Behavioural, Developmental, Sensory, Technology, CBT, Animal- assisted, Other)	String, 777 = Not specified	To be completed based on information provided by SR authors in: • Abstract • Method • Results (including tables)
4. Name of practice	PC_Prac_Name	Name of practice	String, 777= Not specified	To be completed based on information provided by SR authors in: • Abstract • Method
5. Intervention characteristic	PC_Int_Char	Name of intervention characteristic (e.g., Setting, Delivery Mode, Agent)	String, 777 = Not specified	To be completed based on the information provided by SR authors in: Abstract Introduction Method
6. Intervention characteristic detail	PC_Int_Char_Det	Detail of the intervention characteristic	String, 777 = Not specified	To be completed based on the information provided by SR authors in: • Abstract • Introduction



					Method
7.	Number of participants in the practice/category	PC_Total_Part	Total number of participants (specific P/C only)	Number, 777 = Not specified	Only to be completed if there are participant number details
	group	PC_Interv_Part	Number of participants in intervention group (specific P/C only)	Number, 777 = Not specified	different categories or practices. To be completed
		PC_Control_Part	Number of participants in control group (specific P/C only)	Number, 777 = Not specified	 based on information provided by SR authors in: Abstract Method Results (including tables) Supplementary information Must be reported by study authors. No calculations to occur.
8.	Participant age range across studies for those in the practice/category intervention and control	PC_Age_Min_Total	Minimum age for total sample (specific P/C only)	Number, 777 = Not specified	Only to be completed if there are participant number details provided separately for different categories or
gro	group	group PC_Age_Min_Interv Minimum age for intervention group (specific P/C only) Number, 777 = Not sp	Number, 777 = Not specified	practices. To be completed based on information provided by SR authors in: • Abstract	
		PC_Age_Min_Control	Minimum age for control group (specific P/C only)	Number, 777 = Not specified	Method



	PC_Age_Max_Total PC_Age_Max_Interv PC_Age_Max_Control	Maximum age for total sample (specific P/C only)Maximum age for intervention group (specific P/C only)Maximum age for control group (specific P/C only)	Number,777 = Not specifiedNumber,777 = Not specifiedNumber,777 = Not specified	 Results (including tables) Supplementary information
9. Participant mean age for those in the practice/category intervention and control group	PC_Age_Mean_Total PC_Age_Mean_Interv	Mean age for total sample (specific P/C only) Mean age for intervention group (specific P/C only)	Number, 777 = Not specified Number, 777 = Not specified	Only to be completed if there are participant number details provided separately for different categories or practices. To be completed based on information provided by SR authors in: • Abstract • Method • Results (including tables) • Supplementary information Must be reported by study authors. No calculations during extraction to occur.
	PC_Age_Mean_Control	Mean age for control group (specific P/C only)	Number, 777 = Not specified	



10. Setting/Context	PC_Sett_Clinic	Included studies conducted in clinics	1 = Yes, 0 = No, 777 = Not specified	To be completed based on SR:
	PC_Sett_Home	Included studies conducted at home	1 = Yes, 0 = No, 777 = Not specified	 Method (including eligibility criteria) Results (including tables) Supplementary information Mark "yes" if this type of setting is mentioned on at least one occasion.
	PC_Sett_Edu	Included studies conducted in educational settings (schools, early childhood)	1 = Yes, 0 = No, 777 = Not specified	
	PC_Sett_Other	Included studies conducted in other settings	1 = Yes, 0 = No, 777 = Not specified	
	PC_Sett_Other_Desc	Type of other setting(s)	String, N/A	
	PC_Sett_Spec	Setting specified	Yes = 1, 0 = No	
			This is a summary variable based on whether a 1 is present in any of the preceding columns (0 or 777 = 0, 1 = 1)	
11. Delivery format	PC_Format_Indiv	Included therapy delivered to individuals	1 = Yes, 0 = No, 777 = Not specified	To be completed based on SR: • Method (including eligibility criteria)
			unless clearly stated that it was not delivered	Results (including tables)



		to individuals (e.g., group only). Therefore, 777 and 1 will be converted to 1, 0 to remain as zero	 Supplementary information Mark "yes" if this type of delivery format is mentioned
PC_Format_Group	Included therapy delivered to groups	1 = Yes, 0 = No, 777 = Not specified	on at least one occasion.
PC_Format_Other	Included therapy delivered in other ways	1 = Yes, 0 = No, 777 = Not specified	
PC_Format_Other_Desc	Description of other delivery format	String, 777 = Not specified, This is to be changed to	
		identifying if delivery formats other than individual were used. 1 = yes (other formats used - either in addition	
		to, or instead of individual), 0 = no. Not to be used for reliability as dependent on other variables.	
PC_Format_Spec	Delivery format specified	1 = Yes, 0 = No	



12 Intervention acout	PC Agent Parent	Included parent(s)/caregiver(s) as	1- Yes 0 - No	To be completed based on SP:
iz. intervention agent	FC_Agent_Fatent	intervention agent	777 = Not specified	Method (including
	PC_Agent_Peer	Included peer(s)/sibling(s) as intervention agent	1 = Yes, 0 = No, 777 = Not specified	eligibility criteria)Results (including tablec)
	PC_Agent_School	Included school or early childhood staff as intervention agent (e.g. teacher, TA)	1 = Yes, 0 = No, 777 = Not specified	 Supplementary information Mark "yes" if this type of intervention agent is mentioned on at least one occasion.
	PC_Agent_Clinician	Included clinician/researcher as intervention agent	1 = Yes, 0 = No, 777 = Not specified	
	PC_Agent_Other	Included other individuals as intervention agents	1 = Yes, 0 = No, 777 = Not specified	
	PC_Agent_Other_Desc	Description of other agent	String, 777 = Not specified	
	PC_Agent_Spec	Intervention agent specified	1 = Yes, 0 = No	
			This is summary variable. Mark 1 if a 1 was indicated for preceding variables.	
			Mark 0 if not. It is a summary variable (dependent on others) and so not included in reliability estimate.	



13. Delivery mode	PC_Mode_Face	Included face-to-face delivery	1 = Yes, 0 = No, 777 = Not specified It is assumed intervention is face-to- face, unless otherwise specified. Therefore, to be recoded such that 777 or 1 = 1, 0=0.	 To be completed based on SR: Method (including eligibility criteria) Results (including tables) Supplementary information
	PC_Mode_Tele	Included telehealth delivery	1 = Yes, 0 = No, 777 = Not specified	Mark "yes" if this type of delivery mode is mentioned on at least one occasion.
	PC_Mode_Other	Included other delivery modes	1 = Yes, 0 = No, 777 = Not specified	
	PC_Mode_Other_Desc	Description of other delivery modes	String, 777 = Not specified	
	PC_Mode_Spec	Delivery mode specified	1 = Yes, 0 = No	
			This is summary variable. Mark 1 if a 1 was indicated for preceding variables. Mark 0 if not. It is a summary variable (dependent on others)	



			and so not included in reliability estimate.	
14. Dose	PC_Dose_Unit	Unit of measure for dose	1 = Minutes, 2 = Hours, 777 = Not specified	<u>Dose</u> : Refers to the amount of time the child spent engaged in intervention sessions,
	PC_Dose_Mean	Mean dose	Number 777 = Not specified	Authors may report a per session dose, or a total dose
	PC_Dose_Min	Minimum dose	Number, 777 = Not specified	To be completed based on SP.
	PC_Dose_Max	Maximum dose	Number, 777 = Not specified	Method
	PC_Dose_Sum	Dose summary- free text	String,	tables)
		777 = Not specified	Supplementary information	
			Extract all dosage data from studies included in the systematic review, where these data are reported.	Must be reported by study authors. No calculations during extraction to occur.
	PC_Dose_Spec	Dose specified	1 = Yes, 0 = No Mark 1 if information was entered into preceding cells	If multiple doses are reported, complete on separate line in data extraction form.



			(including free text summary by authors or person extracting) AND/OR If some information regarding dosage was available, even if not provided consistently across studies. This is a summary variable and is not for inclusion in reliability calculations.	
15. Frequency	PC_Freq_Unit	Unit of measure for frequency	1 = per day; 2 = per week, 3 = per month, 4 = per year 777 = Not specified	<u>Frequency</u> : Refers to how often sessions occurred, expressed as ratio of time (e.g., per day, per week, per month).
	PC_Freq_Mean	Mean frequency	Number, 777 = Not specified	To be completed based on SR:
	PC_Freq_Min	Minimum frequency	Number, 777 = Not specified	 Method Results (including tables)
	PC_Freq_Max	Maximum frequency	Number, 777 = Not specified	Supplementary information
	PC_Freq_Spec	Frequency specified	1 = Yes, 0 = No	
			Mark 1 if (a) data were extracted for preceding	Must be reported by study authors. No calculations during extraction to occur.



			variables (not including free text) and/or (b) some information was provided, but not consistently across studies. Otherwise mark 0.	If multiple frequencies are reported, complete on separate line in data extraction form.
16. Duration	PC_Dur_Unit	Unit of measure for duration	1 = Days, 2 = Weeks, 3 = Months, 4 = Years, 777 = Not specified	Duration: Refers to the total time period in which the intervention was provided, typically the time between pre- post measures, expressed in
	PC_Dur_Mean	Mean duration	Number 777 = Not specified	To be completed based on SD:
	PC_Dur_Min	C_Dur_Min Minimum duration Number, 777 = No	Number, 777 = Not specified	 Method Results (including tables) Supplementary
	PC_Dur_Max	Maximum duration	Number, 777 = Not specified	
	PC_Dur_Spec	Duration specified	1 = Yes, 0 = No	information
			Mark 1 if (a) data were extracted for preceding variables (not including free text) and/or (b)	Must be reported by study authors. No calculations during extraction to occur.
			some information was provided, but not consistently across	If multiple durations are reported, complete on



			studies. Otherwise mark 0.	separate line in data extraction form.
17. Intensity	PC_Intens_Unit	Unit of measure for intensity	1 = Minutes, 2 = Hours, 3 = Days, 4 = Weeks 5 = Months 777 = Not specified	To be completed based on SR: Method Results (including tables) Supplementary
	PC_Intens_Min	Minimum intensity	Number, 777 = Not specified	information
	PC_Intens_Max	Maximum intensity	Number, 777 = Not specified	Must be reported by study authors. No calculations during extraction to occur.
	PC_Intens_Spec	Intensity specified	1 = Yes, 0 = No	If multiple intensities are reported, complete on separate line in data extraction form.
18. Core autism characteristics a. Autistic behaviours	PC_Autis_Term	Term used by SR to describe autistic behavioural outcome	String, 777 = Not specified	To be completed based on SR: • Methods
	PC_Autis_ES	Specify the overall effect size including confidence intervals	String, 777 = Not specified	 Results (including tables) Supplementary
	PC_Autis_EStype	Specify the types of effect size (e.g. Cohen's <i>d</i> or Hedge's <i>g</i>)	String, 777 = Not specified,	



PC_Autis_ES_Dir	Meta-analysis - direction of the therapeutic effect	1 = Positive 2 = Negative 3 = Null 777 = Not specified 999 = N/A (no meta- analysis)	Qualitative data <u>will not</u> involve counting contents of tables and paragraphs in the results.
PC_Autis_ES_Spec	Effect size specified	1 = Yes, 0 = No	
PC_Autis_Hetero_type	Heterogeneity statistic type	String, 777 = Not specified 999 = N/A (no meta- analysis)	
PC_Autis_Hetero_stat	Heterogeneity statistic value	Number, 777 = Not specified 999 = N/A (no meta- analysis)	
PC_Autis_Study_No	Number of studies	Number, 777 = Not specified	
PC_Autis_ author_summ	For qualitative studies, copy the author's terminology to describe the summary of outcomes verbatim	String, 777 = Not specified	
PC_Autis_Spec	Autistic behavioural outcome specified	1= Yes, 0 = No	



b. Social communication	PC_Soc_Comm_Term	Term used by SR to describe social communication outcome	String, 777 = Not specified	To be completed based on SR: • Methods
	PC_Soc_Comm_ES	Specify the overall effect size including confidence intervals	String, 777 = Not specified	 Results (including tables)
	PC_Soc_Comm_EStype	Specify the types of effect size (e.g. Cohen's <i>d</i> or Hedge's <i>g</i>)	String, 777 = Not specified,	Supplementary
	PC_Soc_Comm_ES_Dir	Meta-analysis - direction of the therapeutic effect	1 = Positive 2 = Negative 3 = Null	Qualitative data <u>will not</u> involve counting contents of tables and paragraphs in the results.
			777 = Not specified	
			999 = N/A (no meta- analysis)	
	PC_Soc_Comm_ES_Spec	Effect size specified	1 = Yes, 0 = No	
	PC_Soc_Comm_Hetero_typ e	Heterogeneity statistic type	String, 777 = Not specified 999 = N/A (no meta- analysis)	_
	PC_Soc_Comm_Hetero_sta t	Heterogeneity statistic value	Number, 777 = Not specified 999 = N/A (no meta- analysis)	-
	PC_Soc_Comm_Study_No	Number of studies	Number, 777 = Not specified	



	PC_Soc_Comm_ author_summ PC_Soc_Comm_Spec	For qualitative studies, copy the author's terminology to describe the summary of outcomes verbatim. Social communication outcome specified	String, 777 = Not specified 1= Yes, 0 = No	
c. Restricted and repetitive interests and activities	PC_RRB_Term	Term used by SR to describe restricted and repetitive behaviours, interests, and activities outcome	String, 777 = Not specified	To be completed based on SR: Methods Results (including tables) Supplementary Qualitative data <u>will not</u> involve counting contents of tables and paragraphs in the results.
	PC_RRB_ES	Specify the overall effect size including confidence intervals	String, 777 = Not specified	
	PC_RRB_EStype	Specify the types of effect size (e.g. Cohen's <i>d</i> or Hedge's <i>g</i>)	String, 777 = Not specified,	
	PC_RRB_ES_Dir	Meta-analysis - direction of the therapeutic effect	1 = Positive 2 = Negative 3 = Null	
			777 = Not specified 999 = N/A (no meta- analysis)	
	PC_RRB_ES_Spec	Effect size specified	1 = Yes, 0 = No	
	PC_RRB_Hetero_type	Heterogeneity statistic type	String, 777 = Not specified 999 = N/A (no meta- analysis)	



	PC_RRB_Hetero_stat	Heterogeneity statistic value	Number, 777 = Not specified 999 = N/A (no meta- analysis) Number.	-
			777 = Not specified	
	PC_RRB_ author_summ	For qualitative studies, copy the author's terminology to describe the summary of outcomes verbatim.	String, 777 = Not specified	
	PC_RRB_Spec	Restricted and repetitive behaviours, interests, and activities outcome specified	1= Yes, 0 = No	
d. Sensory behaviours	PC_Sensory_Term	Term used by SR to describe restricted and repetitive behaviours, interests, and activities outcome	String, 777 = Not specified	To be completed based on SR: Methods Pesults (including
	PC_Sensory_ES	Specify the overall effect size including confidence intervals	String, 777 = Not specified	 Results (including tables) Supplementary Qualitative data <u>will not</u> involve counting contents of tables and paragraphs in the results.
	PC_Sensory_EStype	Specify the types of effect size (e.g. Cohen's <i>d</i> or Hedge's <i>g</i>)	String, 777 = Not specified,	
	PC_Sensory_ES_Dir	Meta-analysis - direction of the therapeutic effect.	1 = Positive 2 = Negative 3 = Null 777 = Not specified	


			999 = N/A (no meta- analysis)	
	PC_Sensory_ES_Spec	Effect size specified	1 = Yes, 0 = No	
	PC_Sensory_Hetero_type	Heterogeneity statistic type	String, 777 = Not specified 999 = N/A (no meta- analysis)	
	PC_Sensory_Hetero_stat	Heterogeneity statistic value	Number, 777 = Not specified 999 = N/A (no meta- analysis)	
	PC_Sensory_Study_No	Numnber of studies	Number, 777 = Not specified	
	PC_Sensory_ author_summ	For qualitative studies, copy the author's terminology to describe the summary of outcomes verbatim	String, 777 = Not specified	
	PC_Sensory_Spec	Sensory behaviours specified	1= Yes, 0 = No	
19. Related skills and development	PC_Comm_Term	Term used by SR to describe overall communication outcome	String, 777 = Not specified	To be completed based on SR: • Methods
a. Communication	PC_Comm_ES	Specify the overall effect size including confidence intervals	String, 777 = Not specified	



PC_Comm_EStype PC_Comm_ES_Dir	Specify the types of effect size (e.g. Cohen's <i>d</i> or Hedge's <i>g</i>) Meta-analysis - direction of the therapeutic effect	String, 777 = Not specified 1 = Positive 2 = Negative 3 = Null 777 = Not specified 999 = N/A (no meta-	 Results (including tables) Supplementary Qualitative data <u>will not</u> involve counting contents of tables and paragraphs in the results.
PC Comm ES Spec	Effect size specified	analysis)	
PC_Comm_Hetero_type	Heterogeneity statistic type	String, 777 = Not specified 999 = N/A (no meta- analysis)	
PC_Comm_Hetero_stat	Heterogeneity statistic value	Number, 777 = Not specified 999 = N/A (no meta- analysis)	
PC_Comm_Study_No	Number of studies	Number, 777 = Not specified	
PC_Comm_ author_summ	For qualitative studies, copy the author's terminology to describe the summary of outcomes verbatim	String, 777 = Not specified	



	PC_Comm_Spec	Overall communication outcome specified	1= Yes, 0 = No	
b. Expressive language	PC_Exp_Lang_Term	Term used by SR to describe expressive language outcome	String, 777 = Not specified	To be completed based on SR: • Methods
	PC_Exp_Lang_ES	Specify the overall effect size including confidence intervals	String, 777 = Not specified	 Results (including tables)
	PC_Exp_Lang_EStype	Specify the types of effect size (e.g. Cohen's <i>d</i> or Hedge's <i>g</i>)	String, 777 = Not specified	Supplementary
	PC_Exp_Lang_ES_Dir	Meta-analysis - direction of the therapeutic effect	1 = Positive 2 = Negative 3 = Null 777 = Not specified 999 = N/A (no meta- analysis)	involve counting contents of tables and paragraphs in the results.
	PC_Exp_Lang_ES_Spec	Effect size specified	1 = Yes, 0 = No	1
	PC_Exp_Lang_Hetero_type	Heterogeneity statistic type	String, 777 = Not specified 999 = N/A (no meta- analysis)	
	PC_Exp_Lang_Hetero_stat	Heterogeneity statistic value	Number, 777 = Not specified 999 = N/A (no meta- analysis)	



	PC_Exp_Lang_Study_No PC_Exp_Lang_ author_summ PC_Exp_Lang_Spec	Number of studiesFor qualitative studies, copy the author's terminology to describe the summary of outcomes verbatim.Expressive language outcome specified	Number, 777 = Not specified String, 777 = Not specified 1= Yes, 0 = No	
c. Receptive language	PC_Rec_Lang_Term PC_Rec_Lang_ES	Term used by SR to describe receptive language outcome Specify the overall effect size including confidence intervals	String, 777 = Not specified String, 777 = Not specified	To be completed based on SR: Methods Results (including tables)
	PC_Rec_Lang_EStype	Specify the types of effect size (e.g. Cohen's <i>d</i> or Hedge's <i>g</i>)	String, 777 = Not specified	Supplementary
	PC_Rec_Lang_ES_Dir	Meta-analysis - direction of the therapeutic effect	1 = Positive 2 = Negative 3 = Null 777 = Not specified 999 = N/A (no meta- analysis)	involve counting contents of tables and paragraphs in the results.
	PC_Rec_Lang_ES_Spec	Effect size specified	1 = Yes, 0 = No	



	PC_Rec_Lang_Hetero_type	Heterogeneity statistic type	String, 777 = Not specified 999 = N/A (no meta- analysis)	
	PC_Rec_Lang_Hetero_stat	Heterogeneity statistic value	Number, 777 = Not specified 999 = N/A (no meta- analysis)	
	PC_Rec_Lang_Study_No	Number of studies	Number, 777 = Not specified	
	PC_Rec_Lang_ author_summ	For qualitative studies, copy the author's terminology to describe the summary of outcomes verbatim	String, 777 = Not specified	
	PC_Rec_Lang_Spec	Receptive language outcome specified	1= Yes, 0 = No	
d. Cognition	PC_Cog_Term	Term used by SR to describe cognition outcome	String, 777 = Not specified	To be completed based on SR: • Methods
	PC_Cog_ES	Specify the overall effect size including confidence intervals	String, 777 = Not specified	 Results (including tables)
	PC_Cog_EStype	Specify the types of effect size (e.g. Cohen's <i>d</i> or Hedge's <i>g</i>)	String, 777 = Not specified	Supplementary



	PC_Cog_ES_Dir	Meta-analysis - direction of the therapeutic effect	1 = Positive 2 = Negative 3 = Null 777 = Not specified 999 = N/A (no meta- analysis)	Qualitative data <u>will not</u> involve counting contents of tables and paragraphs in the results.
	PC_Cog_ES_Spec	Effect size specified	1 = Yes, 0 = No	
	PC_Cog_Hetero_type	Heterogeneity statistic type	String, 777 = Not specified 999 = N/A (no meta- analysis)	
	PC_Cog_Hetero_stat	Heterogeneity statistic value	Number, 777 = Not specified 999 = N/A (no meta- analysis)	
	PC_Cog_Study_No	Number of studies	Number, 777 = Not specified	
	PC_Cog_ author_summ	For qualitative studies, copy the author's terminology to describe the summary of outcomes verbatim	String, 777 = Not specified	
	PC_Cog_Spec	Cognition outcome specified	1= Yes, 0 = No]
e. Motor	PC_Motor_Term	Term used by SR to describe motor outcome	String, 777 = Not specified	To be completed based on SR:



PC_Motor_ES	Specify the overall effect size including confidence intervals	String, 777 = Not specified	MethodsResults (including
PC_Motor_EStype	Specify the types of effect size (e.g. Cohen's <i>d</i> or Hedge's <i>g</i>)	String, 777 = Not specified	tables)Supplementary
PC_Motor_ES_Dir	Meta-analysis - direction of the therapeutic effect	1 = Positive 2 = Negative 3 = Null 777 = Not specified 999 = N/A (no meta- analysis)	Qualitative data <u>will not</u> involve counting contents of tables and paragraphs in the results.
PC_Motor_ES_Spec	Effect size specified	1 = Yes, 0 = No	
PC_Motor_Hetero_type	Heterogeneity statistic type	String, 777 = Not specified 999 = N/A (no meta- analysis)	
PC_Motor_Hetero_stat	Heterogeneity statistic value	Number, 777 = Not specified 999 = N/A (no meta- analysis)	
PC_Motor_Study_No	Number of studies	Number, 777 = Not specified	



	PC_Motor_ author_summ PC_Motor_Spec	For qualitative studies, copy the author's terminology to describe the summary of outcomes verbatim Motor outcome specified	String, 777 = Not specified 1= Yes, 0 = No	-
f. Social emotional/ challenging behaviour	PC_SECB_Term	Term used by SR to describe social emotional/ challenging behaviour outcome	String, 777 = Not specified	To be completed based on SR: Methods Results (including tables) Supplementary
	PC_SECB_ES	Specify the overall effect size including confidence intervals	String, 777 = Not specified	
	PC_SECB_EStype	Specify the types of effect size (e.g. Cohen's <i>d</i> or Hedge's <i>g</i>)	String, 777 = Not specified	
	PC_SECB_ES_Dir	Meta-analysis - direction of the therapeutic effect	1 = Positive 2 = Negative 3 = Null 777 = Not specified 999 = N/A (no meta- analysis)	tables and paragraphs in the results.
	PC_SECB_ES_Spec	Effect size specified	1 = Yes, 0 = No	
	PC_SECB_Hetero_type	Heterogeneity statistic type	String, 777 = Not specified 999 = N/A (no meta- analysis)	



	PC_SECB_Hetero_stat	Heterogeneity statistic value	Number, 777 = Not specified 999 = N/A (no meta- analysis)	_
	PC_SECB_Study_No	Number of studies	Number, 777 = Not specified	
	PC_SECB_ author_summ	For qualitative studies, copy the author's terminology to describe the summary of outcomes verbatim	String, 777 = Not specified	
	PC_SECB_Spec	Social-emotional/challenging behaviour outcome specified	1= Yes, 0 = No	
g. Play	PC_Play_Term	Term used by SR to describe play outcome	String, 777 = Not specified	To be completed based on SR: • Methods
	PC_Play_ES	Specify the overall effect size including confidence intervals	String, 777 = Not specified	 Results (including tables) Supplementary
	PC_Play_EStype	Specify the types of effect size (e.g. Cohen's <i>d</i> or Hedge's <i>g</i>)	String, 777 = Not specified	
	PC_Play_ES_Dir	Meta-analysis - direction of the therapeutic effect	1 = Positive 2 = Negative 3 = Null	involve counting contents of tables and paragraphs in the results.
			777 = Not specified 999 = N/A (no meta- analysis)	



	PC_Play_ES_Spec	Effect size specified	1 = Yes, 0 = No	
	PC_Play_Hetero_type	Heterogeneity statistic type	String, 777 = Not specified 999 = N/A (no meta- analysis)	
	PC_Play_Hetero_stat	Heterogeneity statistic value	Number, 777 = Not specified 999 = N/A (no meta- analysis)	
	PC_Play_Study_No	Number of studies	Number, 777 = Not specified	
	PC_Play_ author_summ	For qualitative studies, copy the author's terminology to describe the summary of outcomes verbatim	String, 777 = Not specified	
	PC_Play_Spec	Play outcome specified	1= Yes, 0 = No	
h. Adaptive behaviour	PC_Adap_Term	Term used by SR to describe adaptive behaviour outcome	String, 777 = Not specified	To be completed based on SR: • Methods
	PC_Adap_ES	Specify the overall effect size including confidence intervals	String, 777 = Not specified	 Results (including tables)
	PC_Adap_EStype	Specify the types of effect size (e.g. Cohen's <i>d</i> or Hedge's <i>g</i>)	String, 777 = Not specified	Supplementary



	PC_Adap_ES_Dir	Meta-analysis - direction of the therapeutic effect	1 = Positive 2 = Negative 3 = Null 777 = Not specified 999 = N/A (no meta- analysis)	Qualitative data <u>will not</u> involve counting contents of tables and paragraphs in the results.
	PC_Adap_ES_Spec	Effect size specified	1 = Yes, 0 = No	
	PC_Adap_Hetero_type	Heterogeneity statistic type	String, 777 = Not specified 999 = N/A (no meta- analysis)	
	PC_Adap_Hetero_stat	Heterogeneity statistic value	Number, 777 = Not specified 999 = N/A (no meta- analysis)	
	PC_Adap_Study_No	Number of studies	Number, 777 = Not specified	
	PC_Adap_ author_summ	For qualitative studies, copy the author's terminology to describe the summary of outcomes verbatim	String, 777 = Not specified	
	PC_Adap_Spec	Adaptive outcome specified	1= Yes, 0 = No	
i. General outcomes	PC_General_Term	Term used by SR to describe general outcomes	String, 777 = Not specified	To be completed based on SR:



PC_General_Outcomes PC_General_ES	Outcomes that contributed to the general effect measure Specify the general effect size including confidence intervals	String, 777 = Not specified String, 777 = Not specified	 Methods Results (including tables) Supplementary
PC_General_ES_type	Specify the types of effect size (e.g. Cohen's <i>d</i> or Hedge's <i>g</i>)	String, 777 = Not specified	Qualitative data will not involve counting contents of
PC_General_ES_Dir	Meta-analysis - direction of the therapeutic effect	1 = Positive 2 = Negative 3 = Null 777 = Not specified 999 = N/A (no meta- analysis)	tables and paragraphs in the results.
PC_General_ES_Spec	Effect size specified	1 = Yes, 0 = No	
PC_General_Hetero_type	Heterogeneity statistic type	String, 777 = Not specified 999 = N/A (no meta- analysis)	
PC_General_Hetero_stat	Heterogeneity statistic value	Number, 777 = Not specified 999 = N/A (no meta- analysis)	
PC_General_Study_No	Number of studies	Number, 777 = Not specified	



	PC_General_ author_summ PC_General_Spec	For qualitative studies, copy the author's terminology to describe the summary of outcomes verbatim General outcome specified	String, 777 = Not specified 1= Yes, 0 = No	_
20. Education and Participation	PC_School_Term	Term used by SR to describe school readiness outcome	String, 777 = Not specified	To be completed based on SR: • Methods
a. School/Learning readiness	PC_School_ES	Specify the overall effect size including confidence intervals	String, 777 = Not specified	 Results (including tables)
	PC_School_EStype	Specify the types of effect size (e.g. Cohen's <i>d</i> or Hedge's <i>g</i>)	String, 777 = Not specified	Supplementary
	PC_School_ES_Dir	Meta-analysis - direction of the therapeutic effect	1 = Positive 2 = Negative 3 = Null 777 = Not specified 999 = N/A (no meta- analysis)	Qualitative data <u>will not</u> involve counting contents of tables and paragraphs in the results.
	PC_School_ES_Spec	Effect size specified	1 = Yes, 0 = No	
	PC_School_Hetero_type	Heterogeneity statistic type	String, 777 = Not specified 999 = N/A (no meta- analysis)	
	PC_School_Hetero_stat	Heterogeneity statistic value	Number, 777 = Not specified	



	PC_School_Study_No PC_School_ author_summ	Number of studies For qualitative studies, copy the author's terminology to describe the summary of outcomes verbatim	999 = N/A (no meta- analysis) Number, 777 = Not specified String, 777 = Not specified	
	PC_School_Spec	School readiness outcome specified	1= Yes, 0 = No	
b. Academic skills	PC_Academic_Term	Term used by SR to describe academic outcome	String, 777 = Not specified	To be completed based on SR: • Methods
	PC_Academic_ES	Specify the overall effect size including confidence intervals	String, 777 = Not specified	 Results (including tables)
	PC_Academic_EStype	Specify the types of effect size (e.g. Cohen's <i>d</i> or Hedge's <i>g</i>)	String, 777 = Not specified	Supplementary
	PC_Academic_ES_Dir	Meta-analysis - direction of the therapeutic effect	1 = Positive 2 = Negative 3 = Null 777 = Not specified	tables and paragraphs in the results.
			999 = N/A (no meta- analysis)	
	PC_Academic_ES_Spec	Effect size specified	1= Yes, 0 = No	



	PC_Academic_Hetero_type	Heterogeneity statistic type	String, 777 = Not specified 999 = N/A (no meta- analysis)	
	PC_Academic_Study_No	Number of studies	Number, 777 = Not specified	
	PC_Academic_Hetero_stat	Heterogeneity statistic value	Number, 777 = Not specified 999 = N/A (no meta- analysis)	
	PC_Academic_ author_summ	For qualitative studies, copy the author's terminology to describe the summary of outcomes verbatim	String, 777 = Not specified	
	PC_Academic_Spec	Academic outcome specified	1= Yes, 0 = No	
c. Quality of Life	PC_QoL_Term	Term used by SR to describe Quality of Life outcome	String, 777 = Not specified	To be completed based on SR: • Methods
	PC_QoL_ES	Specify the overall effect size including confidence intervals	String, 777 = Not specified	 Results (including tables)
	PC_QoL_EStype	Specify the types of effect size (e.g. Cohen's <i>d</i> or Hedge's <i>g</i>)	String, 777 = Not specified	Supplementary
	PC_QoL_ES_Dir	Meta-analysis - direction of the therapeutic effect	1 = Positive 2 = Negative 3 = Null	Qualitative data <u>will not</u> involve counting contents of



			777 - Not specified	tables and paragraphs in the
			999 = N/A (no meta- analysis)	results.
	PC_QoL_ES_Spec	Effect size specified	1 = Yes, 0 = No	
	PC_QoL_Hetero_type	Heterogeneity statistic type	String, 777 = Not specified 999 = N/A (no meta- analysis)	
	PC_QoL_Hetero_stat	Heterogeneity statistic value	Number, 777 = Not specified 999 = N/A (no meta- analysis)	
	PC_QoL_Study_No	Number of studies	Number, Not specified	
	PC_QoL_ author_summ	For qualitative studies, copy the author's terminology to describe the summary of outcomes verbatim	String, 777 = Not specified	
	PC_QoL_Spec	Quality of life outcome specified	1= Yes, 0 = No	
21. Community participation	PC_CP_Term	Term used by SR to describe community participation outcome	String, 777 = not specified	To be completed based on SR: • Methods
	PC_CP_ES	Specify the overall effect size including confidence intervals	String, 777 = Not specified	



PC_CP_EStype PC_CP_ES_Dir	Specify the types of effect size (e.g. Cohen's <i>d</i> or Hedge's <i>g</i>) Meta-analysis - direction of the therapeutic effect	String, 777 = Not specified 1 = Positive 2 = Negative 3 = Null 777 = Not specified 999 = N/A (no meta- analysis)	 Results (including tables) Supplementary Qualitative data <u>will not</u> involve counting contents of tables and paragraphs in the results.
PC_CP_ES_Spec	Effect size specified	1 = Yes, 0 = No	
PC_CP_Hetero_type	Heterogeneity statistic type	String, 777 = Not specified 999 = N/A (no meta- analysis)	
PC_CP_Hetero_stat	Heterogeneity statistic value	Number, 777 = Not specified 999 = N/A (no meta- analysis)	
PC_CP_Study_No	Number of studies	Number, 777 = Not specified	
PC_CP_ author_summ	For qualitative studies, copy the author's terminology to describe the summary of outcomes verbatim	String, 777 = Not specified	



	PC_CP_Spec	Community participation outcome specified	1= Yes, 0 = No	
22. Family wellbeing a. Caregiver communication and interaction strategies	PC_PE_Strat_Term	Term used by SR to describe communication and interaction strategies	String, 777 = Not specified	To be completed based on SR: • Methods
	PC_PE_Strat_ES	Specify the overall effect size including confidence intervals	String, 777 = Not specified	 Results (including tables) Supplementary Qualitative data <u>will not</u> involve counting contents of tables and paragraphs in the results.
	PC_PE_Strat_EStype	Specify the types of effect size (e.g. Cohen's <i>d</i> or Hedge's <i>g</i>)	String, 777 = Not specified	
	PC_PE_Strat_ES_Dir	Meta-analysis - direction of the therapeutic effect	1 = Positive 2 = Negative 3 = Null 777 = Not specified 999 = N/A (no meta- analysis)	
	PC_PE_Strat_ES_Spec	Effect size specified	1 = Yes, 0 = No	
	PC_PE_Strat_Hetero_type	Heterogeneity statistic type	String, 777 = Not specified 999 = N/A (no meta- analysis)	
	PC_PE_Strat_Hetero_stat	Heterogeneity statistic value	Number, 777 = Not specified	



	PC_PE_Study_No	Number of studies	999 = N/A (no meta- analysis) Number, 777 = Not specified	
	PC_PE_Strat_ author_summ	For qualitative studies, copy the author's terminology to describe the summary of outcomes verbatim	String, 777 = Not specified	
	PC_PE_Strat_Spec	Communication and interaction strategies outcome specified	1= Yes, 0 = No	
	PC_PE_Att_Det	Attrition details (string)	String, 777 = Not specified	
	PC_PE_AttHighLow_Spec	Caregiver attrition specified	1= Yes, 0 = No	
b. Caregiver social emotional wellbeing	PC_PE_SE_Well_Term	Term used by SR to describe parent social emotional wellbeing	String, 777 = Not specified	To be completed based on SR: • Results (including
wenbenig	PC_PE_SE_Well_ES	Specify the overall effect size including confidence intervals	String, 777 = Not specified	tables)Supplementary
	PC_PE_SE_Well_EStype	Specify the types of effect size (e.g. Cohen's <i>d</i> or Hedge's <i>g</i>)	String, 777 = Not specified	Qualitative data <u>will not</u>
	PC_PE_SE_Well_ES_Dir	Meta-analysis - direction of the therapeutic effect	1 = Positive 2 = Negative 3 = Null 777 = Not specified	involve counting contents of tables and paragraphs in the results.



			999 = N/A (no meta- analysis)	
	PC_PE_SE_Well_ES_Spec	Effect size specified	1 = Yes, 0 = No	
	PC_PE_SE_Well_Hetero_ty pe	Heterogeneity statistic type	String, 777 = Not specified 999 = N/A (no meta- analysis)	
	PC_PE_SE_Well_Hetero_st at	Heterogeneity statistic value	Number, 777 = Not specified 999 = N/A (no meta- analysis)	
	PC_PE_SE_Well_Study_No	Number of studies	Number, 777 = Not specified	
	PC_PE_SE_Well_ author_summ	For qualitative studies, copy the author's terminology to describe the summary of outcomes verbatim.	String, 777 = Not specified	
	PC_PE_SE_Well_Spec	Parent social emotional wellbeing specified	1= Yes, 0 = No	
c. Caregiver satisfaction	PC_PE_Satis	Evidence for parent/caregiver satisfaction	1 = Yes, 0 = No, 777 = Not specified	To be completed based on SR: • Results (including
	PC_PE_Satis_Desc	Describe the measure of satisfaction	String, 777 = Not specified	tables)



	PC_PE_Satis_Info	Further information about parent satisfaction results	String, 777 = Not specified	Mark "yes" if this type of satisfaction/dissatisfaction is mentioned on at least one
	PC_PE_DisSatis	Evidence for parent/caregiver dissatisfaction	1 = Yes, 0 = No, 777 = Not specified	
	PC_PE_DisSatis_Desc	Describe the measure of dissatisfaction	String, 777 = Not specified	
	PC_PE_DisSatis_Info	Further information about parent dissatisfaction results	String, 777 = Not specified	
	PC_PE_Satis_Spec	Parent/caregiver satisfaction specified	1 = Yes, 0 = No	
d. Caregiver financial wellbeing	PC_PE_Fin_Well_Term	Term used by SR to describe parent financial wellbeing	String, 777 = Not specified	To be completed based on SR: • Results (including
	PC_PE_Fin_Well_ES	Specify the overall effect size including confidence intervals	String, 777 = Not specified	tables)Supplementary
	PC_PE_Fin_Well_EStype	Specify the types of effect size (e.g. Cohen's <i>d</i> or Hedge's <i>g</i>)	String, 777 = Not specified	Qualitative data <u>will not</u>
	PC_PE_Fin_Well_ES_Dir	Meta-analysis - direction of the therapeutic effect	1 = Positive 2 = Negative 3 = Null	involve counting contents of tables and paragraphs in the results.
			777 = Not specified 999 = N/A (no meta- analysis)	



	PC_PE_Fin_Well_ES_Spec	Effect size specified	1 = Yes, 0 = No	
	PC_PE_Fin_Well_Hetero_ty pe	Heterogeneity statistic type	String, 777 = Not specified 999 = N/A (no meta- analysis)	
	PC_PE_Fin_Well_Hetero_st at	Heterogeneity statistic value	Number, 777 = Not specified 999 = N/A (no meta- analysis)	
	PC_PE_Fin_Well_ author_summ	For qualitative studies, copy the author's terminology to describe the summary of outcomes verbatim	String, 777 = Not specified	-
	PC_PE_Fin_Well_Spec	Financial wellbeing specified	1= Yes, 0 = No	-
e. Child satisfaction	PC_CE_Satis	Evidence for child satisfaction	1 = Yes, 0 = No, 777 = Not specified	To be completed based on SR: • Results (including
	PC_CE_Satis_Desc	Describe the measure of satisfaction	String, 777 = Not specified	tables)
	PC_CE_DisSatis	Evidence for child dissatisfaction	1 = Yes, 0 = No, 777 = Not specified	Mark "yes" if this type of
	PC_CE_DisSatis_Desc	Describe the measure of child dissatisfaction	String, 777 = Not specified	mentioned on at least one occasion.
	PC_CE_Satis_Spec	Child satisfaction specified	1 = Yes, 0 = No	



f. Adverse events	PC_CE_Harm_Evidence	Evidence for child distress or harm related to the intervention	1 = Yes, 0 = No, 777 = Not specified	To be completed based on SR: • Results (including tables)
				Mark "yes" if this type of harm/distress is mentioned on at least one occasion.

Variables extracted separately for each moderator analysis on each outcome in the systematic review.

1. Intervention label	PC_Int_Name	Name for the intervention as defined by the authors verbatim	String, 777 = Not specified	To be completed based on the SR: • Methods • Results (including tables) Where possible, copy and paste text verbatim.
2. Moderator	PC_Mod	Variable that was examined as a moderator of a given outcome	String, 777 = Not specified	To be completed based on the SR: • Methods • Results (including tables)



					Where possible, copy and paste text verbatim.
3.	Outcome of moderator analysis	PC_Mod_Outcome	Outcome variable that was the subject of the moderator analysis	String, 777 = Not specified	To be completed based on the SR: • Methods • Results (including tables) Where possible, copy and paste text verbatim.
4.	Finding of moderator analysis	PC_Mod_Outc_Find_Cat	Finding of the moderator analysis	 1 = Consistently positive 2 = Consistently negative 3 = Consistently null; 4 = Mixed or otherwise unclear For outcomes that don't fit into these categories, provide a short string explanation of the pattern of findings (e.g., 'quadratic') 	To be completed based on the SR: • Methods • Results (including tables)
5.	Number of studies included	PC_Mod_No_Studies	Number of studies included in the moderator analyses	Number, 777 = Not specified	To be completed based on the SR:



					 Methods Results (including tables)
6.	Evidence for moderator finding	PC_Mod_Outc_Find_Evide nce	Copy the author's terminology to describe the outcome of the moderator analyses verbatim	String, 777 = Not specified	To be completed based on the SR: Methods Results (including tables)
7.	Statement of finding for tables	PC_Mod_Statement	Summary statement regarding the effect of the moderator on the outcome (e.g., "Younger age associated with greater intervention effects on Social communication"	String	To be completed using the template sentences provided by the document "Intermediate Table Instructions."



Appendix I: Quality appraisal form (adapted from the Critical Appraisal Checklist for Systematic Reviews and Research Syntheses created by the Joanna Briggs Institute [2020])

NB: A 'Yes' decision requires all checkboxes under a single item to be met, unless the criteria specifically state otherwise (i.e., use an 'OR' qualifier). If all checkboxes are not met, a 'No' decision should be specified.

1. Is the review question clearly and explicitly stated?

□ The review question(s) or aim(s)/objectives explicitly state(s) the population, intervention, and outcomes of interest PI(C)O.

2. Were the inclusion criteria appropriate for the review question?

- □ The PICO elements and design were clearly defined in the inclusion and/or exclusion criteria.
- □ The PICO elements were relevant to the objectives of the review and/or the research questions

3. Was the search strategy appropriate?

- \Box The search strategy included key words and/or index terms that specified PI(C)O
- $\hfill\square$ Date and language limits appropriate and/or justified

4. Were the sources and resources used for the study adequate?

- Included at least two major bibliographic databases relevant to the review question, from the following list: Medline, CINAHL, PsycINFO, PubMed, EMBASE, Scopus, Web of Science, and ERIC
- □ Attempt to search for grey literature (e.g. websites relevant to the review question, thesis repositories, trial registries)

5. Were criteria for appraising the studies appropriate?

 $\hfill\square$ Clear statement that critical appraisal was conducted



Details of the items that were used to assess the included studies (within methods, appendix, or further reference) were outlined and appropriate for the relevant study design

6. Was critical appraisal conducted by two or more reviewers independently?

- □ Critical appraisal was conducted by two reviewers working independently from each other and conferring when needed to make a decision; OR
- □ Two reviewers conducted critical appraisal with at least 10% of eligible studies and achieved good agreement (at least 80% or Cohen's kappa = 0.6 or greater), with the remainder extracted by one reviewer.

7. Were there methods to minimise errors in data extraction?

- \square All data extraction was conducted by two reviewers working independently OR
- □ Two reviewers extracted data with a sample of eligible studies and achieved good agreement (at least 80% or Cohen's kappa = 0.6 or greater), with the remainder extracted by one reviewer.

8. Were the methods used to combine studies appropriate?

- Meta-analyses
 - $\hfill\square$ A statement about the extent to which the studies were appropriate to be combined
 - □ Assessment of heterogeneity
 - □ Explanation for heterogeneity that may be present
- Narrative synthesis
 - $\hfill\square$ Methods for data synthesis are congruent with the stated methodology
 - $\hfill\square$ Adequate information is provided to support the synthesised findings
- Meta-analyses and narrative synthesis
 - Summary/extraction tables were structured to provide sufficient information to ascertain
 PICO elements and design for each included study.



9. Was the likelihood of publication bias assessed? (meta-analyses only)

- Publication bias was assessed (e.g. a funnel plot for 10 or more studies or Egger's test Begg test, Harbord test)
- □ N/A

10. Were recommendations for policy and/or practice supported by the reported data?

- □ Clear link made between the results of the review and recommendations for policy and practice.
- □ The strengths of the findings and the quality of the research considered in the formulation of the review recommendations

11. Were the specific directives for new research appropriate?

□ Indication of directions for further research



Appendix J: Data synthesis process

Data were first summarised through the development of a table presenting the characteristics of included SRs (Appendix M), the development of intermediary tables presenting the findings of each SR (Appendix N-P), and the creation of appendices to summarise raw data (e.g., effect sizes, confidence intervals, and heterogeneity reported for each meta-analysis; verbatim statements of effect reported for each narrative synthesis; Appendix T).

Evidence for intervention effects

Evidence for the effects of different intervention practices and categories was synthesised as follows:

- Evidence for intervention effects for each category and practice presented in the intermediate tables was mapped to an excel spreadsheet. Each SR occupied one row and the outcomes of interest were listed as columns.
- 2. A code of 1-4 was inserted in the corresponding cell for piece of evidence for intervention effect: (1) positive pooled/summarised effect, (2) negative pooled/summarised effect, (3) null pooled/summarised effect, or (4) inconsistent pooled/summarised effect. Overall evidence ratings used by the National Autism Center (2015) of 'established' were coded as 1, 'emerging' coded as 4, and 'unestablished' coded as 3. The overall evidence rating used by Steinbrenner et al., 2020) to indicate 'insufficient evidence' was coded as 3. Font colour was used for each outcome to indicate if evidence was based on a meta-analysis or a narrative review. Using this approach, it was possible for more than one piece of evidence to be in each cell (e.g., if an author reported two different measures of adaptive behaviour).
- 3. A within-SR synthesis of evidence of effect for each outcome was then completed. Where more than one piece of evidence was available, a summary code was allocated as follows:
 - a. Positive was coded where all evidence for intervention effect was positive.
 - b. Null was coded where all evidence for intervention effect was null.
 - c. Inconsistent was coded were there was a mixture (positive, null) of evidence for intervention effect.
 - d. Adverse effects were recorded in Table 7.



- 4. An across SR synthesis of evidence of effect for each outcome was then completed, at the category and practice level.
 - a. Where only one SR provided evidence in relation to a particular outcome, the code applied during the within-SR coding (positive, null, mixed) was transferred to a summary line in the spreadsheet.
 - b. Where more than one SR provided evidence for a particular outcome, the evidence for intervention effect from the most recent meta-analysis (where available) was used to determine the code for that outcome. The prioritisation of the most recent meta-analysis occurred irrespective of the number of other meta-analyses and/or narrative reviews. Where there was no meta-analysis but findings from two or more narrative reviews, the findings were synthesised as per the codes specified in step 3 (positive, null, mixed). The code allocated was then transferred to the summary line for the practice/category.
- 5. Data from all summary lines were then transferred to Table 6.

Evidence for the possible influence of child and intervention characteristics on intervention effects were transferred verbatim from the extraction spreadsheet into Tables 8-10 and summarised descriptively.



Appendix K: Excluded articles from full-text screening phase

Exclusion reason: Duplicate (n=14)

Diggle T. T. J., McConachie. H. (2013). Parent-mediated early intervention for young children with autism spectrum disorder. *Cochrane Database of Systematic Reviews, 2013* (4). doi: 10.1002/14651858.CD003496.pub2

Geretsegger, M., Elefant, C., Mössler, K. A., Gold, C. (2014). Music therapy for people with autism spectrum disorder. *Cochrane Database of Systematic Reviews, 2014* (6). doi: 10.1002/14651858.CD004381.pub3

Hillman, K., Dix, K., Ahmad, K., Lietz, P., Trevitt, J., O'Grady, E., ... & Hedley, D. (2020). Interventions for anxiety in mainstream school-aged children with autism spectrum disorder: A systematic review. *Campbell Systematic Reviews, 2020* (16), e1086. doi: 10.1002/cl2.1086

Ho, B. P., Stephenson, J., & Carter, M. (2015). Cognitive–behavioural approach for children with autism spectrum disorder: A literature review. *Journal of Intellectual and Developmental Disability*, 40, 213-229. doi: 10.3109/13668250.2015.1023181

James, A. C., James, G., Cowdrey, F. A., Soler, A., & Choke, A. (2015). Cognitive behavioural therapy for anxiety disorders in children and adolescents. *Cochrane Database of Systematic Reviews*, 2015 (2). doi: 10.1002/14651858.CD004690.pub4

Lake, J., Modica, P. T., Chan, V., Weiss, J. A. (2019). Systematic review comparing efficacy and effectiveness trials of cognitive behavioural therapy among youth with autism. *Journal of Intellectual Disability Research*, 63, 659. <u>https://doi.org/10.1111/jir.12652</u>

Oono I.P., Honey E.J., Mcconachie H. (2013). Parent-mediated early intervention for young children with autism spectrum disorders (ASD). *Cochrane Database of Systematic Reviews, 2013* (4), 1465-1858. doi: 10.1002/14651858.CD009774.pub2

Oono, I., Honey, E., Mcconachie, H. (2013). Parent-mediated early intervention for young children with autism spectrum disorders: A Cochrane systematic review and meta-analyses. *Developmental Medicine and Child Neurology*, 55, 27-28. doi: 10.1111/dmcn.12259

Reichow, B., Barton, E. E., Boyd, B. A., & Hume, K. (2014). Early intensive behavioral intervention (EIBI) for young children with autism spectrum disorders (ASD): A systematic review. *Campbell Systematic Reviews, 2014* (10), 1-116. doi: 10.4073/csr.2014.9

Reichow, B., Steiner, A. M., & Volkmar, F. (2012). Social skills groups for people aged 6 to 21 with autism spectrum disorders (ASD). *Campbell Systematic Reviews, 2012* (8), 1-76. doi: <u>https://doi.org/10.4073/csr.2012.16</u>

Shalev, R. A., Lavine, C., & Di Martino, A. (2019). A systematic review of the role of parent characteristics in parent-mediated interventions for children with autism spectrum disorder. *Journal of Developmental and Physical Disabilities*, *32*, 1-21. doi: https://doi.org/10.1007/s10882-018-9641-x

Zhimin, S., Guihong, L., & Qing, X. (2016). Meta analysis of influence of music therapy on emotion, language, behavior and social skills in children with autism. *Chinese Nursing Research*, *30*(3B), 922–926. <u>https://doi.org/10.3969/j.issn.1009-6493.2016.08.009</u>



Weitlauf, A. S., McPheeters, M. L., Peters, B., Sathe, N., Travis, R., Aiello, R., ... & Warren, Z. (2014). *Therapies for children with autism spectrum disorder: Behavioral interventions update. AHRQ Comparative Effectiveness Review No. 137.* Rockville (MD): Agency for Healthcare Research and Quality (US). Retrieved

from https://effectivehealthcare.ahrq.gov/sites/default/files/pdf/autism-update_research.pdf

Weitlauf, A. S., McPheeters, M. L., Peters, B., Sathe, N., Travis, R., Aiello, R., ... Warren, Z. (2014). No Title. *Agency for Healthcare Research and Quality* (AHRQ).

Exclusion reason: Not systematic (n=152)

Adnan, N. H., Tunggal, D., & Abdullasim, N. (2018). Systematic review on augmented reality application for autism children. *Journal of Advanced Research in Dynamical and Control Systems, 10*(11), 26-32.

Aguirre, A. A., Valentino, A. L., & LeBlanc, L. A. (2016). Empirical investigations of the intraverbal: 2005–2015. *The Analysis of Verbal Behavior, 32*, 139-153. doi: 10.1007/s40616-016-0064-4

Allan, A. C., Vladescu, J. C., Kisamore, A. N., Reeve, S. A., & Sidener, T. M. (2015). Evaluating the emergence of reverse intraverbals in children with autism. *The Analysis of Verbal Behavior*, *31*(1), 59-75.

Al-Oran, H. M., Lee, K., Tan, K. A., & Lim, P. Y. (2019). The effectiveness of educational programs on parenting stress and coping mechanism among parents of children with autism spectrum disorder: A systematic review. *Malaysian Journal of Medicine and Health Sciences, 15*(3), 135-141.

Alzrayer, N. M., & Banda, D. R. (2016). All reviews are not the same: A systematic review on requesting skills and speech generating devices is undone by serious methodological issues. *Evidence-Based Communication Assessment and Intervention, 10*(2), 97-100. doi: 10.1080/17489539.2016.1226730

Aresti-Bartolome, N., & Garcia-Zapirain, B. (2014). Technologies as support tools for persons with autistic spectrum disorder: a systematic review. *International Journal of Environmental Research and Public Health*, *11*, 7767-7802. doi: 10.3390/ijerph110807767

Banda, D. R. (2018). The results of this systematic review on AAC with adolescents and adults with autism spectrum disorder has promising implications, despite there being a limited number of studies. *Evidence-Based Communication Assessment and Intervention, 12*(3), 81-84. doi: 10.1080/17489539.2018.1504423

Banda, D. R., & Okungu, P. A. (2011). This review suggests that video-based instruction improves skills in persons with autism spectrum disorders: Some limitations in review methodology and the original data set render this conclusion tentative. *Evidence-Based Communication Assessment and Intervention*, *5*(3), 144-148. doi: 10.1080/17489539.2011.651908

Banneyer, K. N., Bonin, L., Price, K., Goodman, W. K., & Storch, E. A. (2018). Cognitive behavioral therapy for childhood anxiety disorders: A review of recent advances. *Current Psychiatry Reports, 20*(8), 1-8. doi: https://doi.org/10.1007/s11920-018-0924-9

Bellinger, J. M., Perlman, E. H., & DiPerna, J. C. (2011). Social skills interventions for individuals with autism spectrum disorder. *School Psychology Forum*, *5*(4), 141-159.



Bene, K., & Lapina, A. (2020). A meta-analysis of sibling-mediated intervention for brothers and sisters who have autism spectrum disorder. *Review Journal of Autism and Developmental Disorders*. doi: 10.1007/s40489-020-00212-z

Bene, K., Banda, D. R., & Brown, D. (2014). A meta-analysis of peer-mediated instructional arrangements and autism. *Review Journal of Autism and Developmental Disorders, 1*(2), 135-142. doi: 10.1007/s40489-014-0014-9

Berg, E. L., & Causey, A. (2014). The life-changing power of the horse: Equine-assisted activities and therapies in the US. *Animal Frontiers*, *4*(3), 72-75. doi: 10.2527/af.2014-0025

Berry, A., Borgi, M., Francia, N., Alleva, E., & Cirulli, F. (2013). Use of assistance and therapy dogs for children with autism spectrum disorders: A critical review of the current evidence. *The Journal of Alternative and Complementary Medicine*, *19*(2), 73-80. doi: 10.1089/acm.2011.0835

Black, M. E., & Therrien, W. J. (2018). Parent training programs for school-age children with autism: A systematic review. *Remedial and Special Education, 39*, 243-256. doi: 10.1177/0741932517730645

Boesch, M. C., Shukla Mehta, S., & Da Fonte, M. A. (2016). A review comparing AAC intervention components yields a list of studied components, but conclusions regarding comparative effectiveness appear flawed. *Evidence-Based Communication Assessment and Intervention*, *10*(1), 13-19. doi: 10.1080/17489539.2016.1200256

Boisvert, M., Lang, R., Andrianopoulos, M., & Boscardin, M. L. (2010). Telepractice in the assessment and treatment of individuals with autism spectrum disorders: A systematic review. *Developmental Neurorehabilitation*, *13*, 423-432. doi: 10.3109/17518423.2010.499889

Boster, J. B., McCarthy, J. W., & Benigno, J. P. (2017). Music therapy is beneficial for children with autism spectrum disorders, but more specific clinical guidance is a future need. *Evidence-Based Communication Assessment and Intervention*, *11*(1-2), 20-26. doi: 10.1080/17489539.2017.1328731

Bradshaw, J., Steiner, A. M., Gengoux, G., & Koegel, L. K. (2015). Feasibility and effectiveness of very early intervention for infants at-risk for autism spectrum disorder: A systematic review. *Journal of Autism and Developmental Disorders, 45*, 778-794. doi: 10.1007/s10803-014-2235-2

Burns, C., Lang, R., & Ledbetter Cho, K. (2017). Meta-analysis of single-case experimental design studies involving children with or at risk of autism spectrum disorder suggests intervention is effective during first three years of life. *Evidence-Based Communication Assessment and Intervention, 11*(3-4), 119-123. doi: 10.1080/17489539.2017.1401038

Cannella-Malone, H. I. (2018). Augmentative and alternative communication interventions are effective for adolescents and adults with autism spectrum disorder, but more work is needed. *Evidence-Based Communication Assessment and Intervention, 12*(4), 132-134. doi: 10.1080/17489539.2018.1545400

Cannella-Malone, H. I., & Tullis, C. A. (2010). Use of video technology to teach individuals with autism spectrum disorders: a systematic review of the literature still needed. *Evidence-Based Communication Assessment and Intervention, 4*(3), 109-112. doi: 10.1080/17489539.2010.514722

Carruthers, S., Pickles, A., Slonims, V., Howlin, P., & Charman, T. (2020). Beyond intervention into daily life: A systematic review of generalisation following social communication interventions for young children with autism. *Autism Research*, *13*, 506-522. doi: 10.1002/aur.2264



Carter, E. W., Sisco, L. G., Chung, Y. C., & Stanton-Chapman, T. L. (2010). Peer interactions of students with intellectual disabilities and/or autism: A map of the intervention literature. *Research and Practice for Persons with Severe Disabilities*, *35*(3-4), 63-79. doi: 10.2511/rpsd.35.3-4.63

Carter, M. (2010). Evidence appears limited for group-based social skills training for school-age children with Autism Spectrum Disorders, but this review may not tell the whole story. *Evidence-based Communication Assessment and Intervention*, *4*(1), 11-13. doi: 10.1080/17489530903503738

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Wolstencroft, J., Robinson, L., Srinivasan, R., Kerry, E., Mandy, W., & Skuse, D. (2018). A systematic review of group social skills interventions, and meta-analysis of outcomes, for children with high functioning ASD. *Journal of Autism & Developmental Disorders*, *48*, 2293–2307. doi: https://doi.org/10.1007/s10803-018-3485-1

Woodcock, K.A., Blackwell, S. (2020). Psychological treatment strategies for challenging behaviours in neurodevelopmental disorders: What lies beyond a purely behavioural approach? *Current Opinion in Psychiatry*, *33*(2), 92–109. doi: https://doi.org/10.1097/YCO.000000000000571

Exclusion reason: No relevant intervention (n=13)

Ampuero, M. E., & Miklos, M. (2019). The effect of joint control training on the performance of multiply controlled behavior: A systematic literature review relevant to children with autism spectrum disorder and other developmental disabilities. *Analysis of Verbal Behavior*, *35*, 149–171. doi: https://doi.org/http://dx.doi.org/10.1007/s40616-019-00116-y

Bottini, S., Vetter, J., McArdell, L., Wiseman, K., & Gillis, J. (2018). Task interspersal: A meta-analytic review of effective programming. *Review Journal of Autism and Developmental Disorders*, 5, 119–128. doi: https://doi.org/10.1007/s40489-018-0127-7

Curiel, E. S. L., Axe, J. B., Sainato, D. M., & Goldstein, H. (2020). Systematic review of matrix training for individuals with autism spectrum disorder. *Focus on Autism & Other Developmental Disabilities*, 35, 55–64. doi: https://doi.org/10.1177/1088357619881216

DeJesus, B.M., Oliveira, R.C., de Carvalho, F.O., de Jesus Mari, J., Arida, R.M., Teixeira-Machado, L. (2020). Dance promotes positive benefits for negative symptoms in autism spectrum disorder (ASD): A systematic review. *Complementary Therapies in Medicine*, *49*. doi: https://doi.org/10.1016/j.ctim.2020.102299

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Gilroy, S. P., Kaplan, B. A., & Leader, G. (2018). A systematic review of applied behavioral economics in assessments and treatments for individuals with developmental disabilities. *Review Journal of Autism and Developmental Disorders*, *5*, 247–259. doi: https://doi.org/10.1007/s40489-018-0136-6

Harrop, C., Amsbary, J., Towner-Wright, S., Reichow, B., Boyd, B.A. (2019). That's what I like: The use of circumscribed interests within interventions for individuals with autism spectrum disorder. A systematic review. *Research in Autism Spectrum Disorders*, *57*, 63–86. doi: https://doi.org/10.1016/j.rasd.2018.09.008

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Mortimer, R., Privopoulos, M., Kumar, S. (2014). The effectiveness of hydrotherapy in the treatment of social and behavioral aspects of children with autism spectrum disorders: A systematic review. *Journal of Multidisciplinary Healthcare*, *7*, 93–103. doi: https://doi.org/10.2147/JMDH.S55345

Munandar, V. D., Morningstar, M. E., & Carlson, S. R. (2020). A systematic literature review of videobased interventions to improve integrated competitive employment skills among youth and adults with Autism Spectrum Disorder. *Journal of Vocational Rehabilitation*, *53*(1), 29–41. doi: https://doi.org/10.3233/JVR-201083

Ramey, D., Lydon, S., Healy, O., McCoy, A., Holloway, J., & Mulhern, T. (2016). A systematic review of the effectiveness of precision teaching for individuals with developmental disabilities. *Review Journal of Autism and Developmental Disorders*, *3*, 179–195. doi: https://doi.org/10.1007/s40489-016-0075-z

Schmidt, N.B., Vereenooghe, L. (2020). Inclusiveness of cognitive bias modification research toward children and young people with neurodevelopmental disorders: A systematic review. *International Journal of Developmental Disabilities*. doi: https://doi.org/10.1080/20473869.2020.1720156

Exclusion reason: No children <12 years (n=10)

Baxter, S., Enderby, P., Evans, P., & Judge, S. (2012). Interventions using high-technology communication devices: A state of the art review. *Folia Phoniatrica et Logopaedica*, 64(3), 137–144. doi: https://doi.org/10.1159/000338250

Camargo, M. C., Barros, R. M., Brancher, J. D., Barros, V. T. O., & Santana, M. (2019). Designing gamified interventions for autism spectrum disorder: A systematic review. *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, 341-352. doi: https://doi.org/10.1007/978-3-030-34644-7_28

Hallyburton, A., & Hinton, J. (2017). Canine-assisted therapies in autism: a systematic review of published studies relevant to recreational therapy. *Therapeutic Recreation Journal*, *51*, 127–142. doi: https://doi.org/10.18666/trj-2017-v51-i2-7969

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Ke, F., Whalon, K., & Yun, J. (2018). social skill interventions for youth and adults with autism spectrum disorder: A systematic review. *Review of Educational Research*, *88*, 3–42.

Khowaja, K., Banire, B., Al-Thani, D., Sqalli, M. T., Aqle, A., Shah, A., & Salim, S. S. (2020). Augmented reality for learning of children and adolescents with autism spectrum disorder (ASD): A systematic review. *IEEE Access*, *8*,78779–78807. doi: https://doi.org/10.1109/ACCESS.2020.2986608

Koumpouros, Y., Kafazis, T. (2019). Wearables and mobile technologies in Autism Spectrum Disorder interventions: A systematic literature review. *Research in Autism Spectrum Disorders*, 66. doi: https://doi.org/10.1016/j.rasd.2019.05.005

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Miller, A., Vernon, T., Wu, V., & Russo, K. (2014). Social skill group interventions for adolescents with autism spectrum disorders: A systematic review. *Review Journal of Autism and Developmental Disorders*, *1*, 254–265. doi: Ahttps://doi.org/10.1007/s40489-014-0017-6

Shire, S. Y., & Kasari, C. (2014). Train the trainer effectiveness trials of behavioral intervention for individuals with autism: a systematic review. *American Journal on Intellectual & Developmental Disabilities*, *119*, 436–451. doi: https://doi.org/10.1352/1944-7558-119.5.436

Exclusion reason: No full-text in English (n=12)

Bourgeois, M., Sénéchal, C., Larivée, S., Lepore, F. (2019). Effects of cognitive-behavioral intervention and cognitive training programs on executive function (EF) in people with autism spectrum disorder (ASD): A systematic review. *Annales Medico-Psychologiques*, *177*, 749–757. doi: https://doi.org/10.1016/j.amp.2018.12.012

Cardoso, N. R., & Blanco, M. B. (2019). Sensory integration therapy and autistic spectrum disorder: A systematic review of literature. *Revista Conhecimento Online*, *1*, 108–125. doi: https://doi.org/10.25112/rco.v1i0.1547

Cruveiller, V., & Crespin, G. C. (2017). Early intensive behavioral interventions with autistic children: A critical review of the literature (2009-2012). *La Psychiatrie de l'Enfant*, 60, 197–212. doi: http://dx.doi.org/10.3917/psye.601.0197

de Lima, A. F. C., Gehres, A. de F., Lorenzini, A. R., & Brasileiro, L. T. (2017). The influence of non-verbal educational and therapeutic practices in autism spectrum disorder: The possibilities for physical education professionals. *Motricidade*, *13*(Supp 1), 87–96.

de Oliveira Ribeiro, F., Cunha Pimentel, G., Pantoja Moraes, N. O., & dos Santos Blois, L. V. (2019). Os efeitos da equoterapia em crianças com autismo. *Fisioterapia Brasil, 20*, 684–691. https://doi.org/10.33233/fb.v20i5.2703

de Souza Zamo, R., & Trentini, C. M. (2016). Psychological assessment and therapeutic riding: A systematic review. *Psicologia: Teoria E Pratica*, *18*(3), 81–97.

Fernández Martínez, M. E., & Liébana Presa, C. (2018). La música como cuidado enfermero. Revisión sistemática. Revista Rol de Enfermería, 41, 588-586.

Fernández-García, D., Campa-Menéndez, E., Gómez-Salgado, J., & Navarro-Abal, Y. (2018). Efectos de la musicoterapia en las habilidades de comunicación de niños con autismo. Revista Rol de Enfermería, 41, 374-383.

Gonçalves, C. A. B., & Castro, M. S. J. de. (2013). Proposals for speech therapy for autist children: a systematic review of literature. *Distúrbios da Comunicação*, 25.

Liesa Orús, M., Latorre Cosculluela, C., & Vázquez Toledo, S. (2018). Peer support systems with children with autism spectrum disorders in inclusive schools. A systematic review. *Revista Complutense de Educacion*, *29*(1), 97–111. doi: https://doi.org/10.5209/RCED.52032

Lima, A. F. C. de, Gehres, A. de F., Lorenzini, A. R., & Brasileiro, L. T. (2017). A Influência de práticas pedagógicas e terapêuticas não verbais no transtorno do espectro autista: As possibilidades para o profissional de educação física. Motricidade, 13, 87–96. doi: https://doi.org/10.6063/motricidade.12867



Söchting, E. (2014). Evidenz zur Wirksamkeit der Sensorischen Integrationstherapie bei 3- bis 12jährigen Kindern mit sensorischen Verarbeitungsstörungen -- Eine systematische Forschungsübersicht 2007 bis 2013. *Ergoscience*, *9*(4), 144–154. doi: https://doi.org/10.2443/skv-s-2014-54020140402

Exclusion reason: No full-text available (n=4)

Freitag, C. M., Jensen, K., Teufel, K., Luh, M., Todorova, A., Lalk, C., Vllasaliu, L.(2020). Empirically based developmental and behavioral intervention programs targeting the core symptoms and language development in toddlers and preschool children with autism spectrum disorder. *Zeitschrift Fur Kinder- Und Jugendpsychiatrie Und Psychotherapie*, *48*, 224–243. doi: https://doi.org/10.1024/1422-4917/a000714

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Medved, K., & Begovac, I. (2013). Home intervention in children with autism spectrum disorder. *Paediatria Croatica*, *57*(1), 73–78.

Watling, R., & Lane, A. E. (n.d.). Navigating the evidence for sensory-based therapies. *OT Practice*, 5–7.

Exclusion reason: Geographically specific (n=1)

Shi, Z.-M., Lin, G.-H., & Xie, Q. (2016). Effects of music therapy on mood, language, behavior, and social skills in children with autism: A meta-analysis. *Chinese Nursing Research*, *3*, 137–141. doi: https://doi.org/10.1016/j.cnre.2016.06.018



Appendix L: Articles excluded after Phase 1 extraction

Articles excluded after Phase 1 extraction

Exclusion reason: No relevant moderators (n=10)

Ameis, S. H., Kassee, C., Corbett-Dick, P., Cole, L., Dadhwal, S., Lai, M. C., ... & Correll, C. U. (2018). Systematic review and guide to management of core and psychiatric symptoms in youth with autism. *Acta Psychiatrica Scandinavica*, *138*, 379-400. doi: 10.1111/acps.12918

Bond, C., Symes, W., Hebron, J., Humphrey, N., Morewood, G., & Woods, K. (2016). Educational interventions for children with ASD: A systematic literature review 2008–2013. *School Psychology International*, *37*, 303-320. doi: 10.1177/0143034316639638

Dubin, A. H., & Lieberman-Betz, R. G. (2020). Naturalistic interventions to improve prelinguistic communication for children with autism spectrum disorder: A systematic review. *Review Journal of Autism and Developmental Disorders*, 1-17. doi: oi.org/10.1007/s40489-019-00184-9

Goldstein, H., Lackey, K. C., & Schneider, N. J. (2014). A new framework for systematic reviews: Application to social skills interventions for preschoolers with autism. *Exceptional Children*, *80*, 262-286. doi: 10.1177/0014402914522423

Kossyvaki, L., & Papoudi, D. (2016). A review of play interventions for children with autism at school. *International Journal of Disability, Development and Education*, *63*, 45-63. doi: 10.1080/1034912X.2015.1111303

Morgan, L. J., Rubin, E., Coleman, J. J., Frymark, T., Wang, B. P., & Cannon, L. J. (2014). Impact of social communication interventions on infants and toddlers with or at-risk for autism: A systematic review. *Focus on Autism and Other Developmental Disabilities*, *29*, 246-256. doi: 10.1177/1088357614539835

Odeh, C. E., Martell, R., Griffin, S., Johnson, E. R., & Gladfelter, A. L. (2020). Motor-based interventions improve language outcomes in children with autism: A systematic review. *Clinical Archives of Communication Disorders*, *5*(1), 1-7. doi: <u>10.21849/cacd.2020.00192</u>

Ruggeri, A., Dancel, A., Johnson, R., & Sargent, B. (2020). The effect of motor and physical activity intervention on motor outcomes of children with autism spectrum disorder: A systematic review. *Autism*, *24*, 544-568. doi: 10.1177/1362361319885215

Schertz, H. H., Reichow, B., Tan, P., Vaiouli, P., & Yildirim, E. (2012). Interventions for toddlers with autism spectrum disorders: An evaluation of research evidence. *Journal of Early Intervention*, *34*(3), 166-189. doi: 10.1177/1053815112470721

Yoder, P.J., Bottema-Beutel, K., Woynaroski, T., Chandrasekhar, R., Sandbank, M. (2013). Social communication intervention effects vary by dependent variable type in preschoolers with autism spectrum disorders. *Evidence-Based Communication Assessment and Intervention*, 7(4), 150-174. doi: 10.1080/17489539.2014.917780



Exclusion reason: Incompatible categorisation of interventions (n=6)

Fletcher-Watson, S., McConnell, F., Manola, E., & McConachie, H. (2014). Interventions based on the Theory of Mind cognitive model for autism spectrum disorder (ASD). *Cochrane Database of Systematic Reviews*, *2014* (3). doi: 10.1002/14651858.CD008785.pub2

Maw, S. S., & Haga, C. (2018). Effectiveness of cognitive, developmental, and behavioural interventions for Autism Spectrum Disorder in preschool-aged children: A systematic review and meta-analysis. *Heliyon*, *4*(9), e00763. doi: 10.1016/j.heliyon.2018.e00763

Reichow, B., Servili, C., Yasamy, M. T., Barbui, C., & Saxena, S. (2013). Non-specialist psychosocial interventions for children and adolescents with intellectual disability or lower-functioning autism spectrum disorders: A systematic review. *PLoS Med*, *10*(12), e1001572. doi: 10.1371/journal.pmed.1001572

Tachibana, Y., Miyazaki, C., Ota, E., Mori, R., Hwang, Y., Kobayashi, E., ... & Kamio, Y. (2017). A systematic review and meta-analysis of comprehensive interventions for pre-school children with autism spectrum disorder (ASD). *PloS one*, *12*(12), e0186502. doi: 10.1371/journal.pone.0186502

Weitlauf, A. S., McPheeters, M. L., Peters, B., Sathe, N., Travis, R., Aiello, R., ... & Warren, Z. (2014). *Therapies for children with autism spectrum disorder: Behavioral interventions update*. AHRQ Comparative Effectiveness Reviews. Rockville (MD): Agency for Healthcare Research and Quality (US).

Yu, Q., Li, E., Li, L., & Liang, W. (2020). Efficacy of interventions based on applied behavior analysis for autism spectrum disorder: A meta-analysis. *Psychiatry Investigation*, *17*, 432. doi: 10.30773/pi.2019.0229

Exclusion reason: Previous version of included review (n=5)

Reichow, B., Barton, E. E., Boyd, B. A., & Hume, K. (2012). Early intensive behavioral intervention (EIBI) for young children with autism spectrum disorders (ASD). *Cochrane Database of Systematic Reviews*, *2012* (10). doi: 10.1002/14651858.CD009260.pub3

Reichow, B., Barton, E. E., Boyd, B. A., & Hume, K. (2014). Early intensive behavioral intervention (EIBI) for young children with Autism Spectrum Disorders (ASD): A systematic review. *Campbell Systematic Reviews, 2014* (9). doi: 10.4073/csr.2014.9

Warren, Z., McPheeters, M. L., Sathe, N., Foss-Feig, J. H., Glasser, A., & Veenstra-VanderWeele, J. (2011). A systematic review of early intensive intervention for autism spectrum disorders. *Pediatrics*, *127*, e1303-e1311. doi: 10.1542/peds.2011-0426

Warren, Z., Veenstra-VanderWeele, J., Stone, W., Bruzek, J. L., Nahmias, A. S., Foss-Feig, J. H., & McPheeters, M. L. (2011). Therapies for children with autism spectrum disorders. Comparative effectiveness review no. 26. *Agency for Healthcare Research and Quality (US)*.

Wong, C., Odom, S. L., Hume, K. A., Cox, A. W., Fettig, A., Kucharczyk, S., ... & Schultz, T. R. (2015). Evidence-based practices for children, youth, and young adults with autism spectrum disorder: A comprehensive review. *Journal of Autism and Developmental Disorders*, *45*, 1951-1966. doi: 10.1007/s10803-014-2351-z



Exclusion reason: No (useable) summary of outcomes (n=3)

Baril, E. M., & Humphreys, B. P. (2017). An evaluation of the research evidence on the Early Start Denver Model. *Journal of Early Intervention*, *39*, 321-338. doi: 10.1177/1053815117722618

Hoffman, F. (2013). Evidence-based classroom strategies for reducing anxiety in primary aged children with high-functioning autism. *New Zealand Journal of Teachers' Work*, *10*(1), 25-43.

Miller-Kuhaneck, H., & Watling, R. (2018). Parental or teacher education and coaching to support function and participation of children and youth with sensory processing and sensory integration challenges: A systematic review. *American Journal of Occupational Therapy*, 72(1), 1-11. doi: 10.5014/ajot.2018.029017

Exclusion reason: Included pharmacological intervention (n=1)

Romagnoli, G., Leone, A., Romagnoli, G., Sansoni, J., Tofani, M., De Santis, R., ... & Galeoto, G. (2019). Occupational Therapy's efficacy in children with Asperger's syndrome: A systematic review of randomized controlled trials. *Clinical Therapeutics*, *170*, 382-387. doi: 10.7417/CT.2019.2164.

Exclusion reason: Geographically specific (n=1)

Althoff, C. E., Dammann, C. P., Hope, S. J., & Ausderau, K. K. (2019). Parent-mediated interventions for children with autism spectrum disorder: A systematic review. *American Journal of Occupational Therapy*, *73*(3), 1-13. doi: 10.5014/ajot.2019.030015

Exclusion reason: Publication corresponding to included review (n=1)

Weitlauf, A. S., Sathe, N., McPheeters, M. L., & Warren, Z. E. (2017). Interventions targeting sensory challenges in autism spectrum disorder: a systematic review. *Pediatrics*, *139*(6), e20170347. doi: 10.1542/peds.2017-0347



Appendix M: Characteristics of included reviews

Author (year)	Characteristics of Systematic Review	Characteristics of Included Studies
Akemoglu et al. (2020)	 Type: Narrative synthesis only Objectives: "to systematically review the literature researching telepractice and parent-implemented language and communication interventions." Number of included studies: 12 Search limit (years): Not specified – 2019 Study designs: Randomised controlled trials, singlecase experimental designs Quality of studies: Not specified Sources of funding: Not specified Conflict of interest: Not specified 	 Participant characteristics Number of participating children: 76 Age: 16 – 76 months Sex: 47/63 males, 16/63 females Description: Autism spectrum disorder Increased likelihood of ASD: Not included Other conditions: None Intervention(s): Parent-implemented telehealth interventions – Communication intervention; Early Start Denver Model (ESDM); Parents Early Start Denver Model (P-ESDM); Reciprocal Imitation Training (RIT); Decide, Arrange, Now, Count, and Enjoy (DANCE); Improving Parents as Communication Teachers (imPACT); Internet-based Parent-implemented Communication Strategies (i-PiCS); Prepare, Offer, Wait, and Respond (POWR). Comparison: Not specified Outcomes: Social-communication; caregiver communication and interaction (parents' use of strategies).
Bejarano-Martín et al. (2020)	Type: Meta-analysis with narrative synthesis Objectives: "to ascertain the overall effectiveness of [focused intervention practices] in children with [autism spectrum disorder] 6 years of age and younger." Number of included studies: 43 Search limit (years): 2000 - 2018 Study designs: Randomised controlled trials, non- randomised with control, single-case experimental designs (inclusion criteria)	 Participant characteristics Number of participating children: 1402 (785 intervention, 617 control) Age: 25 – 72 months, M = 41.6 months Sex: Not specified Description: Autism spectrum disorder (inclusion criteria) Increased likelihood of ASD: Not eligible (inclusion criteria) Other conditions: None Intervention(s): Focused intervention practices - Discrete trial training (DTT);



	Quality of studies: Included high quality/low risk of bias only Sources of funding: Specified - Funded Conflict of interest: Specified - No conflicts	 Pivotal Response Training (PRT), Contingent imitation; discrete trial training (DTT) plus social interaction, mediated learning with active engagement; picture exchange communication system (PECS); video modelling; prompting and reinforcement; physical and verbal cues; token economy and prompting; photographic schedules. Comparison: Not specified Outcomes: Social-communication (social-communication, imitation, joint attention, play).
Binns & Oram Cardy (2019)	Type: Narrative synthesis only Objectives: to "systematically review studies examining the impact of developmental social pragmatic interventions in supporting (a) foundational social communication and language skills of preschool children with autism spectrum disorder and (b) caregiver interaction style." Number of included studies: 10 Search limit (years): Database inception - 2018 Study designs: Randomised controlled trials Quality of studies: Included low quality/high risk of bias Sources of funding: Specified - Funded Conflict of interest: Specified - No conflicts	 Participant characteristics Number of participating children: 716 Age: 1 year, 3 months - 6 years, M = 37.8 months Sex: 443/546 males, 103/546 females Description: Autism spectrum disorder Increased likelihood of ASD: Not included Other conditions: None Intervention(s): Developmental social pragmatic interventions - Child Talk; Hanen More than Words; Developmental Individual-Difference Relationship- Based (DIR); Milton and Ethel Harris Research Initiative Treatment (MEHRIT) - DIR based; Pediatric Autism and Communication Therapy (PACT); Joint attention mediated learning; Play and Language for Autistic Youngsters (PLAY) project - DIR based; Social communication, emotion regulation, transactional support (SCERTS). Comparison: Wait list control, treatment as usual, another intervention. Outcomes: Social-communication (social interaction and social communication); Communication (language capacities); Caregiver communication and interaction (parental responsiveness and directiveness).
Boshoff et al. (2020)	Type: Narrative synthesis only Objectives: to examine "the documented developmental outcomes for children who participated	Participant characteristics Number of participating children: 392 Age: 2 – 12 years



	in Developmental Individual-Difference Relationship-	Sex: Not specified
	Based (DIR)/Floortime [™] -based interventions."	Description: Autism spectrum disorder including autism, Asperger's
	Number of included studies: 9	syndrome, pervasive developmental disorder not otherwise specified
	Search limit (years): 2000 - 2019	Increased likelihood of ASD: Not included
	Study designs: Randomised controlled trials, non-	Other conditions: None
	randomised without control group, single-case	Intervention(s): Developmental Individual-Difference Relationship-Based
	experimental designs, other	(DIR)/Floortime [™] model and interventions based on the principles of the
	Quality of studies: Not specified	DIR/Floortime [™] Model- Milton and Ethel Harris Research Initiative Treatment
	Sources of funding: Specified – Not funded	(MEHRIT); Floor time play (FTP); Play and Language for Autistic Youngsters
	Conflict of interact: Not specified	(PLAY); the PLAY Project Home Consultation Program.
		Comparison: Treatment as usual, another intervention, the individual's own
		baseline, no comparison group
		Outcomes: Social-communication (social and emotional development);
		Communication (language); Motor skills (motor and fine motor).
Case & Yun, (2019)	Type: Meta-analysis with narrative synthesis	Participant characteristics
	Objectives: "to analyse the effect of different	Number of participating children: 287
	intervention approaches on gross motor outcomes	Age: 3 – 12 years
	among children with autism spectrum disorder using	Sex: Not specified
	meta-analysis."	Description: Autism spectrum disorder
	Number of included studies: 18	Increased likelihood of ASD: Not included
	Search limit (years): Database inception - 2018	Other conditions: None
	Study designs: Not specified	Intervention(s): Fundamental motor skills including fundamental motor skills
	Quality of studies: Not specified	instruction, adapted physical education instruction, physical activities and
	Sources of funding: Not specified	fitness exercises, young athletes motor program, multisport camp training,
	Conflict of interest: Not specified	adaptive soccer program, physical education program with fundamental motor
		skill instruction, intensive fundamental motor skill instruction, Sports, Play, and
		Active Recreation for Kids (SPARK); equestrian assisted training; technology
		interventions including sports active video game participation, video-based
		makota arena training, robot imitation and movement activities, simulated
		developmental horse riding; physical activity interventions including physical



		activity/table tennis, rhythm training and movement-based games, aquatic
		exercise training.
		Comparison: Not specified
		Outcomes: Motor (gross motor).
Chang & Locke (2016)	Type: Narrative synthesis only	Participant characteristics
	Objectives: to examine "[peer-mediated interventions]	Number of participating children: 260
	for children and adolescents with [autism spectrum	Age: 3 – 17 years (of studies reporting age range)
	disorder] conducted using group designs."	Sex: Not specified
	Number of included studies: 5	Description: Autism spectrum disorder
	Search limit (years): Database inception – 2015	Increased likelihood of ASD: Not eligible (inclusion criteria)
	Study designs: Randomised controlled trials, non-	Other conditions: None
	randomised without control	Intervention(s): Peer-mediated interventions.
	Quality of studies: Included low quality/high visit of high	Comparison: Not specified
	Sources of funding: Specified _ Funded	Outcomes: Social-communication (social initiations, social responses, social
	Sources of funding: Specified – Funded	communications).
	Conflict of Interest: Not specified	
Ferguson et al. (2019)	Type: Narrative synthesis only	Participant characteristics
	Objectives: "to systematically review the literature	Number of participating children: 307 (231 intervention, 76
	researching telehealth and [applied behaviour analysis	control)
	to individuals with autism spectrum disorder]."	Age: 1.75 - 16 years, M = 4.73 years (of studies reporting age)
	Number of included studies: 28	Sex : 93/154 males, 61/154 females
	Search limit (years): Not specified – 2018	Description: Autism spectrum disorder, pervasive developmental
	Study designs: Randomised controlled trials, non-	disorder not otherwise specified
	randomised with control, non-randomised without	Increased likelihood of ASD: Not included
	control, single-case experimental designs, other	Other conditions: None
	Quality of studies: Included low quality/high risk of bias	Intervention(s): Telehealth interventions with behavioural principles- functional
	Sources of funding: Specified - Funded	analysis (FA); functional communication training (FCT); naturalistic and
	Conflict of interact: Specified – No conflicts	incidental teaching; behaviour support strategies (e.g., positive behaviour
	Connict of interest. Specified – No connicts	support); preference assessments; Early Start Denver Model (ESDM); Improving



		Parents as Communication Teachers (imPACT).
		Comparison: Wait list control, treatment as usual, another intervention, the
		individual's own baseline, no comparison group
		Outcomes: General outcomes (efficacy outcomes).
Flippin et al. (2010)	Type: Meta-analysis with narrative synthesis	Participant characteristics
	Objectives: to review "the current empirical evidence for	Number of participating children: 178
	[Picture Exchange Communication System] in affecting	Age: 3 – 12 years
	communication and speech outcomes for children with	Sex: Not specified
	[autism spectrum disorder]."	Description: Autism, autism spectrum disorder, pervasive
	Number of included studies: 11	developmental disorder not otherwise specified (inclusion criteria)
	Search limit (years): 1994 – 2009	Increased likelihood of ASD: Not included
	Study designs: Randomised controlled trials, non-	Other conditions: Not specified
	randomised with control, single-case experimental	Intervention(s): Picture exchange communication system (PECS).
	designs	Comparison: Not specified
		Outcomes: Social-communication (communicative behaviours, communication
	Guanty of studies: Included low quanty/high lisk of bias	outcomes); Expressive language (speech or vocalisation, speech outcomes).
	Sources of funding: Not specified	
	Conflict of Interest: Not specified	
Fuller & Kaiser (2020)	Type: Meta-analysis with narrative synthesis	Participant characteristics
	Objectives: to examine "the effects of early	Number of participating children: 1442 (786 intervention; 656
	interventions on social communication outcomes for	control)
	young children with autism spectrum disorder."	Age range (mean age): 0 – 8 years (inclusion criteria), M = 3.55
	Number of included studies: 29	years
	Search limit (years): Not specified – 2016	Sex: Not specified
	Study designs: Randomised controlled trials, non-	Description: Autism spectrum disorder (inclusion criteria)
	randomised without control (inclusion criteria)	Increased likelihood of ASD: Eligible (inclusion criteria)
		Other conditions: None
		Intervention(s): "Early interventions" – Not specified



	Quality of studies: Not specified	Comparison: Not specified
	Sources of funding: Specified – Funded	Outcomes: Social-communication.
	Conflict of interest: Specified – No conflicts	
Fuller, Oliver et al.	Type: Meta-analysis with narrative synthesis	Participant characteristics
(2020)	Objectives: to examine "the effects of the Early Start Denver Model (ESDM) for young children with autism on	Number of participating children: 640 (286 intervention, 354 control)
	developmental outcome measures."	Age: 9 months – 5 years, $M = 2.51$ years
	Number of included studies: 12	Sex: Not specified
	Search limit (years): Not specified – 2019	Description: Autism spectrum disorder (inclusion criteria)
	Study designs: Randomised controlled trials, non-	Increased likelihood of ASD: Eligible (inclusion criteria)
	randomised with control	Other conditions: None
	Quality of studies: Not specified	Intervention(s): Early Start Denver Model (ESDM).
	Sources of funding: Specified – Funded	Comparison: Wait list control, treatment as usual, another intervention
	Conflict of interest: Specified – Conflicts	Outcomes: Overall autism characteristics (autism symptoms); Social-
		communication; RRB (repetitive behaviours); Communication (language);
		Cognition; Adaptive behaviour (adaptive functioning).
Geretsegger et al.	Type: Meta-analysis with narrative synthesis	Participant characteristics
(2014)	Objectives: "to review the effects of music therapy, or	Number of participating children: 165
(2014)	music therapy added to standard care, for individuals	Age: 2 – 12 years
	with [autism spectrum disorder]."	Sex : 148/170 males, 22/170 females
	Number of included studies: 10	Description: Autism spectrum disorder
	Search limit (years): Database inception – 2013	Increased likelihood of ASD: Not included
	Study designs: Randomised controlled trials, non-	Other conditions: None
	randomised with control (inclusion criteria)	Intervention(s): Music therapy.
	Quality of studies: Not specified Sources of funding: Specified – Funded Conflict of interest: Specified – No conflicts	Comparison: Treatment as usual, another intervention, other comparison group Outcomes: Social-communication (social adaptation-overall); Communication



		(nonverbal-overall; verbal-overall); Quality of life (joy); Caregiver social
		emotional wellbeing (quality of family relationships).
Griffith et al. (2020)	Type: Narrative synthesis only	Participant characteristics
	Objectives: to "present a narrative synthesis of studies	Number of participating children: 4639 (164 ASD)
	examining whether children < 6 years can learn from	Age range (mean age): 0 - 71 months (inclusion criteria)
	interactive apps."	Sex: Not specified
	Number of included studies: 35	Description: Autism spectrum disorder
	Search limit (years): 2008 – 2019	Increased likelihood of ASD: Not included
	Study designs: Randomised controlled trials, non-	Other conditions: Not specified
	randomised with control	Intervention(s): Interactive apps.
	Quality of studies: Included low quality/high risk of bias	Comparison: Treatment as usual, another intervention
	Sources of fundina: Specified – Not funded	Outcomes: Social-communication.
	Conflict of interest: Specified – No conflicts	
Hampton & Kaiser	Type: Meta-analysis with narrative synthesis	Participant characteristics
(2016)	Objectives: to examine "the effects of early	Number of participating children: 1738
(2010)	interventions on spoken language in children with	Age: 1.75 – 4.18 years, M = 3.33 years
	[autism spectrum disorder]."	Sex: Not specified
	Number of included studies: 26	Description: Autism spectrum disorder
	Search limit (years): Not specified – 2014	Increased likelihood of ASD: Not included
	Study designs: Randomised controlled trials, non-	Other conditions: None
	randomised with control	Intervention(s): Early interventions- Early Intensive Behavioural Intervention
	Quality of studies: Included low quality/high risk of bias	(EIBI); Early Intervention Preschool (EIP); Early Start Denver Model (ESDM); Joint
	Sources of fundina: Not specified	Attention Mediated Learning (JAML); Joint Attention; Structured Play
	Conflict of interest: Not specified	Engagement; and Regulation (JAML); Learning Experiences and Alternative
		Program (LEAP); Milton and Ethel Harris Research Initiative Treatment
		(MEHRIT); More Than Words (MTW); Pediatric Autism and Communication
		Therapy (PACT); Play and Language for Autistic Youngsters; PRT, Pivotal
		Response Training (Play and Language for Autistic Youngsters); Treatment and



		Education of Autistic and Related Communication Handicapped Children
		(TEACCH); Scottish Early Intervention Preschool; Parent training model (PSwA);
		Focused playtime (FPI); Speech remediation; Teach Town basics; Early Social
		Interaction (ESI); Parent training, Behaviour analytic.
		Comparison: Not specified
		Outcomes: Expressive language (spoken language).
Hardy & Weston	Type: Narrative synthesis only	Participant characteristics
(2020)	Objectives: to examine "the current state of literature on	Number of participating children: 66
	canine-assisted therapy (CAT) for children with [autism	Age: 3 – 14 years
	spectrum disorder] based on peer-reviewed articles."	Sex: Not specified
	Number of included studies: 5	Description: Autism spectrum disorder
	Search limit (years): Not specified – 2017	Increased likelihood of ASD: Not included
	Study designs: Not specified	Other conditions: None
	Quality of studies: Not exception	Intervention(s): Canine-assisted therapy.
	Sources of funding: Not specified	Comparison: Not specified
	Conflict of interest: Specified – No conflicts	Outcomes: Social-communication (social behaviour).
	connet of interest. Specified – No connets	
Hill et al. (2019)	Type: Narrative synthesis only	Participant characteristics
	Objectives: "to systematically review the current	Number of participating children: 113
	literature exploring the impact of canine-assisted	Age: 3 – 18 years
	interventions on the social behaviours of children (< 18	Sex: 93/113 males, 20/113 females
	years) diagnosed on the autism spectrum."	Description: Autism spectrum disorder, autism, autistic disorder,
	Number of included studies: 13	moderate autism, mild autism, Asperger syndrome, pervasive
	Search limit (years): 1987 – 2017	developmental disorder, pervasive developmental disorder not
	Study designs: Non-randomised with control, non-	otherwise specified, early childhood autism, atypical autism
	randomised without control, single-case experimental	Increased likelihood of ASD: Not included
	designs, other	Other conditions: None
		Intervention(s): Canine-assisted therapy- animal-assisted therapy; animal-
		assisted activities; animal-assisted education; animal-assisted play therapy.


	Quality of studies: Not specified Sources of funding: Specified – Funded Conflict of interest: Specified – No conflicts	 Comparison: Another intervention, the individual's own baseline, no comparison group Outcomes: Social-communication (verbal, non-verbal, desired, undesired behaviours).
Ho et al. (2014)	Type: Meta-analysis with narrative synthesis Objectives: to examine "studies reporting on randomised controlled trials of the use of cognitive- behavioural approaches to intervention for children with autism spectrum disorder." Number of included studies: 10 Search limit (years): Not specified – 2012 Study designs: Randomised controlled trials Quality of studies: Not specified Sources of funding: Not specified Conflict of interest: Not specified	 Participant characteristics Number of participating children: 402 (199/372 completed intervention, 173/372 control) Age: 4.5 – 16 years, M = 10.5 years Sex: Not specified Description: Asperger's syndrome, high functioning autistic disorder/autism spectrum disorder, pervasive developmental disorder not otherwise specified, portion of sample without sub-type diagnoses specified Increased likelihood of ASD: Not included Other conditions: None Intervention(s): Cognitive behavioural intervention - Cool Kids; Building Confidence Family Cognitive Behaviour Therapy (FCBT); Social Skills Training for Children and Adolescents with Asperger Syndrome and Social-Communications Problems; Thinking about you, thinking about me; Coping Cat CBT program; Facing your fears; Group Cognitive Behaviour Therapy. Comparison: Not specified Outcomes: Social-communication (social skills).
Kent et al. (2020)	Type: Meta-analysis with narrative synthesis Objectives: to examine "the efficacy of play-based interventions to address the play skills of children with [autism spectrum disorder] [and] to summarize key characteristics of a range of play-based interventions for children with [autism spectrum disorder] and assess the quality of published [randomised controlled trials]."	Participant characteristics Number of participating children: 1149 Age: 2 – 12 years Sex: Not specified Description: Autism spectrum disorder Increased likelihood of ASD: Not included Other conditions: None



	 Number of included studies: 19 narrative synthesis; 11 meta-analysis Search limit (years): Not specified – 2017 Study designs: Randomised controlled trials Quality of studies: Included moderate quality/moderate risk of bias Sources of funding: Specified – Funded Conflict of interest: Specified – No conflicts 	 Intervention(s): Play-based interventions- [Generic] play intervention; Joint Attention, Symbolic Play, Engagement, and Regulation (JASPER); Lego therapy; Social stories; behavioural approaches; peer training; teacher training; Social Emotional NeuroScience Endocrinology (SENSE) Theater principles; video modelling. Comparison: Wait list control, another intervention Outcomes: Play.
Khan et al. (2019)	Type: Meta-analysis with narrative synthesis Objectives: "to review the effectiveness of randomized controlled trials (RCTs) of Web-based interventions delivered to children and young people with neurodevelopmental disorders." Number of included studies: 10 narrative review; 5 meta-analysis Search limit (years): 2000 – 2018 Study designs: Randomised controlled trials Quality of studies: Included moderate quality/moderate risk of bias Sources of funding: Specified – Funded Conflict of interest: Specified – No conflicts	 Participant characteristics Number of participating children: 523 in analysis (545 in review, of which 289 were diagnosed with ASD) Age: 2 – 17 years, M range= 3.32 – 12.16 years Sex: Not specified Description: Autism spectrum disorder Increased likelihood of ASD: Not included Other conditions: Tic disorders or chronic tic disorders, attention deficit hyperactivity disorder, specific learning disorder, dyscalculia Intervention(s): Web-based interventions- apps; serious games; videoconferencing; virtual environment with playable games; Web-based cognitive behavioural therapy intervention. Comparison: Wait list control, treatment as usual, another intervention Outcomes: General outcomes (condition-specific outcomes or reducing comorbid psychological symptoms); Caregiver satisfaction/dissatisfaction.
Knight et al. (2013)	Type: Narrative synthesis only Objectives: "to determine the degree to which technology-based interventions can be considered an evidence-based practice to teach academic skills to individuals with Autism Spectrum Disorder (ASD)." Number of included studies: 29	Participant characteristics Number of participating children: 191 (142 with ASD) Age: 3 – 18 years, M = 8.4 years Sex: 78/100 males, 22/100 females Description: Autism spectrum disorder, autism, pervasive developmental disorder not otherwise specified, Rett syndrome



	 Search limit (years): 1993 – 2012 Study designs: Randomised controlled trials, non-randomised with control, non-randomised without control, single-case experimental designs Quality of studies: Included low quality/high risk of bias Sources of funding: Not specified Conflict of interest: Not specified 	Increased likelihood of ASD: Not specified Other conditions: Not specified Intervention(s): Computer assisted instruction; simultaneous prompting; differential reinforcement; error correction and feedback procedure; delayed prompting procedure; stimulus prompting. Comparison: Not specified Outcomes: Academic.
Lang et al. (2012)	Type: Narrative synthesis only Objectives: "to systematically identify, analyse, and summarize research involving the use of [sensory integration therapy] in the education and treatment of individuals with [autism spectrum disorder]." Number of included studies: 25 Search limit (years): Not specified – 2011 Study designs: Not specified Quality of studies: Included low quality/high risk of bias Sources of funding: Not specified Conflict of interest: Not specified	 Participant characteristics Number of participating children: 217 Age: 2 – 12 years, M = 5.9 years Sex: 176/207 males, 31/207 females Description: Autism spectrum disorder, pervasive developmental disorder not otherwise specified, Asperger's syndrome Increased likelihood of ASD: Not included Other conditions: None Intervention(s): Sensory-integration therapy- weighted vests; swinging or rocking stimulation; brushing with a bristle or a feather; joint compression or stretching; alternative seating; jumping or bouncing; blanket or "body sock"; playing with a water and sand sensory table; chewing on a rubber tube; and playing with specially textured toys. Comparison: Not specified Outcomes: General outcomes (intervention outcomes).
Logan et al. (2017)	Type: Narrative synthesis only Objectives: "to examine the effectiveness of [augmentative and alternative communication] interventions in supporting children [with autism spectrum disorder] to produce a broader range of communicative functions and determine the extent to	Participant characteristics Number of participating children: 367 Age: 1.5 – 17 years Sex: Not specified Description: Autism spectrum disorder Increased likelihood of ASD: Not included



	 which these interventions have been evaluated beyond immediate effectiveness to address maintenance, generalization, and social validity." Number of included studies: 30 Search limit (years): 1994 – 2015 Study designs: Randomised controlled trials, single-case experimental designs Quality of studies: Included low quality/high risk of bias Sources of funding: Specified – Funded Conflict of interest: Specified – No conflicts 	Other conditions: None Intervention(s): Aided AAC systems- dedicated speech generating devices (SGDs); iPad©/iPod© Touch configured as SGDs; picture exchange communication system (PECS); low-tech aids (e.g., boards or books) incorporating pictures and photos. Comparison: Not specified Outcomes: Social-communication (communication functions); Caregiver satisfaction (social validity).
Makrygianni & Reed (2010)	Objectives: "to provide a comprehensive synthesis of	Participant characteristics Number of participating children: 484
	the research literature on the outcomes and	Age: M = ~38 months
	effectiveness of the behavioural [early intervention	Sex: Not specified
	programs) for children with [autism spectrum disorder].	Description: Autism spectrum disorder
	Search limit (years): Not specified – 2007	Other conditions: None
	Study designs: Not specified	Intervention(s): Behavioural early intervention programs.
		Comparison: Not specified
	Guality of studies: Included low quality/high risk of bias	Outcomes: Social-communication (socialisation); Communication
	Conflict of interest: Not specified	(communication, language); Cognition (IQ); Adaptive behaviour.
Mazon et al. (2019)	Type: Narrative synthesis only	Participant characteristics
	Objectives: "to update the previous [reviews of	Number of participating children: 796 (576 with ASD)
	technology-based interventions] with a focus on clinical-	Age: 3 – 18 years
	quality studies; to examine reliability, consistency,	Sex: 424/515 males, 91/515 temales.
	compare the methodology of two cores of studies	Increased likelihood of ASD: Not included
	according to two dimensions: Therapeutic Effectiveness	Other conditions: Down Syndrome, Speech and Language



	 (TE) and Technology Usability (TU)." Number of included studies: 31 Search limit (years): 2000 – 2016 Study designs: Randomised controlled trials, non-randomised with control Quality of studies: Not specified Sources of funding: Specified – Funded Conflict of interest: Specified – No conflicts 	impairment (also included typically developing children) Intervention(s): Technology based interventions including (but not limited to) computer and robot-based interventions. Comparison: Not specified Outcomes: General outcomes (statistical significance).
McCoy et al. (2016)	Type: Narrative synthesis only Objectives: to provide "a focused review of the efficacy and evidence base of [video modelling], role play, and [computer-based intervention] for teaching social skills to children and adolescents with [high functioning autism]." Number of included studies: 29 Search limit (years): Database inception - 2015 Study designs: Randomised controlled trials, non- randomised with control, non-randomised without control, single-case experimental designs Quality of studies: Included low quality/high risk of bias Sources of funding: Specified – Funded Conflict of interest: Specified – No conflicts	 Participant characteristics Number of participating children: 235 Age: 3 – 17 years, M = 9 years Sex: 145/175 males, 28/173 females Description: high functioning autism with an IQ>85 or Asperger's syndrome Increased likelihood of ASD: Not included Other conditions: None Intervention(s): Role play; video modelling; computer-based instruction. Comparison: Not specified Outcomes: Social-communication (social skills).
Miguel-Cruz et al. (2017)	Type: Narrative synthesis only Objectives: "to examine the extent and type of robots used for the rehabilitation and education of children and young people with [cerebral palsy] and [autism spectrum disorder] and the associated outcomes." Number of included studies: 34	 Participant characteristics Number of participating children: 338 (255 with ASD) Age: 0 – 18 years (inclusion criteria), M = 15.13 years (ASD only), 9.93 years (cerebral palsy and ASD) Sex: 149/192 males, 43/192 females Description: Autism spectrum disorder



	 Search limit (years): 1990 - 2016 Study designs: Randomised controlled trials, non-randomised without control, single-case experimental designs, other Quality of studies: Included low quality/high risk of bias Sources of funding: Specified - Funded Conflict of interest: Specified - No conflicts 	Increased likelihood of ASD: Not included Other conditions: Cerebral palsy Intervention(s): Robots Comparison: Not specified Outcomes: Social-communication (interaction); RRB (repetitive and maladaptive behaviour).
Moon et al. (2020)	Type: Meta-analysis with narrative synthesis Objectives: "to assess the evidence for effects of therapeutic intervention with mobile device applications (apps) for individuals with autism spectrum disorder (ASD)." Number of included studies: 7 Search limit (years): 2009 – 2019 Study designs: Randomised controlled trials Quality of studies: Included low quality/high risk of bias Sources of funding: Specified – Not funded Conflict of interest: Specified – No conflicts	 Participant characteristics Number of participating children: 328 Age: 39 – 120 months Sex: Not specified Description: Autism spectrum disorder (inclusion criteria) Increased likelihood of ASD: Not eligible (inclusion criteria) Other conditions: None Intervention(s): Mobile device applications - including (but not limited to) FindMe game app, Therapy Outcomes By You (TOBY), Camp Discovery. Comparison: Wait list control, treatment as usual, other comparison group Outcomes: Social-communication; Communication (gestures, symbolic); Expressive language (expressive language, words produced); Receptive language; Cognition (visual reception); Motor (fine motor).
Murza et al. (2016)	Type: Meta-analysis with narrative synthesis Objectives: "to provide a quantitative assessment of the effectiveness of joint attention interventions aimed at improving joint attention abilities in children with [autism spectrum disorder]." Number of included studies: 16 narrative synthesis, 12 meta-analysis Search limit (years): Database inception – 2015	Participant characteristics Number of participating children: 694 (410 intervention; 284 control) Age: 11 – 152 months, M = 55 months Sex: Not specified Description: Autism spectrum disorder Increased likelihood of ASD: Not eligible (inclusion criteria) Other conditions: None



	 Study designs: Randomised controlled trials (inclusion criteria) Quality of studies: Included low quality/high risk of bias Sources of funding: Not specified Conflict of interest: Specified – No conflicts 	Intervention(s): Joint attention interventions - Assessment, Evaluation and Programming System (AEPS) for Infants and Children; Caregiver Education Model (CEM); Caregiver Mediated Model (CMM); Hanen More Than Words (HMTW); Joint Attention Mediated Learning (JAML); Joint Attention Symbolic Play Engagement and Regulation (JASPER); Milton and Ethel Harris Research Initiative (MEHRI); Preschool Autism Communication Trial (PACT); parent training modules; and workshop training. Comparison: Not specified Outcomes: Social-communication (joint attention).
National Autism Center (2015)	Type: Narrative synthesis only Objectives: "to provide critical information about which interventions have been shown to be effective for individuals with autism spectrum disorder (ASD)." Number of included studies: 389 Search limit (years): Not specified Study designs: Not specified Quality of studies: Included low quality/high risk of bias Sources of funding: Specified – Not funded Conflict of interest: Not specified	 Participant Characteristics Number of participating individuals: Not specified Age: No age limit (inclusion criteria) Sex: Not specified Description: Autism spectrum disorder, autistic disorder, Asperger's syndrome, pervasive developmental disorder not otherwise specified (inclusion criteria) Increased likelihood of ASD: Not eligible (inclusion criteria) Other conditions: None Intervention(s): Behavioural interventions; Cognitive Behavioural Intervention Package; Comprehensive Behavioural Treatment for Young Children; Pivotal Response Training; Augmentative and Alternative Communication Devices; Developmental Relationship-based Treatment; Functional Communication Training; Music Therapy; Picture Exchange Communication System; Social Communication Intervention; Technology-based Intervention; Theory of Mind Training; Animal-assisted Therapy; Auditory Integration Training; DIR/Floor Time; Facilitated Communication; Movement-based Intervention; Sensory Intervention Package. Comparison: Not specified Outcomes: Overall autism characteristics (general symptoms); social-communication (interpersonal); restricted and repetitive interests and



		behaviours (restricted, repetitive, non-functional patterns of behaviour, interests, or activity); sensory (sensory or emotional regulation); Communication; Cognition (higher cognitive functions); Motor; Social- emotional/challenging behaviour (self-regulation, problem behaviour); Play; Adaptive behaviour (personal responsibility); School/learning readiness (learning readiness, placement); Academic
Naveed et al. (2019)	Type: Meta-analysis with narrative synthesis Objectives: to "a) assess the effectiveness of non- specialist delivered or mediated interventions in autism spectrum disorder (ASD); b) systematically evaluate relevant implementation processes involved in these non-specialists delivered interventions for autism spectrum disorder, and c) and to rate the quality of evidence across different outcomes using the World Health Organization's recommended Grading of Recommendations Assessment, Development and Evaluation (GRADE) criteria." Number of included studies: 33 Search limit (years): Database inception - 2018 Study designs: Randomised controlled trials Quality of studies: Included low quality/high risk of bias Sources of funding: Specified – Not funded Conflict of interest: Specified – No conflicts	 Participant Characteristics Number of participating children: Not specified Age: 16 months – 17 years Sex: Not specified Description: autism spectrum disorder, Asperger's syndrome, childhood disintegrative disorder (inclusion criteria) Increased likelihood of ASD: Not included Other conditions: None Intervention(s): Cognitive behavioural strategies ; Social emotional NeuroScience Endocrinology (SENSE) theatre; Preschool Autism Communication Trial (PACT); Parent mediated intervention for Autism Spectrum Disorders in South Asia (PASS); Project Impact; Peer interventions; Qigong Sensory Treatment (QST); Joint Attention, Symbolic Play, Engagement, and Regulation programme (JASPER); Play project; LEAP project i.e. Learning Experiences and Alternative Program for Preschoolers and Their Parents; Hanen's more than words (HMTW) intervention program; Peer network intervention procedure; family centered music therapy; The Managing Repetitive Behaviours Programme; psychoeducation program; autism preschool program; Video-feedback Intervention to promote Positive Parenting adapted for Autism; Social ABCs; Parent mediated intervention for Autism Spectrum Disorders in South Asia (PASS) plus; enhancing interactions tutorial; Social Tools And Rules for Teens socialization (START); COMPASS for Hope; Program for the Education and Enrichment of Relational Skills (PEERS) eurieutum: Therapoutic Out como Bu You (COPY) application
		curriculum; Therapeutic Out-come By You (TOBY) application.



		Comparison: Not specified Outcomes: Overall autism characteristics (autism symptom severity); social- communication (social skills, joint engagement, joint attention); restricted and repetitive interests and behaviours (repetitive behaviours); communication; expressive language; receptive language; cognition (visual reception); motor (motor skills); social-emotional/challenging behaviour (self-regulation); adaptive behaviour; caregiver social emotional wellbeing (parent distress, parental self- efficacy, parent-child relationship); child satisfaction (child distress).
Nevill et al. (2018)	Type: Meta-analysis with narrative synthesis Objectives: to review "randomised clinical trials of parent-mediated interventions for children with autism spectrum disorder between the ages of 1 and 6 years and [conduct] a meta-analysis on their efficacy." Number of included studies: 19 Search limit (years): 2000 – 2015 Study designs: Randomised controlled trials Quality of studies: Not specified Sources of funding: Specified – Not funded Conflict of interest: Not specified	 Participant Characteristics Number of participating children: 1205 (608 intervention, 597 control) Age: 15 – 72 months, M = 42 months Sex: Not specified Description: Autism spectrum disorder Increased likelihood of ASD: Not included Other conditions: None Intervention(s): Child's Talk Project; Hanen's More than Words (HMTW); DIR/Floortime; Parent Focus Training; Joint Attention Symbolic Play Engagement and Regulation (JASPER); Pivotal Response Training (PRT); Video Intervention to promote Positive Parenting for children with Autism (VIPP-AUTI); Home-based program; Building Blocks; Focused Playtime Intervention; Play and Language for Autistic Youngsters (PLAY) Project; Preschoolers with Autism; Treatment and Education of Autistic and Related Communication Handicapped Children (TEACCH); Social Communication, Emotion Regulation, and Transactional Supports (SCERTS); Parent-mediated Communication-focused Treatment (PACT). Comparison: Treatment as usual, another intervention Outcomes: Overall autism characteristics (autism symptom severity); social-communication (socialisation); communication (language); cognition.



Ona et al. (2020)	Type: Meta-analysis with narrative synthesis Objectives: "to compile evidence examining the effectiveness of [pivotal response treatment] (PRT) on social communication, social interaction, and repetitive behaviour for children with autism spectrum disorder." Number of included studies: 5 Search limit (years): Database inception - 2017 Study designs: Randomised controlled trials Quality of studies: Included low quality/high risk of bias Sources of funding: Not specified Conflict of interest: Specified – No conflicts	Participant Characteristics Number of participating children: 181 (91 intervention, 90 control) Age: 2.4 - 9.2 years, M = 5.3 years Sex: Not specified Description: Autism spectrum disorder Increased likelihood of ASD: Not included Other conditions: None Intervention(s): Pivotal Response Treatment (PRT). Comparison: Wait list control, treatment as usual, another intervention Outcomes: Social-communication (social interaction); RRB; Communication; Expressive language.
Oono et al. (2013)	Type: Meta-analysis with narrative synthesis Objectives: "To assess the effectiveness of parent- mediated early interventions in terms of the benefits for both children with autism spectrum disorder (ASD) and their parents and to explore some potential moderators of treatment effect." Number of included studies: 17 narrative synthesis; 10 meta-analysis. Search limit (years): 2002 – 2012 Study designs: Randomised controlled trials Quality of studies: Not specified Sources of funding: Specified – Funded Conflict of interest: Specified – No conflicts	 Participant Characteristics Number of participating children: 919 Age: 17 months – 6 years Sex: 645/816 males, 171/816 females Description: Autism, autism spectrum disorder Increased likelihood of ASD: Not included Other conditions: None Intervention(s): Parent mediated interventions – Developmental Individual- Difference Relationship-Based (DIR) techniques; massage intervention; management of challenging behaviour; early intensive behavioural intervention; Pivotal Response Treatment (PRT). Comparison: Waitlist control, treatment as usual, another intervention, other comparison group Outcomes: Overall autism characteristics (severity of autism characteristics); social-communication (shared or joint attention, child initiations); communication (communication, joint language); expressive language (expression); receptive language (comprehension); cognitive (developmental/intellectual gains); social-emotional/challenging behaviour



		(maladaptive behaviour); adaptive behaviour; caregiver communication and interaction (parental synchrony); caregiver social emotional wellbeing (parents' level of stress, parental confidence), caregiver satisfaction.
Parsons, Cordier, Vaz et al. (2017)	 Type: Narrative synthesis only Objectives: "to (1) systematically review the existing evidence presented by studies on parent-mediated intervention training, delivered remotely for parents having children with autism spectrum disorder and living outside of urban areas; (2) provide an overview of current parent training interventions used with this population; (3) and provide an overview of the method of delivery of the parent training interventions used with this population." Number of included studies: 7 Search limit (years): 2014 – 2016 Study designs: Randomised controlled trials, nonrandomised with control, non-randomised without control, single-case experimental designs Guality of studies: Included moderate quality/moderate risk of bias Sources of funding: Specified – Not funded Conflict of interest: Specified – No conflicts 	 Participant Characteristics Number of participating children: Not specified Age: 0 - < 18 years (inclusion criteria) Sex: 42/52 males, 10/52 females Description: Autism spectrum disorder Increased likelihood of ASD: Not included Other conditions: None Intervention(s): Web-based training in behavioural interventions; Online and Applied System for Intervention Skills (OASIS) training intervention Research- to-practice; Improving Parents as Communication Teachers (ImPACT) on the Web; Implementation discrete-trial instructions using video training materials; Parent Early Start Denver Model (P-EDSM) training; Functional communication training. Comparison: Another intervention, the individual's own baseline, no comparison group Outcomes: Social-communication (social behaviour and communication skills); communication (vocabulary production and comprehension); caregiver satisfaction; caregiver communication and interaction (parental knowledge acquisition); caregiver social emotional wellbeing (parental self-efficacy).
Parsons, Cordier, Munro et al. (2017)	Type: Meta-analysis with narrative synthesis Objectives: "to conduct a systematic review and meta- analysis of pragmatic language interventions for children with autism spectrum disorder (ASD)." Number of included studies: 21 narrative synthesis; 15 meta-analysis	Participant Characteristics Number of participating children: 925 Age: 21 months – 14 years Sex: Not specified Description: Autism spectrum disorder Increased likelihood of ASD: Not included



	Search limit (years): Database inception - 2016 Study designs: Randomised controlled trials Quality of studies: Included low quality/high risk of bias Sources of funding: Specified – Not funded Conflict of interest: Specified – No conflicts	Other conditions: None Intervention(s): Pragmatic language interventions - The Junior detective Program; Milton and Ethel Harris Research Initiative Treatment (MEHRIT); Building Blocks Program; Social Emotional NeuroScience Endocrinology (SENSE) theatre; Social Skills Group Intervention- High Functioning Autism; FindMe App; Therapeutic Horse Riding; FaceSay; Joint Attention, Symbolic Play, Engagement, and Regulation (JASPER); Improvisational music therapy; SummerMAX; Mind Reading; Skillstreaming; Emotion Recognition Training; Seaver-NETT. Comparison: Wait list control, treatment as usual, another intervention Outcomes: Social-communication (pragmatic language).
Peters-Scheffer et al. (2011)	Type: Meta-analysis with narrative synthesis Objectives: "to investigate the effectiveness of early intensive behavioural intervention (EIBI) based on applied behaviour analysis in young children with Autism Spectrum Disorders (ASD)." Number of included studies: 11 Search limit (years): 1980 – 2009 Study designs: Randomised controlled trials, non- randomised with control Quality of studies: Not specified Sources of funding: Specified – Funded Conflict of interest: Not specified	 Participant Characteristics Number of participating children: 344 Age: 34 – 66 months Sex: 213/246 males, 33/246 females Description: Autism Spectrum Disorder, including autistic disorder, pervasive developmental disorder not otherwise specified, or not specified Increased likelihood of ASD: Not included Other conditions: None Intervention(s): Early Intensive Behavioural Intervention (EIBI). Comparison: Treatment as usual, another intervention Outcomes: Social-communication (socialisation); Communication (overall); Expressive language; Receptive language; Cognition (full scale IQ, non-verbal IQ); Adaptive behaviour (adaptive behaviour, daily living).
Postorino et al. (2017)	Type: Meta-analysis with narrative synthesis Objectives: to summarise "the essential elements of parent training (PT) for disruptive behaviour in	Participant Characteristics Number of participating children: 653 (343 intervention, 310 control) Age: 2 – 14 years



	 children with autism spectrum disorder (ASD) and [evaluate] the available evidence for parent training using both descriptive and meta-analytic procedures." Number of included studies: 8 Search limit (years): 1980 – 2016 Study designs: Randomised controlled trials, non- randomised with control Quality of studies: Included low quality/high risk of bias Sources of funding: Not specified Conflict of interest: Specified – Conflict 	 Sex: 504/594 males, 90/594 females Description: Autism spectrum disorder Increased likelihood of ASD: Not included Other conditions: None Intervention(s): Parent training for disruptive behaviour. Comparison: Wait list control, treatment as usual, another intervention, other comparison group Outcomes: Social-emotional/challenging behaviour (disruptive behaviour).
Reichow et al. (2018)	Type: Meta-analysis with narrative synthesis Objectives: "to systematically review the evidence for the effectiveness of early intensive behavioural intervention (EIBI) in increasing functional behaviours and skills, decreasing autism severity, and improving intelligence and communication skills for young children with autism spectrum disorder (ASD)." Number of included studies: 5 Search limit (years): Database inception - 2017 Study designs: Randomised controlled trials, non- randomised with control Quality of studies: Not specified Sources of funding: Specified – Funded Conflict of interest: Specified – Conflict	 Participant Characteristics Number of participating children: 219 (116 intervention, 103 control) Age: 0 - <6 years (inclusion criteria), M range = 30.2 – 42.5 months Sex: 153/177 males, 24/177 females Description: Autism spectrum disorder, autistic disorder, pervasive developmental disorder not otherwise specified Increased likelihood of ASD: Not included Other conditions: None Intervention(s): Early intensive behavioural intervention (EIBI). Comparison: Treatment as usual, another intervention Outcomes: Overall autism characteristics (autism symptoms); Social-communication (social competence); Communication; Expressive language; Receptive language; Cognition (intelligence quotient); Social-emotional/challenging behaviour (problem behaviour); Adaptive behaviour (adaptive behaviour, daily living skills); School/learning readiness (academic placement), caregiver social and emotional wellbeing (parental stress).



Sandbank et al.	Type: Meta-analysis with narrative synthesis	Participant Characteristics
(2020a)	Objectives: to review "group design studies of non-	Number of participating children: 6240
	pharmacological early interventions designed for young	Age: 0 – 8 years, M = 54.21 months
	children with autism spectrum disorder (ASD)."	Sex: Not specified
	Number of included studies: 130	Description: Autism spectrum disorder (inclusion criteria)
	Search limit (years): Not specified	Increased likelihood of ASD: Not included
	Study designs: Randomised controlled trials, non-	Other conditions: None
	randomised with control	Intervention(s): <u>Animal-assisted therapy-</u> Canine Assistance; Presence of a
	Quality of studies: Not specified	Therapeutic Service Dog; Therapeutic Horseback Riding
	Sources of funding: Specified – Funded	Behavioural- Behavioral Parent Training; Discrete Trial Training with Motor
	Conflict of interest: Specified – Conflict	Vocal Imitation Assessment; Early Intensive Behavioral Treatment; Functional
		Behavior Skills Training; Home-based behavioral treatment; Home-based Early
		Intensive Behavioral; Intervention (EIBI); Intensive Applied Behaviour Analysis
		(ABA); Intensive Early Intervention; Low Intensity Behavioral Treatment;
		Managing Repetitive Behaviors; Picture Exchange Communication System
		(PECS); Peer-Mediated Intervention; Rapid Motor Imitation Antecedent; Regular
		Intensive Learning for Young Children with Autism; Schedules, Tools, and
		Activities for Transitions (STAT); Social Skills Group; Stepping Stones Triple P
		Positive Parenting Program; Strategies for Teaching Based on Autism Research
		(STAR)
		Developmental- Adapted Hanen More Than Words; Developmental, Individual-
		Difference, Relationship-Based (DIR)-Floortime; Hanen More Than Words; Joint
		Attention Mediated Learning (JAML); MEHRIT (Milton and Ethel Harris Research
		Initiative Treatment); Parent-Mediated Communication Focused Treatment;
		Parent-mediated intervention for autism spectrum disorder in South Asia
		(PASS); Play and Language For Autistic Youngsters (PLAY)/ DIR Floortime;
		Scottish Early Intervention Program; Social Communication Intervention for
		Children with Autism and Pervasive Developmental Disorder; Video-feedback
		Intervention to Promote Positive Parenting adapted to autism (VIPP-AUTI)
		Naturalistic developmental behavioural intervention (NDBI)- Advancing Social-



	Communication and Play (ASAP); Caregiver-based intervention program in
	community day-care centers; Denver Model; Early Social Interaction Project
	(SCERTS); Early Start Denver Mode (ESDM); Home-based Building Blocks
	Program; home-based intervention program; ImPACT Online; Interpersonal
	Synchrony; Joint Attention Intervention Joint Attention Symbolic Play
	Engagement Regulation (JASPER); Joint Engagement Intervention; Joint
	Engagement Intervention with Creative Movement Therapy; Parent-Early Start
	Denver Model (P-ESDM); Parent-training intervention; Pivotal Response
	Treatment (PRT); Reciprocal Imitation Training; Social ABCs
	Cognitive behaviour therapy (CBT)
	Sensory based- Developmental Speech and Language Training through Music;
	Family-Centered Music Therapy; Improvisational Music Therapy; Music
	Therapy; Qigong (QST) Massage Treatment; Qigong Massage Treatment;
	Rhythm Intervention Sensorimotor Enrichment; Sensory Enrichment; Thai
	Traditional Massage; Tomatis Sound Therapy; Vestibular Stimulation via a
	Platform Swing
	Technology based- ABRACADABRA; Emotiplay Serious Game; FaceSay;
	FindMe iPad App; Gaming Open Library for Intervention in Autism at Home
	(GOLIAH); Gaze-contingent attention training; Social Skills Training using a
	robotic behavioral intervention system;The Transporters animated series;
	Therapy Outcomes By You (TOBY) App; Transporters DVD; Transporters
	Program for Children with Autism
	Treatment and Education of Autistic and related Communications Handicapped
	Children (TEACCH)
	Other- "Autism 123"; Balance Training Intervention; Circle of Friends; Cognitive
	Method; Colloborative Model for Promoting Competence and Success
	(COMPASS); Comprehensive Inclusion Program; Group Psychoeducational
	Program for Mothers; Home-based intervention; Hyperbaric Oxygen Therapy;
	Individual Parent Sleep Education; Interactive Book Reading; LEAP (Learning
	Experiences and Alternative Program for Preschoolers); NeuroModulation



Schaaf et al. (2018)	Type: Narrative synthesis only Objectives: addresses the question "What is the efficacy	Participant Characteristics Number of participating children: 101
Sandbank et al. (2020b)	Type: Meta-analysis with narrative synthesis Objectives: to synthesise "effects of interventions on language outcomes of young children (ages 0–8 years) with autism and [evaluate] the extent to which summary effects [vary] by intervention, participant, and outcome characteristics." Number of included studies: 60 Search limit (years): Not Specified – 2017 Study designs: Randomised controlled trials, non- randomised with control Quality of studies: Not specified Sources of funding: Specified – Funded Conflict of interest: Specified – No conflicts	Professionally supported intervention; Psychoeducation Intervention; Psychomotor Intervention Program; Reading Mastery; Sleep Education Pamphlet; Sung computer-based intervention; Thought-bubble Training for Theory of Mind; Water Exercise Swimming Program Comparison : Not specified Outcomes : Overall autism characteristics (diagnostic characteristics); Social- communication; Communication (language); Cognition (cognitive); Motor; Social-emotional/challenging behaviour; Adaptive behaviour. Participant Characteristics Number of participating children : 2908 Age : 0 – 8 years (inclusion criteria), M = 48 months Sex : Not specified Description : Autism (inclusion criteria) Increased likelihood of ASD : Not included Other conditions : None Intervention(s) : Behavioural; developmental; naturalistic developmental behavioural intervention (NDBI); Treatment and Education of Autistic and related Communications Handicapped Children (TEACCH); sensory- based; animal-assisted; technology-based. Comparison : Not specified Outcomes : Overall effect (summary across all outcomes and language measures); Communication (composite language); Expressive language; Receptive language.
		Technique (NMT); Outdoor Adventure Program; Parent Education and Counselling (PEAC); Parent-Child Interaction Therapy (PCIT) or Child-directed interaction therapy (CDIT); Positive Family Intervention (Positive Behavior Support +parent optimism training); Primary Care Stepping Stones Triple P;



	of occupational therapy using Ayres Sensory	Age: M range = 4.4 – 8.8 years
	Integration [®] (ASI) to support functioning and	Sex : 85/101 males, 16/101 females
	participation as defined by the International	Description: Autism spectrum disorder
	Classification of Functioning, Disability and Health for	Increased likelihood of ASD: Not included
	persons with challenges in processing and	Other conditions: None
	integrating sensory information that interfere with	Intervention(s): Ayres Sensory Integration [®] (ASI).
	everyday life participation?"	Comparison: Treatment as usual, another intervention, the individual's own
	Number of included studies: 5	baseline
	Search limit (years): 2007 – 2015	Outcomes: Overall autism characteristics (autistic behaviours), social-
	Study designs: Randomised controlled trials, non-	communication (caregiver assistance with social skills), Sensory (sensory-
	randomised with control, single-case experimental	motor), communication (language skills), play, adaptive behaviour (functioning,
	designs	reduction in caregiver assistance with self-care activities), community
	Quality of studies. Nation aridiant	participation (participation).
	Quality of studies: Not specified	
	Sources of funding: Not specified	
	Conflict of Interest: Not specified	
Schoen et al. (2019)	Type: Narrative synthesis only	Participant Characteristics
	Objectives: to "evaluate the effectiveness research from	Number of participating children: 89
	2006 to 2017 on Ayres Sensory Integration (ASI)	Age: Up to 12 years
	intervention for children with autism."	Sex: Not specified
	Number of included studies: 3	Description: Autism spectrum disorder
	Search limit (years): 2006 - 2017	Increased likelihood of ASD: Not included
	Study designs: Randomised controlled trials, non-	Other conditions: None
	randomised with control	Intervention(s): Ayres Sensory Integration [®] (ASI).
	Quality of studies: Not specified	Comparison: Treatment as usual, another intervention
	Sources of funding: Not specified	Outcomes: General outcomes.
	Conflict of interact: Specified No conflicts	
	connict of interest: specified – No connicts	



Srinivasan et al. (2018)	 Type: Narrative synthesis only Objectives: "to examine the effects of equine therapy on specific domains including social, communication, behavioural, and sensorimotor skills as well as broader functional outcomes including overall adaptive functioning and quality of life." Number of included studies: 15 Search limit (years): Database inception – not specified Study designs: Randomised controlled trials, non-randomised with control, non-randomised without control, single-case experimental designs, other Quality of studies: Not specified Sources of funding: Specified – Funded Conflict of interest: Specified – No conflicts 	 Participant Characteristics Number of participating children: 428 (294 intervention, 134 control; 426 ASD) Age: 3 – 16 years Sex: 328/404 males, 76/404 females Description: Autism spectrum disorder, Asperger syndrome Increased likelihood of ASD: Not included Other conditions: Attention deficit hyperactivity disorder Intervention(s): Equine therapy - therapeutic horseback riding; simulated horseback riding; hippotherapy. Comparison: Wait list control, another intervention, the individual's own baseline, no comparison group Outcomes: Social-communication; Sensory; Cognition (cognitive); Motor; Social-emotional/challenging behaviour (behavioural skills); Quality of life; Community participation (functional participation).
Steinbrenner et al. (2020)	 Type: Narrative synthesis only Objectives: "to describe a set of practices that have clear evidence of positive effects with autistic children and youth." Number of included studies: 972 Search limit (years): 2012 - 2017 Study designs: Randomised controlled trials, non-randomised with control, single-case experimental designs. Quality of studies: Included high quality/low risk of bias only Sources of funding: Specified – Funded Conflict of interest: Not specified 	 Participant Characteristics Number of participating individuals: Not specified Age: 0 – 22 years (inclusion criteria) Sex: 5934/7031 males, 1097/7031 females Description: Autism spectrum disorder, Asperger/high functioning autism, autism, pervasive developmental disorder/pervasive developmental disorder/pervasive developmental disorder not otherwise specified Increased likelihood of ASD: Not included Other conditions: None Intervention(s): Antecedent-based interventions - augmentative and alternative communication (AAC); behavioural momentum intervention; Cognitive Behavioural/Instructional Strategies; Differential Reinforcement of Alternative, Incompatible, or Other Behaviour; Direct Instruction; Discrete Trial Training (DTT); Exercise and Movement; Extinction; Functional Behavioural



		Assessment; Functional Communication Training (FCT); Modeling; Music- Mediated Intervention; Naturalistic Intervention; Parent-implemented intervention; peer-based instruction and intervention; prompting; reinforcement; response interruption/redirection; self-management; sensory integration; social narratives; social skills training; task analysis; technology- aided instruction and intervention; time delay; video modelling; visual supports. Comparison: Not specified Outcomes: Social-communication (social, joint attention); Communication; Cognition (cognitive); Motor; Social-emotional/challenging behaviour (challenging/interfering behaviour); Play; Adaptive behaviour (adaptive/self- help); School/learning readiness; Academic.
Sutherland et al. (2018)	Type: Narrative synthesis only Objectives: "to examine the nature and outcomes of studies examining telehealth assessment and/or intervention in autism spectrum disorder (ASD)." Number of included studies: 14 Search limit (years): Database inception - 2016 Study designs: Randomised controlled trials, single- case experimental designs, other Quality of studies: Included low quality/high risk of bias Sources of funding: Not specified Conflict of interest: Specified – No conflicts	Participant Characteristics Number of participating individuals: 284 Age: 19 months – upper age not specified Sex: Not specified Description: Autism, autism spectrum disorder, pervasive developmental disorder not otherwise specified Increased likelihood of ASD: Not included Other conditions: None Intervention(s): Program Improving Parents as Communication Teachers (imPACT); internet-based Parent Implemented Communication Strategies (iPICS); general communication intervention; imitation training; Telehealth diagnostic services; 'Telehealth Facing Your Fears' Intervention'; functional behaviour assessment and functional communication training; school age intervention using web-based education; language intervention. Comparison: Wait list control, treatment as usual, another intervention, the
		Outcomes: Communication; social emotional/challenging behaviour



		(behaviour); caregiver satisfaction (satisfaction and acceptability); caregiver communication and interaction (fidelity).
Tachibana et al. (2018)	Type: Meta-analysis with narrative synthesis Objectives: "to investigate the effectiveness of individual and group interventions for children with autism spectrum disorder (ASD) and to compare the effectiveness of these two types if possible." Number of included studies: 30 studies analysis II, IV; 14 studies Analysis I and III Search limit (years): Not Specified – 2014 Study designs: Randomised controlled trials Quality of studies: Included moderate quality/moderate risk of bias Sources of funding: Specified – Funded Conflict of interest: Specified – No conflict	 Participant Characteristics Number of participating children: 1220 Age: 1 – 6 years Sex: 669/792 males, 123/792 females Description: Autism, autism spectrum disorder Increased likelihood of ASD: Not included Other conditions: None Intervention(s): Social communication intervention - Hanen's More Than Words; Early Start Denver Model (ESDM); Parent training; Joint Attention Symbolic Play Engagement and Regulation (JASPER); Preschool Autism Communication Trial (PACT); Treatment and Education of Autistic and related Communications Handicapped Children (TEACCH)-based group social skills; Reciprocal Imitation Training; Caregiver-based intervention program in community day-care centers; Preschool-based joint attention intervention; Caregiver Mediated Joint Engagement Intervention; Improvisational music therapy; intervention targeting development of socially synchronous engagement; Developmental, Individual-Difference, Relationship-Based(DIR)/ Floortime intervention; Functional Behavior Skills Training (FBST); Building Blocks; Parent delivery of the Early Start Denver Model (P-ESDM); Joint Attention Mediated Learning (JAML) intervention; Focused Playtime Intervention (FPI); Education and Skills Training Program for Parents; Parent education and behaviour management (PEBM) Skills training intervention or control for the non-specific aspects of the PEBM parent education and counselling intervention; Home TEACCHing Program. Comparison: Wait list control, treatment as usual, another intervention Outcomes: Overall autism characteristics (autism general symptoms); social- communication (qualitative impairment in social interaction, reciprocity of social interaction towards others, responding to joint attention, initiating joint



Tarver et al. (2019)	Type: Meta-analysis with narrative synthesis Objectives: to assess the "evidence for the efficacy of behavioural parent interventions for disruptive and hyperactive child behaviour in autism spectrum disorders, as well as parenting efficacy and stress." Number of included studies: 11 Search limit (years): Database inception - 2017 Study designs: Randomised controlled trials Quality of studies: Included low quality/high risk of bias Sources of funding: Specified – Funded Conflict of interest: Not specified	 attention; imitation); restricted and repetitive interests and behaviours (restricted repetitive and stereotyped patterns, behaviours, interests and activities); communication (qualitative impairment in communication); expressive language; receptive language; cognition (developmental quotient); adaptive behaviour; caregiver social emotional wellbeing (parenting stress). Participant Characteristics Number of participating children: 764 (396 intervention, 368 control) Age: 2 – 14 years Sex: Not specified Description: Autism spectrum disorder, Asperger's
Tiede & Walton (2019)	 Type: Meta-analysis with narrative synthesis Objectives: to conduct "a meta-analysis of outcomes of group-design studies testing interventions using naturalistic developmental behavioural intervention strategies [for children with autism spectrum disorder]." Unique included studies: 27 Search limit (years): Not Specified – 2018 	Participant characteristics Number of participating children: Not specified Age: Mean age < 6 (inclusion criteria)



	 Study designs: Randomised controlled trials, non-randomised with control (inclusion criteria) Quality of studies: Included low quality/high risk of bias Sources of funding: Specified – Not funded Conflict of interest: Not specified 	 Intervention(s): Naturalistic Developmental Behavioural Interventions - Early Start Denver Model (ESDM); Early Social Interaction Project (ESI); intervention emphasizing joint attention and imitation skill-building (JA/Imitation); Joint Attention, Symbolic Play, Engagement, and Regulation (JASPER); Learning Experiences Alternative Program (LEAP); Pivotal Response Treatment (PRT); Reciprocal Imitation Training (RIT); Focus parent training program; parent training. Comparison: Not specified Outcomes: Overall autism characteristics (symptoms of ASD); Social- communication (joint attention, social engagement); Expressive language; Receptive language; Cognition (cognitive development); Play; Adaptive behaviour.
Treurnicht Naylor et al. (2011)	Type: Narrative synthesis only Objectives: "to systematically review the effectiveness of music on pediatric health-related outcomes." Number of included studies: 17 Search limit (years): 1984 - 2009 Study designs: Randomised controlled trials Quality of studies: Included low quality/high risk of bias Sources of funding: Specified – Not funded Conflict of interest: Not specified	 Participant characteristics Number of participating individuals: 575 (20 with ASD) Age: 0.38 – 19 years Sex: Not specified Description: Autism, autistic disorder Increased likelihood of ASD: Not included Other conditions: Developmental delay, learning disabilities, attention deficit hyperactivity disorder, intellectual, social, and emotional deficits including attention deficit disorders (not specified), newly arrived immigrant and refugee adolescents, children from divorced and/or separated families, children experiencing bereavement, chronic depression, psychopathology (affective, behaviour, or substance abuse), acute or chronic illness, cystic fibrosis, migraine Intervention(s): Music therapy. Comparison: Wait list control, treatment as usual, another intervention, other comparison group



		Outcomes: Social-communication (cognitive functioning and social communication); Adaptive behaviour.
Trzmiel et al. (2019)	 Type: Meta-analysis with narrative synthesis Objectives: "to assess the effectiveness of Equine- Assisted Activities and Therapies (EAAT) in autism spectrum disorder (ASD) patients." Number of included studies: 15 narrative synthesis; 3 meta-analysis Search limit (years): 2000 – 2017 Study designs: Not specified Quality of studies: Included low quality/high risk of bias Sources of funding: Not specified Conflict of interest: Specified – No conflicts 	 Participant Characteristics Number of participating children: 390 Age: 3 – 16 years, M range = 5.14 – 10.2 years Sex: 308/380 males, 72/380 females Description: Autism spectrum disorder Increased likelihood of ASD: Not included Other conditions: None Intervention(s): Equine-assisted therapy - hippotherapy, therapeutic riding. Comparison: Not specified Outcomes: Social-communication (social); Communication; Adaptive behaviour; General outcomes (socialization, engagement, maladaptive behaviours, reaction time in problem-solving situations).
Tupou et al. (2019)	Type: Narrative synthesis only Objectives: "to identify studies involving the provision of early intervention to children with autism spectrum disorder (ASD) who were attending inclusive preschool settings. We also sought to appraise the quality of the identified studies and evaluate their effects on child outcomes. The strategies used in training teaching staff to implement these interventions with fidelity were a particular focus of the review as well." Number of included studies: 16 Search limit (years): 2000 – 2017 Study designs: Randomised controlled trials, non- randomised with control, non-randomised without control, single-case experimental designs	 Participant characteristics Number of participating children: 809 (517 intervention, 292 control) Age: 12 – 72 months (inclusion criteria), M = 46 months Sex: Not specified Description: Autism/autism spectrum disorder, pervasive developmental disorder not otherwise specified, Asperger's syndrome Increased likelihood of ASD: Included Other conditions: None Intervention(s): Comprehensive treatment programmes - Developmentally Appropriate Treatment for Autism (DATA); Treatment and Education of Autistic and Related Communication Handicapped Children (TEACCH); Early Intensive Behavioural Intervention (EIBI); Learning Experiences and Alternative Program for Preschoolers (LEAP); Comprehensive Autism Program (CAP); EIBI intervention described as being based on Lovaas' UCLA model. Skills focused interventions targeting - communication, play skills, peer



	Quality of studies: Included low quality/high risk of bias Sources of funding: Specified – Funded Conflict of interest: Specified – No conflicts	interaction, and reading skills. Comparison: Not specified Outcomes: Overall autism characteristics (autism severity and/or symptoms); social-communication (social skills); communication (communication and/or language); cognition (cognition or educational strengths);); social- emotional/challenging behaviour (adaptive/maladaptive behaviour); adaptive behaviour (functional skills); general outcomes (child outcomes).
Verschuur et al. (2014)	Type: Narrative review only Objectives: "to analyse the research on [Pivotal Responses Treatment] (PRT) in order to (a) document the range of skills that have been targeted for improvement with PRT, (b) assess the success of PRT for improving the skills of children with autism spectrum disorder (i.e., pivotal skills and untargeted skills), (c) assess the success of PRT for improving the skills of caregivers and staff, (d) evaluate the certainty of evidence arising from these studies, (e) identify limitations of the existing evidence base, and (f) suggest directions for future research." Number of included studies: 43 Search limit (years): Database inception - 2013 Study designs: Randomised controlled trials, non- randomised with control, non-randomised without control, single-case experimental designs, other Quality of studies: Included low quality/high risk of bias Sources of funding: Not specified Conflict of interest: Specified – No conflicts	 Participant characteristics Number of participating children: 420 Age: 1 – 12 years, 7 months, M = 4 years, 7 months Sex: 298/363 males, 65/363 females Description: Autism spectrum disorder, autism, pervasive developmental disorder not otherwise specified, Asperger's syndrome Increased likelihood of ASD: Included Other conditions: None Intervention(s): Pivotal Response Treatment (PRT); Natural Language Paradigm; facilitated social play training; and socio-dramatic play training. Comparison: Wait list control, another intervention, the individual's own baseline, no comparison group Outcomes: General outcomes (child behaviours); Caregiver social emotional wellbeing (caregiver behaviours).
Virués-Ortega (2010)	Type: Meta-analysis with narrative synthesis Objectives: to "ascertain the collective effectiveness of	Participant characteristics Number of participating children: 521 (323 intervention, 198



	applied behavior analytic (ABA) intervention for autism,	control)
	estimate ABA intervention effectiveness in terms of as	Age: M range = 22.6 – 66.3 months
	many outcome variables as possible in order to provide	Sex: Not specified
	a comprehensive assessment of its effects, and analyse	Description: Autism, pervasive developmental disorder not
	the effect of study characteristics including intervention	otherwise specified
	duration and intensity, study design, intervention model	Increased likelihood of ASD: Not included
	and intervention delivery format."	Other conditions: None
	Number of included studies: 22	Intervention(s): Applied Behavior Analytic (ABA) intervention - UCLA model,
	Search limit (years): 1985 - 2009	general ABA.
	Study designs: Randomised controlled trials, non-	Comparison: Another intervention, other comparison group, no comparison
	randomised with control, non-randomised without	group
	control	Outcomes: Social-communication (Socialisation); Communication
	Quality of studios: Included low quality/high risk of bias	(communication, general language skills); Expressive language; Receptive
	Sources of funding: Specified – Not funded	language; Cognition (IQ, non-verbal IQ); Motor skills; Adaptive behaviours
	Conflict of interest: Not specified	(overall).
	Connect of Interest. Not specified	
Waddington et al.	Type: Narrative synthesis only	Participant characteristics
(2016)	Objectives: to evaluate "the Early Start Denver Model	Number of participating children: 336 (209 intervention, 127 control)
	(ESDM) as an early intervention program for children	Age: 9 – 63 months
	with autism spectrum disorder."	Sex: Not specified
	Number of included studies: 12	Description: Autism spectrum disorder, pervasive developmental
	Search limit (years): Database inception - 2015	disorder not otherwise specified
	Study designs: Randomised controlled trials, non-	Increased likelihood of ASD: Included
	randomised with control, non-randomised without	Other conditions: None
	control, single-case experimental designs, other	Intervention(s): Early Start Denver Model (ESDM).
	Quality of studies: Included low quality/high risk of bias	Comparison: Treatment as usual, another intervention, the individual's own
	Sources of funding: Specified – Funded	baseline, no comparison group
	Conflict of interest: Specified – No conflicts	Outcomes: Overall autism characteristics (autism severity and core diagnostic
		outcomes); Social-communication (social interaction and communication);
		General outcomes (child behavioural functioning and development); Caregiver



		communication and interaction (fidelity to intervention); Caregiver social emotional wellbeing (parental stress and sense of competence); Caregiver satisfaction (social validity).
Watkins et al. (2019)	 Type: Meta-analysis with narrative synthesis Objectives: "to examine the characteristics of interventions for students with autism spectrum disorder (ASD) in inclusive settings, offer quantitative analysis of intervention effects, examine potential moderating variables that influence outcomes, analyse the social validity of these interventions, and provide recommendations for practice and future research." Number of included studies: 28 Search limit (years): 1997 – 2017 Study designs: Randomised controlled trials, single- case experimental designs Quality of studies: Included moderate quality/moderate risk of bias Sources of funding: Not specified Conflict of interest: Not specified 	 Participant characteristics Number of participating children: 293 Age: 3 – 21 years Sex: 243/293 males, 50/293 females. Description: Autism spectrum disorder Increased likelihood of ASD: Not included Other conditions: None Intervention(s): Interventions in inclusive settings - visual cues; social scripts; Social Stories; video modelling; communication books; peer-mediated intervention (PMI), self-monitoring; peer networks; individualised interventions based on the results of a functional behaviour assessment (FBA); social skills groups; initiations training; high probability request sequences; music therapy; and behavioural strategies were implemented in one study each. Comparison: Wait list control, another intervention, the individual's own baseline Outcomes: General outcomes; Social-communication; restricted and repetitive interests and behaviours; social-emotional/challenging behaviour (classroom behaviour, challenging behaviour and repetitive behaviour); play
Weitlauf et al. (2017)	Type: Narrative synthesis only Objectives: "To evaluate the effectiveness and safety of interventions targeting sensory challenges in children with autism spectrum disorder (ASD)." Number of included studies: 24 Search limit (years): 2010 – 2016	 Participant characteristics Number of participating children: 1010 Age: 2 – 16 years Sex: Not specified Description: Autism spectrum disorder, autism, pervasive developmental disorder not otherwise specified Increased likelihood of ASD: Not included Other conditions: None



Weston et al. (2016)	randomised with control, other Quality of studies: Included low quality/high risk of bias Sources of funding: Specified – Funded Conflict of interest: Specified – No conflicts Type: Meta-analysis with narrative synthesis Objectives: "to undertake a meta-analytic and systematic appraisal of the literature investigating the effectiveness of cognitive behavioural therapy (CBT) when used with individuals who have autistic spectrum disorders (ASDs) for either a) affective disorders, or b) the symptoms of ASDs." Number of included studies: 48 Search limit (years): Not specified – 2016 Study designs: Randomised controlled trials, non- randomised with control Quality of studies: Not specified Sources of funding: Specified – Funded	 auditory integration-based; music therapy; massage-based; other/additional such as tactile-based tasks, and weighted blankets. Comparison: Wait list control, treatment as usual, another intervention, other comparison group Outcomes: Sensory (sensory-related outcomes), Communication (language), expressive language, cognition (nonverbal cognitive skills), motor. Participant characteristics Number of participating children: 2099 (1081 intervention, 1018 control) Age: 4 – 65 years Sex: Not specified Description: Autism spectrum disorder Increased likelihood of ASD: Not included Other conditions: None Intervention(s): Cognitive behavioural therapy. Comparison: Wait list control, treatment as usual, another intervention, other comparison group Outcomes: Overall autism characteristics (symptoms related to ASD)
	Conflict of interest: Specified – No conflicts	
Wiese et al. (2016)	Type: Narrative synthesis only Objectives: "to examine the effectiveness of equine- based therapy on behavioural and social interactions in the treatment of children with autism spectrum disorder (ASD)." Number of included studies: 8	Participant characteristics Number of participating children: 186 Age: 4 – 16 years Sex: Not specified Description: Autism spectrum disorder, autism, Asperger's syndrome



	 Study designs: Randomised controlled trials, non-randomised with control, non-randomised without control, single-case experimental designs, other Quality of studies: Included low quality/high risk of bias Sources of funding: Not specified Conflict of interest: Not specified 	Other conditions: None Intervention(s): Equine-assisted therapy - Therapeutic horse-riding (THR); Hippotherapy; and Equine-assisted activities. Comparison: Wait list control, another intervention, the individual's own baseline, other comparison group, no comparison Outcomes: General outcomes (behaviour and social interaction).
Zagona & Mastergeorge (2018)	Type: Narrative synthesis only Objectives: to "describe the quality of current [peer- mediated instruction and intervention] empirical research published within the last 10 years, depict the growth and expansion of this practice as determined by published studies, examine implications for practice in inclusive settings, and explore future directions for research given the increasing number of individuals with autism spectrum disorder (ASD) included in general education classrooms." Number of included studies: 17 Search limit (years): 2004 - 2014 Study designs: Randomised controlled trials, single- case experimental designs Quality of studies: Included low quality/high risk of bias Sources of funding: Specified – Not funded Conflict of interest: Specified – No conflicts	Participant characteristics Number of participating children: 110 Age: 3 – 15 years Sex: Not specified Description: Autism spectrum disorder Increased likelihood of ASD: Not included Other conditions: None Intervention(s): Peer-mediated instruction and intervention. Comparison: Another intervention, the individual's own baseline Outcomes: Social-communication.



Appendix N: Summary of findings from practice/category-focused systematic reviews

 Table 1: Summary of findings from systematic reviews of behavioural interventions

	Characteristics of interventions included in the systematic review	Findings from the systematic review	Study designs	Risk of bias (systematic review)	Risk of bias (Included studies)
Systematic rev	iews at the category level				
Makrygianni & Reed (2010)	Label: Behavioural early intervention programs.	Social-communication (socialisation): Positive pooled effect.	Not specified	6/11	Included low quality/high risk of bias
	Setting: Not specified.	Communication: Positive pooled effect.			
	Format: Individual.	Communication (language): Positive pooled effect.			
	Agent: Parents/caregivers,	Cognition (IQ): Positive pooled effect.			
	peers/siblings.	Adaptive behaviour: Positive pooled effect.			
	Mode: Face-to-face.				
	Intervention practices: Behavioural early intervention programs.	Child age: Child age not related to intervention effect on cognition, adaptive behaviour, or language.			
		Child characteristics: Pre-intervention communication not			
		related to intervention effect on communication, cognition, or			
		adaptive behaviour. Pre-intervention cognition not related to			



		 intervention effect on communication, cognition, or adaptive behaviour. Greater pre-intervention adaptive behaviour skills related to greater intervention effects on communication and adaptive behaviour, but not on cognition. Amount of intervention: Higher intensity (hours per week) related to greater intervention effect on cognition and adaptive behaviour, but not language. Intervention duration (months) not related to intervention effect on cognition, adaptive behaviour, or language. Adverse effects: Not reported. 			
National Autism Center (2015)	 Label: Behavioural interventions. Setting: Not specified. Format: Not specified. Agent: Not specified. Mode: Not specified. Intervention practices: Behavioural interventions. 	Social-communication (interpersonal): Summarised positive effect. RRB (restricted, repetitive, non-functional patterns of behaviour, interests, or activity): Summarised positive effect. Sensory (sensory or emotional regulation): Summarised positive effect. Communication: Summarised positive effect. Cognition (higher cognitive functions): Summarised positive effect. Motor: Summarised positive effect. Social-emotional/challenging behaviour (self-regulation, problem behaviour): Summarised positive effect. Play: Summarised positive effect.	Not specified	4/10	Included low quality/high risk of bias



		 Adaptive behaviour (personal responsibility): Summarised positive effect. School/learning readiness (learning readiness): Summarised positive effect. Academic: Summarised positive effect. 			
		Adverse effects: Not reported.			
Sandbank et al. (2020a)	Label: Behavioural interventions. Setting: Not specified. Format: Not specified. Agent: Not specified. Mode: Not specified. Intervention practices: Behavioral Parent Training; Discrete Trial Training with Motor Vocal Imitation Assessment; Early Intensive Behavioral Treatment; Functional Behavior Skills Training Home- based behavioral treatment; Home-based Early Intensive Behavioral Intervention (EIBI); Intensive ABA; Intensive Early Intervention; Low Intensity Behavioral Treatment; Managing Papetitive Behaviors: Picture	Overall autism characteristics (diagnostic characteristics): Positive pooled effect. Social-communication: Positive pooled effect. Communication (language): Positive pooled effect. Cognition (cognitive): Positive pooled effect. Motor: Positive pooled effect. Social-emotional/challenging behaviour: Positive pooled effect. Adaptive behaviour: Positive pooled effect. Adaptive behaviour: Positive pooled effect.	RCTs, non- randomised with control	10/11	Not specified



Exchange Communication System (PECS); Peer-Mediated Intervention; Rapid Motor Imitation Antecedent; Regular Intensive Learning for Young Children with Autism; Schedules, Tools, and Activities for Transitions (STAT); Social Skills Group; Stepping Stones Triple P Positive Parenting Program; Strategies for Teaching Based on Autism Research (STAR).				
iews at the practice level				
ning (DTT)				
Setting: Not specified. Format: Not specified. Agent: Not specified. Mode: Not specified.	 Social-communication (social): Summarised positive effect. Social-communication (joint attention): Summarised positive effect. Communication: Summarised positive effect. Cognition (cognitive): Summarised positive effect. Social-emotional/challenging behaviour (challenging/interfering behaviour): Summarised positive effect. Play: Summarised positive effect. 	RCTs, non- randomised with control, single-case experimental designs	7/10	High quality/low risk of bias only
	Exchange Communication System (PECS); Peer-Mediated Intervention; Rapid Motor Imitation Antecedent; Regular Intensive Learning for Young Children with Autism; Schedules, Tools, and Activities for Transitions (STAT); Social Skills Group; Stepping Stones Triple P Positive Parenting Program; Strategies for Teaching Based on Autism Research (STAR). ews at the practice level ning (DTT) Setting: Not specified. Format: Not specified. Agent: Not specified. Mode: Not specified.	Exchange Communication System (PECS); Peer-Mediated Intervention; Rapid Motor Imitation Antecedent; Regular Intensive Learning for Young Children with Autism; Schedules, Tools, and Activities for Transitions (STAT); Social Skills Group; Stepping Stones Triple P Positive Parenting Program; Strategies for Teaching Based on Autism Research (STAR).Social Skills Group; Stepping Stones Triple P Positive Parenting Program; Strategies for Teaching Based on Autism Research (STAR).Setting: Not specified. Format: Not specified. Agent: Not specified. Mode: Not specified. Mode: Not specified. Mode: Not specified. Mode: Not specified. Mode: Not specified. Pay: Summarised positive effect. Social-emotional/challenging behaviour (challenging/interfering behaviour): Summarised positive effect. Play: Summarised positive effect.	Exchange Communication System (PECS); Peer-Mediated Intervention; Rapid Motor Imitation Antecedent; Regular Intensive Learning for Young Children with Autism; Schedules, Tools, and Activities for Transitions (STAT); Social Skills Group; Stepping Stones Triple P Positive Parenting Program; Strategies for Teaching Based on Autism Research (STAR).Social-communication (social): Summarised positive effect.setting: Not specified. Format: Not specified. Agent: Not specified. Mode: Not specified. Mode: Not specified. Mode: Not specified. Mode: Not specified. Mede: Not specified. Mode: Not specified. Mode: Not specified. Mode: Social-communication (cognitive): Summarised positive effect. Cognition (cognitive): Summarised positive effect. Social-emotional/challenging behaviour (challenging/interfering behaviour): Summarised positive effect. Play: Summarised positive effect.RCTs, non- randomised with control, single-case experimental designs	Exchange Communication System (PECS); Peer-Mediated Intervention; Rapid Motor Initiation Antecedent; Regular Intensive Learning for Young Children with Autism; Schedules, Tools, and Activities for Transitions (STAT); Social Skills Group; Stepping Stones Triple P Positive Parenting Program; Strategies for Teaching Based on Autism Research (STAR).Social-communication (social): Summarised positive effect.RCTs, non- randomised with control, single-case experimental designs7/10Setting: Not specified. Agent: Not specified. Mode: Not specified. Play: Summarised positive effect. Play: Summarised positive effect. Play: Summarised positive effect. Play:



		School/Learning Readiness: Summarised positive effect. Academic: Summarised positive effect.			
		Adverse effects: Not reported.			
Early Intensive E	Behavioural Intervention (EIBI)	·			
Virués-Ortega (2010)	Setting: Clinic, home, educational. Format: Individual. Agent: Parents/caregivers, Clinicians/researchers. Mode: Face-to-face.	 Social-communication (Socialisation): Positive pooled effect. Communication: Positive pooled effect. Communication (general language skills): Positive pooled effect. Expressive language: Positive pooled effect. Receptive language: Positive pooled effect. Cognition (IQ): Positive pooled effect. Cognition (IQ, clinic-based programs): Positive pooled effect. Cognition (IQ, parent-managed programs): Positive pooled effect. Motor: Positive pooled effect. Adaptive behaviours (overall): Positive pooled effect. Adaptive behaviours (clinic-based programs): Positive pooled effect. 	RCTs, non- randomised with control, non- randomised without control	8/11	Included low quality/high risk of bias



		 Adaptive behaviours (parent managed programs): Positive pooled effect. Amount of intervention: Greater total hours related to greater intervention effect on language and adaptive behaviour, but not cognition. Adverse effects: Not reported. 			
Peters-Scheffer et al. (2011)	Setting: Clinic, home, educational. Format: Individual. Agent: Clinicians/researchers. Mode: Face-to-face.	 Social-communication (socialisation): Positive pooled effect. Communication (overall): Positive pooled effect. Expressive language: Positive pooled effect. Receptive language: Positive pooled effect. Cognition (full scale IQ): Positive pooled effect. Cognition (non-verbal IQ): Positive pooled effect. Adaptive behaviour: Positive pooled effect. Adaptive behaviour (daily living): Positive pooled effect. Adverse effects: Not reported. 	RCTs, non- randomised with control	8/11	Not specified
National Autism Center (2015)	Setting: Not specified. Format: Not specified.	Overall autism characteristics (general symptoms): Summarised positive effect.	Not specified	4/10	Included low quality/high risk of bias



	Agent: Not specified. Mode: Not specified.	 Social-communication (interpersonal): Summarised positive effect. Communication: Summarised positive effect. Cognition (higher cognitive functions): Summarised positive effect. Motor: Summarised positive effect. Social-emotional/challenging behaviour (problem behaviour): Summarised positive effect. Adaptive behaviour (personal responsibility): Summarised positive effect. School/learning readiness (learning readiness): Summarised positive effect. Academic: Summarised positive effect. Adverse effects: Not reported. 			
Reichow et al. (2018)	Setting: Not specified. Format: Individual. Agent: Not specified. Mode: Face-to-face.	 Overall autism characteristics (autism symptoms): Null pooled effect. Social-communication (social competence): Positive pooled effect. Communication: Positive pooled effect. Expressive language: Positive pooled effect. Receptive language: Positive pooled effect. Cognition (intelligence quotient): Positive pooled effect. 	RCTs, non- randomised with control	11/11	Not specified



			1		
		Social-emotional/challenging behaviour (problem behaviour): Null pooled effect.			
		Adaptive behaviour: Positive pooled effect.			
		Adaptive behaviour (daily living skills): Positive pooled effect.			
		School/learning readiness (academic placement): Summarised positive effect.			
		Caregiver social and emotional wellbeing (parental stress): Summarised null effect.			
		Adverse effects: Considered, and none identified.			
Functional comm	nunication training				
National	Setting: Not specified.	General outcomes: Summarised inconsistent effect.	Not	4/10	Included low
Autism Center (2015)	Format: Not specified.		specified		quality/high risk of bias
	Agent: Not specified.	Adverse effects: Not reported.			
	Mode: Not specified.				
Steinbrenner et	Setting: Not specified.	Social-communication (social): Summarised positive effect.	RCTs, non-	7/10	High
al. (2020)	Format: Not specified.	Communication: Summarised positive effect.	randomised with control.		quality/low risk of bias
	Agent: Not specified.	Social-emotional/challenging behaviour	single-case		only
	Mode: Not specified.	(challenging/interfering behaviour): Summarised positive effect.	experimental designs.		-
		Play: Summarised positive effect.			


		Adaptive hehevieur (adaptive/celf help): Summericed			
		Adaptive penaviour (adaptive/seit-neip): Summarised			
		positive effect.			
		School/learning readiness: Summarised positive effect.			
		Adverse effects: Not reported.			
Language Traini	ng (production)				
National	Setting: Not specified.	Communication: Summarised positive effect.	Not	4/10	Included low
Autism Center	Format: Not specified.		specified		quality/high
(2015)	Agent: Not specified.	Adverse effects: Not reported.			TISK OF DIAS
	Mode: Not specified.				
Language Traini	ng (production and understanding)		-	-	-
National	Setting: Not specified.	General outcomes: Summarised inconsistent effect.	Not	4/10	Included low
Autism Center	Format: Not specified.		specified		quality/high
(2015)	Agent: Not specified.	Adverse effects: Not reported.			risk of blas
	Mode: Not specified.				
Picture Exchange	e Communication System (PECS)	I	I	I	I
Flippin et al.	Setting: Home, educational,	Social-communication (communicative behaviours):	RCTs, non-	7/11	Included low
(2010)	centres.	Positive pooled effect.	randomised		quality/high
	Format: Individual.	Expressive language (speech or vocalisation): Null pooled	with control,		risk of bias
	Agent: Not specified.	effect.	single-case		



	Mode: Face-to-face.	Adverse effects: Not reported	experimental designs		
National Autism Center (2015)	Setting: Not specified. Format: Not specified. Agent: Not specified. Mode: Not specified.	General outcomes: Summarised inconsistent effect. Adverse effects: Not reported.	Not specified	4/10	Included low quality/high risk of bias



Table 2. Summary of findings from systematic reviews of developmental interventions

	Characteristics of interventions included in the systematic review	Findings form the systematic review	Study designs	Risk of bias (systematic review)	Risk of bias (included studies)
Systematic re	views at the category level				
Binns & Oram Cardy (2019)	 Label: Developmental social pragmatic interventions. Setting: Clinic, home. Format: Individual, group. Agent: Parents/caregivers, educators, clinicians/researchers. Mode: Face-to-face. Intervention practices: Child Talk; Hanen More than Words; Developmental Individual- Difference Relationship-Based (DIR); Milton and Ethel Harris Research Initiative Treatment (MEHRIT)-DIR based; Pediatric Autism and Communication Therapy (PACT); Joint attention mediated learning; Play and Language for Autistic Youngsters (PLAY) project - DIR based; Social communication, emotion regulation, transactional support (SCERTS). 	 Social-communication (social interaction and social-communication): Summarised positive effect. Communication (language capacities): Summarised inconsistent effect. Caregiver communication and interaction (parental responsiveness and directiveness): Summarised positive effect. Child characteristics: The level of pre-intervention overall autism characteristics inconsistently related to intervention effects on social-communication. Adverse effects: Not reported. 	RCTs only	9/10	Included low quality/high risk of bias



Sandbank et al. (2020a)	Label: Developmental interventions. Setting: Not specified. Format: Not specified.	Social-communication: Positive pooled effect. Communication (language): Null pooled effect.	RCTs, non- randomised with control	10/11	Not specified				
	Agent: Not specified.	Adverse effects: Not reported.							
	Mode: Not specified.								
	Intervention practices: Adapted Hanen More Than Words; DIR-Floortime; Hanen More Than Words; Joint Attention Mediated Learning (JAML); MEHRIT (Milton and Ethel Harris Research Initiative Treatment); Parent- Mediated Communication Focused Treatment; Parent-mediated intervention for autism spectrum disorder in South Asia (PASS); Play and Language For Autistic Youngsters (PLAY)/DIR Floortime; Scottish Early Intervention Program; Social Communication Intervention for Children with Autism and Pervasive Developmental Disorder; Video- feedback Intervention to Promote Positive Parenting adapted to autism (VIPP-AUTI)								
Systematic rev	views at the practice level								
Developmenta	Developmental relationship-based treatment								
National Autism	Setting: Not specified. Format: Not specified.	General outcomes: Summarised inconsistent effect.	Not specified	4/10	Included low				



Center (2015) DIR/Floortime National Autism Center	Agent: Not specified. Mode: Not specified. Setting: Not specified. Format: Not specified.	Adverse effects: Not reported. General outcomes: Summarised null effect.	Not specified	4/10	quality/high risk of bias
(2015)	Agent: Not specified. Mode: Not specified.	Adverse effects: Not reported.			risk of bias
Boshoff et al. (2020)	Setting: Clinic, home, natural contexts for the child. Format: Individual. Agent: Parents/caregivers, clinicians/researchers. Mode: Face-to-face.	Social-communication (social and emotional development): Summarised positive effect. Communication (language): Summarised null effect. Motor skills (motor and fine motor): Summarised null effect. Adverse effects: Not reported.	RCTs, non- randomised without control group, single-case experimental designs, other	9/10	Not specified
Naturalistic te	aching strategies				
National Autism Center (2015)	Setting: Not specified. Format: Not specified. Agent: Not specified. Mode: Not specified.	Social-communication (interpersonal): Summarised positive effect. Communication: Summarised positive effect.	Not specified	4/10	Included Iow quality/high risk of bias



		School/learning readiness: Summarised positive effect. Adverse effects: Not reported.			
Steinbrenner et al. (2020)	Setting: Not specified. Agent: Not specified. Mode: Not specified.	 Social-communication (social): Summarised positive effect. Social-communication (joint attention): Summarised positive effect. Communication: Summarised positive effect. Cognition (cognitive): Summarised positive effect. Motor: Summarised positive effect. Social-emotional/challenging behaviour (challenging/interfering behaviour): Summarised positive effect. Play: Summarised positive effect. Adaptive behaviour (adaptive/self-help): Summarised positive effect. School/learning readiness: Summarised positive effect. Academic: Summarised positive effect. Adverse effects: Not reported. 	RCTs, non- randomised with control, single-case experimental designs	7/10	High quality/low risk of bias only

Footnote: "Label" refers to the term used by the authors of the systematic review to describe the category of interventions being examined; "Intervention Practices" refers to the intervention practices described by the authors as being included in the systematic review; participants in the intervention group of a systematic review



generally only received one intervention practice, though this was not always specified; "pre-intervention" refers to child characteristics measured prior to the delivery of intervention; Only outcomes for which evidence was available are included; "Outcomes ()" the first term refers to the outcome categories defined for this umbrella review, the term in parenthesis refers to the author's term(s) for the outcome, where there is no term in brackets, the systematic review author's outcome classification matched that of the current umbrella review; "risk of bias (included studies)" refers to the risk of bias, as assessed by the authors of the systematic review and

appraised by current authors during data extraction, the rating indicates the lower bound of quality/risk of bias for studies included in the review.



Table 3. Summary of findings from systematic reviews of naturalistic developmental behavioural interventions

	Characteristics of interventions included in the systematic review	Findings form the systematic review	Study designs	Risk of bias (systematic review)	Risk of bias (included studies)
Systematic re	eviews at the category level				
Tiede & Walton (2019)	 Label: Naturalistic developmental behavioural interventions. Setting: Clinic, home, educational, community. Format: Individual. Agent: Parents/caregivers, educators, clinicians/researchers. Mode: Face-to-face. Intervention practices: Early Start Denver Model (ESDM); Early Social Interaction Project (ESI); intervention emphasizing joint attention and imitation skill-building (JA/Imitation); Joint Attention, Symbolic Play, Engagement, and Regulation (JASPER); Learning Experiences Alternative Program (LEAP); Pivotal Response Treatment (PRT); Reciprocal Imitation Training (RIT); Focus parent training program; parent training. 	Overall autism characteristics (symptoms of ASD): Positive pooled effect. Social-communication (joint attention): Null pooled effect. Social-communication (social engagement): Positive pooled effect. Expressive language: Positive pooled effect. Receptive language: Positive pooled effect Cognition (cognitive development): Positive pooled effect. Cognition (non-verbal IQ): Positive pooled effect Play: Positive pooled effect. Adaptive behaviour: Null pooled effect.	RCTs, non- randomised with control (inclusion criteria)	10/11	Included low quality/high risk of bias
		related to greater intervention effect on joint			



		attention. Intervention amount (total hours) not related to intervention effect on adaptive behaviour expressive or receptive language, cognitive development, overall autism characteristics, social engagement, or play. Adverse effects: Not reported.			
Sandbank et al. (2020a)	 Label: Naturalistic developmental behavioural interventions. Setting: Not specified. Format: Not specified. Agent: Not specified. Mode: Not specified. Intervention practices: Advancing Social- Communication and Play (ASAP); Caregiver-based intervention program in community day-care centers; Denver Model; Early Social Interaction Project (SCERTS); Early Start Denver Model (ESDM); Home- based Building Blocks Program; home-based intervention program; ImPACT Online; Interpersonal Synchrony; Joint Attention Intervention; Joint Attention Symbolic Play Engagement Regulation (JASPER); Joint Engagement Intervention; Joint Engagement Intervention with Creative Movement Therapy; Parent-Early Start Denver Model (P-ESDM); Parent-training intervention; Pivotal Response 	Overall autism characteristics (diagnostic characteristics): Null pooled effect. Social-communication: Positive pooled effect. RRB: Null pooled effect. Communication (language): Positive pooled effect Cognition (cognitive): Positive pooled effect. Social-emotional challenging behaviours: Null pooled effect Play: Positive pooled effect Adaptive behaviour: Null pooled effect Adaptive behaviour: Null pooled effect	RCTs, non- randomised with control	10/11	Not specified



	Treatment (PRT); Reciprocal Imitation Training; Social ABCs					
Systematic reviews at the practice level						
Early Start De	enver Model					
Waddington et al. (2016)	 Setting: Clinic, home, educational, university, hospital. Format: Individual, group. Agent: Parents/caregivers, clinicians/researchers. Mode: Face-to-face, telepractice. 	Overall autism characteristics (autism severity and core diagnostic outcomes): Summarised null effectSocial-communication (social interaction and communication): Summarised positive effectGeneral outcomes (child behavioural 	RCTs, non- randomised with control, non- randomised without control, single-case experimental designs, other	8/10	Included low quality/high risk of bias	



		 intervention effects. Pre-intervention cognitive ability and social attention not related to intervention effects. Child age: Child age inconsistently related to intervention effects. Amount of intervention: Total hours of intervention inconsistently related to intervention effects. Adverse effects: Not reported. 			
Fuller, Oliver et al. (2020)	Setting: Not specified. Format: Individual, group. Agent: Parents/caregivers, clinicians/researchers. Mode: Face-to-face.	Overall autism characteristics (autism symptoms): Null pooled effect Social-communication: Null pooled effect RRB (repetitive behaviours): Null pooled effect Communication (language): Positive pooled effect Cognition: Positive pooled effect Adaptive behaviour (adaptive functioning): Null pooled effect Amount of Intervention: Duration of intervention (total weeks) not related to intervention effects on child outcomes. Intensity	RCTs, non- randomised with control	10/11	Not specified



Pivotal Respo	onse Treatment	of intervention (hours per week) not related to intervention effects on child outcomes. Total hours of intervention not related to intervention effects on child outcomes. Adverse effects: Not reported.			
Verschuur et al. (2014)	 Setting: Clinic, home, educational. Format: Individual, group. Agent: Parents/caregivers, peers/siblings, educators, clinicians/researchers. Mode: Face-to-face, self-directed learning. 	General outcomes (child behaviours): Summarised inconsistent effect. Caregiver social emotional wellbeing (caregiver behaviours): Summarised inconsistent effect. Adverse effects: Not reported.	RCTs, non- randomised with control, non- randomised without control, single-case experimental designs, other	6/10	Included Iow quality/high risk of bias
National Autism Center (2015)	Setting: Not specified. Format: Not specified. Agent: Not specified. Mode: Not specified.	Communication: Summarised positive effect. Play: Summarised positive effect. School/learning readiness: Summarised positive effect.	Not specified	4/10	Included Iow quality/high risk of bias



		Adverse effects: Not reported.			
Ona et al. (2020)	Setting: Clinic, home. Format: Individual, group. Agent: Parents/caregivers, clinicians/researchers. Mode: Face-to-face.	 Social-communication (social interaction): Summarised inconsistent effect. RRB: Summarised positive effect. Communication: Null pooled effect. Expressive language: Positive pooled effect. Adverse effects: Not reported. 	RCTs only	8/11	Included Iow quality/high risk of bias



Table 4. Summary of findings from systematic reviews of sensory-based interventions

	Characteristics of interventions included in the systematic review	Findings form the systematic review	Study designs	Risk of bias (systematic review)	Risk of bias (included studies)				
Systematic reviews at the category level									
Lang et al. (2012)	 Label: Sensory integration therapies Setting: Clinic, home, educational, specifically-designed room. Format: Individual. Agent: Educators, clinicians/researchers. Mode: Face-to-face. Intervention practices: Weighted vests; swinging or rocking stimulation; brushing with a bristle or a feather; joint compression or stretching; alternative seating; jumping or bouncing; blanket or "body sock"; playing with a water and sand sensory table; chewing on a rubber tube; and playing with specially textured toys. 	General outcomes (intervention outcomes): Summarised null effect. Adverse effects: Considered and identified: "Of those 14 studies [that reported no benefit], 4 suggested that SIT may have contributed to increases in stereotypy and problem behavior" (p. 1015 of original article).	Not specified	4/10	Included low quality/high risk of bias				
National Autism Center (2015)	Label: Sensory intervention package. Setting: Not specified.	General outcomes: Summarised null effect.	Not specified	4/10	Included low quality/high risk of bias				



	 Format: Not specified. Agent: Not specified. Mode: Not specified. Intervention practices: Sensory intervention package. 	Adverse effects: Not reported.			
Sandbank et al. (2020a)	 Label: Sensory-based interventions. Setting: Not specified. Format: Not specified. Agent: Not specified. Mode: Not specified. Intervention practices: Developmental Speech and Language Training through Music; Family-Centered Music Therapy; Improvisational Music Therapy; Music Therapy; Qigong (QST) Massage Treatment; Qigong Massage Treatment; Rhythm Intervention Sensorimotor Enrichment; Sensory Enrichment; Thai Traditional Massage; Tomatis Sound Therapy; Vestibular Stimulation via a Platform Swing 	Communication (language): Null pooled effect. Adverse effects: Not reported.	RCTs, non- randomised with control	10/11	Not specified



Systematic reviews at the practice level								
Auditory Integration-Based Approaches								
National Autism Center (2015)	Setting: Not specified. Format: Not specified. Agent: Not specified. Mode: Not specified.	General outcomes: Summarised null effect. Adverse effects: Not reported.	Not specified	4/10	Included low quality/high risk of bias			
Weitlauf et al. (2017)	Setting: Not specified. Format: Individual. Agent: Not specified. Mode: Face-to-face.	Communication (language): Summarised null effect. Adverse effects: Not reported.	RCTs, non- randomised with control, other	9/10	Included moderate quality/moderate risk of bias			
Steinbrenner et al. (2020)	Setting: Not specified. Format: Not specified. Agent: Not specified. Mode: Not specified.	General outcomes: Summarised null effect. Adverse effects: Not reported.	RCTs, non- randomised with control, single- case experimental designs	7/10	High quality/low risk of bias only			
Ayres Sensory I	ntegration (ASI)							
Schaaf et al. (2018)	Setting: Educational. Format: Individual, group.	Overall autism characteristics (autistic behaviours): Summarised inconsistent effect Social-communication (caregiver assistance with social skills): Summarised null effect	RCTs, non- randomised with control, single-	7/10	Not specified			



	Agent: Caregivers/parents, educators, clinicians/researchers.	Sensory (sensory-motor): Summarised null effect	case experimental designs		
	Mode: Face-to-face.	Communication (language skills): Summarised null effect			
		Play: Summarised null effect			
		in caregiver assistance with self-care activities): Summarised inconsistent effect			
		Community participation (participation): Summarised positive effect			
		Adverse effects: Not reported.			
Weitlauf et al. (2017)	Setting: Not specified. Format: Individual. Agent: Not specified.	Sensory (sensory-related outcomes): Summarised positive effect. Motor: Summarised positive effect.	RCTs, non- randomised with control, other	9/10	Included low quality/high risk of bias
	Mode: Face-to-face.	Adverse effects: Not reported.			
Schoen et al. (2019)	Setting: Clinic, summer camp. Format: Individual, group. Agent: Educators,	General outcomes: Summarised inconsistent effect.	RCTs, non- randomised with control	8/10	Not specified
	clinicians/researchers. Mode: Face-to-face.	Adverse effects: Not reported.			



Steinbrenner et al. (2020)	Setting: Not specified. Format: Not specified. Agent: Not specified. Mode: Not specified.	Social-communication (social): Summarised positive effect. Communication: Summarised positive effect. Cognition (cognitive): Summarised positive effect. Motor: Summarised positive effect. Social-emotional/challenging behaviour (challenging/interfering behaviour): Summarised positive effect. Adaptive behaviour (adaptive/self-help): Summarised positive effect. Academic: Summarised positive effect.	RCTs, non- randomised with control, single- case experimental designs	7/10	High quality/low risk of bias only
Environmental	enrichment				
Weitlauf et al. (2017)	Setting: Not specified. Format: Individual. Agent: Not specified. Mode: Face-to-face.	Expressive language: Summarised null effect. Cognition (nonverbal cognitive skills): Summarised positive effect. Adverse effects: Not reported.	RCTs, non- randomised with control, other	9/10	Included low quality/high risk of bias



Music therapy					
Treurnicht Naylor et al. (2011)	Setting: Clinic, educational. Format: Individual. Agent: Clinician/researcher. Mode: Face-to-face.	Social-communication (cognitive functioning and social communication): Summarised positive effect. Adaptive behaviour: Summarised null effect. Adverse effects: Not reported.	RCTs only	7/10	Included low quality/high risk of bias
Geretsegger at I. (2014)	Setting: Clinic, home, educational, hospital. Format: Individual, group with family. Agent: Clinicians/researchers. Mode: Face-to-face.	 Social-communication (social adaptation – overall): Positive pooled effect. Communication (non-verbal, overall): Positive pooled effect. Communication (verbal, overall): Positive pooled effect. Quality of life (joy): Positive pooled effect. Caregiver social emotional wellbeing (quality of family relationships): Positive pooled effect. Adverse effects: Considered, and none identified. 	RCTs, non- randomised with control (inclusion criteria)	11/11	Not specified
National Autism Center (2015)	Setting: Not specified. Format: Not specified.	General outcomes: Summarised inconsistent effect.	Not specified	4/10	Included low quality/high risk of bias



	Agent: Not specified.	Adverse effects: Not reported.			
	Mode: Not specified.				
Steinbrenner et al. (2020)	Setting: Not specified. Format: Not specified. Agent: Not specified. Mode: Not specified.	Social-communication (social): Summarised positive effect. Communication: Summarised positive effect. Motor: Summarised positive effect. Social-emotional/challenging behaviour (challenging/interfering behaviour): Summarised positive effect. Play: Summarised positive effect. Adaptive behaviour (adaptive/self-help): Summarised positive effect. School/learning readiness: Summarised positive effect.	RCTs, non- randomised with control, single- case experimental designs	7/10	High quality/low risk of bias only
Sensory diet	1	I	1	<u> </u>	I
Steinbrenner et al. (2020)	Setting: Not specified. Format: Not specified. Agent: Not specified. Mode: Not specified.	General outcomes: Summarised null effect. Adverse effects: Not reported.	RCTs, non- randomised with control, single- case experimental designs	7/10	High quality/low risk of bias only





Table 5: Summary of findings from systematic reviews of Treatment and Education of Autistic and related Communications Handicapped Children (TEACCH)

	Characteristics of interventions included in the systematic review	Findings form the systematic review	Study designs	Risk of bias (systematic review)	Risk of bias (included studies)
Systematic r	eviews at the category level				
Sandbank et al. (2020a)	Label: TEACCH Setting: Not specified. Format: Not specified. Agent: Not specified. Mode: Not specified. Intervention practices: TEACCH.	Social-communication: Null pooled effect. Adverse effects: Not reported.	RCTs, non-randomised with control	10/11	Not specified
Systematic r	eviews at the practice level			-	-
Structured te	eaching				
National Autism Center (2015)	Setting: Not specified. Format: Not specified. Agent: Not specified. Mode: Not specified.	General outcomes: Summarised inconsistent effect. Adverse effects: Not reported.	Not specified	4/10	Included Iow quality/high risk of bias





Table 6. Summary of findings from systematic reviews of technology-based interventions

	Characteristics of interventions included in the systematic review	Findings form the systematic review	Study designs	Risk of bias (systematic review)	Risk of bias (included studies)
Systematic re	views at the category level				
National Autism Center (2015)	 Label: Technology-based intervention. Setting: Not specified. Format: Not specified. Agent: Not specified. Mode: Not specified. Intervention practices: Technology-based interventions. 	General outcomes: Summarised inconsistent effect. Adverse effects: Not reported.	Not specified	4/10	Included low quality/high risk of bias
Mazon et al. (2019)	 Label: Technology-based intervention. Setting: Clinic, home, educational, therapeutic centre, overtime clinic Format: Individual. Agent: Not specified. Mode: Face-to-face, computer assisted, robot. 	 General outcomes (statistical significance): Summarised inconsistent effect. Adverse effects: Considered and identified: "6 participants were excluded due to refusal or distress" (p. 243-244 of the original article). 	RCTs, non- randomised with control	6/10	Not specified



	Intervention practices: Technology based interventions including (but not limited to) computer and robot-based interventions.				
Khan et al. (2019)	 Label: Web-Based Interventions. Setting: Clinic, home, educational, hospital. Format: Individual. Agent: Parents/caregivers, clinicians/researchers. Mode: Face-to-face, apps, serious games, online. Intervention practices: Apps; serious games; videoconferencing; virtual environment with playable games; Web-based cognitive behavioural therapy intervention. 	Caregiver satisfaction/dissatisfaction: Summarised inconsistent effect. Adverse effects: Considered, and none identified.	RCTs only	9/11	Included moderate quality/moderate risk of bias
Sandbank et al. (2020a)	Label: Technology-based interventions. Setting: Not specified. Format: Not specified. Agent: Not specified. Mode: Not specified.	Social-communication: Null pooled effect. Social-emotional/challenging behaviour: Null pooled effect. Adverse effects: Not reported.	RCTs, non- randomised with control	10/11	Not specified



	Intervention practices: ABRACADABRA; Emotiplay Serious Game; FaceSay; FindMe iPad App; Gaming Open Library for Intervention in Autism at Home (GOLIAH); Gaze-contingent attention training; Social Skills Training using a robotic behavioral intervention system; The Transporters animated series; Therapy Outcomes By You (TOBY) App; Transporters DVD; Transporters Program for Children with Autism				
Steinbrenner et al. (2020)	 Label: Technology aided instruction and intervention. Setting: Not specified. Format: Not specified. Agent: Not specified. Mode: Not specified. Intervention practices: Technology-aided instruction 	 Social-communication (social): Summarised positive effect. Social-communication (joint attention): Summarised positive effect. Communication: Summarised positive effect. Cognition (cognitive): Summarised positive effect. Motor: Summarised positive effect. Social-emotional/challenging behaviour (challenging/interfering behaviour): Summarised positive effect. Play: Summarised positive effect. 	RCTs, non- randomised with control, single- case experimental designs.	7/10	High quality/low risk of bias only



		 Adaptive behaviour (adaptive/self-help): Summarised positive effect. School/learning readiness: Summarised positive effect. Academic: Summarised positive effect. Adverse effects: Not reported. 			
Systematic rev	views at the practice level				
Apps					
Moon et al.	Setting: Clinic, home, educational.	Social-communication: Null pooled effect.	RCTs only	10/11	Included low
(2019)	Format: Individual.	Communication (gestures): Null pooled effect.			quality/high risk of bias
	Agent: Not specified.	Communication (symbolic): Null pooled effect.			
	Mode: Face-to-face.	Expressive language: Null pooled effect.			
		Expressive language (words produced): Null pooled effect.			
		Receptive language: Null pooled effect.			
		Cognition (visual reception): Positive pooled effect.			
		Motor (fine motor): Positive pooled effect.			
		Adverse effects: Not reported.			



Griffith et al. (2020)	Setting: Home, educational. Format: Individual. Agent: Not specified. Mode: Face-to-face, apps.	Social-communication: Summarised null effect. Adverse effects: Not reported.	RCTs, non- randomised with control	8/10	Included low quality/high risk of bias
Augmentative and Alternative Communication (AAC)					
National Autism Center (2015)	Setting: Not specified. Format: Not specified. Agent: Not specified. Mode: Not specified.	General outcomes: Summarised inconsistent effect. Adverse effects: Not reported.	Not specified	4/10	Included low quality/high risk of bias
Logan et al. (2017)	Setting: Clinic, home, educational, therapy centre Format: Individual. Agent: Parents/caregivers, peers/siblings, educators, clinicians/researchers. Mode: Face-to-face.	Social-communication (communication functions): Summarised inconsistent effect. Caregiver satisfaction (social validity): Summarised inconsistent effect. Adverse effects: Not reported.	RCTs, single-case experimental designs	8/10	Included low quality/high risk of bias
Steinbrenner et al. (2020)	Setting: Not specified. Format: Not specified. Agent: Not specified. Mode: Not specified.	Social-communication (social): Summarised positive effect. Social-communication (joint attention): Summarised positive effect. Communication: Summarised positive effect.	RCTs, non- randomised with control, single- case experimental designs	7/10	High quality/low risk of bias only



		 Motor: Summarised positive effect. Social-emotional/challenging behaviour (challenging/interfering behaviour): Summarised positive effect. Play: Summarised positive effect. Academic: Summarised positive effect. Adverse effects: Not reported. 			
Computer-bas	ed instruction				
Knight et al. (2013)	 Setting: Clinic, home, educational. Format: Individual. Agent: Parents/caregivers, educators. Mode: Face-to-face, computer assisted. Intervention practices: Simultaneous prompting; differential reinforcement; error correction and feedback procedure; delayed prompting procedure; stimulus prompting. 	Academic: Summarised inconsistent effect. Adverse effects: Not reported.	RCTs, non- randomised with control, non- randomised without control, single-case experimental designs	7/10	Included low quality/high risk of bias



McCoy et al. (2016)	Setting: Clinic, home, educational, parent's office Format: Individual. Agent: Peers/siblings Mode: Face-to-face, virtual environment.	Social-communication (social skills): Summarised positive effect. Adverse effects: Not reported.	RCTs, non- randomised with control, non- randomised without control, single-case experimental designs	6/10	Included low quality/high risk of bias
Facilitated co	mmunication		-		-
National Autism Center (2015)	Setting: Not specified. Format: Not specified. Agent: Not specified. Mode: Not specified.	General outcomes: Summarised null effect. Adverse effects: Not reported.	Not specified	4/10	Included low quality/high risk of bias
Robots					
Miguel-Cruz et al. (2017)	Setting: Not specified. Format: Individual. Agent: Not specified. Mode: Face-to-face, robot.	 Social-communication (interaction): Summarised inconsistent effect. RRB (repetitive and maladaptive behaviours): Summarised negative effect. Adverse effects: Considered and identified. Summarised evidence of "negative" effects (p. 434 of the original article). 	RCTs, non- randomised without control, single-case experimental designs, other	5/10	Included low quality/high risk of bias



Sign instruction					
National Autism Center (2015)	Setting: Not specified. Format: Not specified. Agent: Not specified. Mode: Not specified.	General outcomes: Summarised inconsistent effect. Adverse effects: Not reported.	Not specified	4/10	Included low quality/high risk of bias



Table 7. Summary of findings from systematic reviews of animal-assisted interventions

	Characteristics of interventions included in the systematic review	Findings form the systematic review	Study designs	Risk of bias (systematic review)	Risk of bias (included studies)
Systematic re	views at the category level				
National Autism Center (2015)	 Label: Animal-assisted therapy. Setting: Not specified. Format: Not specified. Agent: Not specified. Mode: Not specified. Intervention practices: Animalassisted therapy. 	General outcomes: Summarised null effect. Adverse effects: Not reported.	Not specified	4/10	Included low quality/high risk of bias
Steinbrenner et al. (2020)	 Label: Animal-assisted. Setting: Not specified. Format: Not specified. Agent: Not specified. Mode: Not specified. Intervention practices: Animal- assisted 	General outcomes: Summarised null effect Adverse effects: Not reported.	RCTs, non- randomised with control, single-case experimental designs	7/10	High quality/low risk of bias only



Systematic reviews at the practice level								
Canine-assiste	Canine-assisted intervention							
Hill et al. (2019)	Setting: Not specified. Format: Individual. Agent: Clinicians/researchers, animal handlers. Mode: Face-to-face delivery, canine	 Social-communication (verbal behaviours): Summarised inconsistent effects. Social-communication (non-verbal behaviours): Summarised inconsistent effects. Social-communication (desired behaviours): Summarised inconsistent effects. Social-communication (undesired behaviours): Summarised inconsistent effects. Social-communication (undesired behaviours): Summarised inconsistent effects. Child adverse effects: Considered and identified. Table 5 of the systematic review includes the following statements under "undesirable behaviours"¹ (p. 21): "+ tantrums, anxiety, and aggression" (Mey 2017) "+ Some anxiety expressed towards dog (student C)" (Stevenson et al., 2015) "+ Self-stimulating behaviours (hand flapping) (frequency/-duration)" (Matin 2002) 	Non-randomised with control, non- randomised without control, single-case experimental designs, other	8/10	Not specified			



Hardy & Weston (2020)	Setting: Not specified. Format: Individual. Agent: Not specified. Mode: Face-to-face, canine.	Social-communication (social behaviour): Summarised positive effect. Adverse effects: Not reported.	Not specified	6/10	Not specified
Equine assiste	ed therapy				
Wiese et al. (2016)	Setting: Not specified. Format: Individual. Agent: Not specified. Mode: Face-to-face, equine.	General outcomes (behaviour and social interaction): Summarised inconsistent effect. Adverse effects: Considered, and none identified.	RCTs, non- randomised with control, non- randomised without control, single-case experimental designs, other	9/10	Not specified
Srinivasan et al. (2018)	Setting: Not specified. Format: Individual, group. Agent: Parents/caregivers, riding instructors, assistants (trained personnel or parents), support staff. Mode: Face-to-face, equine.	 Social-communication: Summarised inconsistent effect. Sensory: Summarised positive effect. Cognition (cognitive): Summarised null effect. Motor: Summarised inconsistent effect. Social-emotional/challenging behaviour (behavioural skills): Summarised inconsistent effect. Quality of life: Summarised inconsistent effect. Community participation (functional participation): Summarised inconsistent effect. Adverse effects: Not reported. 	RCTs, non- randomised with control, non- randomised without control, single-case experimental designs, other	7/10	Not specified



Trzmiel et al. (2019)	Setting: Not specified. Format: Individual. Agent: Not specified.	Social-communication (social): Null pooled effect. Communication: Null pooled effect. Adaptive behaviour: Null pooled effect.	Not specified	7/11	Included Iow quality/high risk of bias
	Mode: Face-to-face, equine.	General outcomes (socialization, engagement, maladaptive behaviours, reaction time in problem- solving situations): Summarised inconsistent effect.			
		Adverse effects: Not reported.			

¹ The authors of the current review note that classification of these behaviours as 'undesirable' is based on the subjective judgement of the original authors and do not present a view in documenting these findings.



Table 8. Summary	y of findings from	systematic reviews o	f cognitive behavio	ur therapy
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	Characteristics of interventions included in the systematic review	Findings form the systematic review	Study designs	Risk of bias (systematic review)	Risk of bias (included studies)
Ho et al. (2014)	 Label: Cognitive behavioural approaches. Setting: Clinic. Format: Individual, group. Agent: Parents/caregivers, peers/siblings, clinicians/researchers. Mode: Face-to-face. Intervention practices: Cool Kids; Building Confidence Family Cognitive Behaviour Therapy (FCBT); Social Skills Training for Children and Adolescents with Asperger Syndrome and Social-Communications Problems; Thinking about you, thinking about me; Coping Cat CBT program; Facing your fears: Group Cognitive 	Social-communication (social skills): Positive pooled effect. Adverse effects: Not reported.	RCT only	7/11	Not specified
	Behaviour Therapy.				


National Autism Center (2015)	 Label: Cognitive behavioural intervention package. Setting: Not specified. Format: Not specified. Agent: Not specified. Mode: Not specified. Intervention practices: Cognitive behavioural intervention package 	Social-communication (interpersonal): Summarised positive effect. Sensory (sensory or emotional regulation): Summarised positive effect. Social-emotional/challenging behaviour (problem behaviour): Summarised positive effect. Adaptive behaviour (personal responsibility): Summarised positive effect. School/learning readiness (placement): Summarised positive effect. Adverse effects: Not reported.	Not specified	4/10	Included low quality/high risk of bias
Weston et al. (2016).	 Label: Cognitive behavioural therapy. Setting: Not specified. Format: Individual. Agent: Not specified. Mode: Face-to-face. Intervention practices: Cognitive behavioural therapy. 	Overall autism characteristics (symptoms related to ASD, self-reported): Null pooled effect. Overall autism characteristics (symptoms related to ASD, clinician-reported): Positive pooled effect. Adverse effects: Not reported.	Randomised controlled trials, non- randomised with control	9/11	Not specified
Steinbrenner et al. (2020)	Label: Cognitive behavioural/ instructional strategies. Setting: Not specified.	Social-communication (social): Summarised positive effect. Communication: Summarised positive effect.	Randomised controlled trials, non- randomised with	7/10	High quality/low



	Format: Not specified. Agent: Not specified. Mode: Not specified. Intervention practices: Cognitive behavioural/ instructional strategies.	Cognition (cognitive): Summarised positive effect. Social-emotional/challenging behaviour (challenging/interfering behaviour): Summarised positive effect. Adaptive behaviour (adaptive/self-help): Summarised positive effect. School/learning readiness: Summarised positive effect. Academic: Summarised positive effect. Adverse effects: Not reported.	control, single-case experimental designs.		risk of bias only
Exposure pack	cage				
National Autism Center (2015)	Setting: Not specified. Format: Not specified. Agent: Not specified. Mode: Not specified.	General outcomes: Summarised inconsistent effect. Adverse effects: Not reported.	Not specified	4/10	Included Iow quality/high risk of bias

Footnote: "Label" refers to the term used by the authors of the systematic review to describe the category of interventions being examined; "Intervention Practices" refers to the intervention practices described by the authors as being included in the systematic review; participants in the intervention group of a systematic review generally only received one intervention practice, though this was not always specified; Only outcomes for which evidence was available are included; "Outcomes ()" the first term refers to the outcome categories defined for this umbrella review, the term in parenthesis refers to the author's term(s) for the outcome, where there is no term in brackets, the systematic review author's outcome classification matched that of the current umbrella review; "risk of bias (included studies)" refers to the risk of bias, as assessed by the authors of the systematic review and appraised by current authors during data extraction, the rating indicates the lower bound of quality/risk of bias for studies included in the review.



Table 9. Summary of findings from systematic reviews of 'other' interventions

	Characteristics of interventions included in the systematic review	Findings form the systematic review	Study designs	Risk of bias (systematic review)	Risk of bias (included studies)
Imitation base	ed training				
National Autism Center (2015)	Setting: Not specified. Format: Not specified. Agent: Not specified. Mode: Not specified.	General outcomes: Summarised inconsistent effect. Adverse effects: Not reported.	Not specified	4/10	Included Iow quality/high risk of bias
Multi-compon	ent package				
National Autism Center (2015)	Setting: Not specified. Format: Not specified. Agent: Not specified. Mode: Not specified.	General outcomes: Summarised inconsistent effect. Adverse effects: Not reported.	Not specified	4/10	Included Iow quality/high risk of bias
Reductive pac	:kage				
National Autism Center (2015)	Setting: Not specified. Format: Not specified. Agent: Not specified.	General outcomes: Summarised inconsistent effect. Adverse effects: Not reported.	Not specified	4/10	Included Iow quality/high risk of bias



	Mode: Not specified.							
Social behavioural learning strategy								
National Autism	Setting: Not specified. Format: Not specified.	General outcomes: Summarised null effect.	Not specified	4/10	Included low			
Center (2015)	Agent: Not specified. Mode: Not specified.	Adverse effects: Not reported.			quality/high risk of bias			
Social cognitio	on intervention							
National Autism Center (2015)	Setting: Not specified. Format: Not specified. Agent: Not specified. Mode: Not specified.	General outcomes: Summarised null effect. Adverse effects: Not reported.	Not specified	4/10	Included Iow quality/high risk of bias			
Social commu	nication intervention							
National Autism Center (2015)	Setting: Not specified. Format: Not specified. Agent: Not specified. Mode: Not specified.	General outcomes: Summarised inconsistent effect. Adverse effects: Not reported.	Not specified	4/10	Included Iow quality/high risk of bias			
Social skills tra	aining							
Steinbrenner et al. (2020)	Setting: Not specified.	Social-communication (social): Summarised positive effect.	Randomised controlled trials,	7/10	High quality/low			



	Format: Not specified. Agent: Not specified. Mode: Not specified.	Communication: Summarised positive effect. Cognition (cognitive): Summarised positive effect. Social-emotional/challenging behaviour (challenging/interfering behaviour): Summarised positive effect. Play: Summarised positive effect. Adaptive behaviour (adaptive/self-help): Summarised positive effect. School/learning readiness: Summarised positive effect. Adverse effects: Not reported.	non-randomised with control, single- case experimental designs.		risk of bias only
Social thinking	g intervention				
National Autism Center (2015)	Setting: Not specified. Format: Not specified. Agent: Not specified. Mode: Not specified.	General outcomes: Summarised null effect. Adverse effects: Not reported.	Not specified	4/10	Included Iow quality/high risk of bias
Theory of Min	d training	· 			-
National Autism Center (2015)	Setting: Not specified. Format: Not specified. Agent: Not specified. Mode: Not specified.	General outcomes: Summarised inconsistent effect. Adverse effects: Not reported.	Not specified	4/10	Included Iow quality/high risk of bias



Footnote: "Label" refers to the term used by the authors of the systematic review to describe the category of interventions being examined; "Intervention Practices" refers to the intervention practices described by the authors as being included in the systematic review; participants in the intervention group of a systematic review generally only received one intervention practice, though this was not always specified; Only outcomes for which evidence was available are included; "Outcomes ()" the first term refers to the outcome categories defined for this umbrella review, the term in parenthesis refers to the author's term(s) for the outcome, where there is no term in brackets, the systematic review author's outcome classification matched that of the current umbrella review; "risk of bias (included studies)" refers to the risk of bias, as assessed by the authors of the systematic review and appraised by current authors during data extraction, the rating indicates the lower bound of quality/risk of bias for studies included in the review.



Appendix O: Summary of findings from outcome-focused systematic reviews

	Characteristics of interventions included in the systematic review	Findings form the systematic review	Study designs	Risk of bias (systematic review)	Risk of bias (included studies)
Social-com	munication				
Murza et al. (2016)	 Setting: Clinic, home, educational. Format: Individual, group. Agent: Parents/caregivers, educators, clinicians/researchers. Mode: Face-to-face. Intervention practices: Joint attention interventions - Assessment, Evaluation and Programming System (AEPS) for Infants and Children; Caregiver Education Model (CEM); Caregiver Mediated Model (CMM); Hanen More Than Words (HMTW); Joint Attention Mediated Learning (JAML); Joint Attention Symbolic Play Engagement 	 Social-communication (joint attention): Positive pooled effect. Agent: Intervention agent (parent, non-parent) not related to intervention effects on communication. Adverse effects: Not reported. 	RCT only	9/11	Included low quality/high risk of bias
	and Regulation (JASPER); Milton and Ethel Harris Research Initiative (MEHRI); Preschool Autism Communication Trial				



	(PACT); parent training modules; and workshop training.				
Parsons, Cordier, Munro et al. (2017)	 (PACT); parent training modules; and workshop training. Setting: Clinic, home, educational. Format: Individual, group. Agent: Parents/caregivers, peers/siblings, educators, clinicians/researchers, certified therapeutic riding instructor. Mode: Face-to-face, computer assisted. Intervention practices: Pragmatic language interventions - The Junior detective Program; Milton and Ethel Harris Research Initiative Treatment (MEHRIT); Building Blocks Program; Social Emotional NeuroScience Endocrinology (SENSE) theatre; Social Skills Group Intervention- High Functioning Autism; FindMe App; Therapeutic Horse Riding; FaceSay; Joint Attention, Symbolic Play, Engagement, and Regulation (JASPER); Improvisational music 	 Social-communication (pragmatic language): Positive pooled effect. Child age: Age not related to intervention effects on social-communication. Setting: Intervention setting not related to intervention effects on social-communication. Format: Intervention format (individual, group) not related to intervention effects on social-communication. Agent: Positive intervention effect for interventions with active parent involvement, but not for interventions with parent education alone. Adverse effects: Not reported. 	RCT only	9/11	Included low quality/high risk of bias
	therapy; SummerMAX; Mind Reading; Skillstreaming; Emotion Recognition Training; Seaver- NETT.				



Fuller & Kaiser (2020)	 Setting: Not specified. Format: Individual. Agent: Parents/caregivers, educators, clinicians/researchers. Mode: Not specified. Intervention practices: Early interventions – not specified. 	 Social-communication: Positive pooled effect. Child age: Age related to intervention effects on social-communication. Intervention effects increased from 2 to 4 years of age, but then diminished as children got older. Greatest intervention effects at around 4 years of age. Amount of intervention: Total hours not related to intervention effects on social-communication. Intervention duration (weeks) not related to intervention effects on social-communication. Agent: Intervention agent (clinicians, parents, school staff) not related to intervention effects on communication. Adverse effects: Not reported. 	RCT, non- randomised without control (inclusion criteria)	9/11	Not specified
Bejarano- Martín et al. (2020)	 Setting: Not specified. Format: Individual. Agent: Parents/caregiver, peers/siblings, educators, clinicians/researchers. Mode: Face-to-face. Intervention practices: Focused intervention practices - Discrete trial training (DTT); Pivotal Response Training (PRT), Contingent imitation; discrete trial 	 Social-communication: Positive pooled effect. Social-communication (imitation): Positive pooled effect. Social-communication (joint attention): Positive pooled effect. Social-communication (play): Positive pooled effect. 	RCTs, non- randomised with control, single-case experimental designs (inclusion criteria)	9/11	High quality/low risk of bias only



	training (DTT) plus social interaction, mediated learning with active engagement; picture exchange communication system (PECS); video modelling; prompting and reinforcement; physical and verbal cues; token economy and prompting; photographic schedules.	 Child age: Age inconsistently related to intervention effects on social-communication. Child characteristics: Child communication skills prior to intervention not related to intervention effects on social-communication. Child cognitive ability prior to intervention not related to intervention effects on social-communication. Amount of intervention: Total hours inconsistently related to intervention effects on social-communication. Agent: Interventions involving caregivers or teachers had a similar positive effect to those involving clinicians alone. Adverse effects: Not reported. 			
Communic	ation				
Sandbank et al. (2020b)	Setting: Not specified. Format: Individual. Agent: Parents/caregivers, educators, clinicians/researchers. Mode: Not specified.	 Communication (composite language): Positive pooled effect. Expressive language: Positive pooled effect. Receptive language: Positive pooled effect. General outcomes (summary across all outcomes and language measures): Positive pooled effect. Child age: Age not related to intervention effects on communication. 	RCTs, non- randomised with control	10/11	Not specified



		 Child characteristics: Level of overall autism characteristics prior to intervention not related to intervention effects on communication. Greater language skills prior to intervention related to greater intervention effects on communication. Amount of intervention: Total hours not related to intervention effects on communication. Agent: Intervention agent (clinician, caregiver, educator, technology, combination, other) not related to intervention effects on communication. 			
		Adverse effects: Not reported.			
Expressive	language				
Hampton & Kaiser (2016)	 Setting: Not specified. Format: Individual. Agent: Parents/caregivers, clinicians/researchers. Mode: Face-to-face. Intervention practices: Early interventions- Early Intensive Behavioural Intervention (EIBI); Early Intervention Preschool (EIP); Early Start Denver Model (ESDM); Joint Attention Mediated Learning (JAML); Joint Attention; Structured Play Engagement; and Regulation (JAML); 	 Expressive language (spoken language): Positive pooled effect. Child age: Age not related to intervention effects on expressive language (spoken language). Amount of intervention: Total hours not related to intervention effects on expressive language (spoken language). Agent: Interventions involving clinicians and parents related to greater intervention effect on expressive language (spoken language). Agent: Interventions involving clinicians and parents related to greater intervention effect on expressive language (spoken language) than clinicians or parents alone. 	Randomised controlled trials, non- randomised with control	10/11	Included low quality/high risk of bias



	Learning Experiences and Alternative Program (LEAP); Milton and Ethel Harris Research Initiative Treatment (MEHRIT); More Than Words (MTW); Pediatric Autism and Communication Therapy (PACT); Play and Language for Autistic Youngsters; PRT, Pivotal Response Training (Play and Language for Autistic Youngsters); Treatment and Education of Autistic and Related Communication Handicapped Children (TEACCH); Scottish Early Intervention Preschool; Parent training model (PSwA); Focused playtime (FPI); Speech remediation; Teach Town basics; Early Social Interaction (ESI); Parent training, Behaviour analytic.	Adverse effects: Not reported.			
Gross mot	or				
Case & Yun (2019)	Setting: Experimental, practice/service. Format: Individual. Agent: Not specified. Mode: Face-to-face. Intervention practices: Fundamental motor skills including fundamental motor skills instruction, adapted physical education instruction, physical activities and fitness exercises, young athletes motor program, multisport camp training,	 Motor (gross motor): Positive pooled effect [practices: fundamental motor skills, equestrian assisted therapy, physical activity]. Motor (gross motor): Null pooled effect [practice: technology]. Child age: Age not related to intervention effects on motor skills. 	Not specified	7/11	Not specified



Play	adaptive soccer program, physical education program with fundamental motor skill instruction, intensive fundamental motor skill instruction, Sports, Play, and Active Recreation for Kids (SPARK); equestrian assisted training; technology interventions including sports active video game participation, video- based makota arena training, robot imitation and movement activities, simulated developmental horse riding; physical activity interventions including physical activity/table tennis, rhythm training and movement-based games, aquatic exercise training.	 Amount of intervention: Greater total hours related to greater intervention effects on motor skills. Adverse effects: Not reported. 			
Kent et al. (2020)	 Setting: Clinic, home, educational, community (theatre group). Format: Individual, group. Agent: Parents/caregivers, peers/siblings, educators, clinicians/researchers, unfamiliar adults. Mode: Face-to-face. Intervention practices: Play-based interventions- [Generic] play intervention; Joint Attention, Symbolic Play, Engagement, and Regulation (JASPER); 	 Play: Positive pooled effect. Format: The intervention format (individual, group) did not relate to intervention effects on play. Setting: Intervention setting not related to the intervention effect on play skills. Adverse effects: Not reported. 	RCT only	10/11	Included moderate quality/moderate risk of bias



Lego therapy; Social stories; behavioural		
approaches; peer training; teacher		
training; Social		
Emotional NeuroScience Endocrinology		
(SENSE) Theater principles; video		
modelling.		



Appendix P: Summary of findings from intervention delivery-focused systematic reviews

Table 1. Summary of systematic reviews focussing on the intervention setting.

	Characteristics of interventions included in the systematic review	Findings form the systematic review	Study designs	Risk of bias (systematic review)	Risk of bias (included studies)
Inclusive schoo	l setting				
Tupou et al. (2019)	 Setting: Educational. Format: Individual, group. Agent: Educators. Mode: Face-to-face. Intervention practices: Comprehensive treatment programmes - Developmentally Appropriate Treatment for Autism (DATA); Treatment and Education of Autistic and Related Communication Handicapped Children (TEACCH); Early Intensive Behavioural Intervention (EIBI); Learning Experiences and Alternative Program for Preschoolers (LEAP); Comprehensive Autism 	Overall autism characteristics (autism severity and/or symptoms): Summarised positive effect. Social-communication (social skills): Summarised positive effect. Communication (communication and/or language): Summarised positive effect. Cognition (cognition or educational strengths): Summarised inconsistent effect. Social-emotional/challenging behaviour (adaptive/maladaptive behaviour): Summarised positive effect. Adaptive behaviour (functional skills): Summarised positive effect.	Randomised controlled trials, non- randomised with control, non- randomised without control, single-case experimental designs	9/10	Included low quality/high risk of bias



	Program (CAP); EIBI intervention described as being based on Lovaas' UCLA model; Skills focused interventions targeting - communication, play skills, peer interaction, and reading skills.	General outcomes (child outcomes): Summarised inconsistent effect. Adverse effects: Not reported.			
Watkins et al. (2019)	 Setting: Educational. Format: Individual, group. Agent: Peers/siblings, educators, clinicians/researchers. Mode: Face-to-face. Intervention practices: Interventions in inclusive settings - visual cues; social scripts; Social Stories; video modelling; communication books; peer-mediated intervention (PMI), self-monitoring; peer networks; individualised interventions based on the results of a functional behaviour assessment (FBA); social skills groups; initiations training; high probability request sequences; music therapy; and behavioural strategies were implemented in one study each. 	 General outcomes: Positive pooled effect. Social-communication: Positive pooled effect. RRB: Positive pooled effect. Social-emotional/challenging behaviour (classroom behaviour, challenging behaviour and repetitive behaviour): Positive pooled effect. Social-emotional/challenging behaviour (classroom behaviour): Positive pooled effect. Social-emotional/challenging behaviour (classroom behaviour): Positive pooled effect. Play: Positive pooled effect. Intervention agent: Interventions delivered by teachers had a greater intervention effect than interventions delivered by researchers or peers. Adverse effects: Not reported. 	Randomised controlled trials, single- case experimental designs	10/11	Included moderate quality/moderate risk of bias



Table 2, Sumi	mary of syster	natic reviews t	focussing on	the intervention	format.
Table L. Sulli	mary or syster	natic reviews	locussing on		ionnat.

	Characteristics of interventions included in the systematic review	Findings form the systematic review	Study designs	Risk of bias (systematic review)	Risk of bias (included studies)
Individual/group	•				
Tachibana et al. (2018)	Setting: Clinic, home, educational.Format: Individual, group.Agent: Parents/caregivers, educators, clinicians/researchers.Mode: Face-to-face.Intervention practices: Social communication intervention - Hanen's More Than Words; Early Start Denver Model (ESDM); Parent training; Joint Attention Symbolic Play Engagement and Regulation (JASPER); Preschool Autism Communication Trial (PACT); Treatment and Education of Autistic and related Communications Handicapped Children (TEACCH)-based group social skills; Reciprocal Imitation Training; Caregiver-based	Overall autism characteristics (autism general symptoms – individual intervention): Null pooled effect. Social-communication (qualitative impairment in social interaction – individual intervention): Null pooled effect. Social-communication (reciprocity of social interaction towards others – individual intervention): Positive pooled effect. Social-communication (reciprocity of social interaction towards others – group intervention): Positive pooled effect. Social-communication (initiating joint attention– individual intervention): Null pooled effect. Social-communication (initiating joint attention – group intervention): Null pooled effect. Social-communication (initiating joint attention – group intervention): Null pooled effect. Social-communication (imitation): Null pooled effect. Social-communication (imitation): Null pooled effect.	RCT only	11/11	Included moderate quality/moderate risk of bias



interv	ention program in	RRB (restricted repetitive and stereotyped patterns		
comm	nunity day-care centers;	behaviours, interests and activities): Null pooled effect.		
Presc	hool-based joint attention	Communication (qualitative impairment in		
interv	ention; Caregiver Mediated	communication – individual intervention): Null pooled		
Joint I	Engagement Intervention;	effect		
Impro	visational music therapy;			
interv	ention targeting	Expressive language (individual interventions: Null		
devel	opment of socially	pooled effect.		
synch	ironous engagement;	Expressive language (group intervention): Null pooled		
Devel	lopmental, Individual-	effect.		
Differe	ence, Relationship-			
Based	d(DIR)/Floortime intervention;	Receptive language (individual intervention): Null pooled		
Funct	ional Behavior Skills	effect.		
Traini	ng (FBST); Building Blocks;	Receptive language (group intervention): Null pooled		
Paren	t delivery of the Early Start	effect.		
Denve	er Model (P-ESDM); Joint	Constitute (developmental averticate individual		
Attent	tion Mediated Learning	Cognition (developmental quotient – Individual		
(JAML) intervention; Focused	Intervention): Positive pooled effect.		
Playti	me Intervention (FPI);	Adaptive behaviour (individual intervention): Null pooled		
Educa	ation and Skills Training	effect.		
Progra	am for Parents; Parent	Adaptive behaviour (group intervention): Null pooled		
educa	ation and behaviour	effect		
mana	gement (PEBM) Skills			
trainir	ng intervention or control for	Caregiver communication and interaction (parental		
the or	n specific aspects of the	synchrony): Positive pooled effect.		
PEBM	I parent education and	Caregiver social emotional wellbeing (parenting stress –		
couns	selling intervention; Home	individual intervention): Null pooled effect.		
TEAC	CHing Program.			
		Caregiver social emotional wellbeing (parenting stress –		
		group intervention): Null pooled effect.		



Intervention format: Intervention format (individual, group) did not relate to intervention effects on overall autism characteristics, social-communication, expressive language, receptive language, cognition, or adaptive behaviour.		
Adverse effects: Not reported.		



Table 3. Summary of systematic reviews focussing on the intervention agent.

	Characteristics of interventions included in the systematic review	Findings form the systematic review	Study designs	Risk of bias (systematic review)	Risk of bias (included studies)
Non-specialist in	plemented/mediated				
Naveed et al. (2019)	Setting: Clinic, home, educational, community.	Overall autism characteristics (autism symptom severity): Positive pooled effect.	RCT only	9/11	Included low
	Format: Individual.	Social-communication (social skills): Positive pooled effect.			quality/high risk of bias
	siblings/peers, educators.	Social-communication (joint engagement): Positive pooled effect.			
	Intervention practices: Cognitive behavioural strategies; Social Emotional	Social-communication (joint attention): Null pooled effect.			
	NeuroScience	RRB (repetitive behaviours): Positive pooled effect.			
	Endocrinology (SENSE) theatre;	Communication: Positive pooled effect.			
	Preschool Autism Communication Trial (PACT); Parent mediated intervention	Expressive language: Positive pooled effect.			
	for Autism Spectrum Disorders in South	Receptive language: Null pooled effect.			
	Asia (PASS); Project Impact; Peer interventions; Qigong Sensory	Cognition (visual reception): Positive pooled effect.			
	Treatment (QST); Qigong massage;	Motor (motor skills): Positive pooled effect.			
	Joint Attention, Symbolic Play, Engagement, and Regulation programme (JASPER); Play project;	Social-emotional/challenging behaviour (self- regulation): Positive pooled effect.			



Aaverse effects: Not reported.



Oono et al. (2013)	Setting: Clinic, home, out of home locations.	Overall autism characteristics (severity of autism characteristics): Positive pooled effect.	RCT only	11/11	Not specified
	Format: Individual, group.	Social-communication (shared or joint attention): Positive pooled effect.			
	Mode: Face-to-face, self-training with a manual and videotapes.	Social-communication (child initiations): Null pooled effect.			
	Intervention practices:	Social-communication (summarised): Summarised inconsistent effect.			
	Developmental Individual-Difference Relationship-Based (DIR) techniques;	Communication: Null pooled effect.			
	massage intervention; management of challenging behaviour; early intensive	Communication (joint language): Null pooled effect.			
	behavioural intervention; Pivotal Response Treatment (PRT)	Expressive language (expression - direct or independent assessment): Null pooled effect.			
	response frediment (FRT).	Receptive language (comprehension - direct or independent assessment): Null pooled effect.			
		Cognitive (developmental/intellectual gains): Summarised positive effect.			
		Social-emotional/challenging behaviour (maladaptive behaviour): Summarised null effect.			
		Adaptive behaviour: Null pooled effect.			
		Caregiver communication and interaction (parental synchrony): Positive pooled effect.			
		Caregiver social emotional wellbeing (parents' level of stress): Null pooled effect.			



		Caregiver social-emotional wellbeing (parental confidence): Summarised positive effect. Caregiver satisfaction: Summarised positive effect. Adverse effects: Not reported.			
Nevill et al. (2018)	Setting: Clinic, home, community. Format: Individual, group. Agent: Parents/caregivers. Mode: Face-to-face. Intervention practices: Child's Talk Project; Hanen's More than Words (HMTW); DIR/Floortime; Parent Focus Training; Joint Attention Symbolic Play Engagement and Regulation (JASPER); Pivotal Response Training (PRT); Video Intervention to promote Positive Parenting for children with Autism (VIPP-AUTI); Home-based program; Building Blocks; Focused Playtime Intervention; Play and Language for Autistic Youngsters (PLAY) Project; Preschoolers with Autism; Treatment and Education of Autistic and Related Communication Handicapped Children (TEACCH); Social Communication, Emotion Regulation, and Transactional Supports (SCERTS): Parent-mediated	 Overall autism characteristics (autism symptom severity): Positive pooled effect. Social-communication (socialisation): Positive pooled effect. Communication (language): Positive pooled effect. Cognition: Positive pooled effect. Amount of intervention: Intervention amount (total hours) not related to intervention effect on autism core characteristics, socialisation, communication, or cognition. Adverse effects: Not reported. 	RCT only	7/11	Not specified



	Communication-focused Treatment (PACT).				
Tarver et al. (2019)	 Setting: Not specified. Format: Individual, group, workshops. Agent: Parents/caregivers. Mode: Face-to-face. Intervention practices: Behavioural parent interventions – Research Units in Behavioural Intervention (RUBI) Parent Training Manual; Child directed interaction therapy (CDIT); Compass for help (C-HOPE); Parent management training; parent-child interaction therapy (PCIT); Primary care stepping stones Tripe P (PCSSTP); Stepping stones triple P (SSTP). 	Social-emotional/challenging behaviour (parent- reported disruptive behaviour): Positive pooled effect. Social-emotional/challenging behaviour (parent- reported hyperactivity): Positive pooled effect. Caregiver social emotional wellbeing (parenting stress): Positive pooled effect. Caregiver social emotional wellbeing (parenting efficacy): Null pooled effect. Adverse effects: Not reported.	RCT only	8/11	Included low quality/high risk of bias
Steinbrenner et al. (2020)	Setting: Not specified. Format: Not specified. Agent: Not specified. Mode: Not specified. Intervention practices: Not specified	 Social-communication (social and joint attention): Summarised positive effect. Communication: Summarised positive effect. Cognition (cognitive): Summarised positive effect. Motor: Summarised positive effect. Social-emotional/challenging behaviour (challenging/interfering behaviour): Summarised positive effect. 	Randomised controlled trials, non- randomised with control, single-case experimental designs.	7/10	Included high quality/low risk of bias only



		Play: Summarised positive effect.			
		Adaptive behaviour (adaptive/self-help): Summarised positive effect.			
		School/learning readiness: Summarised positive effect.			
		Academic: Summarised positive effect.			
		Adverse effects: Not reported.			
Parent training	-		-		
National	Setting: Not specified.	Overall autism characteristics (general symptoms):	Not specified	4/10	Included
Autism Center (2015)	Format: Not specified.	Summarised positive effect.			low quality/high
()	Agent: Not specified.	Social-communication (interpersonal): Summarised positive effect.			risk of bias
	Mode: Not specified.	RRB (restricted, repetitive, nonfunctional patterns of			
	Intervention practices: Not specified	behavior, interests, or activity): Summarised positive effect.			
		Social emotional/challenging behaviour (problem			
		Denaviour): Summarised positive effect.			
		Play: Summarised positive effect.			
		Adverse effects: Not reported.			
Postorino et al.	Setting: Clinic.	Social-emotional/challenging behaviour (disruptive	Randomised	7/11	Included
(2017)	Format: Individual, group.	behaviour): Positive pooled effect.	controlled trials, non-		low



	Agent: Parents/caregivers. Mode: Face-to-face, telepractice. Intervention practices: Parent training for disruptive behaviour	Adverse effects: Not reported.	randomised with control		quality/high risk of bias
Peer implemente	d/mediated				
Chang & Locke (2016)	Setting: Educational, afternoon camp. Format: Individual, group. Agent: Peers/siblings. Mode: Face-to-face. Intervention practices: Peer-mediated interventions	Social-communication (social initiations, social responses, social communications): Summarised positive effect. Adverse effects: Not reported.	Randomised controlled trials, non- randomised without control	7/10	Included Iow quality/high risk of bias
Zagona & Mastergeorge (2018)	 Setting: Clinic, educational, research centre. Format: Individual, group. Agent: Peers/siblings. Mode: Face-to-face. Intervention practices: Peer-mediated instruction and intervention 	Social-communication: Summarised positive effect. Adverse effects: Not reported.	Randomised controlled trials, single- case experimental designs	6/10	Included Iow quality/high risk of bias
Steinbrenner et al. (2020)	Setting: Not specified. Format: Not specified. Agent: Not specified.	Social-communication (social and joint attention): Summarised positive effect. Communication: Summarised positive effect.	Randomised controlled trials, non- randomised with control,	7/10	Included high quality/low



	Mode: Not specified. Intervention practices: Not specified	 Cognition (cognitive): Summarised positive effect. Play: Summarised positive effect. Social emotional/challenging behaviour (challenging/interfering behaviour): Summarised positive effect. School/learning readiness: Summarised positive effect. Academic: Summarised positive effect. Adverse effects: Not reported. 	single-case experimental designs.		risk of bias only
National Autism Center (2015)	Setting: Not specified. Format: Not specified. Agent: Not specified. Mode: Not specified. Intervention practices: Not specified.	Social-communication (interpersonal): Summarised positive effect.RRB (restricted, repetitive, nonfunctional patterns of behaviour, interests, or activity): Summarised positive effect.Communication: Summarised positive effect.School/learning readiness: Summarised positive effect.	Not specified	4/10	Included low quality/high risk of bias
		Adverse effects: Not reported.			



Table 4. Summary of systematic reviews focussing on the intervention mode.

	Characteristics of interventions included in the systematic review	Findings form the systematic review	Study designs	Risk of bias (systemat ic review)	Risk of bias (included studies)
Telepractice					
Parsons, Cordier, Vaz et al. (2017)	Setting: Home. Format: Individual. Agent: Parents/caregivers. Mode: Telepractice, videoconferencing, DVD, online modules. Intervention practices: Web-based training in behavioural interventions; Online and Applied System for Intervention Skills (OASIS) training intervention Research-to- practice; Improving Parents as Communication Teachers (ImPACT) on the Web; Implementation discrete-trial instructions using video training materials; Parent Early Start Denver Model (P-EDSM) training; Functional communication training.	Social-communication (social behaviour and communication skills): Summarised inconsistent effect. Communication (vocabulary production and comprehension): Summarised positive effect. Caregiver satisfaction: Summarised positive effect. Caregiver communication and interaction (parental knowledge acquisition): Summarised positive effect. Caregiver social emotional wellbeing (parental self-efficacy): Summarised positive effect. Adverse effects: Not reported.	Randomised controlled trials, non- randomised with control, non- randomised without control, single-case experimental designs.	7/10	Included moderate quality/ moderate risk of bias
Ferguson et al. (2019)	Setting: Clinic, home. Format: Individual, group.	General outcomes (efficacy outcomes): Summarised positive effect.	Randomised controlled trials, non- randomised	9/10	Included low quality/high risk of bias



	Agent: Parents/caregivers, peers/siblings, educators, clinicians/researchers, other associated professionals working in the field.Mode: Telehealth, written instructions, videoconferencing, websites, DVDs.Intervention practices: Telehealth interventions with behavioural principles- functional analysis (FA); functional communication training (FCT); naturalistic and incidental teaching; behaviour support strategies (e.g., positive behaviour support); preference assessments; Early Start Denver Model (ESDM); Improving Parents as Communication Teachers (imPACT).	Adverse effects: Not reported.	with control, non- randomised without control, single-case experimental designs, other.		
Sutherland et al. (2019)	Setting: Clinic. Format: Individual. Agent: Parents/caregivers, educators. Mode: Telepractice, online training. Intervention practices: Program Improving Parents as Communication Teachers (imPACT); internet-based Parent Implemented Communication Strategies (iPICS); general communication intervention; imitation training; Telehealth diagnostic services; 'Telehealth Facing Your Fears' Intervention'; functional behaviour	Communication: Summarised inconsistent effect. Social emotional/challenging behaviour (behaviour): Summarised positive effect. Caregiver satisfaction (satisfaction and acceptability): Summarised positive effect. Caregiver communication and interaction (fidelity): Summarised positive effect. Adverse effects: Not reported.	Randomised controlled trials, single- case experimental designs, other.	7/10	Not specified



	assessment and functional communication training; school age intervention using web- based education; language intervention.				
Akemoglu et al. (2020)	 Setting: Not specified. Format: Individual. Agent: Parents/caregivers. Mode: Telepractice, online training, DVDs, handouts. Intervention practices: Parent-implemented telehealth interventions – Communication intervention; Early Start Denver Model (ESDM); Parents Early Start Denver Model (PESDM); Reciprocal Imitation Training (RIT); Decide, Arrange, Now, Count, and Enjoy (DANCE); Improving Parents as Communication Teachers (imPACT); Internet-based Parent-implemented Communication Strategies (i-PiCS); Prepare, Offer, Wait, and Respond (POWR). 	Social-communication: Summarised inconsistent effect. Caregiver communication and interaction (parents' use of strategies): Summarised positive effect. Adverse effects: Not reported.	Randomised controlled trials, single- case experimental designs.	8/10	Not specified



Appendix Q: Location (by continent) of included studies

Author (year)	Continent(s)
Akemoglu et al. (2020)	Europe, North America
Bejarano-Martín et al. (2020)	Not specified
Binns & Oram Cardy (2019)	Not specified
Boshoff et al. (2020)	Asia, Europe, North America
Case & Yun (2019)	Not specified
Chang & Locke (2016)	Not specified
Ferguson et al. (2019)	Not specified
Flippin et al. (2010)	Not specified
Fuller & Kaiser (2020)	Not specified
Fuller, Oliver et al. (2020)	Asia, Australia, Europe, North America
Geretsegger et al. (2014)	Australia, South America/Caribbean, North America
Griffith et al. (2020)	Asia, Australia, Europe, North America
Hampton & Kaiser (2016)	Australia, Europe, North America
Hardy & Weston (2020)	Not specified
Hill et al. (2019)	Not specified
Ho et al. (2014)	Not specified
Kent et al. (2020)	Not specified
Khan et al. (2019)	Australia, Europe, South America/Caribbean, North America
Knight et al. (2013)	Not specified
Lang et al. (2012)	Not specified
Logan et al. (2017)	Not specified



Makrygianni & Reed (2010)	Not specified
Mazon et al. (2019)	Not specified
McCoy et al. (2016)	Not specified
Miguel-Cruz et al. (2017)	Not specified
Moon et al. (2020)	Australia, Europe, North America
Murza et al. (2016)	Not specified
National Autism Center (2015)	Not specified
Naveed et al. (2019)	Asia, Australia, Europe, North America
Nevill et al. (2018)	Asia, Australia, Europe, North America
Ona et al. (2020)	Not specified
Oono et al. (2013)	Asia, Australia, Europe, North America
Parsons, Cordier, Vaz et al. (2017)	Australia, North America
Parsons, Cordier, Munro et al. (2017)	Asia, Australia, Europe, North America
Peters-Scheffer et al. (2011)	Not specified
Postorino et al. (2017)	Australia, North America
Reichow et al. (2018)	Europe, North America
Sandbank et al. (2020a)	Not specified
Sandbank et al. (2020b)	Not specified
Schaaf et al. (2018)	Not specified
Schoen et al. (2019)	Asia, North America
Srinivasan et al. (2018)	Asia, Europe, North America
Steinbrenner et al. (2020)	Not specified
Sutherland et al. (2018)	North America
Tachibana et al. (2018)	Asia, Australia, Europe, North America



Tarver et al. (2019)	Australia, North America
Tiede & Walton (2019)	Not specified
Treurnicht Naylor et al. (2011)	Asia, Australia, Pacific, Europe, North America
Trzmiel et al. (2019)	Not specified
Tupou et al. (2019)	Not specified
Verschuur et al. (2014)	Not specified
Virues-Ortega (2010)	Asia, Australia, Europe, South America/Caribbean, North America
Waddington et al. (2016)	Australia, North America
Watkins et al. (2019)	Not specified
Weitlauf et al. (2017)	Asia, Australia, Europe, South America/Caribbean, North America
Weston et al. (2016)	Asia, Australia, Europe, North America
Wiese et al. (2016)	Europe, North America
Zagona & Mastergeorge (2018)	Not specified



Appendix R: Quality appraisal ratings: item-level and total quality appraisal ratings for each included systematic review

	1. Review question stated	2. Inclusion criteria appropriate	 Search strategy appropriate 	 Sources and resources adequate 	5. Quality appraisal appropriate	6. Independent critical appraisal	7. Minimised errors in data extraction	8. Methods to combine studies appropriate	9. Publication bias assessed (meta- analyses)	10. Policy and/or practice recommendations	11. Directives for new research appropriate	Total*
Akemoglu et al. (2020)	\checkmark	\checkmark	\checkmark	×	\checkmark	\checkmark	\checkmark	×	N/A	\checkmark	\checkmark	8/10
Bejarano-Martín et al. (2020)	\checkmark	\checkmark	\checkmark	×	\checkmark	\checkmark	\checkmark	×	\checkmark	\checkmark	\checkmark	9/11
Binns & Oram Cardy (2019)	\checkmark	\checkmark	\checkmark	×	\checkmark	\checkmark	\checkmark	\checkmark	N/A	\checkmark	\checkmark	9/10
Boshoff et al. (2020)	\checkmark	\checkmark	\checkmark	×	\checkmark	\checkmark	\checkmark	\checkmark	N/A	\checkmark	\checkmark	9/10
Case & Yun (2019)	\checkmark	\checkmark	\checkmark	×	×	\checkmark	×	×	\checkmark	\checkmark	\checkmark	7/11
Chang & Locke (2016)	\checkmark	\checkmark	\checkmark	×	\checkmark	\checkmark	×	×	N/A	\checkmark	\checkmark	7/10
Ferguson et al. (2019)	\checkmark	~	\checkmark	×	\checkmark	\checkmark	\checkmark	\checkmark	N/A	\checkmark	\checkmark	9/10



Flippin et al. (2010)	\checkmark	\checkmark	\checkmark	×	\checkmark	\checkmark	×	×	×	\checkmark	\checkmark	7/11
Fuller & Kaiser (2020)	\checkmark	\checkmark	\checkmark	\checkmark	\checkmark	×	\checkmark	×	\checkmark	\checkmark	\checkmark	9/11
Fuller, Oliver et al. (2020)	\checkmark	\checkmark	\checkmark	\checkmark	×	\checkmark	\checkmark	\checkmark	\checkmark	\checkmark	\checkmark	10/11
Geretsegger et al. (2014)	\checkmark	11/11										
Griffith et al. (2020)	\checkmark	\checkmark	\checkmark	×	\checkmark	\checkmark	×	\checkmark	N/A	\checkmark	\checkmark	8/10
Hampton & Kaiser (2016)	\checkmark	×	\checkmark	\checkmark	\checkmark	10/11						
Hardy & Weston (2020)	\checkmark	×	\checkmark	×	\checkmark	\checkmark	×	×	N/A	\checkmark	\checkmark	6/10
Hill et al. (2019)	\checkmark	\checkmark	\checkmark	×	\checkmark	\checkmark	×	\checkmark	N/A	\checkmark	\checkmark	8/10
Ho et al. (2014)	\checkmark	×	\checkmark	×	\checkmark	×	\checkmark	×	\checkmark	\checkmark	\checkmark	7/11
Kent et al. (2020)	\checkmark	\checkmark	\checkmark	\checkmark	\checkmark	\checkmark	×	\checkmark	\checkmark	\checkmark	\checkmark	10/11
Khan et al. (2019)	\checkmark	\checkmark	\checkmark	\checkmark	\checkmark	\checkmark	×	\checkmark	×	\checkmark	\checkmark	9/11



Knight et al. (2013)	\checkmark	\checkmark	\checkmark	×	\checkmark	\checkmark	×	×	N/A	\checkmark	\checkmark	7/10
Lang et al. (2012)	\checkmark	×	\checkmark	×	\checkmark	×	×	×	N/A	\checkmark	×	4/10
Logan et al. (2017)	\checkmark	\checkmark	\checkmark	×	\checkmark	\checkmark	\checkmark	×	N/A	\checkmark	\checkmark	8/10
Makrygianni & Reed (2010)	×	\checkmark	×	×	\checkmark	\checkmark	\checkmark	×	×	\checkmark	\checkmark	6/11
Mazon et al. (2019)	\checkmark	\checkmark	\checkmark	×	\checkmark	×	×	×	N/A	\checkmark	\checkmark	6/10
McCoy et al. (2016)	\checkmark	\checkmark	\checkmark	×	\checkmark	×	×	×	N/A	\checkmark	\checkmark	6/10
Miguel-Cruz et al. (2017)	\checkmark	\checkmark	×	×	×	×	\checkmark	×	N/A	\checkmark	\checkmark	5/10
Moon et al. (2020)	\checkmark	×	\checkmark	10/11								
Murza et al. (2016)	\checkmark	×	×	\checkmark	\checkmark	9/11						
National Autism Center (2015)	✓	×	×	×	\checkmark	×	×	×	N/A	✓	\checkmark	4/10


Naveed et al. (2019)	\checkmark	\checkmark	\checkmark	×	\checkmark	\checkmark	\checkmark	×	\checkmark	\checkmark	\checkmark	9/11
Nevill et al. (2018)	\checkmark	\checkmark	\checkmark	×	\checkmark	×	×	\checkmark	×	\checkmark	\checkmark	7/11
Ona et al. (2020)	\checkmark	\checkmark	\checkmark	\checkmark	\checkmark	×	×	\checkmark	×	\checkmark	\checkmark	8/11
Oono et al. (2013)	\checkmark	11/11										
Parsons, Cordier, Vaz et al. (2017)	\checkmark	\checkmark	\checkmark	×	\checkmark	\checkmark	×	×	N/A	\checkmark	\checkmark	7/10
Parsons, Cordier, Munro et al. (2017)	\checkmark	\checkmark	\checkmark	\checkmark	\checkmark	×	×	\checkmark	\checkmark	\checkmark	\checkmark	9/11
Peters-Scheffer et al. (2011)	\checkmark	\checkmark	×	×	\checkmark	\checkmark	×	\checkmark	\checkmark	\checkmark	\checkmark	8/11
Postorino et al. (2017)	\checkmark	\checkmark	\checkmark	×	\checkmark	×	\checkmark	×	\checkmark	\checkmark	×	7/11
Reichow et al. (2018)	~	\checkmark	11/11									
Sandbank et al. (2020a)	\checkmark	×	\checkmark	\checkmark	\checkmark	10/11						



Sandbank et al. (2020b)	\checkmark	×	\checkmark	\checkmark	\checkmark	10/11						
Schaaf et al. (2018)	\checkmark	\checkmark	\checkmark	×	\checkmark	×	×	\checkmark	N/A	\checkmark	\checkmark	7/10
Schoen et al. (2019)	\checkmark	\checkmark	\checkmark	×	\checkmark	\checkmark	\checkmark	×	N/A	\checkmark	\checkmark	8/10
Srinivasan et al. (2018)	\checkmark	×	\checkmark	×	×	\checkmark	\checkmark	\checkmark	N/A	\checkmark	\checkmark	7/10
Steinbrenner et al. (2020)	\checkmark	\checkmark	\checkmark	×	\checkmark	\checkmark	×	×	N/A	\checkmark	\checkmark	7/10
Sutherland et al. (2018)	\checkmark	\checkmark	\checkmark	×	\checkmark	×	×	\checkmark	N/A	\checkmark	\checkmark	7/10
Tachibana et al. (2018)	\checkmark	11/11										
Tarver et al. (2019)	\checkmark	\checkmark	\checkmark	×	\checkmark	\checkmark	×	\checkmark	×	\checkmark	\checkmark	8/11
Tiede & Walton (2019)	\checkmark	×	\checkmark	\checkmark	\checkmark	10/11						
Treurnicht Naylor et al. (2011)	\checkmark	\checkmark	\checkmark	×	\checkmark	×	×	\checkmark	N/A	\checkmark	\checkmark	7/10



Trzmiel et al. (2019)	\checkmark	\checkmark	×	\checkmark	\checkmark	\checkmark	×	×	\checkmark	×	\checkmark	7/11
Tupou et al. (2019)	\checkmark	\checkmark	\checkmark	×	\checkmark	\checkmark	\checkmark	\checkmark	N/A	\checkmark	\checkmark	9/10
Verschuur et al. (2014)	\checkmark	×	\checkmark	×	\checkmark	×	×	\checkmark	N/A	\checkmark	\checkmark	6/10
Virués-Ortega (2010)	\checkmark	\checkmark	\checkmark	×	\checkmark	\checkmark	×	×	\checkmark	\checkmark	\checkmark	8/11
Waddington et al. (2016)	\checkmark	\checkmark	\checkmark	×	\checkmark	\checkmark	\checkmark	×	N/A	\checkmark	\checkmark	8/10
Watkins et al. (2019)	\checkmark	\checkmark	\checkmark	×	\checkmark	10/11						
Weitlauf et al. (2017)	\checkmark	\checkmark	\checkmark	\checkmark	\checkmark	\checkmark	×	\checkmark	N/A	\checkmark	\checkmark	9/10
Weston et al. (2016)	\checkmark	\checkmark	\checkmark	\checkmark	\checkmark	\checkmark	×	\checkmark	\checkmark	×	\checkmark	9/11
Wiese et al. (2016)	\checkmark	\checkmark	\checkmark	\checkmark	\checkmark	\checkmark	×	\checkmark	N/A	\checkmark	\checkmark	9/10
Zagona & Mastergeorge (2018)	\checkmark	×	\checkmark	×	\checkmark	\checkmark	×	×	N/A	\checkmark	\checkmark	6/10



Appendix S: Appraisal tool(s) used within each included systematic review to assess study quality/risk of bias

Systematic Review	Appraisal tool(s)
Akemoglu et al. (2020)	Horner et al. (2005) single-case research; Gersten et al. (2005) group-design
Bejarano-Martín et al. (2020)	EBP Update Workgroup Reviewer Training criteria (Wong et al., 2015) of the National Professional Development Centre on Autism Spectrum Disorders
Binns & Oram Cardy (2019)	Critical Appraisal Skills Programme tool (CASP, 2018); Dollaghan's (2007) scale
Boshoff et al. (2020)	McMaster Critical Review Form for Quantitative Studies (Law et al., 1998)
Case & Yun, (2019)	Quality assessment tool for pre–post studies with no control group (National Heart, Lung, and Blood Institute, 2014)
Chang & Locke (2016)	Evaluative method for evaluating and determining evidence-based practices in autism (Reichow et al., 2008)
Ferguson et al. (2019)	Evaluative method for evaluating and determining evidence-based practices in autism (Reichow et al., 2008)
Flippin et al. (2010)	Horner et al. (2005) and Wolf (1978) single-subject designs; Gersten et al. (2005) group designs
Fuller & Kaiser (2020)	Cochrane Collaboration (Higgins et al., 2011)
Fuller, Oliver et al. (2020)	Study quality indicators (random assignment, use of assessors who were blind or naïve of the group assignment). Measurement–quality variables were coded based on Sandbank et al. (2020a).
Geretsegger et al. (2014)	Cochrane risk of bias tool (Higgins, 2011)



Griffith et al. (2020)	Adapted Cochrane risk of bias tool
Hampton & Kaiser (2016)	Cochrane Collaboration (Higgins et al., 2011)
Hardy & Weston (2020)	Adapted from Jarde et al. (2013)
Hill et al. (2019)	Single-case experimental design scale (Tate et al. 2008); Downs and Black (1998) checklist
Ho et al. (2014)	Gersten et al. (2005)
Kent et al. (2020)	The QualSyst critical appraisal tool (Kmet et al., 2004)
Khan et al. (2019)	Joanna Briggs Institute Critical Appraisal Checklist for RCTs
Knight et al. (2013)	Horner et al. (2005) single-case; Gersten et al. (2005) group designs
Lang et al. (2012)	Certainty of evidence (Schlosser, 2009; Simeonsson & Bailey, 1991; Smith, 1981).
Logan et al. (2017)	Strength of evidence (e.g., Millar et al., 2006); Methodological rigor (Odom et al., 2003)
Makrygianni & Reed (2010)	Evaluative method for evaluating and determining evidence-based practices in autism (Reichow et al., 2008)
Mazon et al. (2019)	SIGN ratings for levels of evidence (SIGN, 2008); Jadad Score for methodological quality (Jadad et al., 1996)
McCoy et al. (2016)	Evaluative method for evaluating and determining evidence-based practices (Reichow, 2011)
Miguel-Cruz et al. (2017)	Physiotherapy Evidence Database (PEDro) scale for RCTs; available standards and recommendations for critical reviews as a proxy of assessment of the risk of bias in non-RCTs
Moon et al. (2020)	Cochrane risk of bias (RoB)-2 tool



Murza et al. (2016)	Cochrane Collaboration's Tool for Assessing Risk of Bias (Higgins et al., 2011).
National Autism Center (2015)	Scientific Merit Rating Scale (SMRS)
Naveed et al. (2019)	Cochrane Collaboration tool for randomized controlled trials (Higgins et al., 2011)
Nevill et al. (2018)	Grading of Recommendations Assessment, Development and Evaluation (Guyatt et al., 2011)
Ona et al. (2020)	Modified version of the guidelines from the Cochrane Consumers and Communication Review Group (Ryan et al., 2007)
Oono et al. (2013)	Cochrane Collaboration tool for assessing risk of bias (Higgins 2011)
Parsons, Cordier, Vaz et al. (2017)	Standard quality assessment (Kmet et al. 2004)
Parsons, Cordier, Munro et al. (2017)	Standard quality assessment (Kmet et al. 2004)
Peters-Scheffer et al. (2011)	Downs and Black (1998) Checklist
Postorino et al. (2017)	Cochrane risk of bias assessment tool (Higgins 2013)
Reichow et al. (2018)	Cochrane Collaboration's tool for assessing risk of bias (Higgins, 2017)
Sandbank et al. (2020a)	Cochrane Collaboration's tool for assessing risk of bias (Higgins, 2011), plus additional indicators proposed by Yoder et al. (2013)
Sandbank et al. (2020b)	As per Sandbank 2020a
Schaaf et al. (2018)	Cochrane Collaboration tool for assessing risk of bias (Higgins 2011)
Schoen et al. (2019)	CEC Standards for Evidence-Based Practices in Special Education (Cook et al., 2015)



Srinivasan et al. (2018)	Levels of evidence described by Sackett and colleagues (1997); Physiotherapy Evidence Database (PEDro) scale
Steinbrenner et al. (2020)	Gersten et al. (2005) group design; Horner et al. (2005) single-case; review guidelines established by the WWC
Sutherland et al. (2018)	Scientific Merit Rating Scale (SMRS; National Autism Center, 2015)
Tachibana et al. (2018)	Cochrane Collaboration's Tool for Assessing Risk of Bias (Higgins et al., 2011).
Tarver et al. (2019)	Cochrane risk of bias tool (Higgins et al., 2011)
Tiede & Walton (2019)	Evaluative Method for Determining Evidence-Based Practice in Autism (Reichow et al., 2008)
Treurnicht Naylor et al. (2011)	Physiotherapy Evidence Database (PEDro) scale
Trzmiel et al. (2019)	Quality Assessment Tool for Quantitative Studies (QATQS; National Collaborating Centre for Methods and Tools, 2008)
Tupou et al. (2019)	Modified version of Goldstein et al.'s (2014) framework
Verschuur et al. (2014)	Certainty of evidence rated using the classification system described by Lang et al. (2012), Palmen et al. (2012), Ramdoss et al. (2012).
Virués-Ortega (2010)	Downs and Black (1998) checklist
Waddington et al. (2016)	Evaluative Method for Determining Evidence-Based Practices in Autism (Reichow et al., 2008; Reichow, 2011)
Watkins et al. (2019)	What Works Clearinghouse (WWC, 2014)
Weitlauf et al. (2017)	Self-developed tool: ASD-specific assessment informed by the Methods Guide for Effectiveness and Comparative Effectiveness Reviews (2014)



Weston et al. (2016)	National Institute for Health and Care Excellence Quality Appraisal Checklist for Quantitative Intervention Studies (National Institute for Health and Care Excellence, 2012)
Wiese et al. (2016)	The National Health and Medical Research Council (NHMRC) hierarchy of evidence (Australian Government 2009); The McMaster Quantitative Critical Appraisal Review Form for Quantitative Studies (Law et al., 1998)
Zagona & Mastergeorge (2018)	Scientific Merit Rating Scale (SMRS; National Autism Center, 2015)



Appendix T: Raw data and summary statements from each included systematic review for all categorised outcomes in the current umbrella review

Akemoglu et al. (2020) - Narrative synthesis

Outcome	Verbatim summary from systematic review	Categorised outcome
Social-communication	"Parents' use of naturalistic teaching strategies resulted in improvements in child Social- communication skills although not all studies have found robust effects on child outcomes. Because communication levels of participants varied, researchers targeted different child communication responses (i.e., behavior) and focused on a variety of communication skills across studies."	Summarised inconsistent effect
Caregiver communication and interaction (parent's use of strategies)	"parent-implemented interventions were found to be effective at increasing parents' use of specific strategies, such as environmental arrangement (Guðmundsdóttir et al. 2017, 2019), modeling, mand model (McDufe et al. 2013;Meadan et al. 2016), time delay (Douglas et al. 2018; Meadan et al. 2016), following the child's lead (McDufe et al. 2013; Vismara et al. 2012, 2013, 2018), and prompting strategies and expansions (Douglas et al. 2018; McDufe et al. 2013; Wainer and Ingersoll 2013). Specifically, coaching parents to embed communication strategies into a variety of family routines resulted in increased responsive and modelling strategy use by parents and targeted communication rates by children (Douglas et al. 2018; McDufe et al. 2013; Meadan et al. 2016).	Summarised positive effect



Bejarano-Martín	et al.	(2020)	- Meta-analy	ysis
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Outcome	Context		Studies included	Effect size	Heterogeneity	Categorised outcome
Social-communication	Group studies		18	g = 0.51, 95Cl [0.37, 0.65]	l ² = 23.01	Positive pooled effect
	Single case studies		25	NAP = 0.86, 90Cl [0.59, 0.98]	-	Positive pooled effect
Social-communication	Group studies		4	g = 0.43, 95CI [0.10, 0.75]	l ² = 6.62	Positive pooled effect
(initiation)	Single case studies		7	NAP = 0.90, 90CI [0.59, 0.96]	-	Positive pooled effect
Social-communication	Group studies		14	g = 0.55, 95Cl [0.39, 0.70]	l ² = 19.83	Positive pooled effect
(Joint attention)	Single case studies		10	NAP = 0.86, 90Cl [0.59, 0.99]	-	Positive pooled effect
Social-communication	Group studies		6/71	g = 0.47, 95Cl [0.25, 0.70]	l ² = 73.56	Positive pooled effect
(ridy)	Single case studies		8/9 ¹	NAP = .81, 90CI [0.58, 0.96] -		Positive pooled effect
Moderators	Context	Outcome	Studies Included	Verbatim summary from syst	ematic review	Categorised outcome
Child age	Group/single case	Social- communication	24 group, 31 SCD	Group: "did prove to be signifi = 0.008. Effect sizes were great participants' preintervention at (see Appendix H for more info Single case: "The correlations effects in terms of age, IQ or la Appendix I for more informatic	Age inconsistently related to intervention effects on social- communication	



Child characteristics	Group/single case	Social- communication	14 group, 17 SCD	"nonsignificant for group and single case" "All the descriptive moderators (overall cognitive ability, verbal ability) were nonsignificant"	Child communication skills and cognitive ability prior to intervention not related to intervention effects on social- communication.
Intervention amount	Group/single case	Social- communication	16 group, 27 SCD	Group: "were nonsignificant Treatment dosage increased with increasing participants' age, although this relationship was not significant (r = 0.271, p = 0.076). In addition, when we eliminated the two studies where treatment dosage was much higher than the rest of the studies, the relationship between the dosage and the effect was significantly positive (see Fig. 6 in Appendix I). Single case: "The correlation analyses for single- case studies showed significant effects according to the treatment dosage moderator (Table 2), with the effect being greater when the treatment dosage was increased (number of sessions X hours)"	Total hours inconsistently related to intervention effects on social- communication.
Intervention agent	Overall	Social- communication	9 group, 7 SCD	"Nine studies with group design included caregivers or teachers as active components in treatment programmes. The effect sizes	Interventions involving caregivers or teachers had a similar positive effect to those



fc	or programmes where, in addition to the main	involving clinicians
tł	herapist, the caregivers or teachers had an	alone.
а	active role in the intervention, ranged	
fr	rom g = 0.11 to g = 1.02. Fig. 4 shows the	
ir	ndividual effect size for this analysis (g = 0.50, K	
=	= 9, 95% [Cl 0.32, 0.68], Z = 5.39, p <0.001). This	
N	vas a medium effect. The sample of studies was	
n	not sufficiently large and the I ² statistic (0.00) did	
n	not meet the criteria	
to	o proceed with moderator or publication bias	
а	analyses.	
S	Seven studies with single-case design included	
с	caregivers or teachers in treatment programmes.	
Т	The effect sizes for these programmes ranged	
fr	rom NAP = 0.75 to NAP = 0.99. Fig. 4 shows the	
ir	ndividual effect size for this analysis (NAP = 0.89,	
К	< = 7, 90% [CI 0.66,	
	0.001 = 62.82 p < 0.001 This was a modium	
U	5.99, $Z = 62.83$, p < 0.00 J. This was a medium	
e .	effect. The sample of studies was not sufficiently	
la	arge to proceed with publication bias analyses."	
	f t a f i i i i i t t a i i i i i i i i i i i i	for programmes where, in addition to the main therapist, the caregivers or teachers had an active role in the intervention, ranged from g = 0.11 to g = 1.02. Fig. 4 shows the individual effect size for this analysis (g = 0.50, K = 9, 95% [CI 0.32, 0.68], Z = 5.39, p <0.001). This was a medium effect. The sample of studies was not sufficiently large and the l ² statistic (0.00) did not meet the criteria to proceed with moderator or publication bias analyses. Seven studies with single-case design included caregivers or teachers in treatment programmes. The effect sizes for these programmes ranged from NAP = 0.75 to NAP = 0.99. Fig. 4 shows the individual effect size for this analysis (NAP = 0.89, K = 7, 90% [CI 0.66, 0.99], Z = 62.83, p < 0.001). This was a medium effect. The sample of studies was not sufficiently large to proceed with publication bias analyses."

¹Both numbers reported.



Binns &	& Oram	Cardy	(2019)	– Narrative	synthesis

Outcome	Verbatim summary from systematic review	Categorised outcome
Social-communication (social interaction and Social-communication)	"Each of the four studies evaluating social interaction capacities or overall Social-communication reported positive results, with moderate (Solomon et al., 2014; Wetherby et al., 2014) to large effects (Aldred et al., 2004; Green et al., 2010; Pajareya & Nopmaneejumruslers, 2011). Aldred et al. (2004)	Summarised positive effect
	included both social interaction and communication outcome measures, and reported positive results in the social interaction domain of the ADOS, but no significant change on the communication domain"	
Communication (language capacities)	"Six studies used standardized language tests as outcome measures (e.g. Preschool Language Scale; Zimmerman, Steiner, & Pond, 2006). Of these, three reported mixed results across different language tests (Green et al., 2010; Schertz et al., 2013;Wetherby et al., 2014) and three reported no effects (Aldred et al., 2004; Casenhiser et al., 2013; Solomon et al., 2014). Two of the studies that reported mixed results found small to moderate positive effects in children's receptive language, but not in expressive language (Schertz et al., 2013; Wetherby et al., 2014). Green et al. (2010) found no effects using assessor rated measures of language."	Summarised inconsistent effect
Caregiver communication and interaction (parent responsiveness and directiveness)	"Caregiver interaction outcomes. Pre–post Social-communication or language outcomes of caregivers were examined within six studies. Parent outcomes most commonly reported related to parent responsiveness and parental control. <i>Responsiveness</i> . Parental responsiveness significantly increased for parents who had participated in DSP intervention, with two studies reporting large positive effects (Casenhiser et al., 2013; Solomon et al., 2014). By contrast, Carter et al. (2011) reported no changes in parental responsiveness with moderate effects noted, which may have related to small sample size (n=28).	Summarised positive effect
	Parental control/directiveness. Within DSP interventions, parental directiveness is not thought to support spontaneous communication or language and is therefore discouraged. Three studies reported reductions in directiveness with moderate (Solomon et al., 2014) to large effects (Aldred et al., 2004; Venker et al., 2012)."	



Moderators	Outcome	Verbatim summary from systematic review	Categorised outcome
Child characteristics	Social-communication (Social-communication and language skills)	"Two studies examined how a child's autism severity influenced treatment effects, and results were conflicting. Pajareya et al.(2012) found that the less severe the impairments or the higher the level of overall performance of the child prior to intervention, the more likely they were to have positive gains from the DSP intervention. In contrast, Schertz et al. (2018) found that more positive changes in responding to joint attention occurred for the children with more severe autism. However, treatment effects for following faces, turn taking, and initiating joint attention were not influenced by autism severity."	The level of pre- intervention Overall autism characteristics inconsistently related to intervention effects on social- communication.

Boshoff et al. (2020) – Narrative synthesis

Outcome	Verbatim summary from systematic review	Categorised outcome
Social-communication (social and emotional development)	"In Table 3, it can be seen that the most prominent developmental area in which positive outcomes were indicated across the studies was the socio-emotional area, with the use of various outcome measures. Positive results were found on the FEAS outcome measure in five studies, on the FEDQ used in two studies, the CARS (n=2 studies), CoC (n=1 study),CBRS (n=2 studies), FEDL (n=1 study), the Assessment of Child Socio-Communication (n=1 study), the Assessment Scale of Children with ASD (n=1 study), and the VABS-2 (n=1 study), acknowledging that studies may have used more than one of these measures."	Summarised positive effect
Communication (language)	"and language showed no changes in the Preschool Language Scale (n = 1 study) and the Mullen Scales (n = 1 study)."	Summarised null effect



Motor skills (motor and fine motor) "(m p	"Other developmental changes did not show improvements: the VABS-2 showed no changes in motor development (n = 1 study), the Mullen Scales showed no changes in fine motor and visual perception"	Summarised null effect
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Case & Yun (2019) – Meta-analysis

Outcome	Context	Studies included	Effect size	Heterogeneity	Categorised outcome
Gross motor	Overall	20 interventions from 18 studies	δ = 0.99, 95Cl [0.62, 1.36]	Q = 223.36 I ² = 91.49	Positive pooled effect
	Technology interventions	4	δ = 1.42, 95CI [-0.78, 3.62]	-	Null pooled effect
	Fundamental motor skills	11	δ = 0.68, 95Cl [0.44, 0.92]	-	Positive pooled effect
	Equestrian assisted therapy	2	δ = 1.20, 95CI [0.67, 1.37]	-	Positive pooled effect
	Physical activity	3	δ = 1.20, 95CI [0.41, 1.98]	-	Positive pooled effect



Moderators	Context	Outcome	Studies Included	Verbatim summary from systematic review	Categorised outcome
Child age	Overall	Motor (gross motor)	20 interventions from 18 studies	"The use of evidence-based practices and the mean age of the sample were not found to be significant moderators based on the results of the heterogeneity analyses. However, the summary effect sizes for interventions with younger and older children were both considered to be large."	Age not related to intervention effects on motor skills.
Intervention amount	Overall	Motor (gross motor)	20 interventions from 18 studies	"The total intervention time and intervention setting were found to be significant moderators, with interventions with 16 or more hours and interventions within a research or experimental setting eliciting significantly larger effect sizes than the interventions that were less than 16 hr and in practical or service settings."	Greater total hours related to greater intervention effects on motor skills.
Intervention practice	Overall	Motor (gross motor)	20 interventions from 18 studies	"The use of evidence-based practices and the mean age of the sample were not found to be significant moderators based on the results of the heterogeneity analyses. However, the summary effect sizes for interventions with younger and older children were both considered to be large."	Intervention practices had similar intervention effects on motor skills.



Chang & Locke (2016) – Narrative synthes
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Outcome	Verbatim summary from systematic review	Categorised outcome
Social-communication (social initiations, social responses, Social-communications)	"All studies used a social skills measure, but the type of measure and social outcome widely varied across studies. All studies used direct observations to measure children's social skills, but only two studies used observers who were blinded to children's treatment condition (Kasari et al., 2012; Roeyers, 1996). All of the observation measures examined children's initiations of and responses to Social-communication; however, these data were collected in different social contexts and used different operational definitions. For example, Kalyva and Avramidis (2005) examined social initiations and responses separately during a one-hour circle time, while Kamps et al. (2014) combined both social initiations and responses (i.e., communicative acts) and observed children during a 10-min free play. Other studies also measured children's joint engagement, conversation, and duration of social interaction (Kasari et al., 2012; Roeyers, 1996).	Summarised positive effect
	In addition to observations, two of the studies also used multi-rater (i.e., parents, teachers, and researchers) social skills measures (Corbett et al., 2014; Kasari et al., 2012). Corbett et al. (2014) had parents complete the Social Responsiveness Scale (Constantino & Gruber, 2005), which measures children's social awareness, Social-communication, and social cognition. Researchers were asked to rate children's social skills using the Developmental Neuropsychological Assessment (NEPSY; Korkman, Kirk, & Kemp, 2007), that measures social perception, and the Companionship Scale (Bauminger, 2007) that assesses children's verbal and nonverbal social behaviors using a 5-point Likert scale (Corbett et al., 2014). Kasari et al. (2012) used the Teacher Perceptions of Social Skills, which measures children's social skills and classroom behaviors (e.g., quality interactions with peers) on a 3-point Likert scale. Data also were collected directly from children. Children were asked to complete a peer nomination measure that examined their social acceptance and social network inclusion before and after treatment as well as during a 3-month follow-up (Kasari et al., 2012). Lastly, two of the studies also reported effect sizes for the social outcomes (Corbett et al., 2014; Kasari et al., 2012). The effect sizes varied depending on the social outcome and ranged from small to large effect size (d = 0.23–0.74). Of the different social outcomes from the two studies, social awareness had the smallest effect size and total social skills had the largest effect size Using Reichow et al.'s (2008) framework and	



	Idence demonstrated by the reviewed studies indicates that PMis have established
evidence based	practice."

Ferguson et al. (2019) – Narrative synthesis

Outcome	Verbatim summary from systematic review	Categorised outcome
Child outcomes (efficacy outcomes)	"Results of efficacy (Fig. 3) show that 61% (n=17) of studies were rated as 'positive' in which improvements were achieved by all participants across all dependent variablesOverall, 32% (n=9) of studies received a 'mixed' efficacy rating (Barkaia et al. 2017; Bearss et al. 2017; Machalicek et al. 2016; Meadan et al. 2016; Suess et al. 2014; Vismara et al. 2013, 2016; Wainer and Ingersoll 2015; Wilczynski et al. 2017). For example, 44% (n=4) of these studies found improvements in interventionist treatment fidelity across all participants but failed to increase scores of Social-communication or imitation behaviours consistently across participants (Meadan et al. 2016; Wainer and Ingersoll 2015; Vismara et al. 2013). None of the 28 studies included in this review received a 'negative' rating."	Summarised positive effect

Flippin et al. (2010) – Meta-analysis

Outcome	Context	Studies included	Effect size	Heterogeneity	Categorised outcome
Social-communication (communicative behaviours)	Single-subject designs	8	Glass's ∆ = 0.51, 95Cl [0.04, 0.67]	-	Positive pooled effect
Expressive language (speech or vocalisation)	Single-subject designs	5	Glass's ∆ = 0.17 95CI [–0.01, 0.36]	-	Null pooled effect



Fuller & Kaiser (2020) – Meta-analysis

Outcome	Context		Studies included	Effect size	Heterogeneity	Categorised outcome
Social-communication	-		29	g = 0.355, 95Cl [0.207,0.503]	Q = 49.83 $l^2 = 43.8\%$ $\tau^2 = 0.065$	Positive pooled effect
Moderators	Context	Outcome	Studies Included	Verbatim summary from systematic revi	ew	Categorised outcome
Child age	-	Social- communication	Not specified	"The mean age of participants, in years, was a significant predictor of treatment effect size on Social-communication outcomes, such that older participants were associated with larger out-comes ($\beta = 0.84$; $p = 0.039$). The quadratic of participant age was also a significant predictor of treatment effect size, but in the opposite direction ($\beta =$ -0.11; $p = 0.049$), indicating that the benefit of age diminished as children approached 8 years. Optimal outcomes were observed at age 3.81 years. Including age in the model explains some of the observed heterogeneity in the sample ($\tau 2 = 0.052$, $I2 = 37.28\%$, Adjusted $R^2 =$ 24.40%).		Age related to intervention effects on social- communication, with greatest gains made at around 4 years of age.
Intervention amount	-	Social- communication	Not specified	"The total dosage of intervention (measur number of hours) and the duration or inte (measured as length in weeks) were used of intervention dosage. Total dosage and not significant predictors of treatment effe	ed as the total rvention as two measures duration were ect sizes on	Total hours not related to intervention effects on social- communication.



Intervention duration	-	Social- communication	Not specified	Social-communication outcomes, using separate meta- regressions (total dosage: $\beta = -0.00003$, p = 0.746; duration: $\beta = 0.00082$, p = 0.972). Additionally, neither dose nor duration explained any of the observed heterogeneity in the sample (dosage: I2 = 48.34% Adjusted R ² = 0%; duration: I2 = 45.81% Adjusted R ² = 0%)."	Intervention duration (weeks) not related to intervention effects on social- communication.
Intervention agent	-	Social- communication	29	"A total of 19 studies included the parent in the intervention, four studies included school staff in the intervention, and six studies were implemented directly by clinicians (researcher or therapist). The largest effect sizes were shown when the intervention was delivered by clinicians (g = 0.587, 95% CI [0.258–0.916], p < 0.001, Q = 5.26 , I2 = 4.9% , k = 6), followed by parents (g = 0.330, 95% CI [0.203–0.447], p < 0.001, Q = 39.35 , I2 = 54.3% , k = 19), and school staff (g = 0.218, 95% CI [– 0.006 to – 0.441], p = 0.057 , Q = 1.91 , I2 = 0% , k = 4). The only effect size that was not statistically significant at the 0.05 level was the effect for interventions implemented by school staff; however, this effect size was calculated from only four studies. There was no significant between-group variance (Q = 3.32 , p = 0.190), indicating that the effect size of intervention did not differ significantly based on the interventionist."	Intervention agent (clinicians, parents, school staff) not related to intervention effects on communication.



Fuller, Oliver et a	. (2020) –	Meta-analysis
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Outcome	Context		Studies included	Effect size	Heterogeneity	Categorised outcome
Overall autism characteristics (autism symptoms)	-		9	g = 0.070 (-)	$l^2 = 48.90\%$ $\tau^2 = 0.073$	Null pooled effect
Social-communication	-		8	g = 0.209 (-)	$l^2 = 72.53\%$ $\tau^2 = 0.176$	Null pooled effect
RRB (repetitive behaviours)	-		5	g = -0.016 (-)	-	Null pooled effect
Communication (language)	-		11	g = 0.408 (-)	$l^2 = 52.70\%$ $\tau^2 = 0.088$	Positive pooled effect
Cognition	-		9	g = 0.412 (-)	$l^2 = 66.30\%$ $\tau^2 = 0.145$	Positive pooled effect
Adaptative behaviour (adaptive functioning)	-		6	g = 0.121 (-)	$l^2 = 49.03\%$ $\tau^2 = 0.062$	Null pooled effect
Moderators	Context	Outcome	Studies Included	Verbatim summary from systematic	review	Categorised outcome
Duration of intervention	-	Child outcomes	Not specified	"The studies used a wide range of interventionDuration of interventiondosages both in intensity and in length, ranging in(total weeks) not reader		Duration of intervention (total weeks) not related to



				intensity from one hour per week to 20 hours per week, and ranging in length from six weeks to 156	intervention effects on child outcomes.
Intensity of intervention	-	Child outcomes	Not specified	ranging from 12 hours to 2080 hours. However, a meta-regression showed that child outcomes were not significantly related to the length of intervention (B = -0.01, p = 0.46), to the hours per week of intervention	Intensity of intervention (hours per week) not related to intervention effects on child outcomes.
Intervention amount	-	Child outcomes	Not specified	(B = -0.02, p = 0.73), or to the total number of hours (B = 0.004, p = 0.66)."	Total hours of intervention not related to intervention effects on child outcomes.



Geretsegger et al. (2014) – Meta-analysis

Outcome	Context	Studies included	Effect size	Heterogeneity	Categorised outcome
Social-communication (social adaptation)	Overall	4	SMD = 0.41, 95CI [0.21, 0.60]	Chi ² = 15.34 I ² = 80%	Positive pooled effect
Communication (non-verbal)	Overall	Not specified	SMD = 0.47, 95CI [0.21, 0.73]	Chi2 = 1.32 I ² = 0%	Positive pooled effect
Communication (verbal)	Overall	6	SMD = 0.33, 95CI [0.16, 0.49]	Chi ² = 0.72 I ² = 0%	Positive pooled effect
Quality of life (joy)	-	1	SMD = 0.96, 95CI [0.04, 1.88]	-	Positive pooled effect
Caregiver social emotional wellbeing (quality of family relationships)	-	2	SMD = 0.82, 95CI [0.13, 1.52]	Chi ² = 0.03 I ² = 0%	Positive pooled effect



Griffith et al. (2020) – Narrative synthesis

Outcome	Verbatim summary from systematic review	Categorised outcome
Social-communication	"None of the 3 studies reported significant improvement in the primary Social-communication skills outcome measures for the app treatment group compared with the control group. Effect sizes for gains in the app groups on Social-communication outcomes ranged from 0 to 0.40."	Summarised null effect

Hampton & Kaiser (2016) – Meta-analysis

Outcome	Context		Studies included	Effect size	Heterogeneity	Categorised outcome
Expressive language (spoken language)	-		26	g = 0.26, 95Cl [0.11, 0.42]	τ ² = 0.083 Q = 59.08 I ² = 57.7%	Positive pooled effect
Moderators	Context	Outcome	Studies Included	Verbatim summary from syst	ematic review	Categorised outcome
Child age	-	Expressive language (spoken language)	26	"The second meta-regression moderator analysis examined the impact of age of participants and included the same 26 studies and control variables. The null hypothesis could not be rejected: the effect of interventions on spoken-language for younger and older participants did not differ significantly (β = 0.092,SE=0.096). This analysis accounted for none of the heterogeneity (R2=0.00%),		Age not related to intervention effects on spoken language.



				indicating that interventions delivered at different ages resulted in similar outcomes."	
Intervention amount	- E: la la	Expressive anguage (spoken anguage)	26	"The first meta-regression included all 26 studies. The results indicated the total intervention dose (β =0.008,SE =0.010; total hours of intervention computed as length of treatment x hours per week), and number of indicators of bias (β =0.027,SE=0.027) did not significantly predict the magnitude of spoken- language outcomes."	Total hours of intervention not related to intervention effects on expressive language (spoken language).
Intervention agent	- E la la	Expressive anguage (spoken anguage)	26	"The random effects ANOVA model for the sub- group analysis of implementers (clinician only, parent only or parent plus clinician) summarises the outcomes within types of implementers (Fig.2). There was a significant difference among the sub-groups [Q=59.08(25),P<0.001]. None of the heterogeneity was explained within the parent-only group, the parent plus clinician group explained 36.4%, and77.1% was explained by the clinician-only group. The sub- group analysis indicated a significantly better effect on language outcomes for parent plus clinician delivered interventions (g=0.42)as compared with parent-only (g=0.11) or clinician- only (g=0.08) delivered interventions."	Interventions involving clinicians and parents related to greater intervention effect on spoken language than clinicians or parents alone.



Hardy & Weston (2020) – Narrative synthesis

Outcome	Verbatim summary from systematic review	Categorised outcome
Social-communication (social behaviour)	"Results of the five studies indicated positive effects of CAT on the frequency and duration of social behavior of children with ASD (Becker et al. 2017; Fung and Leung 2014; Grigore and Rusu 2014; Martin and Farnum 2002; Redefer and Goodman 1989) However, due to the methodological weaknesses of these studies, it would be unfitting to make any assertions about the degree to which CAT impacts social behavior."	Summarised positive effect

Hill et al. (2019) – Narrative synthesis

Outcome	Verbatim summary from systematic review	Categorised outcome
Social-communication (verbal behaviours)	Table 5 in the systematic review provides evidence of a	Summarised inconsistent effects
Social-communication (non-verbal behaviours)	outcomes. The authors do not provide a brief cohesive	Summarised inconsistent effects
Social-communication (desired behaviours)	summary in text.	Summarised inconsistent effects
Social-communication (undesired behaviours)		Summarised inconsistent effects



Ho et al. (2014) – Meta-analysis

Outcome	Context	Studies included	Effect size	Heterogeneity	Categorised outcome
Social-communication (social skills)	-	3	g = 0.98, 95Cl [0.47, 1.49]	-	Positive pooled effect

Kent et al. (2020) – Meta-analysis

Outcome	Context		Studies included	Effect size	Heterogeneity	Categorised outcome
Play	Pre/post within group analysis of 1 intervention groups		11	g = 0.439, 95Cl [0.209, 0.669]	Q = 17.210 l ² = 41.9%	Positive pooled effect
	Between-group analysis		8	g = 0.335, 95Cl [0.083, 0.586]	-	
Moderators	Context	Outcome	Studies Included	Verbatim summary from syst	ematic review	Categorised outcome
Format	Individual, group	Play	8	"Following the subgroup analysis of intervention characteristics, a meta-regression analysis was performed on eight studies to further explain variability of the results (Chang et al. 2016, b; Goods et al. 2013, b; Kasari et al. 2006, b, 2012, b, 2014, b, 2015, b; Poslawsky et al. 2015, b; Quirmbach et al. 2009, b). The analysis of intervention characteristics indicated		The intervention format (individual, group) did not relate to intervention effects on play.



				that intervention setting and group vs individual were not significant mediators of intervention effects (see Table 5). However, focus of the intervention (i.e., child, parent, peer or teacher) was found to be a significant mediator of play outcomes (Q(3) = 8.52, $p = 0.036$)."	
Focus of intervention	Child, parent, peer, teacher	Play	Not specified	"The three interventions that focused on the child demonstrated a significant, large effect size ($z(3) = 2.954$, p= 0.003, Hedges'g= 0.903, 95% CI [0.304, 1.501]), whereas the three interventions that had a combination of child and parent focus demonstrated a significant, small effect size($z(3) = 2.387$, p= 0.017, Hedges' g= 0.291, 95% CI[0.052, 0.529]). There was only one intervention that focused on a combination of the child and peer and only one that focused on the teacher included in analysis, both demonstrated a negligible effect size that was not significant($z(1) = 0.094$, p= 0.925, Hedges' g= 0.033, 95% CI [-0.663, 0.730]) and ($z(1) = 0.142$, p= 0.887, Hedges' g=0.036, 95% CI [-0.455, 0.526]) respectivelyHowever, focus of the intervention (i.e., child, parent, peer or teacher) was found to be a significant mediator of play outcomes (Q(3) = 8.52, p= 0.036)."	Interventions that focused on the child related to better intervention effects on play skills compared to interventions that focused on parents, peers, or teachers.
Intervention setting	Clinic, home, school	Play	Not specified	"No effect size for the clinic, home, or school setting was significant (clinic z(2) = 1.221,p= 0.222, Hedges' g=0.887,95%Cl[-0.537, 2.311]; home: z(2) = 1.402,p= 0.161, Hedges' g= 0.286,	Intervention setting not related to the intervention



		95% CI [-0.114, 0.685]; school: z(4) = 1.469,p=	effect on play
		0.142, Hedges' g=0.259, 95% CI [-0.087,	skills.
		0.605]) The analysis of intervention	
		characteristics indicated that intervention	
		setting and group vs individual were not	
		significant mediators of intervention effects (see	
		Table5)."	

Khan et al. (2019) – Meta-analysis (relevant outcomes based on narrative synthesis only)

Outcome	Verbatim summary from systematic review	Categorised outcome
Caregiver satisfaction/dissatisfaction	"In the study by Conaughton et al [22], children and parents reported moderate levels of satisfaction following treatment. In the study by Fletcher-Watson et al [24], parents gave verbal comments on the app and what they perceived to be their child's response to it. Replies were categorized as Positive, Mixed, or Negative, and there were positive responses to questions on overall experience with the app, whether the child and parent liked the app, and ease of use. In the other study to measure participant satisfaction [26], caregivers of children in the Therapy Outcomes By You (TOBY) intervention group were asked to list up to 3 features that they liked or disliked about the app. The most frequent like statement related to TOBY providing a helpful therapy-planning tool. Other common statements were that TOBY was easy to use and that the app provided a positive learning experience for their child with an attractive structure and layout. The most common dislike	Summarised inconsistent effect
	statement was that the offline iPad activities were too time-consuming to prepare"	



Knight et al. (2013) – Narrative synthesis

Outcome	Verbatim summary from systematic review	Categorised outcome
Academic	Results are summarised in Table 3 "Three demonstrations of effect" and indicated inconsistent effects.	Summarised inconsistent effect

Lang et al. (2012) – Narrative synthesis

Outcome	Verbatim summary from systematic review	Categorised outcome
General outcomes (intervention outcomes)	"The results of 14 studies (56%) were classified as negative because no benefit to any participant on any dependent measure was found. Of those 14 studies, 4 suggested that SIT may have contributed to increases in stereotypy and problem behavior (Carter, 2005; Davis et al., 2011; Devlin et al., 2011; Kane et al., 2004). Across the studies reporting negative findings, eight were rated as providing a suggestive level of certainty (e.g., Watling & Dietz, 2007), one was rated at the preponderance level (Devlin et al., 2011) and five were rated as providing a conclusive level of certainty. All five studies with a conclusive level of certainty and negative findings involved wearing a weighted vest. The results of eight studies were classified as mixed because some but not all participants improved or some but not all dependent variables improved. For example, Ayres and Tickle (1980) classified six participants as "good responders" to SIT and four as "poor responders". Across the studies with mixed results, six were classified at the suggestive level of certainty and two were classified at the conclusive level of certainty (Hodgetts et al., 2011b; Van Rie & Heflin, 2009). The results of three studies were classified as positive level of certainty (Fazlioglu & Baran, 2008; Linderman & Stewart, 1999; Thompson, 2011)."	Summarised null effect



Logan	et	al.	(2017)	– Narrative	svnthesis
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Outcome	Verbatim summary from systematic review	Categorised outcome
Social-communication (communication functions)	<i>Single-case</i> : "In six of the SCEDs (25%), evidence was provided of at least partial improvement over time, and in 18 (75%) there was evidence of improvement in all participants over time. Notably, all targeted communication functions improved to some extent"	Summarised inconsistent effect
	<i>Group designs</i> : "In each of the group studies of PECS (Table 2), improvements were found consistently for teaching object requests, but inconsistently for other functions."	
	<i>Maintenance</i> : "Assessment of intervention maintenance was included in 12 SCED studies (50%) (see Table 1). In all of these, at least partial maintenance was demonstrated (i.e., of some dependent	
	variables or participants). In the group studies, four included assessment of intervention maintenance, but it was demonstrated in only two (see Table 2). Where maintenance did occur, it was demonstrated in performance on communication assessments (e.g., Schreibman & Stahmer, 2014), or varied according to communication behavior (e.g., demonstration of maintenance of production of comments over time versus attenuation of effects on other dependent variables; Kasari et al., 2014)."	
	<i>Generalisation</i> : "Of the SCED studies, 12 (50%) included assessment of generalization, with all demonstrating it to some degree (see Supplemental Appendix B for definition). Generalization was addressed in only two group studies (33%). Schreibman and Stahmer (2014) included a generalization setting in their intervention, but did not report specific information about transfer of effects. In a follow-up to Yoder and Stone (2006), Yoder and Lieberman (2010) reported generalization for a far-treatment measurement context (i.e., with the use of a different examiner, setting, activity, and materials)."	
Caregiver satisfaction (social validity)	"Of the SCED studies, six (25%) included assessment of social validity for procedures, and nine (38%) for outcomes (see Table 1). All demonstrated social validity at least partially for procedures and outcomes. Social validity was not assessed or included in five of the six group studies (83%). In contrast, Schreibman and Stahmer (2014) surveyed parental satisfaction, finding that although highly satisfied with the PECS intervention, parents of children who	Summarised inconsistent effect



received the intervention rated it as significantly more difficult to implement than did parents of children who	
received Pivotal Response Training, an intervention that did not include aided AAC."	

Makrygianni & Reed (2010) – Meta-analysis

Outcome	Context	Studies included	Effect size	Heterogeneity	Categorised outcome
Social- communication (socialisation)	High methodological quality group, and pre/post in treatment group only	4	wES = 0.736, Mean SE = 0.141	Q = 7.800	Positive pooled effect
Communication	High methodological quality group, and pre/post in treatment group only	4	wES = 0.967, Mean SE = 0.115	Q = 2.100	Positive pooled effect
Communication (language)	High methodological quality group, and pre/post in treatment group only	4	wES = 0.990, Mean SE = 0.134	Q = 1.672	Positive pooled effect
	Low methodological quality group, and pre/post in treatment group only	4	wES = 0.897, Mean SE = 0.148	Q = 3.298	Positive pooled effect
	High methodological quality group, and pre/post compared to control group	2	wES = 0.534, Mean SE = 0.224	Q = 0.404	Positive pooled effect
	Low methodological quality group, and pre/post compared to control group	4	wES = 0.910, Mean SE = 0.177	Q = 1.996	Positive pooled effect
Cognition (IQ)	High methodological quality group, and pre/post in treatment group only	5	wES = 0.950, Mean SE = 0.132	Q = 0.535	Positive pooled effect



	Low methodologic pre/post in treatme	cal quality group, and ent group only	11	wES = 0.909, Mean SE = 0.079	Q = 17.73	Positive pooled effect
	High methodologi pre/post compare	cal quality group, and d to control group	3	wES = 0.568, Mean SE = 0.192	Q = 5.076	Positive pooled effect
	Low methodological quality group, and pre/post compared to control group		8	wES = 0.730, Mean SE = 0.123	Q = 19.431	Positive pooled effect
Adaptive behaviour	High methodological quality group, and pre/post in treatment group only		4	wES = 0.421, Mean SE = 0.154	Q = 7.990	Positive pooled effect
	Low methodological quality group, and pre/post in treatment group only		7	wES = 0.474, Mean SE = 0.108	Q = 8.032	Positive pooled effect
	High methodological quality group, and pre/post compared to control group		2	wES = 0.971, Mean SE = 0.256	Q = 4.310	Positive pooled effect
	Low methodological quality group, and pre/post compared to control group		5	wES = 0.656, Mean SE = 0.153	Q = 11.523	Positive pooled effect
Moderators	Context	Outcome	Studies included	Verbatim summary from systematic review		Categorised outcome
Child age	-	IQ	ES ₁ = 14 ES ₂ = 8	"Apart from the above trends, there were no statistical significantly correlations found with the ES1s ¹ . Concerning the other ES2 ² relationships, there were not any statistically significant correlation, and it would be unwise to comments further, as the number of the programs providing the relevant ES2s was quite small"		Child age not related to intervention effect on cognition, adaptive behaviour, or language.



 communication (Intervention of the SDI and ES2 or the studied evelopmental aspects. This implies that the children's intellectual abilities at the children at intake. The behavioural EIPs are equally effective for both non- inguistic children, and children at intake. The behaviour for abilities at the children at intake. The behaviour for abay the behaviour is a studies across outcome Adaptive behaviour is a studies at the behaviour is a studies at the behaviour is a studies across outcome Adaptive behaviour abilities of the children at intake. The order at intake at the behaviour abilities of the children at intake. The intervention adaptive behaviour abilities at the behaviour is a studies across outcome Adaptive behaviour abilities of the children at intake. The more effective the behavioural EIPs are iniproving the language abilities of the children at intake, the more effective the behaviour abilities of the c



Intervention duration	-	IQ	ES ₁ = 14 ES ₂ = 8	"No statistical significant relationship was found for any ES1 of developmental aspects. Thus, the most conservative conclusion would be that prolonging an intervention program over several years does not necessarily entail the maintenance of the same progress rate in the developmental domains, and that the effectiveness of the program varies independently from the programs' duration"	Intervention duration (months) not related to intervention effect on cognition, adaptive behaviour, or language.
Intervention intensity	-	IQ	ES ₁ = 12 ES ₂ = 8	"The present analysis shows (see Table 4) that there are statistically significant correlations between the intensity of the EIP and ES1 for children's intellectual, and adaptive behavioural, functioning. The correlation coefficients of 0.674 for intellectual abilities, and 0.855 for adaptive behavioural functioning, are characterised as moderate to high. Thus, it appears that more intensive programs, in general, have a higher impact on the gain in intellectual, and adaptive behavioural abilities of children with ASD. However, the intensity of the behavioural program does not seem to be correlated with progress on the children's language abilities. There was also a high, positive correlation between program intensity and ES2 for intellectual abilities (r = 0.842), and between program intensity and ES2 for adaptive behaviour abilities (r = 0.885). This means that the more intensive the behavioural EIP, the more effective it is compared to the control program in	Higher intensity (hours per week) related to greater intervention effect on cognition and adaptive behaviour, but not language.



	improving the intellectual and adaptive behaviour	
	abilities of children with ASD."	

¹ "ES1 describes the effectiveness of the behavioural EIPs in terms of the difference between the pre-treatment and posttreatment performances."

² "ES2 The second approach to assessing the effectiveness of the behavioural EIPs, ES2, gives the magnitude of the effect comparing the behavioural group with the control group (where one existed)"

Mazon et al. (2019) – Narrative synthesis

Outcome	Verbatim summary from systematic review	Categorised outcome
General outcomes (statistical significance)	"Overall, TE studies reported inconsistent results concerning the TBI effect, i.e., 7 with highly-positive, 8 with slightly-positive, and 8 with limited evidence. Fewer of the TBI effects reported in RCT studies were highly-positive ($N = 3/14$) than in controlled studies ($N = 4/8$, Table 5). Although there were fewer TU studies, all controlled trials, the TBI effects reported were mostly slightly-positive ($N = 4/6$). Hence, the highly-positive evidence for TBI was dependent on the study design, irrespective of its aim (TE vs. TU): the more robust the study design, the less consistent the results."	Summarised inconsistent effect

McCoy et al. (2016) – Narrative synthesis

Outcome	Verbatim summary from systematic review	Categorised outcome
Social-communication (social skills)	"Two of the SSRD studies used a CBI intervention to increase social skills, producing a median NAP effect size of [note NAP could only be calculated based on two studies] 1.0. A NAP effect size between 0.93 and 1 reflects a treatment of large effect. Table 4 provides a summary of the NAP effect size for each individual study[regarding research strength and evidence-based practice evaluation]:	Summarised positive effect


For studies that used a CBI intervention, one (8.33 %) study was rated as "strong" and two (16.66 %)	
studies were rated as "adequate". The remaining nine studies (75 %) were rated as "weak". An	
evidence-based status Z score of 45 was calculated [(1*30)+ (2*15)+ (0*4)+ (0*2)=60], indicating that	
CBI interventions could be categorized as an established evidence-based practice (Reichow 2011).	
Table 4 provides a summary of the strength ratings for each study included in this review."	
Tuble + provides a summary of the strength futings for each study metaded in this review.	

Miguel-Cruz et al. (2017) – Narrative synthesis

Outcome	Verbatim summary from systematic review	Categorised outcome
Social-communication (interaction)	"Regarding the outcome interaction, the highest level of evidence is 4, which was provided by a post- test-only control group that showed that children with ASD did not show any statistically significant differences compared with typically developing children when recognizing the basic emotional expressions of the Zeno R50 robot [14], and two pretest–post-test no control group studies had a level of evidence of 4, whereby the autistic behaviour of children with ASD decreased after interacting with a NAOTMrobot[35], and that they showed more engagement in their interactive behaviour with a NAOTMrobot than with a teacher [36]. The remaining studies that assessed the outcomes related to inter-action skills in children with ASD achieved the lowest level of evidence, i.e., 5, including a case study and a single case that showed that the KEEPONVRrobot sparked the child's interest in interacting [37] and facilitated the spontaneous exchange and sharing of mental states with other children [38]. Another case study showed that children with ASD paid attention to the Gipy-1robot for almost 80% of the sessions [39]. Three case studies reported mixed results regarding the effects of using the NAOTMrobot on children's skills at imitating the robot's actions [40–42]. One case study reported that children with ASD showed a decrease in stereotyped behaviours during interaction with aNAOTMrobot [43]. A single case design reported that children showed improved social behaviour when playing with their peers after they had interacted with the KASPAR robot during play activities [44]. Thus, the level of evidence is low regarding these robots for the interaction skills outcome."	Summarised inconsistent effect



RRB (repetitive and maladaptive	"The highest level of clinical evidence in the papers involving children with ASD was an RCT that got a	Summarised
behaviours)	PEDro score of 5 [15]. According to the Sackett criteria [26], this paper offers a level of evidence of 3	negative effect
	that an intervention with a NAOTMrobot did not have an effect on reducing repetitive and	
	maladaptive behaviours in children with ASD. In contrast, a significant reduction in repetitive and	
	maladaptive behaviours was observed in the group that received treatment based on interaction with	
	a therapist. Similarly, the group that interacted with a human showed a significant reduction in	
	negative affect and an increase in interested affect, whereas the robot group showed a reduction in	
	positive affect."	

Moon et al. (2020) – Meta-analysis

Outcome	Context	Studies included	Effect size	Heterogeneity	Categorised outcome
Social-communication	3-month follow-up	2	SMD = 0.18, 95CI [-0.20, 0.56]	l ² = 0%	Null pooled effect
	6-month follow-up	2	SMD = 0.00, 95CI [-0.55, 0.55]	l ² = 53.11%	Null pooled effect
Communication (gestures)	3-month follow-up	2	SMD = 0.32, 95CI [-0.05, 0.69]	l ² = 0%	Null pooled effect
Communication (symbolic)	3-month follow-up	2	SMD = 0.05, 95CI [-0.33, 0.43]	l ² = 0%	Null pooled effect
Expressive language	-	2	SMD = 0.25, 95CI [-0.36, 0.86]	l ² = 60.99%	Null pooled effect



Expressive language (words produced)	-	2	SMD = -0.23, 95CI [-0.68, 0.22]	l ² = 32.56%	Null pooled effect
Receptive language	-	2	SMD = 0.24, 95CI [-0.13, 0.61]	l ² = 0%	Null pooled effect
Cognition (visual reception)	-	2	SMD = 0.41, 95CI [0.03, 0.80]	l ² = 5.2%	Positive pooled effect
Motor (fine motor)	-	2	SMD = 0.44, 95CI [0.06, 0.81]	l ² = 0%	Positive pooled effect

Murza et al. (2016) – Meta-analysis

Outcome	Context	Studies included	Effect size	Heterogeneity	Categorised outcome
Social-communication (joint attention)	Joint attention versus control group	9	g = 0.660 (0.395, 0.925)	Not specified	Positive pooled effect
	Joint attention versus symbolic play	2	g = 0.527 (0.077, 0.978)	Not specified	Positive pooled effect
	Joint attention versus control group: treatment administered by parent	5	g = 0.678 (0.313, 1.043)	Not specified	Positive pooled effect



	Joint attention versus control group: discrete trial training plus social interactive approach		5	g = 0.762 (0.337, 1.187)	Not specified	Positive pooled effect
	Joint attention vers social interactive a	sus control group: pproach only	4	g = 0.589 (0.194, 0.983)	Not specified	Positive pooled effect
Moderators	Context	Outcome	Studies Included	Verbatim summary from syste	ematic review	Categorised outcome
Intervention agent	-	Social- communication (joint attention)	Not specified	"All comparisons, including the follow ups, resulted in a statist effect, with the largest effects discrete trial training plus social approach followed by joint atte that were administered by a part the overlapping confidence into that none of the comparisons of different from each other (Sche Gentleman 2001). This implies interventions are similar in terr one type of intervention not sig efficacious than another. Spec administrator, dosage, and des comparison, etc.) characteristic do not appear to produce sign effects due to the overlapping intervals."	ose conducted as ically significant evidenced for al interactive ention treatments arent. However, tervals suggest were statistically enker and that the ns of efficacy with gnificantly more ifically, treatment sign (control or cs of the studies ificantly different confidence	Intervention agent (parent, non-parent) not related to intervention effects on communication.



National Autism Center (2015) – Narrative synthesis

Outcome	Verbatim summary from systematic review	Categorised outcome
Behavioural interventions		
Social-communication (interpersonal)	Noted as 'skill increased'	Summarised positive effect
RRB (restricted, repetitive, non-functional patterns of behaviour, interests, or activity)	Noted as 'behaviors decreased'	Summarised positive effect
Sensory (sensory or emotional regulation)	Noted as 'behaviors decreased'	Summarised positive effect
Communication	Noted as 'skill increased'	Summarised positive effect
Cognition (higher cognitive functions)	Noted as 'skill increased'	Summarised positive effect
Motor	Noted as 'skill increased'	Summarised positive effect
Social-emotional/challenging behaviour (self- regulation, problem behaviour)	Self-regulation: Noted as 'skill increased' Problem behaviour: Noted as behaviours decreased'	Summarised positive effect
Play	Noted as 'skill increased'	Summarised positive effect
Adaptive behaviour (personal responsibility)	Noted as 'skill increased'	Summarised positive effect
School/learning readiness (learning readiness)	Noted as 'skill increased'	Summarised positive effect
Academic	Noted as 'skill increased'	Summarised positive effect



Early Intensive Behavioural Interventions (EIBI)				
Overall autism characteristics (general symptoms)	Noted as 'behaviors decreased'	Summarised positive effect		
Social-communication (interpersonal)	Noted as 'skill increased'	Summarised positive effect		
Communication	Noted as 'skill increased'	Summarised positive effect		
Cognition (higher cognitive functions)	Noted as 'skill increased'	Summarised positive effect		
Motor	Noted as 'skill increased'	Summarised positive effect		
Social-emotional/challenging behaviour (problem behaviour)	Noted as 'behaviors decreased'	Summarised positive effect		
Adaptive behaviour (personal responsibility)	Noted as 'skill increased'	Summarised positive effect		
School/learning readiness (learning readiness)	Noted as 'skill increased'	Summarised positive effect		
Academic	Noted as 'skill increased'	Summarised positive effect		
Functional Communication Training				
General outcomes	Identified as having an 'emerging level of evidence'	Summarised inconsistent effect		
Language Training (Production)				
Communication	Noted as 'skill increased'	Summarised positive effect		



Language Training (Production and Understanding)					
General outcomes	Identified as having an 'emerging level of evidence'	Summarised inconsistent effect			
Picture Exchange Communication System (PE	CS)				
General outcomes	Identified as having an 'emerging level of evidence'	Summarised inconsistent effect			
Developmental Relationship-based Treatment					
General outcomes	Identified as having an 'emerging level of evidence'	Summarised inconsistent effect			
DIR/Floortime					
General outcomes	Identified as having an 'unestablished level of evidence'	Summarised null effect			
Naturalistic Teaching Strategies					
Social-communication (interpersonal)	Noted as 'skill increased'	Summarised positive effect			
Communication	Noted as 'skill increased'	Summarised positive effect			
School/learning readiness (learning readiness)	Noted as 'skill increased'	Summarised positive effect			
Pivotal Response Treatment (PRT)					
Communication	Noted as 'skill increased'	Summarised positive effect			
Play	Noted as 'skill increased'	Summarised positive effect			



School/learning readiness (learning readiness)	Noted as 'skill increased'	Summarised positive effect				
Sensory-intervention package	Sensory-intervention package					
General outcomes	Identified as having an 'unestablished level of evidence'	Summarised null effect				
Auditory Integration Training						
General outcomes	Identified as having an 'unestablished level of evidence'	Summarised null effect				
Music Therapy						
General outcomes	Identified as having an 'emerging level of evidence'	Summarised inconsistent effect				
Structured Teaching						
General outcomes	Identified as having an 'emerging level of evidence'	Summarised inconsistent effect				
Technology-based Intervention						
General outcomes	Identified as having an 'emerging level of evidence'	Summarised inconsistent effect				
Augmentative and Alternative Communication (AAC)						
General outcomes	Identified as having an 'emerging level of evidence'	Summarised inconsistent effect				
Facilitated Communication						
General outcomes	Identified as having an 'unestablished level of evidence'	Summarised null effect				



Sign Instruction						
General outcomes	Identified as having an 'emerging level of evidence'	Summarised inconsistent effect				
Animal-assisted Therapy	Animal-assisted Therapy					
General outcomes	Identified as having an 'unestablished level of evidence'	Summarised null effect				
Cognitive Behavioural Intervention						
Social-communication (interpersonal)	Noted as 'skill increased'	Summarised positive effect				
Sensory (sensory or emotional regulation)	Noted as 'behaviors decreased'	Summarised positive effect				
Social-emotional/challenging behaviour (problem behaviour)	Noted as 'behaviors decreased'	Summarised positive effect				
Adaptive behaviour (personal responsibility)	Noted as 'skill increased'	Summarised positive effect				
School/learning readiness (placement)	Noted as 'skill increased'	Summarised positive effect				
Exposure Package						
General outcomes	Identified as having an 'emerging level of evidence'	Summarised inconsistent effect				
Imitation Based Training						
General outcomes	Identified as having an 'emerging level of evidence'	Summarised inconsistent effect				



Multi-component Package								
General outcomes	Identified as having an 'emerging level of evidence'	Summarised inconsistent effect						
Reductive Package								
General outcomes	Identified as having an 'emerging level of evidence'	Summarised inconsistent effect						
Social Behavioural Learning Strategy								
General outcomes	Identified as having an 'unestablished level of evidence'	Summarised null effect						
Social Cognition Intervention								
General outcomes	Identified as having an 'unestablished level of evidence'	Summarised null effect						
Social-communication Intervention								
General outcomes	Identified as having an 'emerging level of evidence'	Summarised inconsistent effect						
Social Thinking Intervention								
General outcomes	Identified as having an 'unestablished level of evidence'	Summarised null effect						
Theory of Mind Training								
General outcomes	Identified as having an 'emerging level of evidence'	Summarised inconsistent effect						



Parent Training							
Overall autism characteristics (general symptoms)	Noted as 'behaviors decreased'	Summarised positive effect					
Social-communication (interpersonal)	Noted as 'skill increased'	Summarised positive effect					
RRB (restricted, repetitive, nonfunctional patterns of behaviour, interests, or activity)	Noted as 'behaviors decreased'	Summarised positive effect					
Social emotional/challenging behaviour (problem behaviour)	Noted as 'behaviors decreased'	Summarised positive effect					
Play	Noted as 'skill increased'	Summarised positive effect					
Peer-Training							
Social-communication (interpersonal)	Noted as 'skill increased'	Summarised positive effect					
RRB (restricted, repetitive, nonfunctional patterns of behaviour, interests, or activity)	Noted as 'behaviors decreased'	Summarised positive effect					
Communication	Noted as 'skill increased'	Summarised positive effect					
School/learning readiness (learning readiness)	Noted as 'skill increased'	Summarised positive effect					



Naveed et al. (2019) – Meta-analysis

Outcome	Context	Studies included	Effect size	Heterogeneity	Categorised outcome
Overall autism characteristics (autism symptom severity)	-	7 trials, 10 studies ¹	SMD = 0.44, 95CI [0.27, 0.60]	l ² = 0% Chi ² = 5.42	Positive pooled effect
Social-communication (social skills)	-	10 trials, 18 studies ¹	SMD = 0.53, 95CI [0.34, 0.73]	l ² = 48.59% Chi ² = 31.12	Positive pooled effect
Social-communication (joint engagement)	-	4 trials, 7 studies ¹	SMD = 0.63, 95CI [0.21, 1.06]	l ² = 75.88% Chi ² = 24.87	Positive pooled effect
Social-communication (joint attention)	-	7 trials, 8 studies ¹	SMD = 0.16, 95CI [-0.22, 0.54]	l ² = 76.13% Chi ² = 29.32	Null pooled effect
RRB (repetitive behaviours)	-	2 trials, 3 studies ¹	SMD = 0.33, 95CI [0.05, 0.62]	l ² = 0% Chi ² = 0.17	Positive pooled effect
Communication	-	15 trials, 13 studies ¹	SMD = 0.23, 95CI [0.03, 0.42]	l ² = 37.96% Chi ² = 17.73	Positive pooled effect
Expressive language	-	15 trials, 6 studies ¹	SMD = 0.47, 95CI [0.22, 0.72]	l ² = 53.59% Chi ² = 8.62	Positive pooled effect
Receptive language	-	15 trials, 4/5 studies ¹	SMD = 0.16, 95CI [-0.24, 0.55]	l ² = 53.34% Chi ² = 7.38	Null pooled effect



Cognition (visual reception)	-	3	SMD = 0.29, 95CI [0.01, 0.57]	l ² = 0% Chi ² = 1.22	Positive pooled effect
Motor (motor skills)	-	5 trials, 6 studies ¹	SMD = 0.25, 95CI [0.02, 0.48]	l ² = 0% Chi ² = 4.18	Positive pooled effect
Social emotional/challenging behaviour (self-regulation)	-	3	SMD = 0.54, 95CI [0.06, 1.03]	l ² = 55.91% Chi ² = 4.36	Positive pooled effect
Adaptive behaviour	-	6 trials, 7 studies ¹	SMD = 0.26, 95CI [-0.001, 0.52]	l ² = 41.44% Chi ² = 10.25	Null pooled effect
Caregiver social emotional wellbeing (parental distress)	-	7	SMD = 0.33, 95CI [0.09, 0.57]	l ² = 52.01% Chi ² = 18.75	Positive pooled effect
Caregiver social emotional wellbeing (parental self- efficacy)	-	4	SMD = 0.42, 95CI [0.23, 0.62]	$l^2 = 0\%$ Chi ² = 4.64	Positive pooled effect
Caregiver social emotional wellbeing (parent-child relationship)	-	6	SMD = 0.67, 95CI [0.23, 1.10]	l ² = 76.0% Chi ² = 20.83	Positive pooled effect
Child satisfaction (child distress)	-	2	SMD= 0.55, 95CI [0.25, 0.85]	l ² = 0% Chi ² = 1.76	Positive pooled effect
Moderators	Context	Outcome Studies Included	Verbatim summary from systemat	ic review	Categorised outcome



Child age	-	General outcomes	Not specified	"Initially, meta-regression analysis was run inclusive for all outcomes. It did not reveal any significant effects of age, year of publication or duration of program and session or	Age not related to intervention effects
Intervention duration	-	General outcomes	Not specified	number of sessions or quality of trials on the significance of these interventions."	Intervention duration (weeks) not related to intervention effects
Intervention amount	-	General outcomes	Not specified		Number of intervention sessions not related to intervention effects
Intervention agent	-	Autism core characteristics (symptom severity), social- communication (joint attention)	Not specified	"Subgroup analyses was run when specific outcomes reported in four studies. It did not reveal any significant differences among interventions delivered by different agents on outcomes of symptom severity and joint attention."	Intervention agent (parent, peer, teacher, school staff, childcare worker) not related to intervention effects on autism core characteristics (including joint attention)

¹Both numbers reported.

Nevill et al. (2018) – Meta-analysis

Outcome	Context	Studies included	Effect size	Heterogeneity	Categorised outcome
Overall autism characteristics (autism symptom severity)	-	6	g = 0.22, 95Cl [0.03, 0.41]	Q = 3.79 ² = 0%	Positive pooled effect



Social-communication (socialisation) Communication (language) Cognition	-		13 13 6	g = 0.23, 95CI [0.09, 0.36] g = 0.16, 95CI [0.02, 0.31] g = 0.24, 95CI [0.03, 0.46]	Q = 35.90 $l^2 = 66.57\%$ Q = 11.50 $l^2 = 0\%$ Q = 1.86 $l^2 = 0\%$	Positive pooled effect Positive pooled effect Positive pooled effect
Moderators	Context	Outcome	Studies Included	Verbatim summary from syst	ematic review	Categorised outcome
Intervention amount	<20h parent training vs 20 hours or higher of parent training	Autism core characteristics (symptom severity), social- communication (socialisation), communication (language), cognition	ASD severity: <20h n=2, $\geq 20h n=4$ Social- communication (socialisation): <20h n=5, $\geq 20h n=8$ Communication (language): <20h n=6, $\geq 20h n=7$ Cognition: <20h n=1, $\geq 20h n=5$	"Effect of intervention by dose training. Dose of active interve from 2.3 to 104 h. Studies were providing less than 20 h (k = 9 (k = 10) of parent training while treatment group. Results of su analyses based on dose are si For studies with less than 20 h training, socialization and com language was associated with effects. Analyses were not per cognition or ASD symptom set there was only one study asse cognition and two studies asso ASD symptom severity. Across doses at or above 20 h, small observed for socialization and	e of parent ention ranged e coded as) or 20 h or more e in the active bgroup meta- hown in Table 8. n of parent munication- small treatment formed for verity because essing change in essing change in s studies with effects were cognition, and	Total hours of intervention not related to intervention effect on autism core characteristics, socialisation, communication, or cognition.



		trivial non-significant effects were observed for	
		ASD symptom severity and communication-	
		language. Outcomes were not significantly	
		different based on dose of treatment. Hedges'-	
		Q homogeneity tests were non-significant	
		across outcomes."	

Ona et al. (2020) – Meta-analysis with narrative synthesis

Outcome	Context	Studies included	Verbatim summary from systematic review	Categorised outcome
Social-communication (social interaction)	-	-	"Hardan et al. (2015) measured the effectiveness of PRT by using an objectively assessed severity scale (CGI-S) (SMD 0.46; 95% CI-0.12 to 1.04;P= 0.12) and an improvement scale (CGI-I) (SMD 1.12; 95% CI 0.50 to 1.74;P=0.0004).The authors also reported a more subjective outcome measure (SRS) that gave rise to an SMD of 0.48 (95% CI-1.10 to 1.06; P= 0.10). The reported effect estimates were highly inconsistent, preventing us from drawing firm conclusions about the effectiveness of PRT."	Summarised inconsistent effect
RRB	-	-	"Only Mohammadzaheri et al. (2015) assessed repetitive behavior through direct assessment, and the authors showed a statistically significant effect in favor of PRT (SMD 15.97;95% Cl 11.57 to 20.36;P<0.0001)."	Summarised positive effect



			Effect size	Heterogeneity	
Communication	-	2	SMD = 1.12, 95CI [-0.49, 2.73]	$l^2 = 89\%$ $\tau^2 = 1.2$	Null pooled effect
Expressive language	-	2	SMD = 0.48, 95CI [0.04, 0.93]	$l^2 = 0\%$ $\tau^2 = 0.0$	Positive pooled effect

Oono et al. (2013) – Meta-analysis

Outcome	Context	Studies included	Effect size	Heterogeneity	Categorised outcome
Overall autism characteristics (severity of autism characteristics)	-	6	SMD = -0.30, 95CI [-0.52, -0.08]	l ² = 0%	Positive pooled effect
Social-communication (shared or joint attention)	-	3	SMD = 0.41, 95CI [0.14, 0.68]	l ² = 0%	Positive pooled effect
Social-communication (child initiations)	-	4	SMD = 0.38, 95CI [-0.07, 0.82]	l ² = 60%	Null pooled effect
Communication	Parent or teacher report	3	SMD = 5.31, 95CI [-6.77, 17.39]	l ² = 75%	Null pooled effect
Communication (joint language)	Direct or independent assessment	2	SMD = 0.45, 95CI [-0.05, 0.95]	l ² = 0%	Null pooled effect



Expressive language (expression)	Direct or independent assessment	3	SMD = 0.14, 95CI [-0.16, 0.45]	l ² = 29%	Null pooled effect
Receptive language (comprehension)	Direct or independent assessment	2	SMD = 0.29, 95CI [-0.20, 0.78]	l ² = 57%	Null pooled effect
			Verbatim summary from systematic revie	w	
Social-communication			"Carter 2011 used a directly observed assessment measure, the Early Social Communication Scales, and found no difference after intervention. Studies using a parent-report of socialisation skills, the Vineland Adaptive Behavior Scales (Smith 2000; Roberts 2011; Tonge 2012) found a varied picture depending on the contrast condition, but suggesting some improvement within the more intensive treatment group. Despite the treatment focus being on physical massage, Silva 2009 also reported a significant improvement on a measure of teacher-reported social and language skills."		Summarised inconsistent effect
Cognitive (developmental/intellectual gains)	-	-	"five studies (Smith 2000; Drew 2002; Rickards 2007; Dawson 2010; Tonge 2012) with varying theoretical basis and methods for assessing developmental/intellectual gains reported on this outcome. Dawson 2010 and Rickards 2007 suggest that small gains were made in this domain following intervention. However, Drew 2002 and Tonge 2012 (individual and group intervention, respectively) did not report any difference in this domain between intervention and control groups following intervention. Smith 2000 found greater gains for the intensive therapist-delivered		Summarised positive effect



Social-emotional/challenging behaviour (maladaptive behaviour)	-	_	 intervention condition. Evidence for gains from parent- mediated intervention therefore may be suggested. However, gains in formal assessment may in part reflect child co-operation." "Four studies (Smith 2000; Tonge 2006/Tonge 2012; Rickards 2007; Roberts 2011) reported on this outcome. Due to significant and important differences between these studies in theoretical basis and outcome measures used, a meta-analysis could not be conducted. None found a significant difference in maladaptive behaviour in favour of the intervention group, even where that was the focus of intervention (Tonge 2012)." 		Summarised null effect
			Effect size	Heterogeneity	
Adaptive behaviour	-	2	SMD = 1.06, 95CI [-2.95, 5.06]	l ² = 86%	Null pooled effect
Caregiver communication and	_	з	SMD - 0.90 0ECI [0.E6, 1.22]	1 ² - 77 %	Besitive peoled
interaction (parental synchrony)		5	SMD – 0.90, 95CI [0.56, 1.25]	1 - 2770	effect
interaction (parental synchrony) Caregiver social emotional wellbeing (parents' level of stress)	-	2	SMD = -0.17, 95CI [-0.70, 0.36]	² =0%	effect Null pooled effect
interaction (parental synchrony) Caregiver social emotional wellbeing (parents' level of stress)	-	2	SMD = -0.17, 95CI [-0.70, 0.36] Verbatim summary from systematic revie	$l^2 = 0\%$	effect Null pooled effect



Caregiver satisfaction	-	-	"Parents' satisfaction with therapy: only one study reported on this outcome and it was stated that "customer" satisfaction was high with mean ratings of 5.48 (out of 6) on the group experience questionnaire and 3.46 (out of 4) on the group leader experience questionnaire (Carter 2011)"	Summarised positive effect
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Parsons, Cordier, Munro et al. (2017) – Meta-analysis

Outcome	Context		Studies included	Effect size	Heterogeneity	Categorised outcome
Social-communication (pragmatic language)	Compared to co	ontrols	17 intervention groups from 15 studies	g = 0.274, 95CI [0.088 – 0.460]	Q = 19.413 I ² = 17.570%	Positive pooled effect
	Intervention effe intervention gro comparison)	ect (i.e., within oup, pre/post	17 intervention groups from 15 studies	g = 0.500, 95Cl [0.352 – 0.647]	-	Positive pooled effect
Moderators	Context	Outcome	Studies Included	Verbatim summary from systematic re	eview	Categorised outcome
Child age		Social- communication (pragmatic language)	17 intervention groups from 15 studies	"No differences were detected in outco participant age or method of pragmatic measurement (i.e., parent report, obser task)Lastly, as there was a concordar age and receiving intervention in a gro examined in relation to mode. This did	omes as a result of anguage vation, or lab nee between increased up, participant age was not produce a	Age not related to intervention effects on social- communication.



				significant result, indicating age did not mediate the effect of mode of delivery (i.e., individual, group, or both)."	
Intervention setting	Home, school, clinic	Social- communication (pragmatic language)	17 intervention groups from 15 studies	"Interventions set in the clinic demonstrated a significant, moderate effect size ($z(12) = 5.758$, p < 0.001, Hedge's g = 0.535, 95%CI = 0.353–0.718), which was the largest effect size calculated as a function of setting. Interventions set in the school were approaching significance, with a small effect ($z(3)$ = 1.925, p = 0.054, Hedge's g = 0.408, 95%CI = -0.007–0.824), Interventions set in the clinic demonstrated a significant, moderate effect size ($z(12) = 5.758$, p < 0.001, Hedge's g = 0.535, 95%CI = 0.353–0.718), which was the largest effect and interventions set in the home did not have a significant effect on improving pragmatic language skills when compared to the other settings ($z(2) = 1.846$, p = 0.065). However, these results should be interpreted with caution as only two studies were set in the home and just one at school compared to 12 in the clinic setting group"	Intervention setting not related to intervention effects on social- communication.
Intervention format	Individual, group	Social- communication (pragmatic language)	17 intervention groups from 15 studies	"Whether interventions were administered to a group, the individual or both, effects were significant and moderate in size. Group interventions produced the largest effect of the three modalities ($z(5) = 3.811$, p < 0.001, Hedge's g = 0.553, 95%CI = 0.269–0.838). The analysis of intervention characteristics indicated that intervention setting and mode were not significant mediators of intervention effect."	Intervention format (individual, group) not related to intervention effects on social- communication.



			Î.		
Intervention agent	Child, parent,	Social-	17 intervention	"Approaches that integrated a caregiver into the program via	Positive
	children and	communication	groups from 15	education and/or coaching in intervention techniques	intervention
	parent	(pragmatic	studies	demonstrated a significant, moderate-large effect (z(4) =	effect for
		language)		5.265, p < 0.001, Hedge's g = 0.760, 95%Cl = 0.477–1.043),	interventions
				while the intervention that focused on parent education only	with active
				had no significant impact on the pragmatic language skills of	parent
				children with ASD ($z(1) = 0.341$, $p = 0.733$). The majority of	involvement,
				studies focused on administering the intervention directly to	but not for
				the children with ASD, and these interventions demonstrated	interventions
				a significant, moderate effect (z(12) = 5.842,p < 0.001, Hedge's	with parent
				g = 0.482, 95%Cl = 0.320–0.644). Again, caution is required in	education
				interpreting these results as there is only one study in the	alone.
				parent focused group, and 12 and 4 in the child focused and	
				combined child and parent focused groups	
				respectivelyintervention focus (e.g. child, parent or child and	
				parent) was found to be a significant mediator of pragmatic	
				language outcomes (F(2) = 4.17, p = 0.0381), accounting for all	
				of the between study variance in the model (R2 = 100%)."	

Parsons, Cordier, Vaz et al. (2017) – Narrative synthesis

Outcome	Verbatim summary from systematic review	Categorised outcome
Social-communication (social	"Improvements in social behavior were measured in 2 studies using the Vineland adaptive behavior	Summarised
behaviour and communication skills)	scales (2nd edition)[55] with Ingersoll and Berger [43], Ingersoll et al [44], and Pickard et al [45]	inconsistent effect
	reporting no significant difference prepost intervention and Vismara et al [48] reporting a significant	
	difference in the social domains. Video-recorded interactions of the children with their parents were	
	used in the studies conducted by Vismara et al [12,48] and Wacker et al [47]. All reported statistically	



	significant improvements prepost intervention in joint attention and affect toward the parents with Wacker et al [47] reporting a reduction in child problem behavior."	
Communication (vocabulary production and comprehension)	"Vismara et al [12,48] and the study by Ingersoll and Berger [43], Ingersoll et al [44], and Pickard et al [45] utilized the MacArthur communicative developmental inventories [54] to measure the child's abilities in vocabulary production and comprehension. In all 3 studies, statistically significant improvements were reported in the children's vocabulary production and comprehension from baseline to follow-up."	Summarised positive effect
Caregiver satisfaction	"All reported that parents were satisfied with the training they received. When comparing a therapist- assisted and self-guided website versus a self-guided website only, large effect sizes were recorded in parents' perception of the appropriateness of the intervention and child Social-communication gains (Cohen d=0.94 and 0.84 respectively) in the study by Ingersoll and Berger [43], Ingersoll et al [44], and Pickard et al [45]."	Summarised positive effect
Caregiver communication and interaction (parental knowledge acquisition)	"Knowledge acquisition by parents was measured by Hamad et al [49], Heitzman-Powell et al [50], and in the study by Ingersoll and Berger [43], Ingersoll et al [44], and Pickard et al [45] using quizzes covering the content in the intervention; all studies reported significant increases in knowledge post intervention. All of the studies reported statistically significant improvements in parents' skills in administering skills learnt through the interventions. These findings present evidence that parents who received the appropriate training could gain skills in the delivery of interventions, thus improving the skills in Social-communication and behavior of their children with ASD."	Summarised positive effect
Caregiver social emotional wellbeing (parental self-efficacy)	"Parents' self-efficacy was evaluated in the study by Ingersoll et al [44] and Pickard et al [45]. The authors stated that whereas there was a statistically significant (P<.01) improvement and a large effect size (Cohen d=1.34) preintervention to postintervention for both groups, there was no difference between groups. Parents' stress levels were not measured pre-post interventions in any of the studies. Parents' stress levels were not measured pre-post interventions in any of the studies."	Summarised positive effect



Outcome	Context	Studies included	Effect size	Heterogeneity	Categorised outcome
Social-communication (socialisation)	Comparing intervention and control group	7	z = 2.03, 95CI [0.18 - 9.75]	π ² = 0.75	Positive pooled effect
Communication (overall)	Comparing intervention and control group	7	z = 3.79, 95Cl [5.03 - 15.85]	π ² = 35.98	Positive pooled effect
Expressive language	Comparing intervention and control group	5	z = 4.40, 95Cl [8.43 - 21.99]	π ² = 27.23	Positive pooled effect
Receptive language	Comparing intervention and control group	5	z = 7.19, 95Cl [10.14 - 17.75]	π ² = 0.75	Positive pooled effect
Cognition (full scale IQ)	Comparing intervention and control group	10	z = 4.47, 95Cl [6.73 - 17.23]	π ² = 56.3	Positive pooled effect
Cognition (non-verbal IQ)	Comparing intervention and control group	5	z = 2.36, 95Cl [1.88 - 20.30]	π ² = 0.70	Positive pooled effect
Adaptive behaviour	Comparing intervention and control group	7	z = 3.622, 95CI [2.72 - 9.13]	π ² = 0.14	Positive pooled effect
Adaptive behaviour (daily living)	Comparing intervention and control group	7	z = 5.07, 95Cl [3.36 - 7.61]	π ² = 1.30	Positive pooled effect

Postorino et al. (2017) – Meta-analysis

Outcome	Context	Studies included	Effect size	Heterogeneity	Categorised outcome
Social emotional/challenging behaviour (disruptive behaviour)	-	8	SMD = -0.59, 95CI [-0.88, -0.30]	Q = 16.77 I2 = 57.8%	Positive pooled effect



Reichow et	al. (2018	8) – Meta-analysis
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Outcome	Context	Studies included	Effect size	Heterogeneity	Categorised outcome
Overall autism characteristics (autism symptoms)	EIBI versus treatment as usual	2	SMD = -0.34, 95CI [-0.79, 0.11]	Q = 0.23 $I^2 = 0\%$ Tau ² = 0.00	Null pooled effect
Social-communication (social competence)	EIBI versus treatment as usual	5	MD = 6.56, 95CI [1.52, 11.61]	Q = 5.25 I ² = 23.87% Tau ² = 7.94	Positive pooled effect
Communication	EIBI versus treatment as usual	5	MD = 11.22, 95CI [5.39, 17.04]	Q = 1.86 $I^2 = 0\%$ Tau ² = 0.00	Positive pooled effect
Expressive language	EIBI versus treatment as usual	4	SMD = 0.51, 95CI [0.12, 0.90]	Q = 4.46 I ² = 32.77% Tau ² = 0.05	Positive pooled effect
Receptive language	EIBI versus treatment as usual	4	SMD = 0.55, 95CI [0.23, 0.87]	Q = 1.52 I ² = 0% Tau ² = 0.00	Positive pooled effect
Cognition (intelligence quotient)	EIBI versus treatment as usual	5	MD = 15.44, 95CI [9.29, 21.59]	Q = 1.16	Positive pooled effect



				$I^2 = 0\%$ Tau ² = 0.00	
Social emotional/challenging behaviour (problem behaviour)	EIBI versus treatment as usual	2	SMD = -0.58, 95CI [-1.24, 0.07]	Q = 1.71 I ² = 41.37% Tau ² = 0.09	Null pooled effect
Adaptive behaviour	EIBI versus treatment as usual	5	MD = 9.58, 95CI [5.57, 13.60]	Q = 2.43 I ² = 0% Tau ² = 0.00	Positive pooled effect
Adaptive behaviour (daily living skills)	EIBI versus treatment as usual	5	MD = 7.77, 95CI [3.75, 11.79]	Q = 1.73 I ² = 0% Tau ² = 0.00	Positive pooled effect
			Verbatim summary from systema	tic review	
School/learning readiness (academic placement)	-	2	"Two studies provided data pertain (that is, percentage of time spent w 2006; Smith 2000). Cohen 2006 r receiving EIBI (6/17 full inclusion w paraprofessional support) and 1/21 included in general education sett 6/15 children receiving EIBI (4/6 ful 2/6 partial inclusion with paraprofe children receiving TAU were include settings at post-treatment."	ning to academic placement with typical peers) (Cohen eported that 17/21 children ithout assistance, 11/17 with children receiving TAU were ings. Smith 2000 reported that Il inclusion without assistance essional support) and 3/13 ded in general education	Summarised positive effect



Caregiver social and emotional wellbeing (parental stress)	- 1	"One study (Remington 2007) reported data on parental stress using the Questionnaire on Resources and Stress - Short Form (52- item scale; Friedrich 1983). The results from their study indicated that parents of children receiving EIBI had similar levels of stress compared to parents of children receiving TAU; that is, there was not a statistically significant difference in the levels of stress between parents of children in the treatment and comparison groups at post-treatment (see Analysis 1.10)."	Summarised null effect
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Sandbank et al. (2020a) – Meta-analysis

Outcome	Context	Studies included	Effect size	Heterogeneity	Categorised outcome
Behavioural Interventions					
Overall autism characteristics (diagnostic characteristics)	All studies	8	g = 0.45, 95Cl [0.26, 0.63]	Not specified	Positive pooled effect
Social-communication	All studies	20	g = 0.40, 95Cl [0.18, 0.61]	Not specified	Positive pooled effect
Communication (language)	All studies	14	g = 0.24, 95Cl [0.01, 0.47]	Not specified	Positive pooled effect
Cognition (cognitive)	All studies	21	g = 0.29, 95Cl [0.05, 0.54]	Not specified	Positive pooled effect
Motor	All studies	8	g = 0.42, 95Cl [0.13, 0.72]	Not specified	Positive pooled effect
Social emotional/challenging behaviour	All studies	13	g = 0.46, 95Cl [0.27, 0.66]	Not specified	Positive pooled effect



Adaptive behaviour	All studies	21	g = 0.38, 95Cl [0.19, 0.56]	Not specified	Positive pooled effect		
Developmental Interventions							
Social-communication	All studies	14	g = 0.30, 95Cl [0.11, 0.50]	Not specified	Positive pooled effect		
Communication (language)	All studies	8	g = 0.06, 95Cl [-0.08, 0.21]	Not specified	Null pooled effect		
Naturalistic developmental behaviour	ral interventions (NDBIs)			- -			
Overall autism characteristics (diagnostic characteristics)	All studies	6	g = 0.05, 95Cl [-0.38, 0.48]	Not specified	Null pooled effect		
Social-communication	All studies	24	g = 0.35, 95Cl [0.18, 0.53]	Not specified	Positive pooled effect		
RRB	All studies	7	g = -0.01, 95Cl [-0.34, 0.32]	Not specified	Null pooled effect		
Communication (language)	All studies	19	g = 0.20, 95Cl [0.03, 0.38]	Not specified	Positive pooled effect		
Cognition (cognitive)	All studies	9	g = 0.26, 95Cl [0.01, 0.51]	Not specified	Positive pooled effect		
Social emotional challenging behaviours	All studies	6	g = 0.17, 95CI [-0.28, 0.61]	Not specified	Null pooled effect		
Play	All studies	6	g = 0.33, 95Cl [0.13, 0.54]	Not specified	Positive pooled effect		
Adaptive behaviour	All studies	6	g = 0.16, 95Cl [-0.24, 0.56]	Not specified	Null pooled effect		
Sensory-based Interventions							
Communication (language)	All studies	7	g = 0.28, 95Cl [-0.19, 0.76]	Not specified	Null pooled effect		



Treatment and Education of Autistic and related Communications Handicapped Children (TEACCH)						
Social-communication	All studies	6	g = -0.11, 95CI [-0.93, 0.71]	Not specified	Null pooled effect	
Technology-based Interventions						
Social-communication	All studies	9	g = 0.05, 95Cl [-0.18, 0.27]	Not specified	Null pooled effect	
Social emotional/challenging behaviour	All studies	7	g = 0.42, 95Cl [-0.19, 1.03]	Not specified	Null pooled effect	

Sandbank et al. (2020b) – Meta-analysis

Outcome	Context	Studies included	Effect size	Heterogeneity	Categorised outcome
General outcomes	Summary across all outcomes and	Not	RVE = 0.184, 95CI [0.075, 0.292]	l ² = 58.6%	Positive pooled effect
	language measures spec	specified		$\tau^2 = 0.123$	
				τ = 0.351	
Communication (composite language)	Intervention versus comparison	10	RVE = 0.284, 95CI [-0.0465, 0.614]	Not specified	Positive pooled effect
Expressive language	Intervention versus comparison	59	RVE = 0.18, 95CI [0.077, 0.283]	Not specified	Positive pooled effect
Receptive language	Intervention versus comparison	46	RVE = 0.135, 95CI [0.000, 0.269]	Not specified	Positive pooled effect



Moderators	Context	Outcome	Studies Included	Verbatim summary from systematic review	Categorised outcome
Child age	Combined across categories of intervention	Communication (language)	58	"Results from meta regression models that included participant characteristics suggested that chronological age at intervention onset did not moderate intervention effect sizes (B = 0.03, p = .641)."	Age not related to intervention effects on communication
Child characteristics: Core autism characteristics (autism symptomology)	Combined across categories of intervention	Communication (language)	27	"Autism symptomatology categorizations also did not moderate intervention effects: Significantly different effects were not observed for participant samples rated as "high symptomatology" compared to samples for which autism symptomatology was categorized as "moderate" (B = 0.09, p = .639)."	The level of overall autism characteristics prior to intervention not related to intervention effects on communication.
Child characteristics: Communication (language age)	Combined across categories of intervention	Communication (language)	17	"Language age in months did significantly moderate intervention effects, such that higher mean language ages were associated with larger intervention effects (B = 0.25, p = .010). This result was significant even after correcting for multiple comparisons."	Greater language skills prior to intervention related to greater intervention effects on communication.
Intervention amount	Combined across categories of intervention	Communication (language)	60	"Results from the metaregression models that included intervention variables indicated that effect sizes were not moderated by intervention type (see	Total hours not related to intervention effects on communication.



Intervention practice	Combined across categories of intervention	Communication (language)	60	Table 3) or by cumulative intervention intensity in hours."	Intervention category (behavioural, developmental, NDBI, sensory-based, TEACCH, technology-based, other) not related to intervention effects on communication.
Intervention agent	Combined across categories of intervention	Communication (effect size)	60	"However, interventionist was a significant moderator of effect sizes, when alpha was nominally set at .05. Results from the meta regression model that included the categorical variable of interventionist, with caregiver as the reference category, indicated that intervention effects were significantly larger for interventions implemented by clinicians compared to caregivers alone (B = 0.33 , p = .044) and marginally larger for those implemented by a combination of interventionists (e.g., caregivers and clinicians working together, B = 0.26 , p = .058) compared to caregivers alone. However, when p values were corrected to account for multiple comparisons, they did not pass the significance threshold. Effect sizes for interventions implemented by other interventionist types (e.g., educator, computer mediated instruction) did not significantly differ from caregiver-implemented intervention effects. Figure 5 displays summary effects and confidence intervals by interventionist type."	Intervention agent (clinician, caregiver, educator, technology, combination, other) not related to intervention effects on communication.



Outcome	Verbatim summary from systematic review	Categorised outcome
Overall autism characteristics (autistic behaviours)	"Moderate evidence supported improvements in impairment-level outcomes of improvement in autistic behaviors and skills-based outcomes of reduction in caregiver assistance with self-care activities."	Summarised inconsistent effect
	Note that the authors use the following definition of moderate evidence: Moderate evidence: 1 RCT or 2 or more studies with lower levels of evidence with some inconsistency of findings in well- conducted studies also resulting in a designation of moderate evidence.	
Social-communication (caregiver assistance with social skills)	"Child outcomes in play, sensory–motor, and language skills and reduced caregiver assistance with social skills had emerging but	Summarised null effect
Sensory (sensory-motor)	insuncient evidence.	Summarised null effect
Communication (language skills)		Summarised null effect
Play		Summarised null effect
Adaptive behaviour (functioning; reduction in caregiver assistance with self-care activities)	"The evidence is strong that ASI intervention demonstrates positive outcomes for improving individually generated goals of <u>functioning</u> and participation as measured by Goal Attainment Scaling for children with autism."	Summarised inconsistent effect



	"Moderate evidence supported improvements in impairment-level outcomes of improvement in autistic behaviors and skills-based outcomes of reduction in caregiver assistance with self-care activities."	
Community participation (participation)	"The evidence is strong that ASI intervention demonstrates positive outcomes for improving individually generated goals of functioning and <u>participation</u> as measured by Goal Attainment Scaling for children with autism."	Summarised positive effect

Schoen et al. (2019) – Narrative synthesis

Outcome	Verbatim summary from systematic review	Categorised outcome
General outcomes	"In Stage 3, the remaining three studies were rated using the CEC quality indicators and standards for an evidence-based practice. Two randomized controlled trials respectively met 100% and 85% of the CEC criteria items. One additional study met more than 50% of the criteria. Based on CEC criteria, ASI can be considered an evidence-based practice for children with autism ages 4–12 years old." Note: For two of the three studies, the effect size of the main effect met the authors' definition of not "a substantially important effect."	Summarised inconsistent effect



Srinivasan	et al.	(2018)) – Narrative s	ynthesis
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Outcome	Verbatim summary from systematic review	Categorised outcome
Social-communication	"Overall, out of the 21 ES estimates we calculated only 3 ES had CI that did not include 0 (Table 2C). Taken together, there is limited evidence supporting the use of equine therapies for facilitating Social-communication skills in individuals with ASD."	Summarised inconsistent effect
Sensory	"Out of the total 56 ES calculated from data presented in the 4 studies, 42 ES were significant (CI did not include 0, see Table 2C). Overall, the review suggests promising positive (small to large sized) effects of equine therapies on sensory skills in ASD."	Summarised positive effect
Cognition (cognitive)	"Only 1 Level I study (Borgi et al., 2016) assessed the effects of a 6-month equine therapy intervention on cognitive skills, specifically executive functioning and found that compared to a waitlist control group children with ASD reduced the latency of their first move (ES = 0.76, but CI includes 0) during a problem solving task following THR."	Summarised null effect
Motor	"Although 43 of the 44 calculated ES in this set of studies reported ES that were significantly different from 0 at a 95% CI, note that the Wuang study alone contributed to around 40 ES estimates (Table 2C). Taken together, presently there is only weak evidence for positive treatment effects (varying in magnitude from small to large) of equine therapy on motor skills"	Summarised inconsistent effect
Social emotional/challenging behaviour (behavioural skills)	"Our own calculations suggested that out of the 19 ES computed for behavioral skills, the CI of 11 ES did not include 0 (Table 2C). Overall, current literature provides modest evidence for the use of equine therapies to alleviate behavioral impairments in ASD"	Summarised inconsistent effect
Quality of life	"While large improvements (ES range = 2.05 – 2.43) were found on the custom-developed QOL questionnaire following a 3-month THR intervention, the other two studies reported lack of definitive improvements in QOL of subjects due to the equine interventions provided (Lanning et al., 2014; Kern et al., 2011). Moreover, out of the total 7 ES calculated from these studies, the CI of only 2 ES did not include 0 (Table 2C)To summarize, the current state of literature in this field does not	Summarised inconsistent effect



	allow us to comment on the effect of equine therapy on QOL and functional participation of individuals with ASD."	
Community participation (functional participation)	"In terms of functional participation, following a 3-month HIP intervention, children increased their participation (ES range: 0.62–0.81) in age-appropriate leisure and self-care activities on the Child Activity Card Sort test (Ajzenman et al., 2011) (Note: our ES estimates based on data from the report are more conservative and CI of ES include 0, see Tables 2B & 2C)."	Summarised inconsistent effect

Steinbrenner et al. (2020) – Narrative synthesis¹

Outcome	Verbatim summary from systematic review	Categorised outcome		
Discrete Trial Training (DTT)				
Social-communication (social)	Positive effect for toddlers, pre-schoolers, Elementary School, Middle School, and High School.	Summarised positive effect		
Social-communication (joint attention)	Positive effect for toddlers, pre-schoolers, and Elementary School.	Summarised positive effect		
Communication	Positive effect for pre-schoolers, Elementary School, Middle School, and High School.	Summarised positive effect		
Cognition (cognitive)	Positive effect for pre-schoolers and Elementary School.	Summarised positive effect		
Social emotional/challenging behaviourPositive effect for Elementary School.(challenging/interfering behaviour)		Summarised positive effect		
Play	Positive effect for pre-schoolers, and Elementary School.	Summarised positive effect		



Adaptive behaviour (adaptive/self-help)	Positive effect for pre-schoolers, and Elementary School.	Summarised positive effect		
School/Learning Readiness	g Readiness Positive effect for toddlers.			
Academic	Positive effect for pre-schoolers, and Elementary School.	Summarised positive effect		
Functional Communication Training				
Social-communication (social)	Positive effect for pre-schoolers and Elementary School.	Summarised positive effect		
Communication	Positive effect for pre-schoolers, Elementary School, Middle School, and High School.	Summarised positive effect		
Social emotional/challenging behaviour (challenging/interfering behaviour)	Positive effect for pre-schoolers, Elementary School, Middle School, and High School.	Summarised positive effect		
Play	Positive effect for pre-schoolers and Elementary School.	Summarised positive effect		
Adaptive behaviour (adaptive/self-help)	Positive effect for pre-schoolers, Elementary School, and High School.	Summarised positive effect		
School/learning readiness	Positive effect for pre-schoolers and Elementary School.	Summarised positive effect		
Naturalistic Teaching Strategies				
Social-communication (social)	Positive effect for toddlers, pre-schoolers, Elementary School, Middle School, and High School.	Summarised positive effect		
Social-communication (joint attention)	Positive effect for toddlers, pre-schoolers, and Elementary School.	Summarised positive effect		
Communication	Positive effect for toddlers, pre-schoolers, Elementary School, and Middle School.	Summarised positive effect		


Cognition (cognitive)	Positive effect for pre-schoolers and Elementary School. Summarised positive effect				
Motor	Positive effect for pre-schoolers and Elementary School. Summarised positive				
Social emotional/challenging behaviour (challenging/interfering behaviour)	Positive effect for toddlers, pre-schoolers, Elementary School, Middle School, and High School.	Summarised positive effect			
Play	Positive effect for toddlers, pre-schoolers, Elementary School, Middle School, and High School.	Summarised positive effect			
Adaptive behaviour (adaptive/self-help)	Positive effect for toddlers, and pre-schoolers.	Summarised positive effect			
School/learning readiness	Positive effect for toddlers, pre-schoolers, and Elementary School.	Summarised positive effect			
Academic	Positive effect for toddlers, and pre-schoolers.	Summarised positive effect			
Auditory Integration Training					
General outcomes Identified as having 'insufficient' evidence.		Summarised null effect			
Ayres Sensory Integration (ASI)					
Social-communication (social)	ial) Positive effect for pre-schoolers, Elementary School, and Middle School. Sur				
Communication	Positive effect for pre-schoolers and Elementary School. Summarise				
Cognition (cognitive)	Positive effect for pre-schoolers and Elementary School.	Summarised positive effect			
Motor	Positive effect for pre-schoolers, Elementary School, and Middle School.	Summarised positive effect			



Social emotional/challenging behaviour (challenging/interfering behaviour)	Positive effect for pre-schoolers, Elementary School, and Middle School.	Summarised positive effect	
Adaptive behaviour (adaptive/self-help)	Positive effect for pre-schoolers and Elementary School.	Summarised positive effect	
Academic	Positive effect for pre-schoolers and Elementary School.	Summarised positive effect	
Music Therapy			
Social-communication (social)	Positive effect for pre-schoolers, Elementary School, and Middle School.	Summarised positive effect	
Communication	Positive effect for toddlers, pre-schoolers, Elementary School, and Middle School.	Summarised positive effect	
Motor	Positive effect for pre-schoolers and Elementary School.	Summarised positive effect	
Social emotional/challenging behaviour (challenging/interfering behaviour)Positive effect for pre-schoolers and Elementary School.		Summarised positive effect	
Play	Positive effect for pre-schoolers.	Summarised positive effect	
Adaptive behaviour (adaptive/self-help)	Positive effect for toddlers.	Summarised positive effect	
School/learning readiness	Positive effect for pre-schoolers and Elementary School.	Summarised positive effect	
Sensory Diet			
General outcomes	Identified as having 'insufficient' evidence.	Summarised null effect	
Technology-based Interventions			



Social-communication (social)	Positive effect for pre-schoolers, Elementary School, Middle School, and High School.	Summarised positive effect	
Social-communication (joint attention)	Positive effect for pre-schoolers, Elementary School, Middle School, and High School.	Summarised positive effect	
Communication	Positive effect for toddlers, pre-schoolers, Elementary School, Middle School, and High School.	Summarised positive effect	
Cognition (cognitive)	Positive effect for toddlers, pre-schoolers, Elementary School, Middle School, and High School.	Summarised positive effect	
Motor	Positive effect for toddlers, pre-schoolers, and Elementary School.	Summarised positive effect	
Social emotional/challenging behaviour (challenging/interfering behaviour)	g behaviour Positive effect for pre-schoolers, Elementary School, and Middle School. aviour) Positive effect for pre-schoolers, Elementary School, and Middle School.		
Play	Positive effect for pre-schoolers, Elementary School, Middle School, and High School.	Summarised positive effect	
Adaptive behaviour (adaptive/self-help)	Positive effect for toddlers, pre-schoolers, and Elementary School.	Summarised positive effect	
School/learning readiness	Positive effect for pre-schoolers, Elementary School, Middle School, and High School.	Summarised positive effect	
Academic	Positive effect for pre-schoolers, Elementary School, Middle School, and High School.	Summarised positive effect	



Augmentative and Alternative Communication (AAC)						
Social-communication (social)	Positive effect for toddlers, pre-schoolers, Elementary School, and High School. Summarised positive eff					
Social-communication (joint attention)	ositive effect for toddlers, pre-schoolers, and Elementary School. Summarised positiv					
Communication	Positive effect for toddlers, pre-schoolers, Elementary School, Middle School, and High School.	Summarised positive effect				
Motor	Positive effect for High School.	Summarised positive effect				
Social emotional/challenging behaviour (challenging/interfering behaviour)	Positive effect for pre-schoolers and Elementary School.	Summarised positive effect				
Play	Positive effect for toddlers, pre-schoolers, and Elementary School.	Summarised positive effect				
Academic	Positive effect for pre-schoolers and Elementary School. Summarised pos					
Animal-assisted Interventions						
General outcomes	Identified as having 'insufficient' evidence.	Summarised null effect				
Cognitive behavioural/instructional Strateg	gies					
Social-communication (social)	Positive effect for Elementary School, Middle School, and High School.	Summarised positive effect				
Communication	Positive effect for Elementary School, Middle School, and High School.	Summarised positive effect				
Cognition (cognitive)	Positive effect for Elementary School, and Middle School.	Summarised positive effect				



Social emotional/challenging behaviour (challenging/interfering behaviour)	Positive effect for Elementary School, Middle School, and High School.	Summarised positive effect	
Adaptive behaviour (adaptive/self-help)	Positive effect for Elementary School, Middle School, and High School.	Summarised positive effect	
School/learning readiness	Positive effect for Elementary School, Middle School, and High School.	Summarised positive effect	
Academic	Positive effect for Elementary School, Middle School, and High School.	Summarised positive effect	
Social Skills Training			
Social-communication (social)	Positive effect for toddlers, pre-schoolers, Elementary School, Middle School, and High School.	Summarised positive effect	
Communication	Positive effect for toddlers, pre-schoolers, Elementary School, Middle School, and High School.	Summarised positive effect	
Cognition (cognitive)	Positive effect for pre-schoolers, Elementary School, and Middle School.	Summarised positive effect	
Social emotional/challenging behaviour (challenging/interfering behaviour)	Positive effect for pre-schoolers, Elementary School, Middle School, and High School.	Summarised positive effect	
Play	Positive effect for toddlers, pre-schoolers, Elementary School, Middle School, and High School.	Summarised positive effect	
Adaptive behaviour (adaptive/self-help)	Positive effect for Elementary School, Middle School, and High School.	Summarised positive effect	
School/learning readiness	Positive effect for Elementary School and Middle School.	Summarised positive effect	



Parent-implemented/mediated				
Social-communication (social)	Positive effect for toddlers, pre-schoolers, Elementary School, Middle School, and High School.	Summarised positive effect		
Social-communication (joint attention)	Positive effect for toddlers and pre-schoolers.	Summarised positive effect		
Communication	Positive effect for toddlers, pre-schoolers, Elementary School, Middle School, and High School.	Summarised positive effect		
Cognition (cognitive)	Positive effect for toddlers, pre-schoolers.	Summarised positive effect		
Motor	Positive effect for toddlers, pre-schoolers.	Summarised positive effect		
Social emotional/challenging behaviour (challenging/interfering behaviour)	Positive effect for toddlers, pre-schoolers, Elementary School, Middle School, and High School.	Summarised positive effect		
Play	Positive effect for toddlers, pre-schoolers, Elementary School, and Middle School.	Summarised positive effect		
Adaptive behaviour (adaptive/self-help)	Positive effect for toddlers, pre-schoolers, Elementary School, and Middle School.	Summarised positive effect		
School/learning readiness	Positive effect for toddlers, pre-schoolers, and Elementary School.	Summarised positive effect		
Academic	Positive effect for toddlers, pre-schoolers.	Summarised positive effect		
Peer-mediated/implemented				
Social-communication (social)	Positive effect for pre-schoolers, Elementary School, Middle School, and High School.	Summarised positive effect		
Social-communication (joint attention)	Positive effect for pre-schoolers and Elementary School.	Summarised positive effect		



Communication	Positive effect for pre-schoolers, Elementary School, Middle School, and High School.	Summarised positive effect	
Cognition (cognitive)	Positive effect for Elementary School and Middle School	Summarised positive effect	
Social emotional/challenging behaviour (challenging/interfering behaviour)	Positive effect for Elementary School	Summarised positive effect	
Play	Positive effect for pre-schoolers, Elementary School, and Middle School.	Summarised positive effect	
School/learning readiness	Positive effect for pre-schoolers and Elementary School.	Summarised positive effect	
Academic	Positive for Elementary School, Middle School, and High School.	Summarised positive effect	

¹ This systematic review only reported positive outcomes with no data presented for inconsistent/null findings.

Sutherland et al. (2018) – Narrative synthesis

Outcome	Verbatim summary from systematic review	Categorised outcome
Communication	"Communication. Eight studies reported on communication outcomes (Baharav & Reiser, 2010; Boisvert et al., 2012; Ingersoll et al., 2016; Meadan et al., 2016; Pickard et al., 2016; Ruble et al., 2013; Wainer & Ingersoll, 2014). Positive impacts on communication, including improved initiations and responses, as measured through formal and observation measures were reported by Baharav and Reiser (2010). Similarly, the Boisvert et al. (2012) study reported better use of transition words after telehealth therapy compared with baseline and that the students' performance was more consistent in telehealth condition compared with face to face condition. Ingersoll et al. (2016) used structured observations as well as standardised questionnaires and found that both groups (self directed online learning and therapist assisted online learning) showed improvements, with the therapist assisted group showing significant increases in their standard scores on the social domain of the Vineland Adaptive	Summarised inconsistent effect



(satisfaction and acceptability) Caregiver communication and	Reiser, 2010; Hepburn et al., 2016; Ingersoll & Berger, 2015; Meadan et al., 2016; Pickard et al., 2016; Reese, Braun, et al., 2015; Schutte et al., 2015; Suess et al., 2016; Wainer & Ingersoll, 2015). All studies reported high levels of programme acceptability and parent satisfaction with the telehealth component of the intervention or assessment. In addition, two studies that involved direct telehealth involvement with individuals on the spectrum (Hepburn et al., 2016; Schutte et al., 2015) reported high participant satisfaction with the methods used." "The remaining studies reported high levels of parent fidelity for interventions provided via telehealth (Hepburn et al., 2016; Ingersoll et al., 2016), with a number reporting that the fidelity of programmes taught to parents online	Summarised
Caregiver satisfaction (satisfaction and	"Satisfaction and acceptability. Parent satisfaction was a reported outcome for nine of the 14 studies (Baharav & Reiser, 2010: Hepburn et al., 2016: Ingersoll & Berger, 2015: Meadan et al., 2016: Pickard et al., 2016: Reese.	Summarised
Social emotional/challenging behaviour (behaviour)	"Behaviour. Lindgren et al. (2016) used FA and FCT to reduce challenging behaviour, and found that the mean percentage reduction in problem behaviour was more than 90% for the three groups (home based, centre based telehealth and homebased telehealth). Suess et al. (2016) also reported on a reduction in problem behaviours following telehealth training and coaching."	Summarised positive effect
	Behaviour Scales – 2nd edition while children in the self-directed condition did not. Pickard et al. (2016), in their article about the same study as described by Ingersoll et al. (2016), reported that parents in the therapist assisted group were more likely to report gains in Social-communication than the self-directed condition parents. Ruble et al. (2013) used "Psychometrically Equivalence Tested Goal Attainment Scaling (PET-GAS)" to measure outcomes across a wide range of individual communication, social and learning goals for 49 teacher– child dyads. Results showed similar mean PET-GAS change when comparing the face to face coaching with telehealth coaching and that both groups were better than the non-coached group. The communication outcomes were less robust for the three children in the Meadan et al. (2016) with the authors suggesting there were "no clear results across dyads for children's communication behaviour in the multiple-baseline analysis"	



Tachibana	et al.	(2018)) – Meta-analys	is
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Outcome	Context	Studies included	Effect size	Heterogeneity	Categorised outcome
Overall autism characteristics (autism general symptoms)	Individual intervention (Analysis I)	3	SMD = -0.31, 95CI [-0.63, 0.01]	l ² = 0%	Null pooled effect
Social-communication (qualitative impairment in social interaction)	Individual intervention (Analysis I)	2	SMD = -0.15, 95CI [-0.40, 0.10]	l ² = 0%	Null pooled effect
Social-communication (reciprocity of social interaction towards others)	Individual intervention (Analysis I)	5	SMD = 0.59, 95CI [0.25, 0.93]	l ² = 18%	Positive pooled effect
	Group intervention (Analysis I)	3	SMD = 0.45, 95CI [0.02, 0.88]	l ² = 18%	Positive pooled effect
Social-communication (initiating	Individual intervention (Analysis I)	4	SMD = 0.48, 95CI [-0.14, 1.10]	l ² = 78%	Null pooled effect
joint attention	Group intervention (Analysis I)	2	SMD = 0.15, 95CI [-0.38, 0.68]	l ² = 15%	Null pooled effect
Social-communication (imitation)	Individual intervention (Analysis I)	Not specified	SMD = 0.54, 95Cl [-0.25,1.33]	l ² = 62%	Null pooled effect
Social-communication (responding to joint attention)	Individual intervention (Analysis I)	3	SMD = 0.63, 95CI [-0.14,1.39]	l ² = 97%	Null pooled effect
RRB (restricted repetitive and stereotyped patterns behaviours, interests and activities)	Individual intervention (Analysis I)	3	SMD = −0.21, 95CI [−0.52, 0.09]	l ² = 39%	Null pooled effect



Communication (qualitative impairment in communication)	Individual intervention (Analysis I)	1	SMD = -0.03, 95CI [-0.35, 0.29]	N/A	Null pooled effect
Expressive language	Individual intervention (Analysis I)	7	SMD = 0.13, 95CI [-0.06, 0.33]	l ² = 0%	Null pooled effect
	Group intervention (Analysis I)	1	SMD = -0.03, 95CI [-0.54, 0.48]	N/A	Null pooled effect
Receptive language	Individual intervention (Analysis I)	7	SMD = 0.17, 95CI [-0.09, 0.42]	l ² = 28%	Null pooled effect
	Group intervention (Analysis I)	1	SMD = 0.14, 95CI [-0.65, 0.37]	N/A	Null pooled effect
Cognition (developmental quotient)	Individual intervention (Analysis I)	4/5 ¹	SMD = 0.36, 95CI [0.05, 0.66]	l ² = 20%	Positive pooled effect
Adaptive behaviour	Individual intervention (Analysis I)	7	SMD = -0.05, 95CI [-0.25, 0.14]	l ² = 39%	Null pooled effect
	Group intervention (Analysis I)	1	SMD = 0.44, 95CI [-0.07, 1.65]	N/A	Null pooled effect
Caregiver communication and interaction (parental synchrony)	Individual Intervention (Analysis I)	3	SMD = 0.99 [0.70, 1.29]	N/A	Positive pooled effect
Caregiver social emotional wellbeing (parenting stress)	Individual intervention (Analysis I)	2	SMD = -0.30, 95CI [-0.93, 0.32]	l ² = 0%	Null pooled effect



	Group intervention (Analysis I)		2	SMD = -0.29, 95CI [-0.81, 0.22]	l ² = 0%	Null pooled effect
Moderators	Context	Outcome	Studies Included	Verbatim summary from syste	ematic review	Categorised outcome
Intervention format	Individual, group	Core autism characteristics (autism general symptoms), social- communication (reciprocity of social interaction towards others), expressive language, receptive language, cognition (developmental quotient), adaptive behaviour	Not specified	"The results suggested that the methods did not have significa- effects on autism general symp results of the main analyses al- the two intervention types did significantly different effects on secondary outcomes (develop expressive language, receptive reciprocity of social interaction and adaptive behaviour)."	e two intervention intly different ptoms. The so suggested that not have n other mental quotient, e language, n towards others,	Intervention format (individual, group) did not relate to intervention effects on Overall autism characteristics, social- communication, expressive language, receptive language, cognition, or adaptive behaviour.

¹Both numbers reported.



Tarver et	al. (2019) – Meta-analy	ysis
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Outcome	Context	Studies included	Effect size	Heterogeneity	Categorised outcome
Social emotional/challenging behaviour	Parent-reported disruptive behaviour	9	SMD = 0.67, 95CI [0.49, 0.85]	l ² = 0%	Positive pooled effect
	Parent-reported hyperactivity	3	SMD = 0.31, 95CI [0.07, 0.56]	l ² = 0%	Positive pooled effect
Caregiver social emotional wellbeing (parenting stress)	-	7	SMD = 0.37, 95CI [0.17, 0.57]	l ² = 0%	Positive pooled effect
Caregiver social emotional wellbeing (parenting efficacy)	-	5	SMD = 0.39, 95CI [-0.17, 0.95]	l ² = 81%	Null pooled effect

Tiede & Walton (2019) – Meta-analysis

Outcome	Context	Studies included	Effect size	Heterogeneity	Categorised outcome
Overall autism characteristics (symptoms of ASD)	-	9	g = -0.38, 95Cl [-0.71, -0.04]	Q = 26.1 I ² = 67%	Positive pooled effect
Social-communication (joint attention)	Initiating joint attention	15	g = 0.14, 95Cl [-0.01, 0.28]	Q = 16.0 I ² = 7%	Null pooled effect



Social-communication (social engagement)	-		12	g = 0.65, 95Cl [0.37, 0.93]	Q = 34.2 l ² = 64%	Positive pooled effect
Expressive language	-		12	g = 0.32, 95Cl [0.07, 0.56]	Q = 22.9 ² = 54%	Positive pooled effect
Receptive language	-		10	g = 0.28, 95Cl [-0.02, 0.58]	Q = 24.9 ² = 64%	Positive pooled effect
Cognition (cognitive development)	Composite IQ		5	g = 0.48, 95Cl [0.22, 0.74]	Q = 5.3 ² = 30%	Positive pooled effect
Cognition (nonverbal IQ)	-		7	g = 0.21, 95CI [0.01, 0.41]	Q = 6.1 ² = <1%	Positive pooled effect
Play	-		8	g = 0.23, 95Cl [0.04, 0.41]	Q = 7.7 l ² = 11%	Positive pooled effect
Adaptive behaviour	-		5	g = 0.09, 95Cl [-0.24, 0.42]	Q = 9.1 I ² = 56%	Null pooled effect
Moderators	Context	Outcome	Studies Included	Verbatim summary from syste	ematic review	Categorised outcome
Intervention amount	-	Joint attention, adaptive behaviour, expressive language, receptive	Not specified	<i>Joint attention:</i> "Dosage signif moderated the results such the hours of professional contact r	icantly at increased resulted in more	Greater total hours related to greater intervention



	language, cognitive	positive joint attention outcomes ($\beta = 0.17 \text{ p} =$	effect on ioint
	development.	0.02. 95% CI = 0.02 to 0.32."	attention. Total
	overall autism		hours of
	characteristics		intrervention not
	social engagement	Adaptive behaviour: "A marginally significant	related to
	play	effect was found for dosage: more professional	intervention
	μαγ	contact hours were associated with more	offect on adaptive
		positive findings ($\beta = 0.30$, $p = 0.06$, 95% Cl =	behaviour
		-0.02 to 0.62)."	Denaviour
		0.02 (0 0.02).	expressive or
			receptive
		Expressive language: "Dosage did not	language,
		moderate effects ($\beta = 0.09$, $p = 0.35$, 95% CI =	cognitive
		-0.10 to 0.29) "	development,
		0.10 to 0.23).	Overall autism
			characteristics,
		Recentive language: When study quality and	social
		dosade were added as moderators, neither	engagement, or
		dosage $(\beta = 0.15, p = 0.35, 95\%) = -0.16 to$	play.
		(0.53 gg) = 0.13, p = 0.33, 93% G = -0.16 f 0.16 f 0.16 gg	
		$C_{1} = 0.97 \text{ to } 0.22 \text{ significantly moderated the}$	
		CI = -0.87 to 0.32) significantly moderated the	
		effects.	
		Cognitivo dovolonment: "Desago (8 = 0.06 n =	
		Cognitive development. Dosage (p = 0.06, p = 0.70, P = 0.70,	
		0.79, 95% CI = -0.36 to 0.47) and study quality	
		(B = -0.09, p = 0.80, 95% Cl = -0.82 to 0.63) did	
		not significantly moderate the effects."	



	Overall autism characteristics: "Neither dosage (β = 0.13, p = 0.54, 95% CI = -0.28 to 0.54) nor study quality (β = -0.07, p = 0.86, 95% CI = -0.89 to 0.74) moderated the results."
	Social engagement: "Neither dosage (β = 0.17, p = 0.20, 95% CI = -0.09 to 0.44) nor study quality (β = 0.25, p = 0.42, 95% CI = -0.36 to 0.85) moderated the results."
	Play: "Dosage did not significantly moderate the results (β = -0.11, p = 0.21, 95% Cl = -0.27 to 0.06"



Treurnicht Naylor et al. (2011) – Narrative synthesis

Outcome	Verbatim summary from systematic review	Categorised outcome
Social-communication (cognitive functioning and Social- communication)	"Buday et al. showed that children exposed to recorded music were more likely to remember and imitate signed and spoken words compared with those given rhythm cues. The difference, however, amounted to an average of only one word [35]. Kim et al. examined improvisational music therapy versus play sessions on joint attention behaviors in autistic boys [36]. A large and significant effect size was found for the Early Social-communication Scales—a structured assessment of individual differences in nonverbal communication skills [54]—driven by positive impacts of music therapy on quality and quantity of eye contact and turn-taking behaviors relative to gesturing and behaviors indicating intent."	Summarised positive effect
Adaptive behaviour	"No significant difference was found using the Pervasive Developmental Disorder Behavior Inventory [55]—a pediatric measure of maladaptive and adaptive behavior [36]."	Summarised null effect



Trzmiel et al. (2019) – Meta-analysis

Outcome	Context	Studies included	Verbatim summary from systemat	ic review	Categorised outcome
General outcomes (socialization, engagement, maladaptive behaviours, reaction time in problem-solving situations)	-	13	"Only Jenkins et al ²³ found no evidence for statistically significant beneficial impact of TR on the affect, linguistic competence, spontaneous initiations, or problem behavior of autistic children. Given the results of their study, these authors believe that TR should be treated as a leisure activity rather than therapy. However, we are of the opinion that their study, being only a single report, should not belittle the significance of the evidence on the beneficial effects of EAAT."		Summarised inconsistent effect
			Effect size	Heterogeneity	
Social-communication (social)	-	3	SMD = .220, 95CI [130, .580]	Chi ² = 0.55 I ² = 0.0%	Null pooled effect
Communication	-	3	SMD = .191, 95CI [165, .547]	Chi ² = 0.48 l ² = 0.0%	Null pooled effect
Adaptive behaviour	-	3	SMD = .742, 95CI [010, 1.494]	Chi ² = 5.87 l ² = 66.0%	Null pooled effect



Tupou et al.	(2019)) – Narrative	synthesis
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Outcome	Verbatim summary from systematic review	Categorised outcome
General outcomes (child outcomes)	[single case design studies] "Due to the wide variety of outcomes measured across the nine single- case design studies, it is not possible to make direct comparisons. Results were coded as positive for five studies (Gibson et al.2010; Harjusola-Webb and Robbins 2012; Kernetal 2007; McBride and Schwartz 2003; Olive et al. 2007). Mixed results or minimal improvements were reported in four studies (Fleury and Schwartz 2017; Garfinkle and Schwartz 2002; Kern and Aldridge 2006; Van Der Heyden et al. 2002). For example, Kern and Aldridge (2006) reported positive results across all participants, but for only two of the three intervention phases and Fleury and Schwartz (2017) reported minimal improvement in child verbal initiations, but positive results for all other measured child outcomes."	Summarised inconsistent effect
Overall autism characteristics (autism severity and/or symptoms)	[group design studies only] "Four (57%) of the seven group studies reported on measures of autism severity and/or symptoms (D'Elia et al. 2014; Eikeseth et al. 2012; Strain and Bovey 2011; Young et al. 2016) using the Autism Diagnostic Observation Schedule (ADOS; Lord et al.2008), or the Childhood Autism Rating Scale (CARS; Schopleretal. 2002). D'Elia et al. (2014) reported decreases in autism diagnoses across both EGs and CGs, as measured by the ADOS, with a larger decrease observed in the EG. Similarly, in the study by Strain and Bovey (2011), the EG demonstrated a greater decrease in CARS scores than the CG. The Eikeseth study (2012) reported a significant decrease in CARS scores for the EG, but did not report comparison data for the CG. The authors of the final study (Young et al.2016) did not report any significant change in CARS scores."	Summarised positive effect
Social-communication (social skills)	[group design studies only] "Two (29%) of the group studies (Strain and Bovey 2011; Young et al. 2016) reported on social skills, which were measured via the Social Skills Rating System (SSRS; Gresham and Elliott 1990) and the Autism Screening Instrument for Educational Planning (ASIEP; Krug et al.2008). Both studies reported positive results, with the EG making greater improvements than the CG in both cases"	Summarised positive effect



Communication (communication and/or language)	[group design studies only] "Child communication and/or language was measured in five (71%) of the group studies (Boulware et al. 2006; D'Elia et al. 2014; Fleury and Schwartz 2017; Strain and Bovey 2011; Young et al. 2016) via a range of different instruments including (a) Communication, Social, and Symbolic Behavior Scales (CSBS; Wetherby and Prizant 2002); (b) MacArthur Communication Developmental Inventories (CDI; Fenson et al. 1993; Fenson et al. 1994); (c) Preschool Language Scale (PLS; Zimmerman et al. 1991); (d) Expressive One Word Picture Vocabulary Test (EOWPVT; Brownell 2000a); (e) Receptive One Word Picture Vocabulary Test (ROWPVT; Brownell2000b); and (f) a researcher-delivered book vocabulary assessment (Fleury and Schwartz 2017). Participants demonstrated improvement on at least one communication/language outcome across all five of these studies."	Summarised positive effect
Cognition (cognition or educational strengths)	[group designs only] "Aspects of child cognition or educational strengths and weaknesses were reported as outcomes in four (57%) of the group studies (D'Elia et al. 2014; Eldevik et al. 2012; Strain and Bovey 2011; Young et al. 2016). Intellectual functioning was measured in one study (Eldevik et al. 2012) using the Bayley Scales of Infant Development (BSID; Bayley 2006) for participants younger than 42 months of age, and the Stanford-Binet Intelligence Scale (Thorndike et al. 1986) for participants older than 42 months. Overall, the EG made significantly greater gains than the CG on composite scores for both instruments. Another study (D'Elia et al. 2014) measured psycho-educational skills using the Psychoeducational Profile: Third Edition (PEP-3; Schopler et al. 2005) and found that EG participants made significant improvements over time across most categories. Finally, child cognitive development was measured in two (29%) of the seven group studies (Strain and Bovey 2011; Young et al. 2016) using the Mullen Scales of Early Learning (Mullen 1995) and the cognitive domain of the Bayley Scales of Infant Development (BDI; Bayley 2006). In the Strain and Bovey (2011) study, EG scores were significantly higher than CG scores after intervention; however, no significant change in scores was reported in the Young et al. study."	Summarised inconsistent effect
Social emotional/challenging behaviour (adaptive/maladaptive behaviour)	[group design studies only] "Five (71%) of these group design studies that measured adaptive/maladaptive behavior reported positive results (Boulware et al. 2006; D'Elia et al. 2014; Eikeseth et al. 2012; Eldevik et al. 2012; Strain and Bovey 2011), while the remaining study was coded	Summarised positive effect



	as having no effect because there were no significant changes in participant scores for the EG (Young et al. 2016)."	
Adaptive behaviour (functional skills)	[group design studies only] "Functional skills were measured as outcomes in two (29%) of the group studies (Boulware et al. 2006; Schwartz et al. 2004) and were assessed using (a) Bayley Scales of Infant Development (Bayley 2006); (b) Assessment, Evaluation, and Programming System for Infants and Children (AEPS; Bricker 1994); (c) a researcher-developed functional outcomes index (Schwartz et al. 2004); and (d) a researcher developed functional outcomes scale (Boulware et al. 2006). Participating children from both studies demonstrated gains across at least one functional outcome, and participants from the Schwartz et al. (2004) study made gains across all six of the functional outcomes measured."	Summarised positive effect



Verschuur et al. (2014) – Narrative synthesis

Outcome	Verbatim summary from systematic review	Categorised outcome
General outcomes (child behaviours)	"Of the 35 studies targeting child behaviors, 15 studies (42.9 %) reported positive outcomes and 20 studies (57.1 %) reported mixed outcomes." [Outcomes include communication and language skills; play skills; adaptive functioning; maladaptive behaviours; autism symptoms]	Summarised inconsistent effect
Caregiver social emotional wellbeing (caregiver behaviours)	"Of the 13 studies targeting caregiver behaviors, 7 studies (53.8 %) reported positive outcomes and 5 studies (38.5 %) reported mixed outcomes." [Outcomes include caregiver fidelity of implementation of PRT/NLP; parental stress; parental affect; parental self-efficacy; parent verbalisations]	Summarised inconsistent effect

Virués-Ortega (2010) – Meta-analysis

Outcome	Context	Studies included	Effect size	Heterogenei ty	Categorised outcome
Social-communication (socialisation)	-	11	Inverse–variance weighted random- effects meta-analysis: ES = 0.95, 95CI [0.53, 1.37]	l ² = 66%	Positive pooled effect



Communication	-	11	Inverse–variance weighted random- effects meta-analysis: ES = 1.45, 95CI [1.02, 1.88]	l ² = 68%	Positive pooled effect
Communication (general language skills)	-	6 intervention groups from 5 studies	Inverse–variance weighted random- effects meta-analysis: ES = 1.07, 95CI [0.34, 1.79]	l ² = 86%	Positive pooled effect
Expressive language	-	10 intervention groups from 9 studies	Inverse–variance weighted random- effects meta-analysis: ES = 1.47, 95CI [0.85, 2.08]	l ² = 80%	Positive pooled effect
Receptive language	-	11 intervention groups from 10 studies	Inverse–variance weighted random- effects meta-analysis: ES = 1.48, 95CI [0.96, 1.97]	l ² = 81%	Positive pooled effect
Cognition (IQ)	Overall	20 intervention groups from 19 studies	Inverse–variance weighted random- effects meta-analysis:	l ² = 75%	Positive pooled effect



			ES = 1.19, 95CI [0.91, 1.47]		
	Clinic-based programs	16 intervention groups from 15 studies	Inverse–variance weighted random- effects meta-analysis: ES = 1.23, 95CI [0.95, 1.51]	-	Positive pooled effect
	Parent-managed programs	4	Inverse–variance weighted random- effects meta-analysis: ES = 1.02, 95CI [0.12, 1.93]	-	Positive pooled effect
Cognition (non-verbal IQ)	-	11 intervention groups from 10 studies	Inverse–variance weighted random- effects meta-analysis: ES = 0.65, 95CI [0.17, 1.13]	l ² = 78%	Positive pooled effect
Motor	-	3	Inverse–variance weighted random- effects meta-analysis: ES = 0.71, 95CI [0.19, 1.22]	l ² = 0%	Positive pooled effect



Adaptive behaviours	Overall Clinic-based programs Parent-managed programs		16 intervention groups from 14 studies	Inverse–variance weighted random- effects meta-analysis: ES = 1.09, 95CI [0.70, 1.47]	l ² = 68%	Positive pooled effect
			12 intervention groups from 11 studies	Inverse–variance weighted random- effects meta-analysis: ES = 1.17, 95CI [0.70, 1.47]	-	Positive pooled effect
			4 intervention groups from 3 studies	Inverse–variance weighted random- effects meta-analysis: ES = 0.97, 95CI [0.61, 1.739]	-	Positive pooled effect
Moderators	Context	Outcome	Studies Included	Verbatim summary from review	systematic	Categorised outcome
Intervention amount	-	Cognition (IQ), Communication (language), Adaptive behaviour (adaptation)	Cognition (IQ): 19 Communicatio n (Ilanguage: 4 Adaptive behaviour (adaptation): 17	<i>Cognition (IQ)</i> : "Dose–resanalysis of studies' total t duration suggested that I treatment duration did no treatment gains above av (Fig. 3)."	sponse meta- reatment high total ot improve verage levels	Greater total hours related to greater intervention effect on language and adaptive behaviour, but not cognition.



	Communication (language): "Both results for receptive and expressive language
	demonstrated clear dose-response trends for intervention total duration (Fig.
	3)."
	Adaptive behaviour (adaptation):
	"Dose–response meta-analyses
	demonstrated a clear increase in effect
	sizes by treatment total duration (Fig. 3)."

Waddington et al. (2016) – Narrative synthesis

Outcome	Verbatim summary from systematic review	Categorised outcome
General outcomes (child behavioural functioning and development)	"The four articles using the CBRS (*Vismara et al. 2009a, b; *Vismara et al. 2013a; *Vismara et al. 2008, and the one article (*Fulton et al. 2014) using the ESDM behavior rating scale reported positive results on these measures. Results from articles using the VABS, the MSEL, and the MCDI were mixed. Two articles found positive results for the overall VABS (*Dawson et al. 2010; *Estes et al. 2015), while three articles reported negative results (*Eapen et al. 2013; *Fulton et al. 2014; *Vivanti et al. 2014). Five articles reported positive results for the overall MSEL (*Dawson et al. 2010; *Eapen et al. 2013; *Fulton et al. 2014; *Vivanti et al. 2013; *Vivanti et al. 2014; *Vivanti et al. 2012; *Vismara et al. 2013a), while one article reported negative results (*Rogers et al. 2012). Results for the remaining measures were negative."	Summarised positive effect



Overall autism characteristics (autism severity and core diagnostic outcomes)	"Seven articles (*Dawson et al. 2010; *Estes et al. 2015; *Eapen et al. 2013; *Fulton et al. 2014; *Rogers et al. 2012; *Vivanti et al. 2013; *Vivanti et al. 2014) reported on autism severity using either the ADOS (Lord et al. 2002) or the Social-communication Questionnaire (SCQ; Berument et al. 1999). Of the five articles using the ADOS (*Dawson et al. 2010; *Estes et al. 2015; *Rogers et al. 2012; *Vivanti et al. 2013; *Vivanti et al. 2010; *Estes et al. 2015; *Rogers et al. 2012; *Vivanti et al. 2013; *Vivanti et al. 2014), only one reported positive results following intervention (*Estes et al. 2015). Of the articles using the SCQ, one reported positive results (*Eapen et al. 2013), and the other negative results (*Fulton et al. 2014) following intervention. Three articles (*Dawson et al. 2010; *Estes et al. 2015; *Vismara et al. 2008) reported on participants' change in diagnosis from ASD to PDD-NOS or Bno diagnosis^ following intervention. Two articles reported positive results in this regard (*Dawson et al. 2010; *Vismara et al. 2008), while *Estes et al. (2015) reported negative results."	Summarised null effect
Social-communication (social interaction and communication)	"Six articles reported at least one child outcome measure that was based on direct observation of the child's social interaction and communication skills (*Rogers et al. 2012; *Vismara et al .2012; *Vismara et al .2013a; *Vismara et al. 2008; *Vismara et al. 2012). These measures included spontaneous verbal utterances, imitation skills, social orienting, and joint attention. All articles reported positive results for these outcome measures, with the exception of *Vismara et al. (2009b) and *Rogers et al. (2012) who found negative results on a measure of imitation skills. *Rogers et al. (2012) also found negative results on a measure of social orienting and joint attention."	Summarised positive effect
Caregiver communication and interaction (fidelity to intervention)	"Six articles (*Rogers et al. 2012; *Vismara et al. 2012; *Vismara et al. 2009a, b; *Vismara et al. 2013a; *Vismara et al. 2008) included a measure related to the extent to which parents implemented ESDM therapy correctly. Five articles (*Vismara et al. 2012; *Vismara et al. 2009a, b; *Vismara et al. 2013a; *Vismara et al. 2008) reported positive results in that the majority of parents (at least five out of eight) achieved an acceptable level of treatment integrity (80 % correct implementation) within six to eight sessions. However *Rogers et al. (2012) reported negative results with no significant differences in scores for treatment integrity in the ESDM group compared with the TAU group."	Summarised positive effect
Caregiver social emotional wellbeing (parental stress and sense of competence)	"Three articles (*Estes et al. 2014; *Vismara et al. 2012; *Vismara et al. 2013a) reported on additional parent outcome measures including the Maternal Behavior Rating Scale (MBRS; Mahoney et al. 1998), the Questionnaire of Resources and Stress (QRS; Konstantareas et al. 1992), and the Parenting Sense	Summarised positive effect



	of Competence Qu MBRS and the QRS	estionnaire (PSOC; Joh , but negative results w	nston and M ere reported	ash 1989). Positive results were reported for the I in the PSOC (*Estes et al. 2014)."	
Caregiver satisfaction (social validity)	"Five articles (*Fulto reported positive re *Rogers et al. (2012 and therapists."	Summarised positive effect			
Moderators	Context	Outcome	Studies Included	Verbatim summary from systematic review	Categorised outcome
Child characteristics	No meta-analysis, narrative review only	Unspecified intervention outcomes	2	"Rogers et al. (2012) found that nonsocial orienting was a significant predictor of increased scores on the MSEL and decreased ADOS social affect scores when both the ESDM and TAU groups were combined and that social orienting was a significant predictor of reduced ADOS restricted and repetitive behavior scores. However, contrary to their hypothesis, imitation skills were not a significant predictor of treatment outcomes. In contrast, *Vivanti et al. (2013) found that scores in an imitation task were a significant predictor of positive intervention outcomes, as well as functional object use, and goal understanding."	Greater pre- intervention imitation was inconsistently related to intervention effects. Functional use of objects, and goal understanding related to greater intervention effects. Pre- intervention cognitive ability and social attention not related to



				"*P	intervention outcomes.
Child age	No meta-analysis, narrative review only	MSEL scores	2	"*Rogers et al. (2012) found that higher number of hours of intervention when both the ESDM and TAU groups were combined, predicted significantly better scores on the ADOS, MSEL, MCDI and Nonsocial orienting measures They also found that chronological	Child age inconsistently related to intervention effects.
Intervention amount	No meta-analysis, narrative review only	Scores on the ADOS, MSEL, MCDI and Nonsocial orienting measures.	2	age negatively predicted MSEL scores after intervention. These results suggest that higher intervention hours and lower chronological age predicted better intervention outcomes in this sample. However, *Vivanti et al. (2013) found that intensity of treatment and chronological age did not predict treatment outcomes in a group of 21 children receiving group ESDM therapy."	Total hours of intervention inconsistently related to intervention effects.

Watkins et al. (2019) – Meta-analysis

Outcome	Context	Studies included	Effect size	Heterogeneity	Categorised outcome
General outcomes	Single case experimental designs	25	Tau-U = 0.91, 95CI [0.97, 0.99]	Q = 544.69 ² = 93.94%	Positive pooled effect
Social-communication	Single case experimental designs	20	Tau-U = 0.94, 95CI [0.87, 0.97]	Q = 84.57 ² = 79.90%	Positive pooled effect



RRB	Single case experimental designs		2	Tau-U = .99 [SD = .01] NAP = .99 [SD = .00]	Not specified	Positive pooled effect
Social emotional/challenging behaviour (classroom behaviour, challenging behaviour, and repetitive behaviour)	Single case experimental designs		15 effect sizes from 11 studies	Tau-U = 0.99, 95CI [0.98, 1.00]	Q = 304.65 I ² = 95.08%	Positive pooled effect
Social emotional/challenging behaviour (classroom behaviour)	Single case experin	nental designs	4	Tau-U = 0.97 [SD =0.05]	Not specified	Positive pooled effect
Play	Single case experin	nental designs	2	Tau-U = .92 [SD = .06) NAP = .96 [SD = .03]	Not specified	Positive pooled effect
Moderators	Context	Outcome	Studies Included	Verbatim summary from systemat	tic review	Categorised outcome



Intervention agent	Teachers, peers, researchers	All outcomes	Not specified	"Regarding the intervention agent, teachers who delivered the intervention by themselves produced results with significantly higher effects than interventions delivered by any other agent(s). Studies targeting classroom behaviors resulted in significantly larger effects than those targeting Social-communication."	Interventions delivered by teachers had a greater intervention effect than interventions delivered by
					researchers or
					peers.

Weitlauf et al. (2017) – Narrative synthesis

Outcome	Verbatim summary from systematic review	Categorised outcome
Auditory Integration-Based Approache	25	
Communication (language)	"Two small, short-term RCTs of auditory integration-based approaches assessing language outcomes reported no significant differences between groups in receptive language outcomes;34, 35 one RCT (in a publication reporting 2 unique studies) reported significant parent-rated improvements in spontaneous speech.18 We have low confidence in the conclusion that these approaches do not improve language outcomes (low strength of evidence) (Table 6)."	Summarised null effect
Ayres Sensory Integration (ASI)		
Sensory (sensory-related outcomes)	"Sensory-related and motor skill outcomes improved in children receiving an SI-based	Summarised positive effect
Motor	significant improvements in three of four studies addressing the outcome). We have low confidence in this conclusion (low strength of evidence)"	Summarised positive effect



Environmental Enrichment			
Expressive language	"These approaches do not affect expressive language. We have low confidence in this conclusion (low strength of evidence)."	Summarised null effect	
Cognition (nonverbal cognitive skills)	"Environmental enrichment approaches improved nonverbal cognitive skills. We have low confidence in this conclusion (low strength of evidence)."	Summarised positive effect	

Weston et al. (2016) – Meta-analysis

Outcome	Context	Studies include d	Effect size	Heterogenei ty	Categorised outcome
Overall autism characteristics (symptoms related to ASD)	Self-reported	9	g = 0.25, 95Cl [-0.03, 0.53]	Tau ² = 0.07 Chi ² = 13.39 I ² = 40%	Null pooled effect
	Clinician-reported	6	g = 0.65, 95CI [0.10, 1.21]	Tau ² = 0.21 Chi ² = 9.36 I ² = 47%	Positive pooled effect



Wiese et al. (2016) – Narrative synthesis

Outcome	Verbatim summary from systematic review	Categorised outcome
General outcomes (behaviour and social interaction)	"The results of the studies are summarised in Appendix 2, with the studies grouped according to the NHMRC hierarchy of methodological quality.22 From the summary of the results found in each study, it can be seen that most, but not all, studies found that results were beneficial; however, the lack of significance shows that overall, the result of equine-based therapy on behaviour and social interaction were mixed."	Summarised inconsistent effect

Zagona & Mastergeorge (2018) – Narrative synthesis

Outcome	Verbatim summary from systematic review	Categorised outcome
Social-communication	"PMII studies have demonstrated effectiveness for increasing the social-communication skills for learners with ASD (e.g., Ganz et al., 2012; Kasari et al., 2012; Lee et al., 2007). All of the studies included in this review documented positive outcomes and increases in social-communication skills in both the frequency and duration of these skills. Additionally, several studies demonstrated a functional positive relationship upon introduction of PMII. In addition, several of these studies reported increases in the number of initiations and responses used by individuals with ASD (Jung et al., 2008; Owen-DeSchryver et al., 2008; Strasberger & Ferreri, 2014). Other studies documented increased duration of the interactions of the child with ASD and the peer (Katz & Girolametto, 2013; Lee et al., 2007; Schmidt & Stichter, 2012). In one study, the children with ASD increased number of gestures, verbal utterances, vocalizations, and activations of their communication device (Trottier et al., 2011). Additionally, Kasari and colleagues (2012) found that an intervention that was peer-mediated was more effective than one that was implemented by paraprofessionals for improving the amount of times the student with ASD was engaged with peers, as compared to being unengaged with others."	Summarised positive effect



Footnote: δ = Delta; ES = effect size; I² = Cochran's I² statistic; MD = mean difference; NAP = nonoverlap of all pairs; PND = percentage of nonoverlapping data; Q = Cochran's Q statistic; RRB = restricted and repetitive interests and behaviours; RVE = robust variance estimation; SE = standard error; SMD = standardised mean difference; τ 2 = tau-squared; wES = weighted mean effect size.



Appendix U: Information on the amount of intervention received for all included systematic reviews

Author (year)	Information on the amo	unt of intervention receive	ed	
Akemoglu et al. (2020)	This review included 12 studie	es; intervention amount (total ho	ours) was extracted from Table .	2 of the original article.
Intervention(s): Parent-implemented telehealth interventions – Communication intervention; Early Start Denver Model (ESDM); Parents Early Start Denver Model (P-ESDM); Reciprocal Imitation Training (RIT); Decide, Arrange, Now, Count, and Enjoy (DANCE); Improving Parents as Communication Teachers (imPACT); Internet-based Parent-implemented Communication Strategies (i-PiCS); Prepare, Offer, Wait, and Respond (POWR).	0.5h 1h Not specified for 4 studies	0.5h 1.5h	0.5h 1.5h	0.75h 1.75 to 2h



Bejarano-Martin et al. (2020) Intervention(s): Focused intervention	This review included 43 studies, intervention amount was extracted from Tables 1 and 2 of Appendix C of the original article.			
practices - Discrete trial training (DTT); Pivotal Response Training (PRT), Contingent imitation; discrete trial training (DTT) plus social interaction, mediated learning with active engagement; picture exchange communication system (PECS); video modelling; prompting and	<u>Group Designs:</u> 6 weeks total 1h/week for 32 weeks 2h/week for 8 weeks 10h/week for 6 weeks Not specified for 2 studies	8 weeks total 1.5h p/week for 24 weeks 3h/week for 10 weeks 21h/week for 12 weeks	1h/week for 10 weeks 2h/week for 4 weeks 3.5h/week for 10 weeks 259h total	1h/week for 12 weeks 2h/week for 8 weeks 4h/week for 44 weeks
reinforcement; physical and verbal cues; token economy and prompting; photographic schedules.	1h sessions (4.5h total) 0.7h sessions (12h total) 1h sessions (14h total) 1h sessions (23h total) 38h total 5.5h/week Not specified for 2 studies	9h total 1.5h sessions (12h total) 15h total 23.7h total 0.3h sessions (58.7h total) 10 weeks	 1.5h sessions (10.5h total) 0.1h sessions (13.3h total) 1h sessions (16.7h total) 1h sessions (28h total) 0.25h sessions (80h total) 	10.7h total 0.5h sessions (14h total) 0.3h sessions (21h total) 37.5h total 0.3h sessions (87h total)



Binns & Oram Cardy (2019)	This review included 10 studie	This review included 10 studies (14 articles); intervention amount was extracted from Table 2 of the original article.			
Intervention(s): Developmental social pragmatic interventions - Child Talk; Hanen More than Words; Developmental Individual-Difference Relationship-Based (DIR); Milton and Ethel Harris Research Initiative Treatment (MEHRIT) - DIR based; Pediatric Autism and Communication Therapy (PACT); Joint attention mediated learning; Play and Language for Autistic Youngsters (PLAY) project - DIR based; Social communication, emotion regulation, transactional support (SCERTS).	5 X 2h parent sessions, 2 X 45 minute individual sessions and 2 X 1h/week group sessions for 7 weeks	1 X 1.5h session, other sessions not specified, over 3 months	3 sessions/week for 6 months and 2 sessions/week for 3 months	8 X parent sessions and 3 X home sessions over 3.5 months	
	1 session/month for 6 months and 'less frequent' follow-ups for 6 months Biweekly sessions for 6 months and monthly follow- ups, 18 sessions total over 12 months	15 sessions (minimum) over4 to 12 months (average 7 months)2h/week for 12 months	1h/week for 32 weeks	1 X 3h session/month for 12 months	
Boshoff et al. (2020)	This review included 9 studie.	s; intervention amount was extr	racted from Table 3 of the origir	hal article.	
Intervention(s): Developmental Individual-Difference Relationship-	3h/week for 7 weeks	10h/week for 10 weeks	15.2h/week for 12 weeks	0.5 to 1h/week for 10 months	
Based (DIR)/Floortime [™] model and interventions based on the principles of the DIR/Floortime [™] Model- Milton and Ethel Harris Research Initiative Treatment (MEHRIT); Floor time play (FTP); Play and Language for Autistic Youngsters (PLAY); the PLAY Project Home Consultation Program.	3h/month for 12 months	14.2h/week for 52 weeks	<10h to >15 h/week for 52 weeks	2h/week with therapist and 25h/week with parents, for 52 weeks	
	11.6h/week for 1-96 months				




Chang & Locke (2016)	This review included 5 studies; intervention amount was extracted from Table 1 of the original article.			
Intervention(s): Peer-mediated interventions.	4h/day for 2 weeks 3 X 25 to 30 minute	1 to 2 X 30 minute sessions/week (10 sessions total)	2 sessions/week for 6 weeks	12 X 30 minutes/day over 3 months
	sessions/week for 6 months			
Ferguson et al. (2019)	This review included 28 studie	es; intervention amount was ext	racted from Table 1 of the origi	nal article.
Intervention(s): Telehealth interventions with behavioural	5 minute sessions	1 to 2h	2 X sessions	3 X 30 minute sessions
principles- functional analysis (FA); functional communication training (FCT); naturalistic and incidental teaching; behaviour support strategies (e.g., positive behaviour support); preference assessments; Early Start Denver Model (ESDM); Improving Parents as Communication Teachers (imPACT).	4 online sessions	1h meeting and 3 X 15 minute sessions	1h weekly sessions	1.5h/week
	12 weekly sessions	11 X 75 minute sessions (group 1), 11 X 75 minute sessions and 2 X 30 minute sessions/week (group 2)	11 X 75 minute sessions (group 1), 11 X 75 minute sessions and 2 X 30 minute sessions/week (group 2)	1 X 45 minute coaching and 2 X 5 to 7 minute sessions/week
	6 months	2 day training conference, 2h training, and 1h follow-up (phase 1), 3h seminar, 2h group supervision, 1h tele- conference and 1h video of parent training session (phase 2)		
	Not specified for 15 studies			



Flippin et al. (2010) Intervention(s): Picture exchange communication system (PECS).	Intervention amount was not specified.			
Fuller & Kaiser (2020) Intervention(s): "Early interventions" – Not specified.	This review included 29 studie 1h/week for 1 week 0.69h/week for 52 weeks 1h/week for 6 weeks 1h/week for 16 weeks 2h/week for 6 weeks 2.5h/week for 6 weeks 4h/week for 40 minutes 30h/week for 104 weeks	es; intervention amount was ext 0.5h/week for 4 weeks 0.69h/week for 52 weeks 1h/week for 10 weeks 1.25h/week for 12 weeks 2h/week for 24 weeks 2.6h/week for 10 weeks 15h/week for 20 weeks	tracted from Table 4 of the origination of the original of the	inal article. 0.6h/week for 20 weeks 0.46h/week for 104 weeks 1h/week for 12 weeks 1.77h/week for 9 weeks 2h/week for 52 weeks 3h/week for 10 weeks 25.6h/week for 104 weeks
Fuller, Oliver et al. (2020) Intervention(s): Early Start Denver Model (ESDM).	<i>This review included 12 studie</i> 1h/week for 12 weeks 3h/week for 6 weeks 15h/week for 52 weeks	es, intervention amount was ext 1h/week for 18 weeks 4.6h/week for 52 weeks 16h/week for 116 weeks	racted from Table 2 of the origin 1.5h/week for 12 weeks 5h/week for 8 weeks 15 to 20h/week for 156 weeks (average)	nal article. 1.5h/week for 26 weeks 6h/week for 24 weeks 20h/week for 104 weeks
Geretsegger et al. (2014) Intervention(s): Music therapy.	This review included 10 studie the original article. 20 minute sessions over 5 days	es, intervention amount was ext 6 X sessions over 3 days (Group 1 and 2)	racted from the 'Characteristics	of included studies' table of 6 X individual sessions over 2 weeks (Intervention 1 and 2) or no training (Intervention 3)



	18 X 10 minute sessions over 5 weeks	1 session/day over 10 weeks (10 sessions total)	24 X 15 minute sessions 2 sessions/day over 12 weeks	16 X weekly sessions and standard care over 16 weeks
	3 X assessment sessions, 16 X intervention sessions, 1 final assessment session and 20 X 30 minute weekly standard treatment sessions over 7 months	30 minute weekly sessions over 8 months (24 sessions total)		
Griffith et al. (2020)	This review included 35 studie	es (from 34 articles); intervention	n amount was extracted from To	able 2 of the original article.
Intervention(s): Interactive apps.	9 minutes 4 trials 8 trials 1 week 10 sessions over 2 to 3 weeks 6 weeks 9 weeks 16 weeks 1 year	20 minutes 4 X 5 minute trials 5 days 12 trials 4 weeks 8 weeks 12 weeks 22 weeks 1 year	3 trials 5 trials 5 days 10 days 6 weeks 8 weeks 14 weeks 6 months	4 trials 6 X 1 minute trials 2 X 10 minute sessions over 2 weeks 3 weeks 6 weeks 2 months 15 weeks 1 academic year



Hampton & Kaiser (2016)	This review included 26 studies; intervention amount was extracted from Table 5 of the original article.					
Intervention(s): Early interventions- Early Intensive Behavioural Intervention (EIBI); Early Intervention	2.5h/week for 6 weeks	2.15h/week for 10 weeks (24h total parent training)	1h/week for 12 weeks	1h/week for 12 weeks (12h total parent training)		
Preschool (EIP); Early Start Denver Model (ESDM); Joint Attention Mediated Learning (JAML); Joint	1.5h/week for 12 weeks (18h total parent training)	2.33h/week for 12 weeks (12h total parent training)	1h/week for 14 weeks (14h total parent training)	3.3h/week for 14 weeks		
Attention; Structured Play Engagement; and Regulation (JAML); Learning Experiences and Alternative	1h/week for 16 weeks (16h total parent training)	1.25h/week for 20 weeks (25h total parent training)	2h/week for 40 weeks (40h total parent training)	4h/week for 45 weeks		
Harris Research Initiative Treatment (MEHRIT); More Than Words (MTW); Pediatric Autism and Communication	0.5h/week for 52 weeks (26h total parent training)	0.5h/week for 52 weeks (27h total parent training)	0.61h/week for 52 weeks (36h total parent training)	0.75h/week for 52 weeks (36h PT total parent training)		
Therapy (PACT); Play and Language for Autistic Youngsters; PRT, Pivotal Response Training (Play and	1h/week for 52 weeks	2h/week for 52 weeks (104h total parent training)	2h/week for 52 weeks (104h total parent training)	25.6h/week for 52 weeks		
Language for Autistic Youngsters); Treatment and Education of Autistic and Related Communication	30h/week for 52 weeks	40h/week for 52 weeks (70h total parent training)	20h/week for 54 weeks	PT		
Handicapped Children (TEACCH); Scottish Early Intervention Preschool; Parent training model (PSwA); Focused	17h/week for 104 weeks	20h/week for 104 weeks (24h total parent training)				
playtime (FPI); Speech remediation; Teach Town basics; Early Social Interaction (ESI); Parent training,						
Benaviour analytic.						



Hardy & Weston (2020)	Intervention amount was not	specified.				
Intervention(s): Canine-assisted therapy.						
Hill et al. (2019)	Intervention amount was not	specified.				
Intervention(s): Canine-assisted therapy- animal-assisted therapy; animal-assisted activities; animal- assisted education; animal-assisted play therapy.						
Ho et al. (2014)	This review included 10 studies; intervention amount was extracted from Table 2 of the original article.					
Intervention(s): Cognitive behavioural approaches - Cool Kids; Building Confidence Family Cognitive Behaviour Therapy (FCBT); Social Skills Training for Children and Adolescents with Asperger Syndrome and Social-Communications Problems;	9h total over 9 weeks	12h total over 6 weeks (8h with therapist)	12h total over 6 weeks, 12 therapist hours	17.5h (child), 2.5h (parent) over 16 weeks (17.5h with therapist)		
	18h total over 12-16 weeks	<30h total over 12 weeks (12h with therapist)	24h total over 26 weeks (6.9h with therapist)	9h (child), 12h (parent), 4h (family) over 16 weeks (8h with therapist)		
Thinking about you, thinking about me; Coping Cat CBT program; Facing your fears; Group Cognitive Behaviour Therapy.	9h (child), 12h (parent), 4h (family) over 16 weeks (8h with therapist)	24h total over 16 weeks (13.7h with therapist)				
Kent et al. (2020)	This review included 19 studie	This review included 19 studies; intervention amount was extracted from Table 3 of the original article.				
Intervention(s): Play-based interventions- [Generic] play intervention; Joint Attention, Symbolic Play, Engagement, and Regulation	10 X 4h	9 sessions/day	4 X 30 minute sessions/day and 1 X 90 minute session	3 X 30 minute sessions/week over approximately 6 months		



(JASPER); Lego therapy; Social stories; behavioural approaches; peer training; teacher training; Social Emotional NeuroScience Endocrinology (SENSE) Theater principles; video modelling.	2 X 20 minute sessions/week 60 X 15 minute sessions	12 X 60 minute weekly sessions 16 X 30 to 45 minute	30h over 5 weeks and 10h/week parent delivered 1h/week over 10 weeks	30 minutes/day for 5 to 6 weeks 8 to 10 sessions over 1 term
	over 8 weeks 2 X 30 minutes/week for 12	sessions over 8 weeks 5 X 60 to 90 minutes over 3	2 X 1h/week over 12 weeks	1h/week for 18 weeks
	weeks Weekly sessions including 10–15 min observation and 1h training Not specified for 2 studies	months		
Khan et al. (2019)	This review included 10 studie	s; intervention amount was ext	racted from Table 2 of the origi	nal article.
Intervention(s): Web-based interventions - apps; serious games; videoconferencing; virtual environment with playable games;	30 minutes daily for 4 weeks	2 X 60 minutes/week over 5 weeks (10 sessions total)	2 X 1.5h sessions and 6 X 1h sessions over 10 weeks	6 X weekly sessions and 2 X biweekly sessions over 10 weeks
web-based cognitive behavioural therapy intervention.	1 X 60 minute session/week for 10 weeks, (10 sessions total)	3 X 65 minute sessions/week for 10 weeks	2 X 40 minute sessions/week for 10 weeks (8 to 12 sessions total)	2h/week for 8 to 12 weeks
	5 minutes/day or 10 min every other day for 2 months	20 minutes/day for 6 months		



Knight et al. (2013)

Intervention amount was not specified.

Intervention(s): Computer assisted instruction; simultaneous prompting; differential reinforcement; error correction and feedback procedure; delayed prompting procedure; stimulus prompting.

Lang et al. (2012)

Intervention(s): Sensory-integration therapy- weighted vests; swinging or rocking stimulation; brushing with a bristle or a feather; joint compression or stretching; alternative seating; jumping or bouncing; blanket or "body sock"; playing with a water and sand sensory table; chewing on a rubber tube; and playing with specially textured toys.

Logan et al. (2017)

Intervention(s): Aided AAC systemsdedicated speech generating devices (SGDs); iPad©/iPod© Touch configured as SGDs; picture exchange communication system (PECS); lowtech aids (e.g., boards or books) incorporating pictures and photos. This review included 25 studies; intervention amount was extracted from Table 1 of the original article.

ation ging or vith a ression ng; or "body d sand ubber y	10 minutes 18 X 45 minutes for 6 weeks 2 X sessions/week for 1 year Not specified for 14 studies	2 x 30 minute sessions (experimental group) OR 2 x 30 minute (control group) 1h/week for 11 weeks (participant 1), 1h/week for 7 weeks (participant 2) 6 X 15 minutes/day	5 minute sessions for 17 days 30 minutes/day for 10 weeks 4 X 30 minute sessions/day	2 X 1h sessions/week for 16 sessions7 sessions/day for 5 weeks
stems- devices xchange ; low-	Intervention amount was not s	specified.		



Makrygianni & Reed (2010)	This review included 14 studies; intervention amount was extracted from Appendix A of the original article.				
Intervention(s): Behavioural early intervention programs.	8 months	12.5h/week for 20.3 months	20h/week for 12 months	20.4h/week for 9 months	
	24.52h/week for 58 months	25.6h/week for 24 months	30h/week for 35 months	30.4h/week for 9.5 months	
	32.4h/week for 25.5 months	32.5h/week for 14.21 months	37.5h/week for 36 months	37.58h/week for 48 months	
	40h/week for 24 months	40h/week for 30 months			
Mazon et al. (2019)	This review included 31 studie	s; intervention amount was extr	racted from Tables 2 to 4 of the	original article.	
Intervention(s): Technology based interventions including (but not limited to) computer and robot-based interventions.	Single session Single session Single session 1 week 4 weeks 8 weeks 12 weeks 12 weeks 12 weeks (Experiment 1), 12 weeks (Experiment 2)	Single session Single session Single session 2 weeks 6 weeks 8 weeks 12 weeks 10-20 weeks	Single session Single session Single session 3 weeks 8 weeks 10 weeks 12 weeks 40 weeks	Single session Single session Single session 1 week (Experiment 1), 4 weeks (Experiment 2) 8 weeks 12 weeks 12 weeks	



McCoy et al. (2016)	This review included 29 studi	es; intervention amount was ex	tracted from Tables 1 to 3 of the	e original article.
Intervention(s): Role play; video modelling; computer-based instruction.	2 X 4 minutes	37 sessions (average) X 35 seconds	1 X 45 minute session/day	2 X 7h sessions
	1 X 40 minute session for 5 days	1 session X 10 days	4 to 8 X 45 minute sessions	2 X 1.5h/week
	3 to 6 X 45 minute sessions/week	10 sessions	10 weeks	12 X 45 minute sessions
	1 X 40 minute session for 22 days	2 to 4 X 15 to 20 minutes/week	1 to 5 X 60 minutes/week, range of 3 to 25 sessions	2 to 3 X 60 minute sessions/week (6 to 9 sessions total)
	1 session 3 X weekly for 1 to 4 weeks	10 X 1.5 to 2h sessions for 5 weeks	40 minute sessions for 6 weeks	1h/week for 6 weeks
	12 X 10 to 25 minute sessions for 6 weeks	30 minute sessions X 3 days/week over 8 weeks	1 X 90 minutes/week for 10 weeks	31 to 45 minute sessions X 2 to 3 days/week for 10 weeks
	1 X 2h session/week for 11 weeks	0.5 to 1h for 12 weeks	24 sessions over 15 weeks	2 X 1.5h sessions over 20 to 28 weeks
	Not specified for one study			
Miguel-Cruz et al. (2017)	Intervention amount was not :	specified.		
Intervention(s): Robots.				



Moon et al. (2020) Intervention(s): Mobile device applications - including (but not limited to) FindMe game app, Therapy Outcomes By You (TOBY), Camp Discovery.	Intervention amount was not s	specified.		
Murza et al. (2016)	This review included 16 studie	es; intervention amount was ext	racted from Table 2 of the origi	nal article.
Intervention(s): Joint attention interventions - Assessment, Evaluation and Programming System (AEPS) for Infants and Children; Caregiver Education Model (CEM); Caregiver Mediated Model (CMM); Hanen More Than Words (HMTW); Joint Attention Mediated Learning (JAML); Joint Attention Symbolic Play Engagement and Regulation (JASPER); Milton and Ethel Harris Research Initiative (MEHRI); Preschool Autism Communication Trial (PACT); parent training modules; and workshop training.	 15 X sessions and 30 minutes parent implementation daily 40 X 20 minute sessions over 8 weeks 30 minutes/day for 6 months 	15 to 18 X 30 minute sessions for 5 to 6 weeks 30 minutes/day for 11 weeks 104 X 150 minute sessions over 6 months	 30 X 24 minute sessions over 6 weeks 2 X 30 minutes sessions for 12 weeks 52 X 120 minute sessions (clinic) and 365 X 180 minute sessions (home) over 1 year 	 24 X 30 minute sessions over 8 weeks 12 X 60 minute sessions over 12 weeks 48 X 120 minutes clinic sessions over 6 months and 30 minutes/day suggested at home and 18 booster sessions over the next 6 months



National Autism Center (2015)	Intervention amount was not s	specified.		
Intervention(s): Behavioural				
interventions; Cognitive Behavioural				
Intervention Package; Comprehensive				
Behavioural Treatment for Young				
Children; Pivotal Response Training;				
Augmentative and Alternative				
Communication Devices;				
Developmental Relationship-based				
Treatment; Functional Communication				
Training; Music Therapy; Picture				
Exchange Communication System;				
Social Communication Intervention;				
Technology-based Intervention;				
Theory of Mind Training; Animal-				
assisted Therapy; Auditory Integration				
Training; DIR/Floor Time; Facilitated				
Communication; Movement-based				
Intervention; Sensory Intervention				
Package.				
Naveed et al. (2019)	This review included 33 studie	es; intervention amount was ext	tracted from Table 2 of the orig	inal study.
Intervention(s): Cognitive behavioural strategies (CBT); Social emotional	15 X 23.22 minute sessions	12 X 10 minute sessions over 6 weeks	7 X 15 minute sessions over 7 weeks	80 X 20 minute sessions over 8 weeks
NeuroScience Endocrinology (SENSE) theatre; Preschool Autism Communication Trial (PACT); Parent mediated intervention for Autism	8 X 90 minute sessions over 8 weeks	8 X 120 minute sessions over 8 weeks	10 X 240 minute sessions over 8 weeks	10 X 60 minute sessions over 10 weeks
Spectrum Disorders in South Asia	20 X 60 minute sessions	21 X 75 minute sessions	10 X 240 minute sessions	5 X 75 minute sessions over



(PASS); Project Impact; Peer	over 10 weeks	over 10 weeks	over 10 weeks	12 weeks
interventions; Qigong Sensory				
Treatment (QST); Joint Attention,	12 X 90 minute sessions	13 X 90 minute sessions	90 X 20 minutes over 12	10 X 180 minute sessions
Symbolic Play, Engagement, and	over 12 weeks	over 12 weeks	weeks	over 12 weeks
Regulation programme (JASPER); Play				
project; LEAP project i.e. Learning	9 X 90 minute sessions over	14 X 90 minute sessions	16 X 35 minute sessions	16 X 40 minute sessions
Experiences and Alternative Program	13 weeks	over 14 weeks	over 16 weeks	over 16 weeks
for Preschoolers and Their Parents;				
Hanen's more than words (HMTW)	18 weeks	20 X 15 minute sessions	20 X 90 minute sessions	20 X 90 minute sessions
intervention program; Peer network		over 20 weeks	over 20 weeks	over 20 weeks
intervention procedure; family				
centered music therapy; The	12 X 17.5 minutes over 24	12 X 120 minute sessions	97 X 27.5 minute sessions	48 X 105 minute sessions
Managing Repetitive Behaviours	weeks	over 24 weeks	over 24 weeks	over 24 weeks
Programme; psychoeducation				
program; autism preschool program;	12 X 60 minutes over 24	32 X 1500 minute sessions	12 X 180 minute sessions	834 X 180 minute sessions
Video-feedback Intervention to	weeks	over 32 weeks	over 48 weeks	over 182.5 weeks
promote Positive Parenting adapted				
for Autism; Social ABCs; Parent	Not specified for one study			
mediated intervention for Autism				
Spectrum Disorders in South Asia				
(PASS) plus; enhancing interactions				
tutorial; Social Tools And Rules for				
Teens socialization (START);				
COMPASS for Hope; Program for the				
Education and Enrichment of				
Relational Skills (PEERS) curriculum;				
application				



Nevill et al. (2018)

Intervention(s): Child's Talk Pro Hanen's More than Words (HM) DIR/Floortime; Parent Focus Tra Joint Attention Symbolic Play Engagement and Regulation (JA Pivotal Response Training (PRT) Intervention to promote Positive Parenting for children with Autis (VIPP-AUTI); Home-based progr Building Blocks; Focused Playtin Intervention; Play and Language Autistic Youngsters (PLAY) Proje Preschoolers with Autism; Treat and Education of Autistic and R Communication Handicapped C (TEACCH); Social Communication Emotion Regulation, and Transa Supports (SCERTS); Parent-med Communication-focused Treatm (PACT).

oject;	This review included 19 studies; intervention amount (dose of parent training) was extracted from Table 2 of the original article.					
TW); aining; ASPER);); Video	2.25h total	5 X 1 to 1.5h sessions over 3 months and 2 group sessions (approximately 7 to 9.5h total)	2 X 30 minute sessions/week for 10 weeks (10h total)	1 session/month for 6 months and 3 X bimonthly sessions (approximately 12h total over 9 sessions)		
e sm ram; me e for	3 sessions/week for 8 weeks (12h total)	1 X workshop, 1 X training, and 1 X follow-up session (approximately 13.5h total)	12 X 1 p/week (16h total)	1 X 90 minute session/week for 12 weeks and 3 X 90 minute parent coaching sessions (18h total)		
ect; tment elated Children on,	1.5h/week for 12 weeks (18h total)	8 X 2.5h weekly group sessions and 3 X individual sessions (approximately 23h total)	1 X 3h session every 6 weeks for 12 months (24h total)	2 X 1h sessions/week for 12 weeks (24h total)		
actional diated nent	10 X 1h sessions and 10 X 1.5h sessions over 20 weeks (25h total)	3h monthly sessions for 1 year (36h total)	2h semi-monthly sessions over 40 weeks (40h total)	1 to 1.5h/week for 40 weeks (45 to 65h total)		
	2h sessions biweekly for 6 months and booster sessions for 6 months (96h total)	3 sessions/week for 6 months and 2 sessions/week for 3 months (88.56h total on average)	2h/week for 1 year (104h total)			



Ona et al. (2020)	This review included 5 studies (7 articles); intervention amount was extracted from table 3 of the original article.				
Intervention(s): Pivotal Response Treatment (PRT).	5h/day for 4 days (20h total) 8 X 90 minute groups and 4 X 60 minute groups (total 12 weekly groups) Not specified for 2 studies	2 X 60 minute sessions /week for 3 months (24h total)	2 X 60 minute sessions/ week for 3 months (24h total)	247h (approximately)	
Oono et al. (2013) Intervention(s): Parent mediated	This review included 17 studies across 18 articles, intervention amount was extracted from the "Characteristics of Studies" Table of the original article.				
interventions – Developmental Individual-Difference Relationship- Based (DIR) techniques; massage intervention; management of challenging behaviour; early intensive behavioural intervention; Pivotal Response Treatment (PRT).	1h 6 minutes	1 session/day for 5 days over 2 weeks	5h/week over 2 sessions (parent training) and 10 to 15hrs (child class)	3 X 45 minute sessions/ week (24 sessions total)	
	1 X 90 minute session/week for 12 weeks	1 day workshop, 3h training and 15.2h/week for 3 months	5 X weekly 3h classes and 3h/week for 10 weeks, total 12 weeks	8 group sessions and 3 home sessions over 3.5 months	
	20 weeks	1 session/month for 6 months and less frequent sessions over the next 6 months	bi-weekly 2h sessions for 6 months, monthly booster sessions, (average total 9.5h over 18 sessions)	1 X 2h session/fortnight over 40 weeks (up to 20 sessions)	
	1 to 1.5h/week for 40 weeks over 12 months	3h every 6 weeks for 12 months	2h/week over 12 months therapist delivered and 3h/day parent delivered	2h sessions on 5 days/week for 2 years	



	3h group sessions, 7 X weekly 30 minute support sessions and parent delivered intervention for 15 minutes			
Parsons, Cordier, Vaz et al. (2017)	This review included 7 studies	s (9 articles); intervention amour	nt was extracted from Table 4 o	f the original article.
Intervention(s): Web-based training in behavioural interventions; Online and	4-8 h over 3 weeks	1h/week	1h/week for 12 weeks	1.5h/week for 12 weeks
Applied System for Intervention Skills (OASIS) training intervention Research- to-practice; Improving Parents as Communication Teachers (ImPACT) on the Web; Implementation discrete-trial instructions using video training materials; Parent Early Start Denver Model (P-EDSM) training;	1 X 80 minutes/week for 12 weeks (group 1), 1 X 80 minutes/week for 12 weeks and 2 X 30 minutes/week (group 2) Not specified for 2 studies	1 X 80 minutes/week for 12 weeks (group 1), 1 X 80 minutes/week for 12 weeks and 2 X 30 minutes/week (group 2)	1 X 80 minutes/week for 12 weeks (group 1), 1 X 80 minutes/week for 12 weeks and 2 X 30 minutes/week (group 2)	
Functional communication training.				



Parsons, Cordier, Munro et al. (2017)	This review included 20 studies (21 articles); intervention amount was extracted from Table 3 of the original article.			
Intervention(s): Pragmatic language interventions - The Junior detective Program; Milton and Ethel Harris	2 X 20 minute sessions/day for 8 weeks (2h total)	2 X 10 to 25 minute sessions /week for 6 weeks (2 to 5h total)	1 X 1h session/week for 4 weeks (4h total)	1 X 30 minute session/week for 12 weeks (6h total)
Research Initiative Treatment (MEHRIT); Building Blocks Program; Social Emotional NeuroScience Endocrinology (SENSE) theatre; Social	10 X 45 minute sessions over 10 weeks (7.5h total)	1 X 30 minute session/ day for 5–6 weeks (12.5 to 15h total)	1 X 2h session/week for 7 weeks (total 14h) and home practice	1 X 60 minute session/week for 15 weeks (15h total) and home practice
Skills Group Intervention- High Functioning Autism; FindMe App; Therapeutic Horse Riding; FaceSay; Joint Attention, Symbolic Play, Engagement, and Regulation (JASPER); Improvisational music	3 X 45 minute sessions/week for 8 weeks (18h total)	1 X 90 minute child session/week for 12 weeks (18h total) and 1 X 30 minute parent session/week for 12 weeks (6h total)	2 X 1h sessions/week for 12 weeks (24h total)	1 X 2h session/week for 12 weeks (24h total)
therapy; SummerMAX; Mind Reading; Skillstreaming; Emotion Recognition Training; Seaver-NETT.	2 X 90 minute sessions /week for 12 weeks (36h total)	1 X 2h session/fortnight for 20 fortnights (40h total)	1 X 4h clinic session/week for 10 weeks (40h total) 1 X 15 minute home session/day for 10 weeks (17.5h total)	1 X 5 minute session/day for 6 months or 3 to 4 X 10 minute sessions/week for 6 months (30 to 40h total)
	1 X 2h session/week for 40 weeks (80h total) and 1 X 3h session/week for 40 weeks (120h total)	5 X 70 minute sessions on 5 days per week for 5 weeks (145h total) and 1 X 90 minute parent session/week for 5 weeks (7.5h total)	5 X 70 minute sessions on 5 days per week for 5 weeks (145h total) and 1 X 90 minute parent session/week for 5 weeks (7.5h total)	1 X 2h clinic session/week for 12 months (104h total) 3h/day parent at home (1095h total)



Peters-Scheffer et al. (2011)	This review included 10 studie	es (11 articles); intervention amo	unt was extracted from Table 1	of the original article.
Intervention(s): Early Intensive Behavioural Intervention (EIBI).	12.5h/week for 20.3 months (experimental group) or 12 h/week for 21.4 months (comparison group)	19.45h/week for 15.36 months (experimental group) or 10.7h school-based and 0.44h other (comparison group)	24.52 h/week for > 2 years (experimental group) or 5h/week parent training and 1 h/week supervision for 3-9 months (comparison group)	25-40 h/week (experimental group) or 15 h/week (comparison group 1) or 30h/week (comparison group 2)
	25.6 h/week for >2 years	28h/week (experimental group) or 29.08h/week (comparison group)	30.4 h/week (experimental group) or 12.7 h/nursery placement (comparison group 1) or 8.5h/week (comparison group 2)	>30h/week for >2 years (experimental group), <10 h/week for >2 years (comparison group)
	32.4 h/week for >2 years (experimental group) or 25.6 h/week for >2 years (comparison group)	38.6 h/week for >2 years (experimental group) or 31.67 h/week for >2 years (comparison group)		
Postorino et al. (2017)	This review included 8 studies	s, intervention amount is report	ed in Table 4 of the original arti	cle:
Intervention(s): Parent training for disruptive behaviour.	4 X 15 to 105 minute sessions over 8 weeks	6 X 60 minute sessions over 6 weeks	8 X 60 to 75 minute sessions over 10 weeks	9 sessions over 9 weeks and 3 optional sessions
	9 X 60 to 90 minute sessions over 10 weeks	11 X 60 to 90 minute sessions over 24 weeks and 4 X 60-90 minute optional/booster sessions	11 X 60 to 90 minute sessions over 24 weeks and 6 X 60-90 minute optional/booster sessions	16 X 120 minute sessions over 16 weeks



Reichow et al. (2018) Intervention(s): Early intensive	This review included 5 studies; intervention amount was extracted from the 'Characteristics of included studies' table of the original article.				
behavioural intervention (EIBI).	>24 h/week for 24 months 35 to 40 h/week for 47 weeks per year for 36 months	>25 h/week for 24 months		25 to 30 h/week for 36 months	>30 h/week for 24 months
Sandbank et al. (2020a) Intervention(s): Animal-assisted therapy Service Dog; Therapeutic Horseback Rid <u>Behavioural</u> - Behavioral Parent Training Imitation Assessment; Early Intensive Bet Training; Home-based behavioral treatm Intervention (EIBI); Intensive Applied Bet Intervention; Low Intensity Behavioral Tr Picture Exchange Communication Syste Motor Imitation Antecedent; Regular Inter Schedules, Tools, and Activities for Trans Stones Triple P Positive Parenting Prograves Research (STAR) <u>Developmental-</u> Adapted Hanen More Difference, Relationship-Based (DIR)-Flo Mediated Learning (JAML); MEHRIT (Milt	Indbank et al. (2020a) tervention(s): Animal-assisted therapy-Canine Assistance; Presence of a Therapeutic ervice Dog; Therapeutic Horseback Riding ehavioural- Behavioral Parent Training; Discrete Trial Training with Motor Vocal litation Assessment; Early Intensive Behavioral Treatment; Functional Behavior Skills aining; Home-based behavioral treatment; Home-based Early Intensive Behavioral; tervention (EIBI); Intensive Applied Behaviour Analysis (ABA); Intensive Early tervention; Low Intensity Behavioral Treatment; Managing Repetitive Behaviors; cture Exchange Communication System (PECS); Peer-Mediated Intervention; Rapid otor Imitation Antecedent; Regular Intensive Learning for Young Children with Autism; chedules, Tools, and Activities for Transitions (STAT); Social Skills Group; Stepping ones Triple P Positive Parenting Program; Strategies for Teaching Based on Autism esearch (STAR) Developmental- Adapted Hanen More Than Words; Developmental, Individual- ifference, Relationship-Based (DIR)-Floortime; Hanen More Than Words; Joint Attention		Interventior	n amount was not specified.	
Treatment); Parent-Mediated Communication Focused Treatment; Parent-mediated intervention for autism spectrum disorder in South Asia (PASS); Play and Language For Autistic Youngsters (PLAY)/ DIR Floortime; Scottish Early Intervention Program; Social Communication Intervention for Children with Autism and Pervasive Developmental					



Disorder; Video-feedback Intervention to Promote Positive Parenting adapted to autism (VIPP-AUTI)

Naturalistic developmental behavioural intervention (NDBI)- Advancing Social-Communication and Play (ASAP); Caregiver-based intervention program in community day-care centers; Denver Model; Early Social Interaction Project (SCERTS); Early Start Denver Mode (ESDM); Home-based Building Blocks Program; home-based intervention program; ImPACT Online; Interpersonal Synchrony; Joint Attention Intervention Joint Attention Symbolic Play Engagement Regulation (JASPER); Joint Engagement Intervention: Joint Engagement Intervention with Creative Movement Therapy; Parent-Early Start Denver Model (P-ESDM); Parent-training intervention; Pivotal Response Treatment (PRT); Reciprocal Imitation Training; Social ABCs Cognitive behaviour therapy Sensory based- Developmental Speech and Language Training through Music; Family-Centered Music Therapy; Improvisational Music Therapy; Music Therapy; Qigong (QST) Massage Treatment; Qigong Massage Treatment; Rhythm Intervention Sensorimotor Enrichment; Sensory Enrichment; Thai Traditional Massage; Tomatis Sound Therapy; Vestibular Stimulation via a Platform Swing Technology based- ABRACADABRA; Emotiplay Serious Game; FaceSay; FindMe iPad App; Gaming Open Library for Intervention in Autism at Home (GOLIAH); Gazecontingent attention training; Social Skills Training using a robotic behavioral intervention system; The Transporters animated series; Therapy Outcomes By You (TOBY) App; Transporters DVD; Transporters Program for Children with Autism Treatment and Education of Autistic and related Communications Handicapped Children (TEACCH) Other- "Autism 123"; Balance Training Intervention; Circle of Friends; Cognitive Method; Colloborative Model for Promoting Competence and Success (COMPASS); Comprehensive Inclusion Program; Group Psychoeducational Program for Mothers;

Home-based intervention; Hyperbaric Oxygen Therapy; Individual Parent Sleep Education; Interactive Book Reading; LEAP (Learning Experiences and Alternative Program for Preschoolers); NeuroModulation Technique (NMT); Outdoor Adventure Program; Parent Education and Counselling (PEAC); Parent-Child Interaction Therapy



(PCIT) or Child-directed interaction therapy (CDIT); Positive Family Intervention (Positive
Behavior Support +parent optimism training); Primary Care Stepping Stones Triple P;
Professionally supported intervention; Psychoeducation Intervention; Psychomotor
Intervention Program; Reading Mastery; Sleep Education Pamphlet; Sung computer-
based intervention; Thought-bubble Training for Theory of Mind; Water Exercise
Swimming Program.

Sandbank et al. (2020b) Intervention(s): Behavioural;	This review included 60 studies, intervention amount (total intervention hours) was extracted from Table 1 of the original article.			
developmental; naturalistic developmental behavioural intervention (NDBI); Treatment and	0.9h (intervention group 1), 0.6h (intervention group 2)	1.125h (group 1), 1.125h (group 2)	8.17h	8.55h
Education of Autistic and related Communications Handicapped Children (TEACCH); sensory-based;	11.03h (intervention group 1), 9.6h (intervention group 2)	13.4h	14.3h (intervention group 1), 17.35h (intervention group 2)	17.56h (intervention group 1), 18.44h (intervention group 2)
animal-assisted; technology-based.	20h 27h	25h 36h	25.8h 37.63h	26.93h 36h (intervention group 1), 72h (intervention group 2)
	75h 205.66h 473.95h 1023.4h 1393.2h 2600h 3415h Not specified for 17 studies	90h 214h 478.08h 1040h 1456h 2662.4h 5287.5h	105.35h 247h 591.68h 1083.6h 1768h 3120h 6429.8h	132.4h 354.75h 627.16h 1144h 2137.88h 3276h



Schaaf et al. (2018)	This review included 5 studies	s; intervention amount was extra	acted from Supplemental Table	2 of the original article.
Intervention(s): Ayres Sensory Integration® (ASI).	25 to 50 minute sessions 30 X 1h sessions over 10 weeks	2 X 30 minute sessions weekly for 12 weeks (intervention group), 1h/week for 12 weeks (control group)	1h/week (intervention group) or 1.5h/week (control group)	18 X 45 minute sessions over 6 weeks
Schoen et al. (2019)	This review included 3 studies	s; intervention amount was extra	acted from Table 3 of the origin	al article.
Intervention(s): Ayres Sensory Integration® (ASI).	18 X 45 minute sessions over 6 weeks	1.5h/week for 8–10 months	3 X 1h/week (30 sessions total)	
Srinivasan et al. (2018)	This review included 15 studie	es, intervention amount was ext	racted from Table 1A of the orig	inal article.
Intervention(s): Equine therapy - therapeutic horseback riding;	1 session/week for 4 weeks	1 session /week for 5 weeks	1 session/week for 5 weeks	1 session/week for 9 weeks
simulated horseback riding; hippotherapy.	1 session/week for 10 weeks	1 session/week for 10 weeks	1 session/week for 9 to 12 weeks	1 session/week for 12 weeks
	1 session/week for 12 weeks	1 session/week for 12 weeks	1 session/week for 18 weeks	1 session/week for 24 weeks
	2 session/week for 12 weeks	1 session/week for 25 weeks	2 sessions/week for 20 weeks	
Steinbrenner et al. (2020)	Intervention amount was not specified.			



Intervention(s): Antecedent-based	
interventions - augmentative and	
alternative communication (AAC);	
behavioural momentum intervention;	
Cognitive Behavioural/Instructional	
Strategies; Differential Reinforcement	
of Alternative, Incompatible, or Other	
Behaviour; Direct Instruction; Discrete	
Trial Training (DTT); Exercise and	
Movement; Extinction; Functional	
Behavioural Assessment; Functional	
Communication Training (FCT);	
Modeling; Music-Mediated	
Intervention; Naturalistic Intervention;	
Parent-implemented intervention;	
peer-based instruction and	
intervention; prompting; reinforcement;	
response interruption/redirection; self-	
management; sensory integration;	
social narratives; social skills training;	
task analysis; technology-aided	
instruction and intervention; time	
delay; video modelling; visual	
supports.	
Sutherland et al. (2018)	Intervention amount was not specified.
Intervention(s): Program Improving	
Parents as Communication Teachers	
(imPACT); internet-based Parent	



Implemented COmmunicationStrategies (PCCS): general communication intervention; imitation training; Telehealth Jagnostic services; Telehealth Jagnostic <br< th=""><th></th><th></th><th></th><th></th><th></th></br<>					
Strategies (PICS): general communication intervention; initation rianing; Telehealth diagnostic services; "Telehealth Taging Your Fears' Intervention; functional communication training; school age intervention; functional communication training; school age intervention ing web-based educatior; language intervention.Scheering scheringSchering scheringTabibane et al. (2018)This review included 33 articles4 sessions of 10 to 15 minute classroom observations + 11 training over 4 weeks2 X 30 minute sessions weekly over 6 weeks (10 sessions total)3 naparet session every 6 weeks for 12 weeksStrategies (PICS): general classroom observations + 11 training over 4 weeks2 X 30 minute sessions weekly for 12 weeks (24 sessions total)3 naparet session every 6 weeks for 12 weeksStrategies (PICS): preschool Autier and related Communication intervention program in community days crac centers; Preschool-based joint attention intervention; Caregiver-based intervention; improvisational music therapy; intervention; imp	Implemented Communication				
communication intervention; imitation training; Telehealth facing Your Fears' Intervention'; functional behaviour assessment and functional behaviour file ACC1; Treatment and Education of Autistic and related Communication fraing: Carciptic Passed intervention ritervention (TEACCH) based group social skills; Reciprocal handicapped Children (TEACCH)- based group social skills; Reciprocal handicapped Children (TEACCH)- based group social skills; Reciprocal histindividual and 12 tot hi orgon pessions verial binitividual and 12 tot hi orgon p	Strategies (iPICS); general				
training: Telehealth Gaignostic services; Telehealth Facing Your Fears' Intervention'; functional behaviour assessment and functional communication training: school age intervention using web-based ducation; language intervention. Techiban et al. (2019) Techiban et al. (2018) Techiban et al. (2018) Ter Social communication intervention - Hanen's More Than Nords; Early Start Denver Model (ESDM); Parent training: Joint Attention Symbolic Play Engagement and Regulation (LASPER); Preschool Autistic and related Communications Hand(capped Children (TEACCH)- based group social skills; Reciprocal Intervention roraning: Caregiver-based intervention intervention, Caregiver- Mediated Joint Engagement Intervention intervention, Caregiver- Mediated Joint Engagement Intervention intervention, Caregiver- Mediated Joint Engagement Intervention intervention, Caregiver- Mediated Joint Engagement Intervention intervention intervention; Caregiver- Mediated Joint Engagement Intervention intervention; Mary Gra Joays/week for Variation Training; Caregiver- Mediated Joint Engagement Intervention intervention; Caregiver- Mediated Joint Engagement Intervention intervention; Caregiver- Mediated Joint Engagement Intervention intervention; Caregiver- Mediated Joint En	communication intervention; imitation				
services: "Teleheath Facing Your Pears' Intervention; functional behaviour assessment and functional communication training; school age intervention using web-based education; language intervention.Selection is intervention intervention intervention and selection; language interventionThis review included 33 ortices intervention amount was extracted from supplementary To-training 2 of the original anticle.Tachibane et al. (2018)This review included 33 ortices; intervention amount was extracted from supplementary To-training 2 of the original anticle.Intervention; Social communication (ESDM); Parent training; Joint Attender Regulation (JASPER); Preschool Autism and related Communications Handcapped Children (TEACCH); based group social skills; Reciprocal intervention intervention; Caregiver-based intervention intervention; regriver-based intervention intervention; regriver-based intervention intervention; regriver-based intervention intervention; regriver-based intervention intervention; regriver-based intervention; regriver-based intervention; regriver-based intervention; regriver-based intervention; fungroxisational music therapy; intervention intervention; regriver-based intervention; fungroxisational music therapy; intervention intervention; caregiver-based intervention; regriver-based intervention; regriver-ba	training; Telehealth diagnostic				
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behaviour assessment and functional communication training; school age intervention. using web-based education; language intervention.School age school ageTachibana et al. (2018)This review included 33 orticutes; intervention amount was extracted from supplementary.School age school ageSchool age 	Fears' Intervention'; functional				
communication training; school age intervention using web-based education; language interventionThis review included 33 critical communication intervention (\$): Social communication rintervention - Hanen's More Than Words; Early Start Denver Model (ESDM); Parent training; Joint Attention Symbolic Play Engagement and Education of Autistic and related Communication Training: Caregiver-based intervention rintervention regression sover 5 thandicapped Children (TEACCH)- Based group social sitil; Reciprocal intervention intervention regression sover 6 thandicapped children (TEACCH)- Based group social sitil; Reciprocal intervention rintervention regression sover 6 thandicapped children (TEACCH)- Based group social sitil; Reciprocal intervention regression sover 6 thandicapped children (TEACCH)- Based group social sitil; Reciprocal intervention rintervention regression sover 6 therapy; intervention ragement Intervention rintervention regression and 20 thandicapped children (TEACCH)- Based group social sitil; Reciprocal intervention rintervention; Caregiver-based intervention rintervention; Caregiver-based intervention rintervention; Caregiver-based intervention rintervention; Caregiver-based intervention rintervention; Caregiver-based intervention rintervention; Caregiver-based intervention; Improvisational music therapy; intervention ragement intervention; Improvisational music therapy; intervention regression regressions reversed intervention; Improvisational music therapy; intervention regression regressions reversed index responsessions reversed index responsessions reversed intervention; Improvisational music therapy; intervention regression intervention; Improvisational music therapy; intervention regressions reversed intervention; Improvisational music therapy; intervention regression therapy; interven	behaviour assessment and functional				
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	development of socially synchronous	in/day for 3 days/week for	tor 4 months	10 X 60 minute individual	2h diweekly sessions for 6



engagement; Developmental, Individual-Difference, Relationship- Based(DIR)/ Floortime intervention:	10 weeks		sessions and 10 X 90 minute group sessions	months, monthly sessions for 6 months (18 sessions total) and 30 minutes/day of					
Functional Behavior Skills Training (FBST); Building Blocks; Parent				home practice for 12 months					
delivery of the Early Start Denver Model (P-ESDM); Joint Attention Mediated Learning (JAML) intervention: Focused Playtime	2h weekly for 6 months (20 sessions total)	2h/fortnight for 40 weeks (max 20 sessions)	5 X 3h seminar and 3h weekly home consults for 10 weeks	Monthly sessions and 30 minutes of daily home practice for 12 months					
Intervention (FPI); Education and Skills Training Program for Parents; Parent education and behaviour management (PEBM) Skills training intervention or control for the non-specific aspects of	40 X 2hr weekly sessions, 6 playgroups and 6 parent support/training groups	2h/week and approximately 3h/day 'interacting with their child' for 12 months	15.2h/week for 3 months	10h/week in classroom, 1.5h/month parent training, and 38h parent education over 6 months					
the PEBM parent education and counselling intervention; Home TEACCHing Program.	2 X 2h sessions daily for 5 days/week for 2 years Not specified for 3 studies	24.52n/week for 1 year and reduced hours over a second year							
Tarver et al. (2019) Intervention(s): Behavioural parent	This review included 11 articles representing 9 RCTs, intervention amount was extracted from Table 2 of the original article.								
interventions – Research Units in Behavioural Intervention (RUBI) Parent Training Manual; Child directed interaction therapy (CDIT); Compass for help (C-HOPE); Parent management training; parent-child	4 X 40 minute sessions	4 X 15 to 105 minute sessions	8 X 60 to 75 minute sessions	9 sessions					
	8 X 60 to 120 minute sessions	1 X 360 minute workshop and 6 X 60 minute weekly sessions	11 X 60 to 90 minute sessions	12 sessions					
interaction therapy (FCFF), Finnary Care	11 X 60 to 90 minute								



stepping stones Tripe P (PCSSTP); Stepping stones triple P (SSTP).	sessions, 2 optional and 2 booster sessions										
Tiede & Walton (2019) Intervention(s): Naturalistic	This review included 27 unique studies, intervention amount (professional hours) was extracted from Appendix 1 of the original article.										
Developmental Behavioural Interventions - Early Start Denver	6h	8h	9h	10h							
Model (ESDM); Early Social Interaction Project (ESI); intervention emphasizing	12h	12h	12h	13.75h							
joint attention and imitation skill- building (JA/Imitation); Joint Attention,	14h	15h	16h	16h							
Symbolic Play, Engagement, and Regulation (JASPER); Learning	16.8h	20h	21.6h	26h							
Experiences Alternative Program (LEAP); Pivotal Response Treatment (PRT); Reciprocal Imitation Training (RIT); Focus parent training program;	30h	34h	39h	40h							
	81h	113h	156h	184h							
parent training.	585h	792h	1581h								
Treurnicht Naylor et al. (2011)	This review included 17 studies; intervention amount was extracted from Table 1 of the original article.										
Intervention(s): Music therapy.	1 X 15-20 minute session	1 X 23 minute session	1 X 30 minute session	1 X 45-60 minute session							
	1 X <60 minute session	2 X 20 minute sessions over 1 week	8 sessions over 2 weeks	8 X 60 minute sessions over 8 weeks							
	8 X 45 minute sessions over 8 weeks	12 sessions over 28 weeks	12 X 30 minute sessions over 24 weeks	16 X 30-45 minute sessions over 8 weeks							
	16 X 30-45 minute sessions										



	over 20 weeks 42 to 168 X 30 minute sessions over 12 weeks	20 X 30-40 minute sessions over 20 weeks	24 X 30 minute sessions over 48 weeks	39 X 60 minute sessions over 13 weeks
Intervention(s): Equine-assisted therapy - hippotherapy, therapeutic riding.	9 to 12 X 45 to 60 minutes	24 X 60 minutes	4 sessions over 1 month	6 X 180 minutes over 6 weeks
	4 X 2 30 minute sessions over 2 X 1 month periods	9 X 60 minutes over 9 weeks	10 X 45 minutes over 10 weeks	10 X >45 minutes over 10 weeks
	12 X 45 minutes over 12 weeks	24 X 45 minutes over 12 weeks	12 X 60 minutes over 12 weeks	12 X 60 minutes over 12 weeks
	25 X 60 to 70 minutes over 6 months	10 X 30 minutes over 10 weeks	 > 40 minute sessions (6 weeks intervention, 6 week break, 4 weeks intervention, 6 weeks break, 8 weeks intervention) 	
Tupou et al. (2019)	This review included 16 studie	es; intervention amount was ext	racted from Table 1 of the origin	al article.
Intervention(s): Comprehensive treatment programmes - Developmentally Appropriate Treatment for Autism (DATA); Treatment and Education of Autistic and Related Communication	1 X 15 minutes/day for 12 sessions	2h at home and 2h at school (experimental group) or 2h 'of each type at school' for 24 months (control group)	4 X 0.33h/week, data were collected over 1 month	2 to 10 minutes/day for 2.5 months (mean)



Handicapped Children (TEACCH);		5 X 0.83h/week					
Early Intensive Behavioural	30 to 35 minutes/week for		4 X 0.55h/week for 1.2	2 X daily, data collected			
Intervention (EIBI); Learning	14.5 (mean) sessions/month		months	over 36 sessions			
Experiences and Alternative Program							
for Preschoolers (LEAP);	30 (Eric), 56 (Ben), 63	2 X 3h/week (Integrated					
Comprehensive Autism Program	(Phillip), or 71 (Lucas)	playgroup), 3 X 6h/week	17 (mean) sessions over 2	5 X 13.6h/week			
(CAP); EIBI intervention described as	sessions over 8 months	(individualized instruction),	years (integrated into the	(experimental group), at			
being based on Lovaas' UCLA model.		7h/week for 9 to 21 (mean =	daily preschool program)	least 5h/week for 25 months			
Skills focused interventions targeting -		13.5) months (family/home		(control group)			
communication, play skills, peer		support)					
interaction, and reading skills.							
	18 h/week (integrated into	3 X 15 minutes/day,					
	the daily preschool routine)	integrated throughout the	20h/week for 16 months	15 to 37h/week (mean = 23)			
	data collected for 6 months		(mean)	and additional hours/week			
		one school year		at home over 24 months			
Verschuur et al. (2014)	This review included 43 studie	es; intervention amount was ext	tracted from Table 1 of the man	uscript.			
Intervention(s): Pivotal Response	2 X 10 minute individual and	30 minute sessions	2 X 30 minute sessions	3 X 15 minutes modelling			
Treatment (PRT); Natural Language	2 X 10 minute group		weekly	and 15 minute video			
Paradigm; facilitated social play	sessions			feedback			
training; and socio-dramatic play	2 X 45 minutes	3 to 6 X 10 minute sessions 1	2 X 60 minute sessions	2h sessions			
training.	ng. sessions/week		weekly				
		-					
	3 to 4 X 30 minutes training	4 X 30 minute training	4 X 30 minute training	6 sessions			
		sessions and 10 minutes	session and 10 minutes				
		practice and feedback	practice and feedback				
	10 to 15 X 8 minute video	5 to 9 X 15 minute parent	8 X 20 minute peer training	7 X 20 minutes peer training			



modelling sossiens and 20	training cossions and 4 V 4F	cossions and 2 to 4 V 10	and 7 X 20 minutes pass
Modelling sessions and 20	training sessions and 4 × 15		and 7 X 20 minutes peer
X 30 minute intervention	minute nome sessions/week	minute generalisation	delivered intervention
Sessions		Sessions	
3 X 2h	1 to 3 X 10 minute sessions	1 X 6h group training and 1	1 X 30 minute and 9 X 45 to
	on 1 day/week for 3 months	to 4 X coaching sessions	55 minute sessions
10 minute session weekly	10 X 1h sessions over 10	12 X 1h over 12 weeks	16h
	weeks		
10 X 90 minute group	2 X 8h group training and 3	12 X 1h parent education	5 X 5h sessions
sessions and 1 X 50 minute	X 15 minutes video	sessions and 12 X 1hr	
individual session over 10	feedback sessions	support groups over 12	
weeks		weeks	
6h/week for 5 weeks	8 to 10h/week over 4	3 X 1h sessions weekly	4 to 5 X 10 minute individual
training and 10h parent	months	followed by 3 X sessions	sessions and group staff
delivered intervention		weekly for 8 weeks	training
5 X 5h parent training days,	2 X 2.5hr/week for 12 weeks	2 X 60 minute	5 X 6h groups and 15h/week
3 to 25h caregiver training	(Intervention), 4 X 2.5h	sessions/week for 2.6 years	intervention for 12 months
	sessions (Condition 1), 4 X	(average)	(Cohort 1), 1 week parent
	2.5h sessions for 2 children		training and 15h/week
	and 8 X 2.5h sessions for 1		intervention for 6 months,
	child (Condition 2), or 16 X		10h/week for 3 months then
	2.5h sessions for 2 children		5-6h/week for 3months
	and 12 X 2.5h sessions for 1		(Cohort 2)
	child (Condition 3)		
not specified for 4 studies			



Virués-Ortega (2010)	This review included 22 studie	es; intervention amount was ex	tracted from Table 1 of the origi	nal article.							
Intervention(s): Applied Behavior Analytic (ABA) intervention - UCLA model, general ABA.	12 weeks 27h/week for 41.61 weeks 30h/week for 53 weeks 19.45h/week for 68.9 weeks 40h/week for 106 weeks 23.5h/week for 148.10 weeks 40h/week for 407.34 weeks	20h/week for 12 weeks 40h/week for 48.18 weeks 35h/week for 53 weeks 12h/week for 88.91 weeks 40h/week for 106 weeks 31.28h/week for 198.85 weeks	5.85h/week for 31.6 weeks 49.14 weeks 45h/week for 53 weeks 18.72h/week for 105.12 weeks 32.4h/week for 109.5 weeks 37.58h/week for 211.25 weeks	12.2h/week for 41.61 weeks 20h/week for 53 weeks 32.5h/week for 62.24 weeks 25.6h/week for 105.12 weeks 37.5h/week for 141 weeks 24.52h/week for 250.67 weeks							
Waddington et al. (2016)	This review included 15 article	nis review included 15 articles (12 studies); intervention amount was extracted from Table 1 of the original article.									
Intervention(s): Early Start Denver Model (ESDM).	1 workshop (4 full days)	1h/week with child for minimum 9 weeks, 10h and 3h training seminars and 4h supervision	15 to 20h/week group and 1h/week individual sessions	1h/week for 12 weeks							
	1h/week for 12 weeks	1h/week for 12 weeks	1h/week for 12 weeks	1.5 h/week for 12 weeks							
	1.5h/week for 12 weeks	15-20h/week (group) + 1h/week (individual) for 11.8 months	15-25h/week group intervention for 12 months	15 to 25h/week of group intervention for 1 year							
	15h/week (therapist implemented) and 16h/week (parent implemented) for 2 years	15h/week (therapist implemented) and 16h/week (parent implemented) for 2 years	15h/week (therapist implemented) and 16h/week (parent implemented) for 2 years								



Watkins et al. (2019)	This review included 28 studies; intervention amount was extracted from Table 1 of the original article.									
Intervention(s): Interventions in inclusive settings - visual cues; social scripts; Social Stories; video modelling;	13 X 2 to 5 minute sessions	4 X 15 minute sessions	3 X 10 minutes/week (Mean =13 sessions)	5 X weekly (Mean = 9 sessions per setting)						
communication books; peer-mediated intervention (PMI), self-monitoring; peer networks; individualised interventions based on the results of a functional behaviour assessment	1–3 X 20 minutes/day for 5 days (Mean = 10 sessions)	5 X weekly for up to 3weeks (Mean = 10 sessions)	5 X 5 minutes/week (Mean = 37 sessions) and 4 to 22 minutes before training 10 sessions (mean)	1 X 30 minutes/week (Mean = 7 sessions)						
(FBA); social skills groups; initiations training; high probability request sequences; music therapy; and behavioural strategies were	2 X 20 minutes/week for 6 weeks	2–3 X 30 to 40 minutes/week (Mean = 7 sessions)	11 (mean) X 25 to 35 minute sessions over up to 14 weeks	10 X 30 minute sessions						
implemented in one study each.	10 X 30 minute sessions	21 X 15 minute sessions	2 to 3 sessions weekly (Mean = 13 sessions)	2 to 3 X weekly (11 sessions total)						
	5 X 10 minutes/week for up to 15 weeks (Mean = 35 sessions)	3 X 10 minutes/week for 13 weeks (Mean = 13 sessions per activity)	2 X 30 to 45 minutes/week for 8 weeks	1 X 30 minutes/week for up to 10 weeks (Mean = 13 sessions)						
	1 to 4 X 10 to 20 minute sessions/week for 10 weeks (Mean = 10.5 sessions per behaviour)	16 X 40 minute sessions	2 to 3 X 90 minutes/week (mean = 26 sessions)	5 X 10 minutes/week for up to 34 weeks (mean = 25 sessions)						
	5 X 10 minutes/week for up to 34 weeks (Mean = 25 sessions)	5 X 45 minutes/week (Mean = 37 sessions)								
	not specified for 1 study									



Weitlauf et al. (2017) Intervention(s): Sensory integration-	This review included 24 studies; intervention amount (total duration of treatment) was extracted from Appendix G of the original article.											
based; environmental enrichment- based; auditory integration-based; music therapy; massage-based; other/additional such as tactile-based tasks, and weighted blankets.	24 to 48h 2 weeks 8 weeks 16 weeks 5 months 6 months	1 week 25 days (2 blocks) 8 weeks 4 months 5 months 7 months	1 week 6 weeks 10 weeks 4 months 5 months 8 to 10 months	2 sessions/day for 10 days 45 days 12 weeks 5 months 6 months 12 X 30 minutes weekly								
Weston et al. (2016)	This review included 48 studie	s review included 48 studies; intervention amount was extracted from Appendix A of the original article.										
Intervention(s): Cognitive behavioural therapy.	15 sessions	up to 20 X 60 minute sessions (mean = 17.4 sessions)	10 to 50 sessions (mean=27.5 sessions)	weekly parent training, summer program, and 25 whole day sessions over 5 weeks								
	weekly parent training, summer program, and 25 whole day sessions over 5 weeks	6 X 20 minute sessions	5 X 30 minutes/week for 14 weeks	12 X 40 minutes and 6 to 12 minutes daily								
	4 X 50 minutes 9 X 60 minutes	18 X 50 minutes 10 X 60 minutes and 1 booster session	6 X 60 minutes 12 X 60 minutes	8 X 60 minutes 15 X 60 minutes								
	16 X 75 minutes 12 X 90 minutes 12 X 90 minutes 14 X 90 minutes	16 X 75 minutes 12 X 90 minutes 14 X 90 minutes 14 X 90 minutes	20 X 75 minutes 12 X 90 minutes 14 X 90 minutes 16 X 90 minutes	25 X 75 minutes 12 X 90 minutes 14 X 90 minutes 16 X 60 to 90 minutes								



	20 X 90 minutes 7 X 120 minutes 15 X 120 minutes 9 x 150 minutes	32 X 90 minutes 8 X 120 minutes 20 X 120 minutes 36 X 180 minutes	5 X 120 minutes 9 X 120 minutes 21 X 60 minutes (group) and 3 X 60 minutes (individual)	6 X 120 minutes 12 X 120 minutes 7 X 75 minute group and up to 13 X 60 to 70 minute individual sessions							
Wiese et al. (2016)	This review included 8 studies	his review included 8 studies; intervention amount was extracted from Appendix 1 of the original article.									
Intervention(s): Equine-assisted therapy - Therapeutic horse-riding (THR); Hippotherapy; and Equine- assisted activities.	1 X 60 minute session weekly for 6 weeks 1 X 60 minute session weekly for 12 weeks	1 X 60 minute session weekly for 9 weeks 1 X 45 minute session weekly [6 weeks intervention (6 week break) 4 weeks intervention (6 week break) 8 week intervention]	1 X 45 minute session weekly for 12 weeks 1 X 60 minute session weekly for 12 weeks with 2- month follow-up	1 X 60 minute session weekly for 10 weeks 24 X 45 minute sessions over 3 months							
Zagona & Mastergeorge (2018)	Intervention amount was not :	specified.	·	-							
Intervention(s): Peer-mediated instruction and intervention.											



Appendix V: Summary of the direction of intervention effects and quality of evidence relating to child and family outcomes for parent-mediated, peermediated and telepractice delivered interventions.

		Corea	autism o	characte	eristics		Related skills and development							Education and Participation				Family wellbeing					
Interventions	No. of systematic reviews	Overall autistic characteristics	Social- communication	Restricted and Repetitive Interests and Behaviours	Sensory behaviours	Communication	Expressive Language	Receptive Language	Cognition	Motor	Social-emotional/ challenging behaviour	Play	Adaptive Behaviour	General Outcomes	School/ Learning Readiness	Academic Skills	Quality of life	Community participation	Caregiver communication and interaction strategies	Caregiver social emotional wellbeing	Caregiver satisfaction	Caregiver financial wellbeing	Child satisfaction with intervention
Parent-mediated	6	+ L	+ L	+ L		+ L	о Н	о Н	+ L	+ L	+ L	+ L	о Н		+ L	+ L			+ H	? L	+ H		
Peer-mediated	4		+ LLLL	+ L		+ LL			+ L		+ L	+ L			+ LL	+ L							
Telepractice	4		? LM			? LL					+ L			+ M					+ LLM	+ L	+ LL		

+ Positive therapeutic effect

? Inconsistent therapeutic effect

t o Null effect

Blank cell indicates no evidence available

L = Low quality

M = Moderate quality

H = High quality





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Our values



Inclusion

Working together with those with the lived experience of autism in all we do



Innovation

New solutions for long term challenges



Independence

Guided by evidence based research, integrity and peer review



Cooperation

Bringing benefits to our partners; capturing opportunities they cannot capture alone



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