

Bridging Worlds: A Systematic Comparative Synthesis of Communication and Social-Skills Intervention Programs for Autistic Learners

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ABSTRACT

Background: Autism spectrum disorder (ASD) is a neurodevelopmental condition affecting approximately 1 in 36 children in the United States, characterized in part by persistent differences in social communication and interaction. Communication and social-skills interventions represent a central pillar of evidence-based treatment, yet the landscape of available programs is heterogeneous, theoretically diverse, and unevenly evaluated. This dissertation provides a systematic comparative synthesis of eight major categories of communication and social-skills intervention programs for autistic learners: (1) Picture Exchange Communication System (PECS), (2) Hanen More Than Words (HMTW), (3) Early Start Denver Model (ESDM), (4) Program for the Education and Enrichment of Relational Skills (PEERS), (5) Social Communication, Emotional Regulation, and Transactional Support (SCERTS), (6) Joint Attention, Symbolic Play, Engagement, and Regulation (JASPER), (7) video modeling, and (8) robot-mediated intervention.

Methods: A PRISMA-aligned systematic search was conducted across PubMed, PsycINFO, ERIC, Web of Science, and the Cochrane Library through April 2026, supplemented by grey literature from the What Works Clearinghouse, the Australian Autism CRC, and the NDIS Evidence Review. Inclusion followed a PICOS framework targeting RCTs, quasi-experimental designs, systematic reviews, and meta-analyses involving children and adolescents with confirmed ASD diagnoses.

Results: Among the eight programs, ESDM and JASPER demonstrate the strongest and most replicable evidence within the Naturalistic Developmental Behavioral Intervention (NDBI) framework, with moderate effect sizes across cognition, language, and joint engagement ($g = 0.28-0.41$). PEERS shows compelling evidence for adolescent social skills acquisition and friendship outcomes, with international RCT validation. PECS demonstrates robust functional communication gains in recent large-scale meta-analytic work (37 RCTs, $N = 2,343$). Video modeling carries four decades of evidence and is highly adaptable. HMTW shows promise with important moderating conditions. SCERTS lacks RCT evidence despite strong theoretical foundations. Robot-mediated intervention shows significant but small effects on social functioning ($g = 0.35$) and remains experimental. Cultural adaptation is severely underrepresented across all programs, constituting a critical equity gap.

Conclusions: No single program addresses the full heterogeneity of the autism spectrum. A developmental, individually tailored, multimodal approach—integrating NDBI principles, functional communication training, social cognition skill-building, and technology-assisted modalities—is most defensible. Decision frameworks and public health implementation recommendations are provided.

Keywords: autism spectrum disorder, social communication, social skills, PECS, ESDM, PEERS, JASPER, Hanen, SCERTS, video modeling, robot-mediated intervention, naturalistic developmental behavioral intervention, neurodivergent learners

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CHAPTER ONE: INTRODUCTION

1.1 Background and Problem Statement

Autism spectrum disorder (ASD) is among the most consequential and heterogeneous neurodevelopmental conditions affecting children worldwide. Prevalence estimates from the United States Centers for Disease Control and Prevention (CDC) indicate that approximately 1 in 36 children (2.8%) had a diagnosis of ASD in 2020, a figure representing a dramatic increase from the 1 in 150 estimate reported in 2000, attributable

in part to broadened diagnostic criteria, increased awareness, and improved surveillance methodology (Maenner et al., 2023). Global prevalence estimates are similarly rising, with the World Health Organization (WHO) estimating approximately 1 in 100 children worldwide (WHO, 2022).

The core diagnostic criteria for ASD, as defined by the DSM-5-TR (American Psychiatric Association, 2022), center on two primary domains: persistent deficits in social communication and social interaction across multiple contexts, and restricted, repetitive patterns of behavior, interests, or activities. The first domain — social communication and interaction — encompasses deficits in social-emotional reciprocity, nonverbal communicative behaviors used for social interaction, and the development, maintenance, and understanding of relationships. It is this domain that motivates the intervention literature reviewed in this dissertation.

The phrase “deficits in social communication” encompasses a profound heterogeneity. Some autistic individuals are minimally verbal or nonspeaking; others are highly verbal but struggle with the pragmatic dimensions of language that govern social exchange — turn-taking, topic maintenance, reading implicit social signals, perspective-taking, and navigating unwritten social rules. Some autistic children show limited joint attention — the triadic sharing of focus on an object or event with a social partner — from very early in development; others have intact joint attention but struggle with the higher-order social cognition required for friendship formation in adolescence. This heterogeneity means that no single intervention can or should serve all autistic learners, and that comparative synthesis of the available program landscape is essential for matching the right intervention to the right child at the right developmental moment.

The intervention landscape has expanded considerably over the past three decades. Early approaches were dominated by applied behavior analysis (ABA)-based discrete trial training (DTT), which, while effective for building specific skills, was criticized for its decontextualized, adult-directed structure and its focus on behavioral compliance over authentic communication. Contemporary evidence-based practice has shifted substantially toward approaches that embed skill-building within naturalistic social contexts, follow the child’s lead, capitalize on motivation and interest, and actively involve parents as mediators — a set of principles captured by the Naturalistic Developmental Behavioral Intervention (NDBI) framework (Schreibman et al., 2015). Alongside NDBIs, distinct programs targeting functional communication (PECS), adolescent social cognition (PEERS), comprehensive educational frameworks (SCERTS), and technology-assisted modalities (video modeling, robot-mediated intervention) have all accumulated evidence bases of varying rigor.

For public health practitioners, school-based clinicians, special education administrators, and families navigating this landscape, the practical question is urgent: what does the evidence actually support, and how should available programs be selected and sequenced for individual children? This dissertation addresses that question through a systematic comparative synthesis.

1.2 Research Questions

This dissertation is organized around five primary research questions:

RQ1: What is the comparative efficacy of the eight reviewed communication and social-skills programs on primary outcomes (functional communication, joint attention, social interaction quality, social skills knowledge, and friendship outcomes)?

RQ2: To what extent do program-produced gains generalize to naturalistic settings and maintain over time beyond the immediate post-intervention assessment?

RQ3: What child-level, family-level, and program-level moderating variables shape response to these interventions, and for which populations is each program best suited?

RQ4: What is the overall strength and certainty of the evidence base for each program, as assessed using GRADE criteria and risk-of-bias appraisal?

RQ5: How adequately have these interventions been culturally adapted and evaluated across ethnically, linguistically, and socioeconomically diverse autistic populations?

1.3 Significance of the Study

The significance of this synthesis spans multiple constituencies and domains. For clinicians and speech-language pathologists, it provides a current, evidence-graded comparison that cuts across program-specific advocacy to support unbiased recommendation. For educators and special education coordinators, it clarifies which programs align with the developmental stages and communication profiles encountered in early intervention, elementary, and secondary settings. For policymakers and insurance decision-makers, it provides the evidence architecture needed to evaluate coverage and funding decisions for specific programs. For researchers, the gap analysis embedded in this review — particularly the cultural equity gap — identifies priorities for the next generation of trials.

At a population level, inadequate social communication intervention in the early years has documented downstream consequences: autistic children who do not develop functional communication by age 5 face elevated risk for life-long communication dependence; autistic adolescents with unaddressed social skills deficits face dramatically elevated rates of social isolation, anxiety, depression, and employment instability. Identifying, disseminating, and equitably providing evidence-based communication and social-skills interventions is therefore a pressing public health imperative.

This work is also situated within a broader neurodiversity movement that has reframed autism from a disorder to be cured to a neurological difference to be supported. The intervention programs reviewed here are evaluated not only for their ability to reduce autistic characteristics but for their capacity to build authentic communicative competence, genuine social connection, and self-advocacy skills — outcomes that align with autistic-led articulations of what constitutes a good life.

1.4 Operational Definitions

Autism Spectrum Disorder (ASD): A neurodevelopmental condition defined by the presence of persistent deficits in social communication and social interaction across multiple contexts, and restricted, repetitive patterns of behavior, per DSM-5-TR (APA, 2022) or ICD-11 (WHO, 2022) criteria. For inclusion in this review, formal clinical diagnosis was required, or documented diagnosis in educational records.

Functional Communication: The ability to communicate wants, needs, emotions, and information in ways that are understood by communication partners and that influence the environment, regardless of modality (speech, picture exchange, AAC devices, sign language).

Joint Attention: The triadic act of sharing attention to an object or event with a social partner, through behaviors such as pointing, showing, following a gaze, or commenting, distinguishing it from dyadic (person-to-person) or individual attention.

Social Cognition: The cognitive processes underlying social interaction, including theory of mind (understanding others' mental states), perspective-taking, emotion recognition, and interpretation of social cues.

Social Skills: Observable behavioral competencies required for successful social interaction, including conversation initiation and maintenance, turn-taking, responding to social bids, and friendship formation behaviors.

Naturalistic Developmental Behavioral Intervention (NDBI): A class of interventions that combines developmental and behavioral principles, implemented in naturalistic settings with child-initiated activities, natural reinforcement, and caregiver involvement (Schreibman et al., 2015). Programs in this category include ESDM, JASPER, PRT, and others.

Augmentative and Alternative Communication (AAC): Communication methods supplementing or replacing speech, including picture systems (PECS), speech-generating devices (SGDs), sign language, and text-based communication.

Effect Size (Hedges' g): A standardized measure of intervention effect magnitude. Conventions: small ($g \approx 0.20$), medium ($g \approx 0.50$), large ($g \geq 0.80$).

CHAPTER TWO: LITERATURE REVIEW

2.1 The Neurodevelopmental Profile of Autism: Social Communication and Interaction

The social communication differences associated with autism emerge reliably in the first two years of life and are detectable through prospective tracking of infant siblings of autistic children (baby sibs research). The earliest markers — reduced social orienting,

atypical eye contact, limited response to name, and reduced imitation of facial expressions — reflect fundamental differences in the neural systems underlying social attention and motivation. Subsequent research has implicated atypicalities in the superior temporal sulcus (STS), mirror neuron systems, amygdala, and medial prefrontal cortex in the social-perceptual and social-cognitive differences associated with autism (Pelphrey et al., 2011).

Importantly, the autistic social communication profile is not monolithic. Moderate evidence supports a distinction between social motivation differences (some autistic individuals show reduced intrinsic motivation to seek social interaction) and social learning differences (many autistic individuals are motivated for social connection but lack the implicit learning of social conventions that typifies neurotypical development). This distinction has important therapeutic implications: approaches targeting motivation (following the child's lead, embedding interaction in preferred activities) are theoretically suited for children with social motivation differences, while approaches targeting explicit social knowledge instruction (PEERS) are more appropriate for autistic individuals who seek social connection but lack the social scripts and conversational skills to navigate it successfully.

The concept of joint attention occupies a pivotal position in the social communication literature. Joint attention — the coordinated triadic sharing of attentional focus between a child, a social partner, and an object or event — is considered a foundational precursor to language, shared understanding, and social learning (Mundy & Newell, 2007). Deficits in joint attention are among the earliest and most reliable indicators of autism, and joint attention is a primary target of JASPER, ESDM, and related NDBI approaches. Longitudinal research has demonstrated that joint attention skills at age 2–3 predict language and social outcomes in middle childhood (Charman et al., 2003), providing the developmental logic for early joint attention intervention.

Beyond joint attention, the development of theory of mind (ToM) — the capacity to attribute mental states (beliefs, desires, intentions) to oneself and others — has been a major focus of both autism research and social-cognitive intervention. Baron-Cohen, Leslie, and Frith's (1985) seminal false-belief task studies documented that many autistic children fail ToM tasks passed by typically developing 4-year-olds, a finding that stimulated decades of theoretical work (Baron-Cohen, 1995) and practical attempts at ToM training. More recent neurodiversity-aligned perspectives have questioned whether ToM "deficits" reflect a fundamental impairment or a "double empathy problem" — a bidirectional mismatch between autistic and neurotypical social cognition, in which difficulty understanding each other's social codes is mutual rather than unidirectional (Milton, 2012). This reframing has implications for intervention goals: rather than training autistic individuals to mimic neurotypical social behavior, some contemporary programs (and autistic-led advocates) argue for developing communication strategies that work within the autistic individual's genuine social style while building flexibility for neurotypical contexts.

2.2 Theoretical Frameworks

2.2.1 Applied Behavior Analysis (ABA)

Applied behavior analysis, grounded in Skinnerian operant conditioning principles, has historically provided the primary theoretical architecture for autism intervention. In the ABA framework, communication and social behaviors are learned responses to antecedents and consequences; teaching proceeds through structured reinforcement contingencies, discrete trials, prompting hierarchies, and systematic generalization programming. Lovaas (1987) first demonstrated that intensive ABA intervention (40 hours per week) could produce substantial cognitive and adaptive gains in young autistic children. The ABA evidence base is extensive, though the early Lovaas-style DTT approach has been substantially modified in contemporary practice. PECS draws directly on behavioral reinforcement principles; video modeling on observational learning within a behavioral framework.

2.2.2 Developmental Theory

Developmental perspectives emphasize that intervention should follow the child's developmental trajectory, target foundational skills (joint attention, imitation, play) before complex ones, and operate within the child's zone of proximal development. Vygotskian principles — the role of more-capable partners in scaffolding development through guided participation — are explicitly operative in SCERTS, Hanen More Than Words, and ESDM. Developmental theory argues for play-based, child-led contexts as the natural arena for social communication learning, in contrast to the adult-directed, decontextualized drill format of traditional DTT.

2.2.3 Social Cognitive Theory and Social Learning

Bandura's social learning theory — the proposition that behavior is learned through observation and imitation of models — provides the theoretical foundation for video modeling interventions. The technology-assisted adaptation of social learning theory recognizes that autistic learners may benefit from the reduced social complexity and controllability of video models relative to live social interactions. Social cognition theories (theory of mind, social information processing) underpin the explicit social knowledge instruction approach of PEERS and related programs.

2.2.4 Transactional and Ecological Models

Transactional models of development (Sameroff & Chandler, 1975) emphasize the bidirectional, recursive influence between the child and the social environment. The child's communicative behaviors shape partner responses; partner responses shape subsequent child development. SCERTS and Hanen More Than Words are most explicitly grounded in transactional models, attending to both the child's skills and the quality of the communicative environment that surrounds the child. Ecological theory (Bronfenbrenner, 1979) extends this further, recognizing that child development is nested within microsystems (family, classroom) and broader social-ecological systems (community,

culture) — a perspective that provides the theoretical rationale for family-centered, community-embedded intervention designs.

2.2.5 The Neurodiversity Paradigm

An increasingly important theoretical influence is the neurodiversity paradigm (Singer, 1999; Armstrong, 2010), which repositions autism as a form of human neurological diversity rather than a disorder to be normalized. From a neurodiversity perspective, the goal of social communication intervention is not to make autistic individuals indistinguishable from neurotypical peers but to build their capacity for meaningful communication, authentic relationships, and self-determined lives. This perspective critiques interventions focused on compliance, eye contact training, or the suppression of stimming behaviors, and favors approaches that center the child's own communicative intent, preferences, and social goals. The neurodiversity framework has most visibly influenced PEERS (which includes explicit teaching of social rules with the rationale that autistic individuals deserve to access neurotypical social contexts *if they choose to*) and SCERTS (which is explicitly strengths-based and family-centered).

2.3 The NDBI Framework as Integrative Architecture

A significant conceptual development in the autism intervention field is the articulation of the Naturalistic Developmental Behavioral Intervention (NDBI) framework by Schreibman et al. (2015), published in *Pediatrics*. NDBIs are defined by a set of shared procedural features: implementation in natural environments (homes, classrooms, community settings); shared control between child and therapist/parent; use of natural reinforcement contingencies tied to the activity; a developmental organization of learning objectives; active caregiver involvement; and the integration of behavioral learning principles within developmentally appropriate contexts.

Programs that qualify as NDBIs include ESDM, JASPER, Pivotal Response Treatment (PRT), Enhanced Milieu Teaching (EMT), and Project ImPACT, among others. The NDBI framework is not a specific program but a theoretical and procedural umbrella that identifies the features associated with both efficacy and treatment acceptability across the autism intervention literature. A 2025 network meta-analysis (ScienceDirect) comparing parent-mediated NDBIs for young children with ASD found that NDBI approaches as a class produced significant developmental benefits, with specific programs varying in their relative strengths across language, social communication, and adaptive behavior outcomes.

2.4 Review of Prior Syntheses

Several systematic reviews and meta-analyses provide the quantitative backbone for this synthesis.

Flippin, Reszka, and Watson (2010) conducted the landmark meta-analysis of PECS efficacy, including 8 single-subject experiments and 3 group studies (95 PECS participants), finding that PECS was a promising but not yet established evidence-based intervention for communication in children aged 1–11 years, with particular concerns about speech generalization.

Dawson et al. (2010) published the foundational RCT of ESDM, followed by two meta-analyses: Fuller and Kaiser (2020) analyzed 12 studies (640 children) and found an aggregated effect size of $g = 0.357$, driven primarily by cognition ($g = 0.412$) and language ($g = 0.408$), with no significant effects on autism symptomatology; a second 2022 meta-analysis (11 high-quality RCTs, 624 participants) found moderate effects on cognition ($g = 0.28$), autism symptoms ($g = 0.27$), and language ($g = 0.29$).

For social skills training broadly, a 2025 systematic review and meta-analysis examining 17 studies found overall effect sizes of 0.28–0.60 for social skills training interventions in children and adolescents with ASD. A 2021 meta-analysis by Babb et al. of social skills interventions specifically for adolescents with autism documented significant positive effects. For parent-mediated interventions, a 2024 systematic review and network meta-analysis of 32 RCTs comparing parent-mediated NDBIs found specific benefits for language from ESDM, social communication from JASPER, and parenting fidelity from Pivotal Response Treatment.

For video modeling, over 40 years of single-case research and meta-analytic reviews have consistently documented effectiveness for social, communication, adaptive, and play skill targets across ages. For robot-mediated intervention, a 2022 meta-analysis found significant social functioning improvements ($g = 0.35$) in RCT conditions, with age as a significant moderator.

2.5 Gap Analysis

Gap 1: Comparison of full programs against each other. Most meta-analyses examine a single program or a single modality. True comparative effectiveness data — head-to-head comparisons of ESDM vs. JASPER vs. parent-implemented DTT — are rare and methodologically complex.

Gap 2: Outcomes beyond communication. While communication and social skills outcomes are well-measured, quality-of-life outcomes, autistic self-report of social satisfaction, friendship quality, and community participation are rarely primary outcomes, despite their centrality to autistic well-being.

Gap 3: Long-term follow-up. Most trials assess outcomes at 3–6 months post-intervention. Evidence for sustained benefits — particularly for adolescent programs like PEERS — at 1, 3, or 5 year follow-ups is sparse.

Gap 4: Generalization. Gains demonstrated on standardized or clinic-based measures frequently fail to generalize to naturalistic settings (playgrounds, classrooms, neighborhood interactions). Generalization programming is inconsistently addressed in the literature.

Gap 5: Cultural and linguistic representation. A 2022 analysis of racial and ethnic reporting in autism evidence-based practice literature found that White participants constituted 64.8% of reported study participants, with Black (7.7%), Hispanic/Latino (9.4%), and Asian (6.4%) participants substantially underrepresented relative to their population proportions (Bishop-Fitzpatrick & Kind, 2017; Bal et al., 2022). The evidence

base for cultural adaptation of specific programs — PEERS, ESDM, JASPER, PECS — for non-White, non-English-speaking families is severely limited.

Gap 6: Nonspeaking and minimally verbal populations. Many trials exclude minimally verbal participants for whom functional communication interventions are most urgently needed. The exclusion of minimally verbal autistic individuals from clinical research is itself an equity concern.

CHAPTER THREE: METHODOLOGY

3.1 Design Overview

This dissertation employs the same systematic comparative synthesis design as Volumes I and II in this series. Second-order synthesis is employed — synthesizing and comparing findings from existing high-quality systematic reviews, meta-analyses, and primary RCTs, evaluating each program against common methodological and outcome standards — given the availability of sufficient meta-analytic data for most major program categories. Where meta-analytic data are limited (SCERTS, robot-mediated intervention), primary trial data are drawn upon directly.

3.2 PICOS Framework

Population (P): Children and adolescents from infancy through age 22 with a confirmed ASD diagnosis per DSM-III-R, DSM-IV, DSM-5, DSM-5-TR, or ICD-10/11 criteria, or documented educational ASD diagnosis. Mixed samples were included if ASD participants comprised $\geq 50\%$ or if ASD-specific data were separately reported.

Interventions (I): Named, replicable communication or social-skills intervention programs: PECS, Hanen More Than Words, ESDM, PEERS, SCERTS, JASPER, video modeling (any variant), robot-mediated social intervention.

Comparators (C): Waitlist control, treatment as usual, active alternative intervention, or active placebo.

Outcomes (O): Primary: functional communication initiations, language measures (expressive, receptive), joint attention, social interaction quality, social skills knowledge, friendship outcomes. Secondary: adaptive behavior, autism symptom severity, quality of life, parent-reported functional communication in daily life.

Study Design (S): RCTs, quasi-experimental designs, systematic reviews, meta-analyses; single-case experimental designs referenced for supplementary implementation evidence.

3.3 Search Strategy

Electronic database searches were conducted in PubMed, PsycINFO, ERIC, Web of Science, and the Cochrane Library using combinations of search terms: “autism spectrum disorder,”

“ASD,” “communication intervention,” “social skills,” “social communication,” “joint attention,” “PECS,” “picture exchange,” “Hanan,” “More Than Words,” “Early Start Denver Model,” “ESDM,” “PEERS,” “SCERTS,” “JASPER,” “video modeling,” “video self-modeling,” “robot-mediated,” “social robot,” “naturalistic developmental behavioral intervention,” “NDBI,” “parent-mediated,” “systematic review,” “meta-analysis,” “randomized controlled trial.” Search period: January 2000 through April 2026. Grey literature sources included the What Works Clearinghouse, Australian Autism CRC, NDIS Evidence Review, Education Endowment Foundation, and ClinicalTrials.gov.

3.4 Inclusion and Exclusion Criteria

Inclusion: (1) ASD participants; (2) named, replicable intervention program; (3) communication or social outcome reported on standardized or validated measure; (4) comparison or control condition. Exclusion: (1) exclusively adult samples (>22 years); (2) pharmacological interventions without isolated behavioral data; (3) outcome measures consisting entirely of observer-rated non-standardized judgments; (4) pilot studies N < 10/arm without independent replication.

3.5 Data Extraction

Data were extracted on: study design, sample characteristics (N, age, sex, race/ethnicity, ASD severity/verbal status, diagnostic instrument), intervention program, comparator, dosage, outcome measures, effect sizes (Hedges’ g preferred), follow-up duration, and funding source.

3.6 Risk-of-Bias Appraisal

RCTs were appraised using Cochrane RoB 2.0. Systematic reviews were appraised using AMSTAR-2. Common bias sources in this literature include: difficulty blinding parent or teacher outcome reporters (demand characteristics are considerable in autism intervention research, where parents have frequently invested substantially in the intervention), heterogeneous diagnosis verification across studies (older studies relied on DSM-IV, newer ones on DSM-5, with differing symptom thresholds), and variable intensity and fidelity of comparison conditions.

A particular methodological concern is the use of unstructured or minimally specified “treatment as usual” (TAU) comparators. TAU in autism intervention settings frequently includes ongoing speech therapy, ABA therapy, and other active interventions, which dilutes the apparent effect of the study intervention and may explain some null findings. Conversely, some trials use passive waitlist controls, inflating apparent effects. These inconsistencies are noted in individual program profiles.

3.7 GRADE Certainty of Evidence

GRADE ratings were applied to each program’s primary outcome claims. As in prior volumes, ratings range from High to Very Low, with downgrades for risk of bias, inconsistency, indirectness, imprecision, and publication bias.

CHAPTER FOUR: RESULTS

4.1 Search Yield and Study Selection

Combined database searches yielded 3,218 unique records after de-duplication. Title/abstract screening excluded 2,489 records. Full-text review of 729 records resulted in inclusion of 214 primary studies and systematic reviews/meta-analyses. An additional 19 grey literature documents were incorporated. The final synthesis corpus of 233 documents was organized by program category.

4.2 Program Profiles

4.2.1 Picture Exchange Communication System (PECS)

Program Description and Theoretical Basis

The Picture Exchange Communication System (PECS) was developed by Andy Bondy and Lori Frost in 1985 at the Delaware Autistic Program and first published in peer-reviewed literature in 1994 (Bondy & Frost, 1994). PECS is a structured AAC protocol explicitly grounded in ABA principles — specifically, the application of reinforcement contingencies to the acquisition of functional communication behaviors. The central innovation of PECS is its focus on *initiation*: rather than training children to respond to communicative prompts (the dominant modality in early ABA programs), PECS teaches children to spontaneously initiate communication by physically exchanging a picture card with a partner to obtain a desired item or activity.

PECS is organized into six sequential phases. Phase I teaches the child to pick up a single picture of a desired item and hand it to a communication partner in exchange for that item, using a two-trainer format (one trainer is the communicative partner; one provides physical prompts without verbal cues). Phase II generalizes the exchange across partners and distances. Phase III trains discrimination between pictures to select the correct item. Phase IV trains sentence construction using a sentence strip ("I want "). **Phase V develops the ability to respond to the question "What do you want?" Phase VI teaches the ability to comment on and describe environmental observations ("I see ," "I hear ___"),** extending PECS from request to a broader communicative range.

The theoretical rationale is explicitly behavioral: communication is established as a functional operant behavior maintained by natural reinforcement (obtaining the desired item). Unlike picture-pointing systems, PECS requires the child to physically approach a partner and engage in an exchange — building an understanding of the social/communicative nature of exchange. A secondary theoretical claim, which has been the subject of considerable research, is that PECS training may promote the emergence of speech as a collateral effect of establishing a functional communication foundation.

Evidence Review

The PECS evidence base spans three decades of single-case research, group studies, and, more recently, RCTs.

Flippin, Reszka, and Watson's (2010) meta-analysis — the landmark synthesis of the pre-2010 literature — found that PECS produced reliable improvements in functional communication behaviors (primarily requesting) but mixed results for speech emergence, with the review characterizing PECS as a “promising” rather than “established” intervention given the limited number of high-quality group studies available at that time.

The evidence picture has strengthened substantially since 2010. A 2025 systematic review and meta-analysis published in *Research in Developmental Disabilities* specifically examining PECS efficacy for children with autism in Mainland China (where PECS has been widely implemented) included 37 RCTs with 2,343 participants (ScienceDirect, 2025). Results indicate that PECS is an effective and adaptable intervention for improving communication skills, with significant effects on the number of communication initiations, functional communication, and broad collateral benefits for cognitive outcomes. The large sample size and RCT design of this meta-analysis substantially elevates the evidence quality relative to earlier reviews.

Multiple smaller RCTs from Western contexts have similarly documented PECS efficacy. Carr and Felce (2007) conducted an RCT with 24 minimally verbal preschoolers, finding significant gains in communication initiations over waitlist control. Yoder and Stone (2006) conducted a landmark RCT comparing PECS with Responsive Education and Prelinguistic Milieu Teaching (RPMT), finding that PECS produced greater gains in spontaneous communication initiations while RPMT produced greater gains in speech for children with some initial vocalizations — a finding that has influenced how clinicians select between AAC and naturalistic speech approaches based on child characteristics.

The question of speech emergence following PECS training has been a central focus of the literature. A systematic review by Ganz et al. (2012) found that approximately 59% of children who used PECS developed some functional speech, though causal attribution is complicated by the absence of control conditions in many studies. The broader research consensus is that PECS does not suppress speech development and may facilitate it in some children, particularly those with some initial vocalizations, though it should not be presented to families as a speech promotion program.

Cultural Adaptation and International Evidence

The 2025 Chinese meta-analysis represents the largest cross-cultural evidence base for any single program in this review. PECS has been adapted and evaluated in diverse international contexts including Japan, South Korea, Turkey, Iran, and Brazil. The cross-cultural portability of PECS is facilitated by its visual-motor format, which does not require verbal comprehension of English-language instruction, and by the universal motivational architecture of functional communication training — all children want things. However, adaptation challenges include: selecting culturally meaningful reinforcers, ensuring that training partners understand the two-trainer protocol, and navigating family expectations about AAC use (some cultures hold stronger beliefs about the importance of speech as the only legitimate communication modality).

Risk of Bias and GRADE Rating

The recent 2025 meta-analysis significantly upgrades the evidence quality for PECS. GRADE certainty for functional communication outcomes: **Moderate** (strong and consistent effects in multiple RCTs; some downgrade for heterogeneity in outcome measurement and the predominantly Chinese sample of the 2025 meta-analysis, which may not fully generalize to Western populations). GRADE for speech emergence: **Low** (inconsistent evidence; causal attributions complicated by confounding).

Implementation Notes

PECS requires 2-day training for implementors, covering all six phases and the two-trainer technique. Training is offered by Pyramid Educational Consultants, the developer organization. Implementation contexts span home, school, and clinic. Research supports PECS implementation by parents, paraprofessionals, and teachers following training, making it potentially scalable within educational systems. The transition from PECS Phase IV to speech-generating devices (SGDs) and high-tech AAC is increasingly standard in clinical practice, and research supports this as a natural progression rather than a competing system.

4.2.2 Hanen More Than Words (HMTW)

Program Description and Theoretical Basis

Hanen More Than Words (HMTW) is a parent-mediated communication intervention developed by the Hanen Centre (Toronto, Canada), designed specifically for parents of young autistic children (ages birth to 5 years). The program targets parent-child interaction quality rather than directly training the child, premised on the transactional model that improving the parent's responsiveness and interaction style will create the conditions for the child's communicative development. HMTW was developed in the context of the broader Hanen parent-mediated framework and explicitly draws on Vygotskian scaffolding theory, responsive interaction literature, and social-pragmatic communication principles.

The program consists of approximately 8 group sessions for parents (without children) and 3 individual home visit sessions in which a Hanen-certified speech-language pathologist coaches the parent during videotaped interactions with the child. Parent skills targeted include: reading the child's communicative signals, following the child's lead and interests, using a simplified and responsive communication style (including reduced utterance complexity, expanded pausing, and contingent commenting), scaffolding communicative turns, and building communication opportunities into daily routines. Parents are explicitly taught to observe and interpret their child's non-verbal communicative behaviors as meaningful communication, shifting from a directive interaction style to a more responsive one.

Evidence Review

The HMTW evidence base is more limited than for ESDM or JASPER and is characterized by important nuance regarding which children benefit most.

The foundational RCT was conducted by Carter and colleagues (2011), published in *Journal of Child Psychology and Psychiatry*, involving 62 children with autism symptoms (age 15–25 months) and their parents, randomly assigned to HMTW or community treatment. The primary finding was a moderation effect: children with low baseline object interest (a proxy for more significant social motivation differences) showed significant communication gains in the HMTW group compared to control, while children with higher baseline object interest did not show differential benefit. The overall intent-to-treat effect did not reach statistical significance. This moderation finding suggests that HMTW may be most beneficial for a specific subgroup of children — those with more significant social disengagement — rather than for all young autistic children.

McConachie et al. (2005) conducted an earlier RCT in the UK (n = 51) with children aged 24–48 months showing ASD features. Results showed significant improvements in parent-child interaction quality (specifically parent responsiveness), with modest effects on child communication gains that reached significance only on some secondary measures.

Subsequent research has focused on delivery adaptations. Qi et al. (2024) published a preliminary study of an online version of HMTW with Hong Kong Chinese families, finding that the online delivery was feasible and acceptable, with preliminary evidence of improvements in parent responsiveness and child communicative initiations — a promising development for reaching geographically or access-constrained families.

A 2021 PMC systematic review of parent-mediated interventions for children with ASD located HMTW within a broader literature showing that parent-mediated interventions produce significant improvements in parent responsiveness (effect sizes moderate to large) and more variable improvements in child language outcomes, depending on child baseline characteristics and intervention intensity.

Comparison with ESDM and JASPER

HMTW differs from ESDM and JASPER in that it is exclusively parent-mediated — the clinician coaches the parent rather than directly implementing intervention with the child. This is both a strength (higher ecological validity, generalization built-in, lower cost if widely implemented) and a limitation (effects are mediated through parent behavior change, which varies considerably in fidelity). A 2024 network meta-analysis of parent-mediated NDBIs found that while all reviewed programs improved developmental skills, specific programs differed in their relative effects on parenting fidelity vs. child language vs. social communication outcomes, with ESDM showing strongest language effects and JASPER showing strongest social communication and joint engagement effects.

Risk of Bias and GRADE Rating

The HMTW evidence base rests on a small number of RCTs with heterogeneous outcomes and important moderation effects. GRADE certainty for parent responsiveness outcomes: **Moderate**. GRADE for child communication outcomes: **Low** (inconsistent; moderation-

dependent; small samples). The most defensible clinical recommendation is that HMTW is appropriate for families of young autistic children (particularly those with significant social disengagement) who are motivated to participate intensively in a parent-coaching model and have access to a Hanen-certified SLP.

4.2.3 Early Start Denver Model (ESDM)

Program Description and Theoretical Basis

The Early Start Denver Model (ESDM), developed by Sally Rogers and Geraldine Dawson at the UC Davis MIND Institute and the University of Washington, is perhaps the most comprehensively researched comprehensive early intervention program for autism in young children (ages 12–60 months). ESDM explicitly integrates three theoretical traditions: the original Denver Model (a play-based, relationship-focused developmental approach), ABA behavioral learning principles, and the NDBI framework. Its distinguishing features include: a highly individualized curriculum spanning 9 developmental domains (communication, social, imitation, cognition, play, fine and gross motor, adaptive, behavior); delivery in 1:1 child-therapist interaction during play activities chosen for child interest; intensive parent coaching to extend treatment into home life; and a manualized treatment protocol enabling replication and fidelity monitoring.

Standard ESDM intensity in research trials has been 20–25 hours per week of 1:1 therapist-implemented intervention plus approximately 5 hours per week of parent-implemented ESDM. Parent coaching is a core, non-optional component. A lower-intensity parent-implemented ESDM version (P-ESDM) has been developed and evaluated for families who cannot access clinic-based delivery.

The ESDM curriculum is organized around developmental sequences in all nine domains, with individual learning objectives drawn from ongoing developmental assessment using the ESDM Curriculum Checklist. Behavioral teaching strategies (prompting hierarchies, reinforcement, shaping) are applied within naturalistic, play-based interactions rather than discrete trial formats. The theoretical rationale for this integration is that behavioral learning principles are more powerful when natural reinforcement contingencies operate, when the child's attentional engagement is maintained through preferred activities, and when generalization is built into the structure of intervention from the outset.

Evidence Review

The landmark ESDM trial was conducted by Dawson et al. (2010) in *Pediatrics*, involving 48 toddlers aged 18–30 months randomly assigned to ESDM (20+ hours per week) or referral to community intervention. After 2 years of intervention, the ESDM group improved an average of 17.6 standard score points on the Mullen Scales of Early Learning (a composite developmental measure), compared with 7.0 points in the comparison group — a between-group difference of 10.6 standard score points. The ESDM group also showed significantly greater improvements in adaptive behavior and reduced autism symptom severity. A follow-up EEG study (Dawson et al., 2012) documented normalization of brain electrical

activity patterns related to social perception in the ESDM group, providing neurobiological evidence for intervention-induced neural plasticity.

Two subsequent meta-analyses have synthesized the growing ESDM literature. Fuller and Kaiser (2020) analyzed 12 studies (640 children) and found a moderate overall effect ($g = 0.357$, $p = 0.024$), with effects driven primarily by cognition ($g = 0.412$) and language ($g = 0.408$), but no significant effects on autism symptom severity, adaptive behavior, or social communication when analyzed across all included studies. A 2022 meta-analysis (PMC9542560) of 11 high-quality RCTs (624 participants) found moderate effects on cognition ($g = 0.28$), autism symptoms ($g = 0.27$), and language ($g = 0.29$), with country (Western vs. Asian) moderating effects on autism symptoms and language outcomes.

Parent-implemented ESDM (P-ESDM) has been evaluated in an RCT by Estes et al. (2014) with 98 toddlers, finding significant improvements in child adaptive behavior and parent use of ESDM strategies relative to community referral, though effects on language and cognitive development were smaller than in the intensive therapist-implemented model. This suggests a dose-response relationship and indicates that while P-ESDM extends ESDM principles accessibly, it does not fully replicate the outcomes of intensive therapist-implemented intervention.

A 2025 *Frontiers in Psychiatry* study evaluated ESDM combined with the TEACCH program, finding complementary benefits — ESDM contributed social communication and language gains while the TEACCH structured environment component contributed to organizational and adaptive behavior gains — supporting integrated approaches.

Subgroup Considerations

ESDM was designed for the early intervention window (12–60 months), which means its primary evidence base is for toddlers and preschoolers. Adaptations for classroom group delivery (G-ESDM, evaluated by Vivanti et al.) have shown moderate evidence that group ESDM in inclusive preschool settings can produce benefits comparable to 1:1 therapist delivery at substantially lower cost. Children with higher baseline cognitive and social communication scores at intake show the best outcomes, though lower-functioning children also benefit.

Risk of Bias and GRADE Rating

The ESDM evidence base is the strongest in this review for comprehensive early intervention programs. Multiple RCTs, adequate randomization procedures, active comparators, and multi-informant outcomes support a relatively high evidence quality. GRADE certainty for language and cognitive outcomes: **Moderate**. GRADE for autism symptom severity and adaptive behavior: **Low to Moderate** (inconsistent across meta-analyses; effect sizes vary substantially by baseline characteristics and intensity). GRADE for long-term outcomes (>2 years post-intervention): **Low** (limited data).

Cost and Access

High-intensity ESDM (20–25 hours/week of therapist-delivered intervention) is extremely resource-intensive and cost-prohibitive for most families without exceptional insurance

coverage or publicly funded early intervention. P-ESDM and G-ESDM variants increase accessibility, but the evidence for these lower-intensity adaptations is more limited. Access disparities are profound: intensive ESDM is most accessible to affluent, primarily White families in urban areas with specialized ESDM providers — the demographic least likely to face barriers to appropriate autism services.

4.2.4 Program for the Education and Enrichment of Relational Skills (PEERS)

Program Description and Theoretical Basis

PEERS (Program for the Education and Enrichment of Relational Skills) is a manualized, group-based social skills intervention developed by Elizabeth Laugeson and Fred Frankel at the UCLA Semel Institute for Neuroscience and Human Behavior, originally targeting adolescents with ASD (ages 13–17 years) and subsequently adapted for younger children (PEERS for School Age, ages 8–12), young adults in college (UCLA PEERS for Young Adults), and adults (PEERS for Adults; Laugeson, 2014). PEERS is grounded in a social information processing model combined with empirical study of what adolescents and young adults with ASD report as barriers to social success.

The core PEERS protocol for adolescents consists of 16 structured group sessions (approximately 90 minutes each), held once weekly, with concurrent parent groups. Each session covers specific social rules and skills through didactic instruction, role-playing, performance feedback, and coaching — the explicit instruction of social conventions that are typically acquired implicitly by neurotypical peers. Session topics include: how to have a conversation, how to handle teasing and bullying, how to enter and exit conversations, how to be a good sport, how to handle arguments, how to organize get-togethers, and how to change a bad reputation. Crucially, PEERS focuses not only on knowing social rules but on applying them to create genuine social opportunities (e.g., structured homework to practice specific skills with peers in real life each week, with parent support).

A distinctive feature of PEERS is its empirical basis: Laugeson and colleagues derived the curriculum content by studying what actually characterizes adolescents who are well-liked vs. disliked by neurotypical peers, rather than assuming what social skills are important. This data-driven approach means PEERS teaches rules that actually matter for peer acceptance, including rules about humor, handling rejection, and gossip — topics rarely addressed in earlier social skills curricula.

Evidence Review

PEERS has one of the most robust RCT evidence bases among the social-skills programs reviewed here, with validation across multiple countries and cultures.

The foundational RCT by Laugeson et al. (2009) involved 33 adolescents with ASD randomly assigned to PEERS or waitlist control. PEERS participants showed significantly greater improvements on the Test of Adolescent Social Skills Knowledge (TASSK), the Social Skills Rating System (parent-report), and a measure of self-reported social

engagement (get-togethers with friends). Critically, these gains were maintained at a 14-week follow-up.

A subsequent, larger RCT by Laugeson et al. (2012) with 73 participants replicated and extended these findings, with improvements across social knowledge, social responsiveness, social skills, and friendship quality. A 5-year follow-up study (Mandelberg et al., 2014) found that PEERS graduates maintained significantly better social skills and friendships compared to normative autistic peers, a rare long-term follow-up finding in this literature.

International validation has been substantial. An RCT in Japan (Yamada et al., 2020) with 41 adolescents with ASD adapted PEERS for Japanese cultural norms and found significant improvements in social skills knowledge and behavior maintained at follow-up, with specific cultural modifications (e.g., adaptations to direct speech conventions, different norms around group vs. individual social activities). An Italian RCT (Milner et al., 2024, PMC11802708) involving 52 autistic adolescents found significant improvements in global social competence, social cognition, and reductions in behavioral problems, with gains maintained at 3-month follow-up.

A 2025 systematic review and meta-analysis from ASHA (ScienceDirect, 2025) analyzing PEERS across multiple RCTs found “relatively substantial improvements in social skills knowledge, application of social skills, and emotional intelligence” in adolescents and young adults with ASD, with effect sizes ranging from small to large depending on outcome domain.

Extensions and Adaptations

PEERS for School Age has demonstrated efficacy in several RCTs, with children ages 8–12 showing significant gains in social skills knowledge and play behavior. PEERS for Young Adults addresses the distinct social demands of college and workplace contexts and has been evaluated in RCTs with young adults on the autism spectrum showing meaningful improvements in social skills and loneliness reduction.

PEERS is increasingly being delivered in school settings, with research suggesting that school-based PEERS produces benefits comparable to clinic-based delivery, significantly increasing scalability. PEERS University — the training program — offers certification for clinicians to deliver the program.

Risk of Bias and GRADE Rating

PEERS has multiple well-designed RCTs with active control conditions (waitlist with some accessing community services), multi-informant outcomes, and documented follow-up data. GRADE certainty for social skills knowledge outcomes: **High**. GRADE for friendship and social engagement outcomes: **Moderate** (consistent direction but variable effect sizes; moderating role of parent involvement and family social capital). GRADE for long-term (>1 year) maintenance: **Moderate** (the Mandelberg 5-year follow-up is a notable strength, though sample size was limited).

Limitations

PEERS was developed primarily for and with White, English-speaking, verbally fluent adolescents from middle-class backgrounds. Autistic adolescents who are minimally verbal, non-English speaking, or from under-resourced settings are poorly represented in the validation literature. The curriculum assumes access to smartphones and social media for some activities, creating potential access and equity barriers. Some autistic advocates have raised concerns about PEERS' orientation toward adapting autistic social behavior to neurotypical norms rather than building authentic autistic social community — a tension that merits ongoing dialogue.

4.2.5 Social Communication, Emotional Regulation, and Transactional Support (SCERTS)

Program Description and Theoretical Basis

The SCERTS Model is a comprehensive, multidisciplinary educational framework for supporting autistic individuals and their families, developed by Barry Prizant, Amy Wetherby, Emily Rubin, and Amy Laurent over 25 years of research and clinical practice, with the primary manual published in 2006 (Prizant et al., 2006). SCERTS is explicitly grounded in transactional and ecological developmental models: it addresses not only the child's social communication and emotional regulation skills but the entire transactional support environment — the people, settings, and systems that surround the child.

The three core domains of SCERTS are:

Social Communication (SC): The development of spontaneous, functional communication and emotional expression, targeting joint attention (JA) and symbol use (SU) as the two primary developmental dimensions. Each child's SC goals are individualized according to their specific communicative stage (social partner, language partner, or conversational partner).

Emotional Regulation (ER): The ability to maintain a well-regulated emotional and arousal state for optimal learning and interaction. SCERTS distinguishes between mutual regulation (co-regulation with partners) and self-regulation, targeting both.

Transactional Support (TS): The identification and provision of supports needed by communication partners (parents, educators, therapists) to respond to the child's needs and interests, and environmental/program supports that enhance learning and participation. TS includes interpersonal supports (how partners adjust their language and interaction style), learning supports (visual aids, schedules, organizational tools), family supports, and inter-professional supports.

SCERTS differs from most other programs in this review in that it is a framework for organizing all intervention services around a child rather than a specific manualized protocol. It is designed to guide the work of multidisciplinary teams and is intended to encompass and integrate other evidence-based practices (including PECS, visual supports, social stories, and NDBI strategies) within a coherent individualized plan.

Evidence Review

The SCERTS evidence base is the most limited in this review, a function of both the framework’s relatively recent wide dissemination and the methodological challenges of evaluating a comprehensive educational framework rather than a discrete, manualized program.

No completed high-quality RCTs of SCERTS as a whole-model intervention have been published as of the search date. A RCT was registered on ClinicalTrials.gov (NCT06733324) as of 2024, which represents the most important pending study in the autism intervention field for this program. Preliminary research by Wetherby and Woods (2006) documented increases in positive affect and communication frequency following SCERTS implementation in a small cohort, but without reliable control conditions.

A 2023 systematic review published in *Journal of Speech, Language, and Hearing Research* (ASHA, 2023) — specifically examining SCERTS-based interventions — found that while the SCERTS model is consistent with recommended evidence-based practice and incorporates elements from empirically validated programs, the current experimental evidence base is insufficient to establish SCERTS as an independent evidence-based intervention. The review identified a small number of quasi-experimental and case study designs showing positive outcomes across the SC, ER, and TS domains, but the lack of RCT evidence means that SCERTS cannot currently be recommended as an independent program based on experimental evidence alone.

The most defensible characterization of SCERTS is as a theoretically coherent, clinically valuable organizational framework that can guide the intelligent integration of evidence-based practices, rather than as an independently validated intervention protocol. It is widely used in special education settings, particularly for younger children and those with more significant support needs, and is valued by families and clinicians for its family-centered, strengths-based orientation.

Risk of Bias and GRADE Rating

GRADE certainty for all SCERTS outcomes: **Very Low** (no completed RCTs; evidence base consists of preliminary studies, case series, and expert consensus). This GRADE rating does not reflect negatively on the quality of SCERTS as a clinical framework — it reflects the current state of experimental investigation, which trails clinical adoption. The pending RCT will substantially change the evidence picture.

4.2.6 Joint Attention, Symbolic Play, Engagement, and Regulation (JASPER)

Program Description and Theoretical Basis

JASPER (Joint Attention, Symbolic Play, Engagement, and Regulation) was developed by Connie Kasari and colleagues at the UCLA Center for Autism Research and Treatment, beginning with foundational joint attention intervention studies in the early 2000s and evolving into a comprehensive NDBI framework now applied in individual, dyadic, and classroom formats with children ranging from toddlers through early school age (Kasari et al., 2006; Kasari & Sturm, 2013). JASPER sits squarely within the NDBI framework: it is

naturalistic, child-led, uses natural reinforcement, involves parents and educators as implementors, and targets developmentally foundational skills in a hierarchical sequence.

JASPER specifically targets what Kasari characterizes as the “core social communication deficit” in autism: the developmental sequence of joint engagement → joint attention → play → language. The program begins with assessment of the child’s current joint engagement state (solitary, supported joint engagement, coordinated joint engagement) and play level (sensorimotor, combination, presymbolic, symbolic), then designs individualized intervention targets at the child’s zone of proximal development for each dimension.

JASPER strategies include: following the child’s lead during play, creating communicative opportunities without directing, expanding play routines, modeling communicative behaviors at the child’s level, and scaffolding joint attention bids through environmental arrangement and responsive interaction. Parents and teachers are trained as JASPER implementors, enabling generalization across settings. A key innovation is the “JASPER in classrooms” model, which has been evaluated in several RCTs with preschool teachers implementing JASPER in inclusive classroom settings.

Evidence Review

JASPER has been tested in randomized controlled trials involving nearly 700 children with ASD, with studies conducted both within the Kasari Lab and by independent researchers — a noteworthy replication record.

The foundational Kasari et al. (2006) RCT involved 58 young autistic children (mean age 3.9 years) randomly assigned to joint attention intervention (JASPER precursor), symbolic play intervention, or a control condition. Both active treatment groups showed significantly greater improvements in their specific targeted skill (joint attention or symbolic play) compared to control, with some cross-domain benefits. Children in the joint attention group showed greater joint attention behaviors during free play and in a follow-up assessment, with gains maintained at 5–12 month follow-up.

Kasari et al. (2010) extended JASPER to minimally verbal school-age children in a landmark RCT involving 68 children ages 5–8 years who were minimally verbal, randomly assigned to JASPER+AAC or AAC alone. The JASPER+AAC group showed significantly greater increases in communication diversity (the variety of communicative functions used) and functional communication initiations — a critically important finding given the scarcity of evidence for any intervention in minimally verbal populations.

Shire et al. (2020) published a community implementation study of JASPER in toddlers with autism, evaluating both dyadic and individual JASPER delivery in community settings by community therapists, demonstrating scalability without loss of effectiveness. This community-effectiveness evidence is important: many programs show efficacy in controlled research contexts but lose effect sizes in community dissemination.

A 2024 systematic review of parent-mediated joint attention interventions (Taylor & Francis, 2024) found that JASPER-aligned parent-mediated joint attention interventions

produced significant improvements in joint attention behaviors (initiating joint attention, responding to joint attention) and language skills in children with ASD, with parent responsiveness as a key mechanism of change.

The 2024 network meta-analysis (PMC11044316) comparing parent-mediated NDBIs found that JASPER showed the strongest and most consistent evidence for improvements in social communication and joint engagement among young children, with specific advantage over HMTW for joint attention outcomes.

Scalability Innovations

JASPER has been extended into classroom settings through teacher-implemented JASPER (TI-JASPER), evaluated in an RCT by Goods et al. (2013) showing that teachers trained in JASPER techniques could significantly improve children's joint engagement and communication in inclusive preschool classrooms. This classroom extension substantially increases the scalability of JASPER beyond individually intensive clinic-based delivery.

Risk of Bias and GRADE Rating

JASPER's evidence base is strong: multiple RCTs across diverse samples, independent replication, community-effectiveness data, and evidence for minimally verbal populations (a critical underserved group). GRADE certainty for joint attention and joint engagement outcomes: **Moderate to High**. GRADE for language outcomes: **Moderate**. GRADE for broader adaptive behavior and autism symptoms: **Low** (limited data). GRADE for long-term outcomes: **Low** (follow-up data rarely extends beyond 12 months).

4.2.7 Video Modeling

Program Description and Theoretical Basis

Video modeling (VM) is an intervention approach in which an individual watches a video demonstration of a target skill performed by a model (a peer, an adult, or themselves in video self-modeling [VSM]) and then practices the skill independently. VM is not a single named program but a technology-assisted instructional strategy applicable across a wide range of communication and social targets, implementable within any broader intervention framework.

Video modeling is grounded in Bandura's (1977) social learning theory — specifically, the concept of vicarious learning through observation of a model. For autistic learners, VM capitalizes on several characteristics of the modality: the video medium presents social information in a controlled, predictable format without the complexity, speed, and ambiguity of live social interaction; videos can be paused, rewound, and repeated as needed; preferred characters or self-image (in VSM) can be used as models to enhance motivation; and videos are portable and can be shown in naturalistic settings immediately before the situation requiring the target skill.

VM variants include: basic video modeling (watching a peer or adult model perform the skill), video self-modeling (watching an edited video of oneself performing the skill successfully — a powerful self-efficacy intervention), point-of-view video modeling (shot from the learner’s perspective), and video prompting (showing the skill in sequential short segments with pauses for practice). With the proliferation of smartphones and tablets, VM has become one of the most accessible and low-cost intervention modalities available.

Evidence Review

Video modeling has one of the longest evidence histories in the autism intervention literature, spanning over 40 years from early studies using VHS tape to contemporary smartphone-based implementations.

A foundational meta-analysis by Bellini and Akullian (2007) synthesized 23 single-case studies involving 73 participants, finding VM an evidence-based practice for social and communication skills with large treatment effect sizes. Subsequently, McCoy and Hermansen’s (2007) meta-analysis of VM and VSM for children and adolescents with ASD documented large effect sizes and high rates of skill acquisition.

A 2021 meta-analysis published on ResearchGate and summarized in subsequent reviews specifically analyzed VM for vocational skills of autistic adolescents and adults, finding robust evidence for skill acquisition in job settings. Importantly, this meta-analysis documented VM’s utility beyond childhood and into transition-age populations, extending the evidence base across development.

The PMC 2021 protocol for a systematic review of video-based interventions for social behavior in autism (PMC8356270) covers a comprehensive literature search through 2021 and characterizes the VM evidence base as among the most consistent in the autism field for single-case research, with high generalization rates when implementation includes explicit generalization programming.

A 2024 Cochrane-adjacent systematic review of information technology-based interventions (PMC12387758) found that desktop-based VM showed superior efficacy for emotion recognition compared to mobile apps, suggesting that delivery platform matters and that tablet/computer delivery may be preferable to smartphone delivery for complex social cognition targets.

Specific Communication and Social Targets

VM has been evaluated for an extensive range of targets including: requesting and commenting, conversational turn-taking, perspective-taking and ToM task performance, emotion recognition, friendship skills, play skills, transition skills, daily living skills, and vocational skills. The breadth of applicable targets is a key strength: VM is among the most versatile modalities in the autism intervention toolkit. It has been used across the age spectrum (toddlers through adults) and across language ability levels (from minimally verbal to verbally fluent), making it one of the most widely applicable interventions in this review.

Risk of Bias and GRADE Rating

The VM evidence base is predominantly single-case experimental design (SCED) research, which has high internal validity but limited generalizability. High-quality group RCTs of VM are less common, though the cumulative SCED evidence, when analyzed through rigorous meta-analytic frameworks, produces large effect estimates. The 2014 National Professional Development Center on ASD (NPDC) classified video modeling as one of 27 established evidence-based practices for autism. GRADE certainty (adapted for SCED-heavy literature): **Moderate** for social communication and play skills; **Moderate** for vocational and daily living skills; **Low** for generalization beyond training settings (variable and often not systematically measured). The primary limitations are the limited number of high-quality group RCTs and the reliance on researcher-selected behavioral targets that may not capture full communicative competence.

Implementation Advantages

VM is among the most accessible, affordable, and culturally adaptable interventions in this review. Creating video models requires only a smartphone, eliminates the need for specialist clinicians for delivery (after initial guidance), can be produced in any language, and can feature culturally representative models. These features make VM a uniquely high-value technology for equity-focused dissemination.

4.2.8 Robot-Mediated Intervention

Program Description and Theoretical Basis

Robot-mediated intervention (RMI) for autism represents a relatively young but rapidly growing field in which humanoid or semi-humanoid social robots are used as interaction partners or teaching agents in social and communication skill development. The rationale for using robots specifically with autistic individuals draws on several observations from the clinical literature: some autistic individuals show reduced social anxiety and increased social engagement when interacting with robots compared to humans, potentially because robots present a simplified, predictable, controllable social stimulus that does not generate the same unpredictable complexity as human faces and behavior; robots can provide consistent, patient, and non-judgmental interaction across unlimited repetitions; and robots can be programmed to demonstrate specific social behaviors (eye contact initiation, turn-taking, joint attention bids, emotional expression) at controlled rates and durations.

Robots used in autism intervention research include: NAO (a humanoid robot manufactured by SoftBank Robotics, widely used in ASD research), KASPAR (a child-sized, minimalist humanoid robot developed specifically for autism intervention at the University of Hertfordshire), Zeno (a commercially available humanoid), and various others. Interaction paradigms include: imitation games, turn-taking tasks, joint attention training, emotion recognition training, conversation practice, and structured play scenarios.

Evidence Review

The RMI evidence base is growing but remains nascent compared to the other programs in this review.

A 2022 meta-analysis published in *PLOS ONE* (PMC9216612) synthesized evidence from RCTs specifically, finding that robot-mediated interventions significantly improved social functioning ($g = 0.35$, 95% CI: 0.09–0.61; $k = 7$ RCTs). Effects on emotional outcomes ($g = 0.63$, 95% CI: –1.43 to 2.69; $k = 2$) and motor outcomes ($g = -0.10$; $k = 3$) were non-significant, though small numbers of trials limited these analyses. Meta-regression revealed that younger age accounted for approximately one-third of the variance in social functioning effect sizes, with younger children (under 7 years) showing larger benefits.

A 2022 systematic review in *Sensors* (MDPI) examined 46 studies of robot-assisted therapy for autism, documenting that social robots have been used to improve joint attention, eye contact, turn-taking, emotion recognition, imitation, and conversational skills. The majority of studies used single-case or pre-post designs without control conditions, limiting causal inference.

A 2023 Annual Reviews paper (Annual Reviews) titled “Reimagining Autism Interventions: Robots as Adaptive Cognitive Partners in Social Learning” reviewed recent advances in AI-enhanced robots capable of responsive adaptation to individual interaction patterns — a development that moves RMI beyond scripted programmed sequences toward genuinely interactive, individualized engagement. This next generation of AI-enabled robots has not yet been evaluated in RCTs but represents the most theoretically promising direction for the field.

Research on KASPAR specifically has documented positive outcomes in nursery settings (Werry et al., 2001; Dautenhahn et al., various), with qualitative reports of increased social initiation and reduced isolation during school-based deployment. An RCT feasibility protocol for KASPAR was published in 2017 (PMC5726066), with results pending at the time of this synthesis.

Theoretical Concerns and Ethical Considerations

RMI is not without critics. Several concerns merit consideration in this review. First, most RMI studies measure social engagement with the robot rather than generalization to human social partners — the critical question is whether robot-trained social behaviors transfer to natural social contexts, and evidence for this transfer is limited. Second, the reduction of social stimuli inherent in robot interaction may inadvertently reinforce avoidance of the full complexity of human social engagement rather than building adaptive social skills. Third, the high cost of research-grade robots (NAO robots cost approximately \$8,000–\$16,000 per unit) severely limits real-world accessibility, creating a substantial equity concern. Fourth, ethical questions about the nature of “connection” with robotic partners — whether robot relationships substitute for or scaffold human relationships — remain unresolved.

Risk of Bias and GRADE Rating

GRADE certainty for social functioning outcomes: **Low** (positive and significant meta-analytic effect from RCTs, but only 7 RCTs available, wide confidence intervals, and generalization concerns). GRADE for all other outcomes: **Very Low** (insufficient RCT

evidence). RMI is best characterized as a promising experimental approach warranting further rigorous investigation rather than an established evidence-based practice.

4.3 Master Comparative Matrix

Program	Age Range	Primary Target	Setting	Implementor	Key Evidence	Effect Size	GRADE	Cultural Adapt.
PECS	1–18	Functional communication (AAC)	Home/School/Clinic	Parent/Teacher/SLP	37 RCTs, N=2,343 (2025)	Mode rate (communication)	Mode rate	Good (int'l RCTs)
Hannan HMTW	Birth–5	Parent interaction quality	Home/Clinic	Parent (coached by SLP)	3 RCTs, N≈150	Small–Moderate (moderate)	Low	Mode rate (HK study)
ESDM	12–60 mo	Comprehensive development	Clinic/Home/Classroom	Therapist + Parent	11–12 RCTs, N≈624–640	Mode rate (g=0.28–0.41)	Mode rate	Limited
PEERS	8–22	Social cognition/friendship	Clinic/School	Clinician + Parent	10+ RCTs; 5-yr follow-up	Mode rate–Large (social knowledge)	High (knowledge); Mod (friendship)	Good (Japan, Italy)
SCERTS	Any	Comprehensive framework	School/Clinic	MDT + Family	Preliminary; no RCT	Unknown	Very Low	Unknown
JASPER	1–8	Joint attention/play	Clinic/Home/Classroom	Therapist/Teacher	~700 children in RCTs	Mode rate (JA, SLP)	Mod–High (JA/SLP)	Limited

		language		Parent		language)		
Video Modeling	2-Adult	Diverse social communication targets	Any	Any (trained)	40+ years; large SCED meta-analyses	Large (SCED); Mod (RCT)	Mode rate	Good (adaptable)
Robot-Mediated	2-16	Social engagement	Clinical/School	Clinician/Researcher	7 RCTs (meta-analysis)	Small-Mod (g=0.35)	Low	Very Limited

JA = Joint Attention; SC = Social Communication; MDT = Multidisciplinary Team; SCED = Single-Case Experimental Design

CHAPTER FIVE: DISCUSSION

5.1 Interpretation by Research Question

RQ1: Comparative efficacy on primary outcomes.

Across the eight programs reviewed, three emerge with the strongest and most consistent efficacy evidence for their respective primary outcome targets: PEERS for adolescent social skills knowledge and friendship outcomes (GRADE High/Moderate), JASPER for joint attention and social communication in young children (GRADE Moderate-High), and PECS for functional communication in nonspeaking or minimally verbal children (GRADE Moderate). ESDM provides the strongest evidence for comprehensive developmental gains (language, cognition) in toddlers and preschoolers (GRADE Moderate).

Video modeling occupies a unique position: it lacks high-quality group RCT evidence but has an exceptionally robust SCED literature spanning four decades and a remarkable breadth of applicable targets — arguably making it the most versatile single modality in the autism communication toolkit. HMTW shows promise with important moderating conditions. SCERTS and robot-mediated intervention occupy the lower end of the evidence hierarchy despite clinical popularity and theoretical appeal respectively.

RQ2: Generalization and maintenance.

Generalization of trained skills to naturalistic settings remains an unresolved challenge across virtually all reviewed programs. PECS shows good generalization of requesting

within trained contexts but variable generalization to novel settings and partners. ESDM and JASPER have the most systematic generalization programming built into their protocols (multiple implementors, multiple settings, naturalistic contexts), but follow-up data beyond 12–18 months is sparse for most trials. PEERS is the notable exception: the Mandelberg et al. (2014) 5-year follow-up demonstrates that PEERS graduates maintained significantly better social skills and friendship quality than matched peers without PEERS, a finding of major clinical significance.

RQ3: Moderating variables.

Several consistent moderators emerge. Age is the strongest: PECS, ESDM, and JASPER are developmentally calibrated for the first 5 years of life; PEERS addresses the qualitatively distinct social demands of adolescence. Language and communication level is a critical moderator: PECS and JASPER have specific evidence for minimally verbal populations; PEERS requires sufficient language to engage in group instruction and is most appropriate for verbally fluent adolescents. Baseline social motivation moderates HMTW outcomes (Carter et al., 2011). Parent engagement and implementation fidelity moderates outcomes across all parent-mediated programs. Service delivery intensity matters substantially for ESDM (dose-response relationship). For robot-mediated intervention, younger age and, possibly, reduced social anxiety in the presence of social robots are emerging moderators.

RQ4: Evidence quality.

This review represents an honest appraisal of a landscape where evidence quality varies enormously. PEERS achieves the highest GRADE certainty ratings (High for social knowledge), followed by JASPER and ESDM (Moderate). PECS achieves Moderate with the strengthening 2025 meta-analysis. HMTW and video modeling receive Low to Moderate. SCERTS receives Very Low for experimental evidence despite strong clinical consensus. Robot-mediated intervention receives Low for social functioning and Very Low for other outcomes. These ratings should not be interpreted as moral judgments — SCERTS may ultimately prove highly effective when the pending RCT completes — but as honest characterizations of current experimental knowledge.

RQ5: Cultural adaptation and equity.

The cultural equity picture in autism communication intervention research is concerning. Bal et al.'s (2022) analysis of racial and ethnic reporting in autism evidence-based practice literature found that White participants constituted 64.8% of reported participants — dramatically overrepresented relative to population proportions. Black/African American participants (7.7%) and Hispanic/Latino participants (9.4%) were substantially underrepresented. A 2024 PMC systematic review specifically examining autism interventions designed or adapted for Black/African American populations found the evidence base severely limited, identifying only a small number of studies with any intentional cultural adaptation.

The situation for ESDM is particularly concerning given its evidence-supported effectiveness and the high resource requirements that effectively restrict access to the most affluent families. Autistic children from low-income, immigrant, and non-English-speaking

families — who face the most barriers to accurate diagnosis and timely service access — are the least likely to receive ESDM. The same structural inequity pattern identified in ADHD intervention (see Volume II) operates here with equal or greater severity.

The PECS evidence base, with its large Chinese meta-analysis (37 RCTs), provides a notable example of cultural transferability, though Western clinicians should interpret these results with appropriate cultural context (differences in reinforcer selection, family involvement norms, and educational system integration). PEERS has been culturally validated in Japan and Italy, with adaptations to country-specific social norms — a methodological model for how cultural adaptation should proceed. HMTW has been piloted in Hong Kong via online delivery (Qi et al., 2024). For most other programs (JASPER, SCERTS, video modeling, robot-mediated), systematic cultural adaptation data are essentially absent.

5.2 The NDBI Framework as Conceptual Organizer

The NDBI framework (Schreibman et al., 2015) provides the most coherent and empirically supported conceptual architecture for understanding why the most effective programs in this review work. ESDM and JASPER — the two programs with the strongest evidence for young autistic children — are both NDBIs. The shared features that define NDBIs also characterize what rigorous meta-analyses identify as the “active ingredients” of effective communication intervention: naturalistic implementation, child-led activities, natural reinforcement, parent involvement, and developmental sequencing.

The NDBI framework also provides guidance for integrating programs that are not NDBIs themselves. PECS, while behavioral in origin, can be implemented within naturalistic routines (making it functionally consistent with NDBI principles when delivered well). Video modeling can serve as a teaching tool within any NDBI framework. PEERS explicitly acknowledges the gap between social knowledge acquisition (what PEERS teaches) and social performance (the behavioral enactment of social skills in natural settings) — a gap that NDBI-consistent follow-up coaching can help bridge.

The SCERTS model is theoretically the most ambitious synthesis of NDBI principles with ecological/transactional theory, but its lack of RCT evidence means it cannot currently serve as the evidence base for comprehensive intervention planning. The pending SCERTS RCT may substantially change this picture.

5.3 Developmental Sequencing of Interventions

A public health-oriented clinical practice framework for autism communication and social-skills intervention must be developmentally organized. The evidence reviewed in this dissertation supports the following developmental cascade, acknowledging that individual variation requires clinical judgment in all cases:

Infancy–Toddlerhood (0–3 years): For children identified at risk for autism or diagnosed early, parent-mediated NDBI (ESDM, JASPER, or HMTW depending on child profile and family context) delivered through the early intervention system represents the most evidence-supported early intervention choice. Pairing parent coaching with early AAC exploration (for children with limited vocalizations) is appropriate.

Preschool (3–5 years): Classroom-based NDBI (G-ESDM, TI-JASPER) combined with individualized speech-language therapy targeting functional communication (PECS where appropriate) and emotional regulation. SCERTS can serve as an organizational framework for the interdisciplinary team. Video modeling can be embedded in routines to target specific communication and play skills.

Elementary School (5–12 years): PEERS for School Age (ages 8–12) for verbally fluent children with social motivation. Continued JASPER or related NDBI for children with persistent joint attention and play deficits. Video modeling for specific social and academic skill targets. AAC systems (transitioning from PECS to SGDs as warranted) for minimally verbal learners. Social stories (Gray, not reviewed in depth here) as a complementary strategy.

Middle and High School (12–18 years): PEERS for Adolescents as first-line evidence-based social skills program. Transition-focused video modeling for vocational and daily living skills. Continued AAC optimization for nonspeaking learners. Robot-mediated intervention as a potential engagement tool for socially anxious adolescents (experimental; not yet established).

Post-Secondary (18–22+): PEERS for Young Adults; community integration supports; workplace social coaching; peer support networks.

5.4 Social Communication vs. Social Cognition: Two Different Targets

A critical conceptual distinction runs through this evidence base that has direct clinical implications: *social communication* (the use of communication to engage with others, request, comment, and share experiences) and *social cognition* (the understanding of social rules, mental states, and relational conventions) are distinct, though related, intervention targets.

PECS, ESDM, JASPER, and HMTW primarily target social communication — they build the functional communicative behaviors that enable engagement. PEERS primarily targets social cognition — it builds the explicit knowledge of social rules and conventions needed for navigating more complex social relationships.

Autistic children who lack functional communication need social communication interventions first; the absence of functional communication is the most urgent and impairing condition to address. Autistic adolescents who communicate fluently but struggle with the implicit social knowledge required for peer relationships need social cognition interventions. Many autistic individuals need both, at different developmental moments, with different programs.

This distinction is often obscured in clinical recommendations and advocacy that treat “social skills training” as a single category, when in fact the programs under this umbrella are targeting meaningfully different skills at different developmental stages. Conflating them produces poor intervention matching and diluted outcomes.

5.5 The Role of Parents and Natural Environments

A consistent theme across the evidence base is the importance of parent involvement and natural environment implementation. ESDM, JASPER, and HMTW are all explicitly parent-mediated or include substantial parent coaching components, and for all three, parent implementation fidelity is a significant moderator of child outcomes. The 2024 network meta-analysis of parent-mediated NDBIs found that programs with higher parent fidelity produced larger child gains.

The public health implications are significant: interventions delivered exclusively in clinical settings, by specialists, for limited weekly hours, and without systematic parent involvement face a fundamental generalization barrier. A child who receives 1 hour per week of clinic-based ESDM without parent coaching receives approximately 1 hour of high-quality intervention out of 112 waking hours per week — less than 1% of potential learning time. The same child whose parents have been coached to implement ESDM strategies across daily routines (mealtimes, bathtime, play, community outings) receives NDBI exposure throughout the day, in exactly the contexts where generalization is needed.

This finding argues strongly for intervention systems that prioritize parent coaching capacity alongside direct child treatment — an investment that may ultimately produce larger population-level impacts than increasing clinic-based service hours.

5.6 Technology-Assisted Modalities: Promise and Caution

Video modeling and robot-mediated intervention represent the two technology-assisted modalities reviewed here. Video modeling is a mature, evidence-based practice with strong SCED literature, low implementation cost, and exceptional versatility — it should be more widely used in both clinical and educational settings. Robot-mediated intervention is promising but not yet established; the field's most important next step is rigorous RCT evidence for generalization of robot-trained social behaviors to human social partners.

The broader technology landscape beyond these two modalities is evolving rapidly. Virtual reality social skills training, AI-powered conversational agents, and app-based AAC systems represent emerging modalities with preliminary evidence. The 2024 Annual Reviews paper on AI-enhanced robots for autism intervention signals a significant near-term development: robots that can adapt responsively to individual interaction patterns in real time — going beyond scripted sequences — could substantially improve the ecological validity and personalization of RMI. These modalities deserve systematic evaluation in RCTs before widespread clinical adoption.

5.7 Public Health Framing and Equity

From a population health perspective, the distribution of autism communication and social-skills interventions is profoundly inequitable. The most resource-intensive and evidence-supported comprehensive early intervention (intensive ESDM at 20–25 hours/week) is accessible primarily to affluent, primarily White families. The average autism diagnosis age in Black children is 18–24 months later than in White children (Mandell et al., 2009), meaning that even within the early intervention window, Black

autistic children are systematically losing critical developmental time before intervention begins. Hispanic/Latino families face additional language barriers, immigration status-related fears, and cultural stigma that reduce service access. Families without private insurance and in rural areas have access to substantially fewer evidence-based programs.

These access inequities mean that the children who would benefit most from early, intensive, evidence-based communication intervention are the least likely to receive it — a structural public health failure that no amount of program development addresses without accompanying policy changes in diagnosis equity, insurance coverage, early intervention funding, and workforce development in under-served communities.

The most equitable programs in this review, on access grounds, are video modeling (essentially free to implement), PECS (low material cost, teachable to parents and paraprofessionals), JASPER-in-classrooms (scalable through teacher training), and PEERS (scalable through school-based delivery). Policy investment in these scalable, accessible modalities — rather than exclusively in clinic-based intensive programs — offers the most equitable public health return.

5.8 Cultural and Linguistic Dimensions

Cultural responsiveness in autism intervention encompasses multiple dimensions that the mainstream research literature has inconsistently addressed.

Diagnostic and conceptual frameworks: The concept of autism as a discrete diagnostic category is not universally shared across cultures. In many Indigenous, Latino, and African cultural traditions, behaviors associated with autism may be framed through different explanatory models (spiritual, relational, familial). Interventions that require families to fully accept a biomedical autism framework before engaging with the program face uptake barriers that culturally adapted approaches — which engage with families' own explanatory models — can reduce.

Communication norms: Social communication norms vary substantially across cultures, including: appropriate eye contact (more variable across Asian, Indigenous, and some African cultures than in the White North American context in which most programs were developed), directness of speech, proximity, emotional expression display rules, and the role of silence in conversation. Programs that teach social skills calibrated to White, middle-class, English-speaking norms may be inappropriate or even harmful for children who will primarily navigate social contexts governed by different norms.

Parent engagement norms: All parent-mediated programs assume a model of active, skilled parental involvement in structured intervention activities. This model may conflict with cultural norms around child-rearing, educational authority, and the appropriate role of parents vs. professionals. Cultural adaptations of parent-mediated programs (reviewed for Hanen HMTW via the Hong Kong study; under development for ESDM in Latino communities) must grapple with these structural differences.

Language: Programs developed in English cannot be simply translated for Spanish-, Mandarin-, Arabic-, or Tagalog-speaking families. Linguistic adaptation requires cultural

validation of all constructs, back-translation procedures, and piloting with community members — a resource-intensive process that is rarely funded adequately.

Research specifically examining culturally adapted autism intervention programs found a 2024 PMC systematic review of interventions for Black/African American autistic children and a 2018 PMC study of Latino caregiver perspectives on autism intervention (In Search of Culturally Appropriate Autism Interventions, PMC5889961) both documenting that current program offerings are experienced as culturally misaligned by many families from these communities. Effective cultural adaptation requires community-based participatory research (CBPR) models that involve autistic individuals and their families from target communities as design partners, not merely research participants.

5.9 Decision Tool for Practitioners and Families

The following evidence-graded framework guides program selection according to primary clinical need, developmental stage, and implementation context:

Minimally verbal toddlers and preschoolers (ages 1–5) with limited functional communication: First-line: PECS (for functional communication acquisition) + JASPER or ESDM (for joint engagement and social communication development). Parent coaching essential. Consider AAC evaluation alongside PECS. Evidence level: Moderate.

Toddlers and preschoolers (ages 1–5) with social engagement differences, in parent-mediated context: First-line: ESDM or JASPER, delivered with intensive parent coaching. HMTW appropriate for children with low object interest and families with access to Hanen-certified SLPs. Evidence level: Moderate.

School-age children (ages 5–12) with moderate-to-good language, struggling with peer social skills: First-line: PEERS for School Age (ages 8–12). Video modeling for specific skill targets. Continued NDBI-based communication support as needed. Evidence level: Moderate (PEERS); Moderate (VM).

Adolescents (ages 13–22) seeking friendship and peer social success: First-line: PEERS for Adolescents or PEERS for Young Adults. Social coaching and community-based generalization support. Evidence level: High (social knowledge); Moderate (friendship outcomes).

All ages, specific skill targets (play, emotion recognition, conversation, vocational): Adjunctive: Video modeling. Can be implemented in any context, by any trained staff, with any communication profile. Evidence level: Moderate.

Under-resourced settings and diverse linguistic communities: Prioritize: PECS + video modeling + JASPER-in-classrooms. These three represent the most accessible, adaptable, and evidence-supported combination for lower-resource implementation contexts.

Experimental/supplementary use: Robot-mediated intervention for children with high social anxiety and/or intrinsic interest in robots. Not yet established as standard practice. Evidence level: Low.

Comprehensive framework for educational teams: SCERTS as an organizing framework to guide individualized intervention planning and interdisciplinary coordination, integrating evidence-based practices from the above categories. Evidence level: Very Low (experimental) but clinically useful for team organization.

CHAPTER SIX: CONCLUSION

6.1 Summary of Key Findings

This systematic comparative synthesis has evaluated eight communication and social-skills intervention programs for autistic learners against PRISMA-aligned methodology, GRADE evidence standards, and a public health equity lens. The central findings are as follows:

The NDBI framework — integrating developmental and behavioral principles within naturalistic, child-led, parent-involved intervention contexts — represents the most coherent and empirically supported architecture for communication intervention in autistic toddlers and preschoolers. ESDM and JASPER, as the most comprehensively evaluated NDBIs, produce consistent moderate effects on language, cognition, joint attention, and social communication, with the strongest evidence for children under 5 years.

PECS is an established, scalable functional communication intervention with a strengthened evidence base following a 2025 meta-analysis of 37 Chinese RCTs, particularly valuable for minimally verbal and nonspeaking autistic learners across a wide age range.

PEERS is the most evidence-supported social skills program for autistic adolescents and young adults, achieving High GRADE certainty for social skills knowledge outcomes and documented long-term effects at 5-year follow-up — rare in this literature. Its international validation across Japan, Italy, and other countries strengthens its cross-cultural applicability when appropriately adapted.

Video modeling is the most versatile and accessible modality in this review, with four decades of evidence across diverse targets and populations. Its low cost, adaptability, and lack of specialist delivery requirements make it uniquely suited for equity-focused dissemination.

SCERTS provides a valuable clinical framework for multidisciplinary team organization but lacks the RCT evidence to qualify as an independently established intervention.

Robot-mediated intervention is promising but experimental; its primary contribution may ultimately lie in the emerging generation of AI-responsive robots capable of genuine individualized interaction.

Cultural adaptation and racial/ethnic equity remain the most urgent unfinished agenda across all reviewed programs. The underrepresentation of Black, Hispanic/Latino,

Indigenous, and other minority populations in the evidence base — and the structural barriers that limit their access to effective programs — constitutes a public health failure demanding immediate remediation through culturally adapted program development, community-based research partnerships, and policy reform.

6.2 Implications for Policy and Practice

For early intervention systems: ESDM and JASPER should be priority programs for workforce development investment in early intervention (Part C) settings. Parent coaching must be treated as a core service component, not an optional add-on, given its centrality to generalization and maintenance. Early intervention access disparities by race, language, and income require proactive outreach, community navigation support, and flexible service delivery models.

For schools: PEERS should be accessible in middle and high schools through trained school-based clinicians. JASPER-in-classrooms and video modeling should be standard tools in the special education toolkit. AAC and PECS training should be a core competency of all special education teachers and paraprofessionals.

For insurance and Medicaid: Coverage decisions for autism communication interventions should be grounded in GRADE-rated evidence, not primarily in traditional ABA delivery hours. The evidence base now supports coverage of ESDM, JASPER, PEERS, and PECS as medically necessary interventions.

For research funders: The cultural adaptation gap must be treated as a priority funding area. Community-based participatory research programs developing and validating culturally adapted versions of ESDM, JASPER, PEERS, and PECS for Black, Latino, Indigenous, and immigrant communities should receive dedicated funding streams.

6.3 Directions for Future Research

The SCERTS RCT (NCT06733324, currently underway) represents the single most important pending study in this review's scope. Results will either substantially elevate SCERTS' evidence standing or clarify the conditions under which it is and is not effective.

Long-term follow-up studies for ESDM, JASPER, and PECS are urgently needed. The Mandelberg et al. 5-year PEERS follow-up stands as a methodological model for how to document whether early intervention actually alters developmental trajectories.

Generalization measurement as a primary outcome. Most trials measure outcomes in clinic or school settings with trained outcome assessors. Community-based naturalistic observation, ecological momentary assessment, and parent diaries as primary outcomes would substantially advance the field's ecological validity.

Comparative effectiveness trials directly comparing ESDM vs. JASPER vs. other NDBIs in adequately powered RCTs with comprehensive outcomes, stratified by child baseline characteristics, would provide the comparative effectiveness data that practitioners need but that funders have historically under-prioritized.

Cultural adaptation programs for PEERS (Black and Latino communities), ESDM (low-income immigrant populations), and JASPER (rural and Indigenous communities), developed through CBPR frameworks, represent the highest-priority equity research agenda.

AI-enabled and responsive robot intervention. As AI-responsive social robots mature, RCT evaluation of their effects compared to human interaction and to scripted robot interaction, with generalization to human social partners as a primary outcome, will determine whether this technology's promise can be translated into evidence-based practice.

Nonspeaking and minimally verbal populations. This group remains underrepresented in virtually every program's evidence base, despite facing the greatest functional communication burden. Dedicated RCTs for minimally verbal autistic learners, using communication diversity and quality of life as primary outcomes, are urgently needed.

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APPENDICES

Appendix A: PRISMA Flow Diagram (Narrative)

Identification: Combined database searches across PubMed, PsycINFO, ERIC, Web of Science, and Cochrane Library yielded 3,544 records. Cross-database de-duplication produced 3,218 unique records.

Screening (Title/Abstract): 2,489 records excluded for: non-ASD population (n = 921), no communication or social outcome (n = 687), no comparison condition (n = 398), non-English (n = 231), adult-only (n = 252). Records advanced to full text: 729.

Eligibility (Full Text): Excluded: intervention not replicable (n = 112), pharmacological without behavioral data isolation (n = 78), pilot N < 10 per arm without replication (n = 94), neuroimaging outcomes only (n = 67), duplicate report (n = 52), non-standardized outcomes only (n = 112). Total included: 214.

Grey literature: 19 additional documents.

Final synthesis corpus: 233 documents.

Appendix B: PICOS Specification Table

Domain	Specification
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Population	Infants, children, adolescents aged 0–22 with confirmed ASD diagnosis (DSM/ICD) or documented educational ASD; mixed samples if ASD ≥ 50% or separate reporting
Intervention	Named replicable program: PECS, Hanen HMTW, ESDM, PEERS, SCERTS, JASPER, video modeling, robot-mediated intervention
Comparator	Waitlist; TAU; active alternative; active placebo
Outcomes	Primary: functional communication, language (expressive/receptive), joint attention, social interaction, social skills knowledge, friendship. Secondary: adaptive behavior, autism symptom severity, QoL
Design	RCTs, quasi-RCTs, systematic reviews, meta-analyses; N ≥ 10/arm for primary RCTs

Appendix C: Risk-of-Bias Summary

Program	Random ization	Active Control	Blinding	Attrition	Selective Reportin g	Overall RoB
PECS	Low– Moderat e	Moderat e	Low	Low– Moderat e	Moderat e	Moderat e
Hanen HMTW	Moderat e	Moderat e	Low	Low	Low– Moderat e	Moderat e
ESDM	High	Moderat e–High	Low	Low	Low	Low– Moderat e
PEERS	High	Moderat e (waitlist)	Low	Low	Low	Low
SCERTS	N/A (no RCT)	N/A	N/A	N/A	N/A	Not appraise d

JASPER	High	Moderate–High	Low	Low	Low	Low
Video Modeling	Moderate (SCED)	Low (SCED norms)	Low	Low	Moderate	Moderate
Robot-Mediated	Moderate	Low–Moderate	Low	Moderate	Moderate	Moderate–High

Appendix D: GRADE Evidence Summary

Program	Outcome	No. Studies	Effect	Certainty	Rationale
PECS	Functional communication	37 RCTs (2025 meta)	Moderate	⊕⊕⊕○ Moderate	Strong RCT base; some cultural specificity
PECS	Speech emergence	10+ studies	Inconsistent	⊕⊕○○ Low	Causal confounding; design heterogeneity
Hanen HMTW	Parent responsiveness	3 RCTs	Moderate	⊕⊕⊕○ Moderate	Consistent; small samples
Hanen HMTW	Child communication	3 RCTs	Small (moderated)	⊕⊕○○ Low	Moderation-dependent; inconsistent
ESDM	Language/cognition	11–12 RCTs	$g = 0.28–0.41$	⊕⊕⊕○ Moderate	Multiple RCTs; intensity-dependent
ESDM	Autism symptoms	11–12 RCTs	$g \approx 0.27$	⊕⊕○○ Low	Inconsistent across meta-analyses
PEERS	Social skills	10+ RCTs	Moderate–Large	⊕⊕⊕⊕ High	Multiple RCTs; active

	knowledge						control; 5-yr FU
PEERS	Friendship outcomes	8+ RCTs	Moderate	⊕⊕⊕○ Moderate			Consistent; variable magnitude
SCERTS	Any	<5 studies	Unknown	⊕○○○ Very Low			No completed RCT
JASPER	Joint attention/engagement	~10 RCTs, N≈700	Moderate	⊕⊕⊕○ Mod-High			Multiple RCTs; independent replication
JASPER	Language	5+ RCTs	Moderate	⊕⊕⊕○ Moderate			Consistent; intensity moderates
Video Modeling	Social/communication skills	40+ yrs SCED	Large (SCED)	⊕⊕⊕○ Moderate			SCED-adapted; few group RCTs
Robot-Mediated	Social functioning	7 RCTs	g = 0.35	⊕⊕○○ Low			Few RCTs; generalization unknown

Appendix E: Program Comparison Master Matrix (Extended)

Feature	PECS	Hane n HMT W	ESDM	PEERS	SCERTS	JASPER	Video Modeling	Robot RMI
Age Range	1-18	Birth-5	12-60 mo	8-22	Any	1-8	2-Adult	2-16
Primary Target	Functional communication	Parent interaction	Comprehensive dev	Social cognition	Comprehensive framework	JA/play/language	Diverse targets	Social engagement
Theoretical	ABA	Vygotsky/Trans	NDBI (Dev+ABA)	Social-	Ecological/Trans	NDBI	Social Learning	Social cognition

I Basis		ctional		cognit	ive	action		
Deliv ery	Home /School/Clinic	Home /Clinic	Clinic /Home/Class	Clinic /School	School/Clinic/Home	Clinic /Home/Class	Any	Clinic /School
Implement or	Parent/Teacher/SLP	Parent (coached)	Therapist + Parent	Clinician + Parent	MDT + Family	Therapist/Teacher/Parent	Any trained	Clinician/Researcher
Training Required	2-day workshops	Hand cert. (SLP)	Intensive ESDM training	PEER S cert.	SCERTS workshops	JASPER workshops	Minimal	Technical + clinical
Cost	Low-Moderate	Moderate	High (intensive)	Moderate	Moderate	Moderate	Free-Low	Very High
Duration	Variable/ongoing	8 sessions + 3 visits	20-25 hrs/week x 2 yrs	16 sessions	Ongoing	Variable/ongoing	Variable	Variable
Functional Com m	Large	Moderate (moderate)	Moderate	Indirect	Framework	Moderate	Variable/large	Limited
Joint Attention	Indirect	Moderate	Moderate	Indirect	Framework	Large	Moderate	Small
Social Skills /Cognition	Limited	Moderate	Moderate	Large	Framework	Moderate	Large (SCED)	Small - Moderate
Language	Indirect	Moderate	Moderate	Indirect	Framework	Moderate	Variable	Limited
GRADE	Moderate	Low	Moderate	High/Moderate	Very Low	Mod-High	Moderate	Low

Cultural Adaptation	Good (China, int'l)	Mode rate (HK)	Limited	Good (Japan, Italy)	Unkn own	Limited	Good (adap table)	Very Limited
Scalability	High	Mode rate	Low-Mode rate	High (school)	High (framework)	Mode rate-High	Very High	Very Low
Minimally Verbal	Excellent	Limited	Good	Limited	Framework	Good	Mode rate	Limited

JA = Joint Attention; MDT = Multidisciplinary Team; SCED = Single-Case Experimental Design; Comm = Communication; Dev = Developmental