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REVIEW ARTICLE

Robots for Autism Therapy

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ABSTRACT

A growing body of work on robot-mediated therapy suggests that robots can elicit engagement and novel social behaviors among users with autism. In this narrative review, we trace the full historical arc of this field to date, from its inception in 2001 to 2024, covering 304 studies that present a robot for autism support. Early work largely consisted of short, highly structured sessions conducted in controlled laboratory or clinical environments. More recent research has shifted toward longer-term, real-world deployments in which robots operate with greater autonomy and engage users over multiple days or weeks. However, evidence for lasting and generalized benefits is still limited. The literature also remains focused primarily on children, with comparatively little research involving adults or individuals across a wider range of support needs. Despite rapid growth over these past two decades, the research remains fragmented across disciplinary boundaries, with robotics and clinical communities advancing similar goals without a cohesive, shared research framework. To address this, we offer a translational roadmap that details what interventions work, for whom, under which conditions, and why. We highlight current methodological gaps, outline key design considerations, and propose priorities for future research.

1 | Introduction

Formally known as Autism Spectrum Disorder (ASD), autism encompasses a broad range of neurodevelopmental conditions, marked by significant variability in communication styles, cognitive profiles, sensory processing, and daily functioning. The operational criteria have evolved over time, sometimes ahead of fully conclusive scientific consensus and reflecting shifting clinical perspectives (Waterhouse and Waterhouse 2012; Rosen et al. 2021). Yet, core diagnostic hallmarks have remained consistent: persistent difficulties in social communication and interaction, alongside restricted, repetitive patterns of behavior, interests, or activities (Rosen et al. 2021; American Psychiatric Association 2013).

Although autism is regarded as a lifelong condition, a range of behavioral interventions have been shown to meaningfully improve quality of life and support greater independence. Early intervention programs, in particular, aim to target foundational social and adaptive skills during critical psycho-developmental windows (LeBlanc and Fagiolini 2011; Marín 2016) in order to maximize the potential for lasting, long-term impact (Landa 2018). However, these programs demand sustained time, expertise, and involvement from families, clinicians, and educators—making equitable access a persistent challenge (Bearss et al. 2022). These challenges are further intensified by the profound heterogeneity of the autism spectrum, which necessitates highly individualized care. However, such personalized models are difficult to implement at scale within institutional systems that often default to standardized protocols (e.g., in public schools (Locke et al. 2015), child welfare models (Bilaver and Havlicek 2013), or healthcare (Weir et al. 2022)).

Summary

For over two decades, researchers have tested different ways robots might support autism therapy. The results are encouraging, but we still need a clearer picture of what works, for whom, and why. In this narrative review, we bring together the lessons learned so far and discuss next steps for future research.

To supplement the level of human involvement required for personalized and readily available care, some approaches have explored the use of non-human partners to facilitate human–human social interaction, such as in pet-assisted therapy (Redefer and Goodman 1989; Solomon 2010). Digital tools such as computer-assisted programs and virtual reality platforms have also shown potential to support engagement and skill development in individuals with ASD (Mesa-Gresa et al. 2018; Ramdoss et al. 2012). However, there remains limited research on the specific mechanisms that make these facilitative interactions effective and on the conditions necessary to generalize gains to real-world engagement with human partners.

Robots, particularly socially assistive robots (SARs), extend this line of inquiry by offering physically embodied, interactive systems that can engage users in structured, socially meaningful ways. By virtue of their embodiment, robots enable co-present, behaviorally contingent, real-time social interaction. Together, these properties distinguish SARs from simulated or purely virtual technologies. In autism-focused studies, the inclusion of SARs has been associated with increased engagement, improved attention regulation, and more appropriate social behaviors, including joint attention and spontaneous imitation (Scassellati et al. 2012; Pennisi et al. 2016).

1.1 | Scope of This Review

This narrative review summarizes the current state of research on robots for ASD therapy for a broad interdisciplinary audience. We organize the review around three connected but discrete phases: designing the intervention goals and structure; engineering the robot's physical form and behavior to deliver those goals; and evaluating the outcomes of the robot-assisted intervention. In particular, *intervention design* (Section 2) concerns the social, cognitive, or behavioral goals the robot is meant to support. *Robot development* (Section 3) concerns the design choices that shape the robot's form and function to support the intervention. Finally, *evaluation* (Section 4) considers whether the system achieves its intended outcomes. These phases are often iterative and overlap, but together they form a common structure for designing, developing, and deploying robots for autism therapy.

We did not pursue a formal systematic review or meta-analysis because the literature is highly heterogeneous in study aims, robot platforms, participant profiles, intervention targets, settings, and outcome measures, making pooled quantitative analysis inappropriate. Instead, we use a structured, preregistered method (Ramnauth et al. 2024) to narratively synthesize how the field has evolved and where methodological and clinical gaps remain. Additional details, including the PRISMA-style flowchart, database-specific search queries, and inclusion and exclusion criteria, are provided as Appendix A.

The review draws on an extensive collection of peer-reviewed studies published from 2001 to 2024. Studies were included if they involved direct interaction between at least one physically embodied robot and at least one individual with a formal diagnosis of ASD. We excluded studies involving only virtual agents, screen-based representations, design-only systems without user interaction, robots used solely for mechanical or nonsocial assistance, and papers that did not report empirical interaction data with autistic participants. Applying these criteria yielded a final corpus of 304 studies, summarized as Appendix B (Table B1).

Numerous reviews have examined the use of robots in autism therapy, including two foundational reviews published in 2012. Scassellati et al. (2012) offered a robotics-centered perspective that emphasizes system design, behavior modeling, and early technical challenges. Diehl et al. (2012) assessed clinical utility, critically examining the therapeutic validity and evidence base of robotic interventions to outline methodological gaps in the literature. Both reviews concluded that robots showed promise for eliciting engagement and social behaviors in children with ASD, but that the evidence base remained preliminary, with small samples, limited experimental rigor, and little evidence of clinically meaningful generalization. Together, these reviews formalized the research agenda for the following decade. In the present review, we use them as a historical benchmark for examining how the field has responded to those challenges. Since these 2012 reviews—which together captured 21 studies, a subset of the 55 studies captured in this present review—an additional 249 studies have been published within this recent decade (from 2013 to 2024; Figure 1).

Subsequent reviews have examined robots for autism therapy from several important perspectives, including therapeutic roles and robot embodiment (Cabibihan et al. 2013; Kumazaki et al. 2020; Puglisi et al. 2022), evidence quality and clinical readiness (Begum et al. 2016; Dickstein-Fischer et al. 2018), child-focused outcomes and meta-analytic efficacy (Pennisi et al. 2016; Alabdulkareem et al. 2022; Kouroupa et al. 2022; Alkhaldi et al. 2026), and broader taxonomies of robot applications (Ismail et al. 2019; Saleh et al. 2021; Szymona et al. 2021). The present review differs by treating robot-assisted autism therapy as a translational pipeline rather than as a single intervention category. Specifically, we examine how intervention goals are selected, how robotic form and function are designed to support those goals, and how outcomes are evaluated for clinical meaning, generalization, and real-world use. This framing allows us to synthesize the field's development from 2001 to 2024 while identifying why persistent gaps in standardization, clinical integration, population coverage, and long-term evaluation remain.

1.2 | Field Growth

The literature on robot-assisted autism therapy has expanded substantially since its early exploratory phase. Between 2001

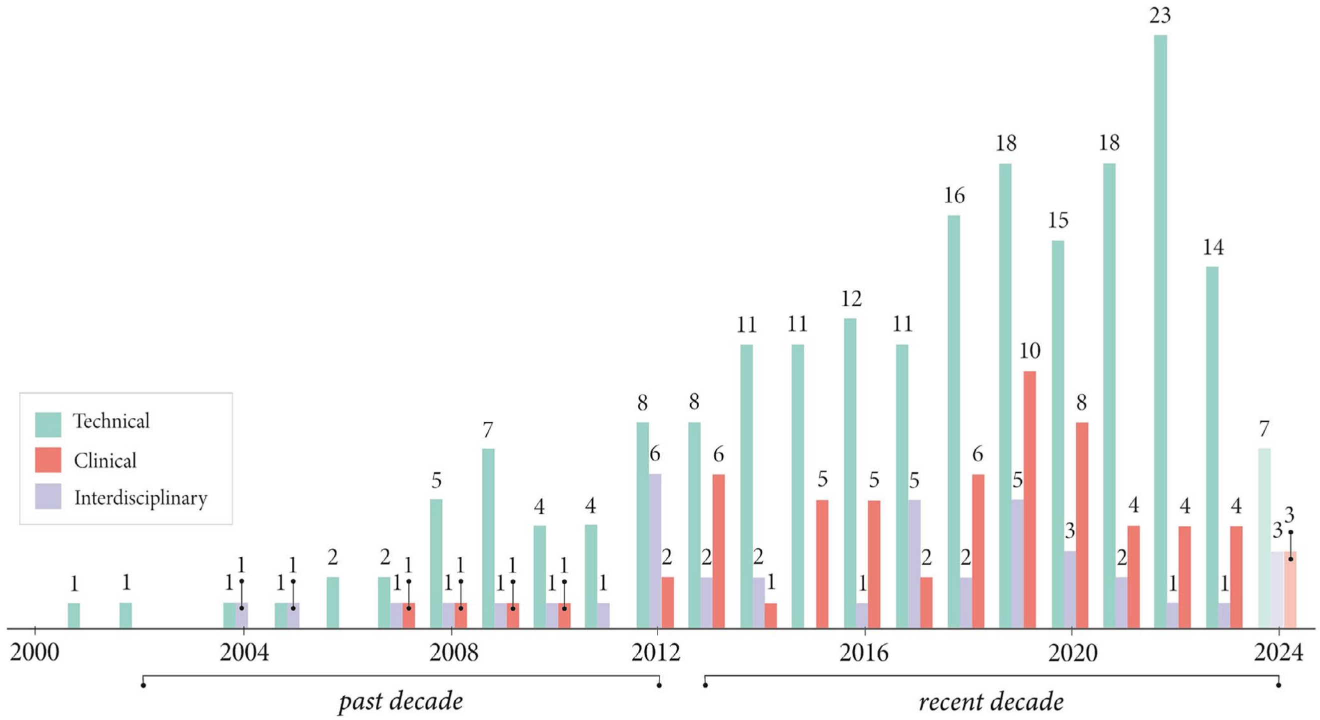

FIGURE 1 | Annual publication count by venue domain. This figure shows the number of published studies per year, between January 2000 and January 2025, categorized by broad venue domain: Technical (blue), clinical (red), and other or interdisciplinary (purple).

and 2004, only four studies were published (Werry et al. 2001; Dautenhahn and Werry 2002; Robins, Dautenhahn, et al. 2004; Robins, Dickerson, et al. 2004), largely reflecting proof-of-concept. Publication volume grew modestly in 2005–2008, with 15 studies, as researchers began introducing more structured pilot evaluations and early humanoid platforms. The field then gained momentum in 2009–2012, with 36 studies, coinciding with wider access to programmable robots and increased interdisciplinary interest.

Following the 2012 agenda-setting reviews, the literature expanded more rapidly. We identified 64 studies in 2013–2016 and 101 studies in 2017–2020, marking the field's most active period to date. This growth was accompanied by broader intervention targets, more autonomous systems, and early movement beyond tightly controlled laboratory or clinical settings toward schools, homes, and other real-world contexts. Although publication volume declined to 84 studies in 2021–2024, likely reflecting some combination of COVID-19-related disruption, output remained historically high. Overall, these trends suggest that the field has moved from demonstrating whether users will engage with robots toward asking how robot-assisted interventions can be sustained, adapted, and evaluated in more ecologically valid settings.

1.3 | Disciplinary Fragmentation

Following the 2012 agenda-setting reviews, the field expanded not only in volume but also in disciplinary breadth. At that point, only six clinical studies had been published (Kozima et al. 2007; Pioggia et al. 2008; Stribling et al. 2009; Giannopulu and Pradel 2010; Huskens et al. 2013; Kim et al. 2013). Of the 249 studies published from 2013 onward, 58 (23%) appeared in clinical venues and 27 (11%) in interdisciplinary outlets. Nevertheless, SAR research for autism therapy remains divided between robotics and clinical domains, which differ in timelines and evidentiary standards.

In clinical psychology, studies typically appear in longer manuscripts (10–30+ pages) in monthly or quarterly journals that are peer reviewed and highly competitive. These studies tend to be large-scale experiments that involve hypothesis-driven controlled trials, are statistically powered to detect group-level effects, and evaluate therapeutic efficacy through validated outcome measures. In robotics, on the other hand, high-impact findings are often disseminated through competitive, peer-reviewed, annual conference proceedings, typically featuring short-format papers (6–10 pages). User testing in robotics frequently centers on fine-grained qualitative and quantitative data collected from a small number of participants. From our corpus, it is not uncommon for studies to include detailed, second-by-second analyses of system performance or user behavior based on data from a single participant or fewer than 10.

Thus, robotics rewards rapid iteration and technical novelty, often leading to the publication of new systems within months of their development—even before the system has undergone extensive user testing. In contrast, clinical research typically unfolds over much longer timeframes, requiring extended recruitment, standardized assessment, and ethical oversight, spanning several years. This temporal misalignment is exacerbated by the short lifecycle of robotic platforms: many commercial or research-grade robots have become outdated or unsupported within 3–5 years of their release,[1] making it difficult to sustain research beyond initial pilot studies. As a result, clinically validated interventions may be tied to platforms that no longer reflect the state-of-the-art, while state-of-the-art platforms may lack the empirical validation required to demonstrate therapeutic use.

This divide matters because it reveals differing disciplinary values. To illustrate, a robotics study may emphasize that a robot's emotion classifier achieves 85% accuracy or that its engagement model outperforms a baseline in predicting attention. While these are meaningful technical milestones, they may have limited clinical relevance if not linked to real-world improvements in a child's behavior or functioning. From a clinical perspective, the more pressing question might be: Does detecting a child's emotional cues with 85% accuracy translate into improved social participation? If a child is still not initiating interactions with peers, then even the most accurate classifier may not meaningfully impact therapeutic outcomes. The most impactful studies would connect the two—for example, showing that an emotion classifier enabled the robot to keep the child engaged longer, which correlated with the child learning more, which led to improvements in the child's experiences outside of the specific human–robot context.

This disconnect raises an important question: Are we building technically impressive systems that lack clinical relevance? Or are we conducting clinically meaningful interventions with outdated or fragile platforms? Although there is a growing degree of cross-pollination between technical innovation and clinical application, there remains no unified framework for conducting SAR research in a way that fully satisfies both engineering and clinical expectations.

2 | Intervention Design and Goals

Here, we focus on how intervention goals are designed and structured. We first summarize established clinical approaches to ASD therapy, then examine how these approaches have been adapted in robot-mediated contexts. We consider the social, cognitive, and behavioral targets of these interventions, situating them within developmental needs across age groups. Finally, we identify gaps in current intervention designs and highlight opportunities for more targeted, developmentally appropriate approaches.

2.1 | Clinical Foundations of Autism Therapy

ASD interventions are often structured programs designed to teach young children (Lovaas 1987; Dawson et al. 2010) how to initiate, sustain, and respond appropriately in social interactions (Paul 2008; Arnold et al. 2000). Complex skills, such as engaging appropriately with peers, are broken down into low-level, teachable components (e.g., maintaining eye contact, turn-taking, greeting others, or interpreting facial expressions) and are taught explicitly through role play and repetition (Peters-Scheffer et al. 2011; Foxx 2008; Hustyi et al. 2023).

Generally, humans deduce the unwritten rules of social interaction through everyday observation and exposure (Bandura 1962). For instance, we learn the social constructs of when to initiate a handshake versus a wave, how close to stand during a conversation, or when to make eye contact and when to look away—all by observing and imitating others around us. These behaviors are rarely taught explicitly; instead, they are absorbed through repeated exposure to contexts where timing and appropriateness nuance often defy simple, rule-based explanations. However, for ASD, this kind of incidental social learning may be less accessible.

Many individuals with ASD experience difficulties with imitation or interpreting social cues (Smith and Bryson 1994), and may not naturally seek out or attend to the social interactions by which these norms are typically learned (Spain et al. 2018).

Rather than relying on passive exposure, many programs actively shape behavior through reinforcement-based methods, such as Applied Behavior Analysis (ABA) (Foxx 2008). Organic sources of reinforcement appear in peer-mediated strategies (DiSalvo and Oswald 2002; Chang and Locke 2016) such as in Naturalistic Developmental Behavioral Interventions (NDBIs), in which children practice skills alongside neurotypical peers in small-group settings, allowing for real-time feedback and social modeling.

Crucially, most interventions involve caregivers to ensure that the exercises during structured sessions is repeated beyond scheduled therapy times and spaces. The ultimate goal is not merely to teach isolated, low-level social skills, but to foster the capacity for socially meaningful and developmentally appropriate engagement that can generalize beyond the confines of formal intervention. For instance, even a modest improvement in joint attention—that is, the ability to coordinate attention with another person toward a shared object or event—can serve as a critical scaffold for more complex skills such as participating in cooperative play across diverse, real-world contexts.

2.2 | Targeted Behaviors for Robot Therapy

Roboticists have applied many of these established clinical practices to create SARs that model, prompt, and reinforce key social behaviors in structured and repeatable ways. To this end, robots have been developed to support a variety of interaction goals, which we summarize here.

While the seminal reviews in 2012 demonstrate the field's exclusive focus on children at that time, the recent decade has seen a notable broadening in user demographics. We organize this section by age group to examine how intervention goals align with developmental needs. This categorization should be interpreted flexibly, as many studies included broad age ranges spanning multiple developmental stages (e.g., Pioggia et al. 2008; Feil-Seifer and Matarić 2009; Pioggia et al. 2007; Nakadoi 2015; da Luz Schreider et al. 2024), and few directly compare outcomes across age groups. After presenting our age-based analysis, we turn to a complementary examination of how the intervention goals vary between studies stratified by functional profile and diagnostic presentation.

2.2.1 | Early Childhood: Joint Attention and Imitation

Atypical gaze behavior is a core diagnostic feature of ASD and is closely linked to many social and communicative difficulties characteristic of the condition. As such, it is one of the earliest targets for intervention (robotic or otherwise). More than half of the studies in our corpus ($N = 162$, 53.3%) report robotic interactions aimed at developing gaze-related skills, such as making eye contact, gaze following, and joint attention.[2] Of these, 84 studies (52%) involved participant samples in which the age range primarily constituted of those in early childhood (birth through age 5). This distribution suggests that, while gaze is a central focus in early childhood interventions, it remains a priority across later developmental stages.

Many studies report spontaneous joint attention during robot interactions, such as children shifting gaze between the robot and an adult or pointing toward the robot to share interest. These behaviors are typically measured through eye-tracking or frame-by-frame gaze coding, which provides fine-grained evidence of engagement but often remains limited to the immediate robot–child context. A notable exception is Scassellati et al. (2018), which explicitly tested generalization using a clinician-administered joint-attention probe (Bean and Eigsti 2012) before, during, and after the intervention, measuring whether children transferred robot-supported joint-attention behaviors to a new social context without the robot.

Imitation is another common target, appearing in 87 studies in our corpus (28.6%). Because many social routines are learned by observing and reproducing others' actions, SARs often use exaggerated, salient cues to invite imitation. In some studies, children are explicitly prompted by the robot or an adult to copy robot actions (e.g., Robins, Dautenhahn, et al. 2004; Duquette et al. 2008; Robins et al. 2005); in others, imitation emerges more spontaneously with repeated exposure to the robot's behavior (e.g., Scassellati et al. 2018; Shamsuddin, Yussof, Ismail, Hanapiah, et al. 2012). Sixteen studies specifically targeted motor imitation or praxis training.

2.2.2 | Middle Childhood: Turn-Taking, Language, and Peer Engagement

In middle childhood (approximately ages 6–12), robot-assisted interventions continue to target foundational behaviors such as joint attention and imitation but increasingly embed them within school- and peer-relevant tasks. Compared with early-childhood studies, which emphasize gaze-related behaviors, studies in this age range more often focus on language use.

Expressive and receptive language goals at this age often involve expanding vocabulary, improving sentence use, or practicing the back-and-forth of conversation. SARs are used in this capacity to model clear, consistent speech patterns, provide contingent social responses, and create opportunities for low-pressure conversational practice. Sixty-five studies in our corpus (21.4%) support these goals. For example, Kim et al. (2013) found that children with ASD produced more speech in robot-mediated sessions than in adult-led ones, while Pioggia et al. (2008) and Lee, Takehashi, Nagai, Obinata, and Stefanov (2012) reported gains in communicative responding following repeated, animated robot interactions. These studies suggest that predictable, engaging robot routines may help elicit both expressive behaviors, such as labeling and requesting, and receptive behaviors, such as following instructions.

Turn-taking is an inherent feature of SAR-based interventions, even when it is not the explicit target of the design. Human–robot interaction is reciprocal: the robot elicits a response, and the user is expected to attend and respond in turn. Still, turn-taking appears as a targeted and measured outcome in 40 studies in our corpus (13.2%). These studies range from collaborative activities that require alternating roles or contributions (e.g., Huskens et al. 2015; Wainer et al. 2014; Dimitrova et al. 2012), to conversational practice, information-sharing, self-disclosure (e.g., Pliasa and Fachantidis 2019), and spontaneous help-seeking (e.g., Melo et al. 2019), all of which depend on reciprocal timing.

Together, these behaviors can scaffold more effective peer engagement as children become better able to initiate and sustain conversations, interpret social cues, and respond contingently to others. However, our data do not show an expected proportional shift toward triadic or group-based designs in middle childhood (53%, compared to 59% of early-childhood studies), a point we return to in Section 2.3.

2.2.3 | Adulthood: Emotion Expression and Vocational Readiness

Of all behavioral targets of SARs for ASD, *emotion recognition and expression* span a wider range of age groups, appearing in nearly equal proportions across early childhood, middle childhood, and adolescence (ages 13–17). In early childhood, emotion recognition is often taught through visual attention to facial expressions or affective cues, frequently paired with gaze and imitation tasks. In middle childhood, interventions shift toward expressive skills such as identifying, labeling, and appropriately responding to one's own or others' emotions, often through dialogue and storytelling. By adolescence (16 studies total, nine of which target emotion-related skills), interventions continue to emphasize recognizing emotions in others and expressing appropriate emotional responses. Notably, there are currently no studies in the corpus that explicitly teach emotional regulation strategies—that is, what to actually *do* when experiencing stress or anxiety.

Despite the growing social and functional demands of adolescence, studies with adolescents remain rare, comprising only 5.3% of the corpus. Few SAR-based interventions target domains that become especially salient during this period, such as emotional regulation, independent living, or vocational readiness. Adult studies are even less common, with only nine studies involving adults with ASD (3.0%), four of which focus on adult social contexts exclusively through job interview practice (Kumazaki, Muramatsu, Yoshikawa, Corbett, et al. 2019; Shahverdi et al. 2023; Kumazaki, Warren, Corbett, et al. 2017; Kumazaki, Muramatsu, Yoshikawa, Matsumoto, et al. 2019). While employment readiness is important, this narrow emphasis leaves broader adult needs largely unaddressed, including daily living skills, workplace social dynamics, financial literacy, community navigation, and everyday emotional regulation. Only one study (Ramnauth et al. 2022) begins to address this broader scope by targeting *interruption resiliency*, a skill linked to both employability and daily self-regulation.

2.2.4 | Participant Profiles and Functional Variation

Developmental stage is a useful lens for organizing intervention goals, but it does not capture the full diversity of needs and capabilities across the autism spectrum. In practice, interventions are also shaped by support needs, verbal ability, cognitive functioning, mental age, and co-occurring conditions. These factors often determine who is eligible to participate in SAR studies and what therapeutic goals are prioritized, even among individuals of the same chronological age.

Most studies in our corpus focus on participants with fewer support needs or normative IQ, sometimes described as "high-functioning."[3] This likely reflects the practical demands of many SAR protocols, which often require participants to follow robot or adult prompts, attend to structured tasks, and complete standardized assessments. While these requirements support feasibility and experimental control, they also exclude many individuals with higher support needs, including minimally verbal individuals and those with co-occurring intellectual disabilities.

This bias is also evident in how studies report diagnostic and inclusion criteria. Although all studies report an autism diagnosis, the specificity of that diagnosis varies widely: some simply state that participants had ASD, while others report confirmation through tools such as the ADOS-2 (Kim and Lord 2018), SCQ (Snow 2021), or clinical judgment. Inclusion criteria also often favor participants with fewer support needs, requiring, for example, verbal fluency, typical vision or hearing, or the ability to remain seated and attend to a robot for a set period of time. These restrictions are often necessary for safety, feasibility, experimental control, and the suitability of the intervention target, but they also limit generalizability and contribute to the underrepresentation of individuals with more complex communication or cognitive profiles.

A small number of studies explicitly attempt to address this gap. Abu-Amara et al. (2024) designed a robot-based intervention for children with moderate to severe ASD, while Giannopulu and Pradel (2012) worked with children diagnosed with severe autism, using rhythmic movement and sensory feedback to reduce anxiety.[4] Clabaugh et al. (2019) also emphasized long-duration, personalized adaptation as a necessary step toward supporting children who may not engage reliably in short, lab-based sessions. These examples remain exceptions. Because most studies focus on participants with fewer support needs, the field has not yet produced robust within-sample comparisons across functional profiles. As a result, it remains difficult to determine which robot-assisted interventions work for whom or how robot behavior should be adapted for users with more complex needs.

2.3 | Structure of Robot Therapy

Beyond the specific behavioral skill targeted, we now consider the structural elements of robot-based therapy. These elements include the physical setting in which the therapy takes place, the configuration of interactions (e.g., dyadic between just the robot and participants, or small group in several peers interact with the robot alongside the participant; examples shown in Figure 2), and the amount of exposure to the therapy and robot.

2.3.1 | Intervention Setting

The setting of SAR therapy shapes both feasibility and ecological validity. Across the corpus, most studies were still conducted in controlled laboratory or clinical environments (233 studies; 76.6%), reflecting the field's early emphasis on experimental control, proof-of-concept demonstrations, and researcher-supported robot operation. These settings enabled detailed behavioral coding and technical oversight but offered limited insight into how robot-assisted interventions function in everyday contexts.

Since 2012, more studies have moved into real-world environments, especially schools and homes. In our corpus, 52 studies took place in school settings, where robot-assisted activities could be embedded into classroom routines and observed alongside teacher facilitation and peer interaction. Only nine studies described in-home deployments, despite the home offering a highly naturalistic context for studying caregiver involvement, spontaneous interaction, and changes in daily routines. Of these home studies, seven involved repeated sessions over at least 1 week, eight used dyadic child–robot interaction, and only one directly incorporated a caregiver in a triadic intervention (Scassellati et al. 2018). Only one targeted adults with ASD (Ramnauth et al. 2022), and only one included a control condition (Silva et al. 2019).

Home deployments highlight both the promise and difficulty of real-world SAR use. Because therapists or researchers cannot typically remain present across multi-day or week-long interventions, these studies require greater robot autonomy and must contend with the variability of household environments. At the same time, compared with schools, homes provide fewer opportunities for structured observation of peer interaction or externally guided social generalization.

Despite this shift toward more naturalistic settings, all studies in our corpus remain confined to a single physical context. None implement structured generalization procedures across settings, such as classroom-based robot sessions followed by observation in peer-rich contexts like the playground or cafeteria. This remains a missed opportunity to test whether SAR-supported gains translate into spontaneous human–human interaction beyond the intervention setting.

2.3.2 | Interaction Configuration

The most common experimental setup is a single child interacting one-on-one with a robot ($N = 169$, 55.6% of our corpus). This dyadic structure is especially common in interventions targeting foundational skills such as joint attention, imitation, and turn-taking, where the robot's controlled behavior can make specific social cues more salient. By limiting the number of social partners, dyadic designs support experimental control

FIGURE 2 | Examples of robot-assisted autism research. The collage shows (A) Keepon in early caregiver-mediated sessions designed to elicit contingent social responses (Kozima et al. 2005); (B) Kaspar in structured classroom games for teaching visual perspective-taking (Wood et al. 2018); (C) CHARLIE, an adaptive robot for reaction-time training using hand and face tracking (Boccanfuso and O'Kane 2011; Boccanfuso et al. 2017); and (D) a month-long autonomous in-home deployment using Jibo to support storytelling, turn-taking, and joint attention in family routines (Scassellati et al. 2018). Together, these examples highlight the field's heterogeneity in duration (minutes-long sessions to multiweek deployments), context (laboratories, clinics, schools, and homes), interaction structures (dyadic vs. triadic; free play vs. structured games), and therapeutic goals, illustrating the methodological range through which robots have been explored as supports for children with autism. Photographs are reproduced courtesy of the respective authors, who obtained the appropriate informed consent from identifiable participants for publication of the images.

and make it easier to isolate how robot actions shape child responses. However, they may also create a disconnect between the learning context and the intended transfer context, since the robot is often both the instructional agent and the primary social target, even when the broader goal is improved human–human interaction.

Triadic designs introduce a third participant, typically a therapist, caregiver, researcher, or peer, who can scaffold the interaction ($N = 117$, 38.5%). These configurations allow the adult or peer to interpret the robot's behavior, model responses, provide reinforcement, and create richer opportunities for generalization. Still, relatively few studies use peer-mediated triads, despite the central role of peer interaction in everyday social development. This limits opportunities to practice contingent behavior with a more natural social partner and makes it harder to evaluate whether robot-supported gains transfer to typical peer contexts.

A small number of studies instead create triadic interactions using two robots as social agents (Soleiman et al. 2023; Kumazaki, Muramatsu, Yoshikawa, Yoshimura, et al. 2019; Takata et al. 2023). For example, Soleiman et al. (Kostrubiec et al. 2024) used two parrot-like robots to model social exchanges for emotion recognition, creating a fully robotic social environment that a single robot could not provide alone. Overall, however, most SAR studies continue to rely on configurations in which the robot is the main or only social partner. While this simplifies intervention delivery and outcome measurement, it leaves open whether observed gains persist beyond the robotic context or transfer to more complex human social interactions.

2.3.3 | Session Frequency and Duration

Session frequency and duration also shape the feasibility and therapeutic impact of SAR-based autism interventions. Early studies, particularly before 2012, were often single-session experiments or short trials of only two or three sessions, designed to test feasibility, capture initial user responses, or pilot specific behaviors such as joint attention or imitation. While useful for proof-of-concept work, these designs offer limited insight into sustained engagement, learning over time, or generalized behavioral change.

This limitation is important because meaningful behavioral change does not occur in a single session, and children's engagement can vary substantially across days or even within the same day. A child may be highly engaged in one session and distracted, frustrated, or unwilling to interact in the next. Human therapists are trained to respond to this variability, and SAR systems intended for therapy must eventually support similar adaptability (Begum et al. 2016).

More recent work has increasingly moved toward repeated sessions and longer-term deployments, reflecting a shift from feasibility testing toward measuring therapeutic change over time. Twenty studies in our corpus feature interventions lasting several days to multiple months,[5] allowing researchers to examine skill acquisition, novelty and habituation effects, sustained engagement, and the need for personalization as users progress.

3 | Design of Robot Form and Function

At its core, the robot is meant to serve as a stimulus for eliciting desired behaviors from users. To do so, SARs adapt established clinical practices (Section 2.1) into embodied systems that model, prompt, and reinforce social behaviors in structured and repeatable ways (Section 2.2).

However, SAR research involves more than placing a psychosocial intervention onto a robotic platform. It raises new design questions about how to create systems that are acceptable, intuitive, and therapeutically useful. Under what conditions do users accept an assistive robot in their environment (Zehnder et al. 2022; van den Berk-Smeekens et al. 2020; Frenkel et al. 2025)? How should the robot's behavior adapt to user personality or cognitive profile (Sorrentino et al. 2021; Shi et al. 2022)? How can robots initiate interaction in ways that feel approachable without requiring extensive training or acclimation (Zheng et al. 2017; Coeckelbergh et al. 2016)? And, critically, how can SARs support therapeutic goals without becoming the primary social focus or displacing opportunities for human–human interaction?

The previous section examined how these questions are shaped by the overall intervention structure. Here, we focus on the robot itself: how it first appears to the user, and how its behavior unfolds within the therapeutic framework. These design choices center on two basic questions: how should the robot *look*, and how should the robot *behave*?

3.1 | Form: How Should the Robot Look?

The physical form of a SAR is a non-trivial design choice. Prior work spans a wide range of embodiments, from highly anthropomorphic robots with silicone skin and expressive facial features (e.g., KASPAR (Dautenhahn et al. 2009), Actroid-F (Yoshikawa et al. 2011), Milo (Robokind 2018)), to visually simplified, cartoon-like systems with exaggerated primary features and reduced secondary features (e.g., Sota and CommU (Osaka University, and Vstone Co., Ltd./Ishiguro Symbiotic HRI Project 2015), NAO (SoftBank Robotics 2022), QTrobot (LuxAI, n.d.)), to low-actuation, limbless, stationary, or animal-like robots (e.g., Paro (PARO Robots U.S., Inc. 2014), Pleo (Fernaeus et al. 2010), Keepon (Kozima et al. 2009), Kiwi (Pakkar et al. 2019)). The variety of robot form is illustrated in Figure 3.

These aesthetic decisions are rarely arbitrary and instead reflect competing priorities in therapeutic design: on one hand, the desire to create an engaging, relatable partner that can adequately convey social cues; on the other, the need to avoid overstimulation, uncanny valley effects, or distraction. This is a particularly important consideration when designing for users with heightened sensory sensitivity or social anxiety. We outline a few nuanced aspects of robot form below, focusing on specific design considerations that arise in the context of ASD therapy.

3.1.1 | Material Properties

Physical materials are a critical design consideration for SARs in ASD therapy, especially when tactile interaction is part of the intervention. Examples include the soft Veltex exterior of a fish-shaped robot designed for non-verbal children with autism (Soft Interaction Lab 2014), the silicone skin used for KASPAR (Dautenhahn et al. 2009), and Keepon's rubberized, squeezable body, which was designed to invite repeated touch (Kozima et al. 2009). Touch-responsive coverings, such as RoboSkin on KASPAR (Dautenhahn et al. 2009) and pressure-sensitive foam layers in the Huggable robot (Stiehl et al. 2006), further allow robots to detect and respond to physical contact.

These designs show that touch can serve as a meaningful communication channel, particularly for users with limited verbal or nonverbal expression. While robots are often imagined as hard plastic systems that communicate primarily through visual or auditory cues, SARs for ASD therapy increasingly use soft, textured materials to support more holistic, multisensory forms of engagement (Casas-Bocanegra et al. 2020; Pinto-Bernal et al. 2022).

3.1.2 | Safety and Mechanical Complexity

Safety in human–robot interaction is a multidimensional design concern, spanning physical, emotional, and social risk. In ASD interventions, this is especially important because children may have unpredictable responses to novel stimuli. Researchers therefore often adopt conservative design choices, such as limiting movement speed, range of motion, and applied force; avoiding sharp edges; covering joints to prevent pinching; and using compliant or soft materials where contact may occur. Pepper, for example, includes soft arm padding and compliant joints to reduce the risk of physical harm during interaction.

These safety concerns also shape decisions about mechanical complexity. A higher number of degrees of freedom can support smoother, more expressive movement, but it also increases cost, calibration demands, mechanical failure points, and maintenance burden, especially in long-term or real-world deployments. For this reason, many ASD-focused SARs intentionally use simplified designs that reduce both technical risk and sensory load. Robota, for instance, uses simple head and arm gestures for imitation games (Billard et al. 2007), while Keepon conveys affect through only four motors for bouncing, tilting, and turning (Kozima et al. 2009). These streamlined behaviors can still communicate attention and emotion without overwhelming the user or making the system unnecessarily fragile.

FIGURE 3 | Examples of robot embodiments. The collage above shows (A) Keepon, a small, compliant, creaturelike robot with a two-axis head and tactile input for simple expressive behaviors; (B) Pleo, a quadrupedal animatronic dinosaur with lifelike motion driven by multiple servos and touch sensors; (C) Kaspar, a child-sized humanoid with simplified facial features and limited articulated gestures to reduce sensory complexity; (D) Jibo, a tabletop social robot with a three-axis expressive head and an animated eye displayed on a screen; (E) NAO, a fully articulated bipedal humanoid enabling complex gestures and postures; (F) Kiwi, an owl-like tabletop robot with an animated facial display, and expressive head and body motion; (G) InfanToid, an infant-like mechanical torso with exaggerated facial cues and upper-body actuation; (H) CHARLIE, a robot with actuated head and arms and integrated hand- and face-tracking sensors for responsive interaction; and (I) Pepper, a full-height mobile humanoid with articulated arms, speech capabilities, and a touchscreen interface. Photographs are reproduced courtesy of the respective authors, who confirmed that appropriate informed consent for publication was obtained from identifiable participants (B. Scassellati for panels A, B, D, and E; and M. Matarić for panel F).

3.1.3 | Mobility

Researchers must make strategic decisions about a robot's level of physical expressiveness and mobility based on the goals of the interaction, technical feasibility, and the demands of the therapeutic setting. As most SAR interventions are designed for children, and given that children are the demographic least prone to staying in one place for a therapy session, the robot's mobility becomes another crucial factor. While some robots are designed to move freely through space (rolling or walking alongside users), many remain stationary on tables or stands. Fixed robots offer greater mechanical stability, reduced safety risks, and tighter control over interaction context, making them well suited for structured therapeutic tasks. In contrast, mobile robots allow for dynamic, spatial interactions such as following a child, guiding navigation, or exploring a shared environment. These interactions can be more engaging and naturalistic but also introduce new technical challenges in autonomous navigation and behavior coordination.

3.1.4 | Cost and Maintainability

Cost and maintainability are practical constraints that shape platform selection in SAR research. Many commonly used robots are commercial-grade systems costing 10,000 to more than 30,000 USD, with additional expenses for software licenses, developer tools, accessories, maintenance contracts, and replacement parts. These costs can quickly limit scalability, especially when studies require multiple robots for parallel testing, multisite trials, or long-term deployment.

Repairability and customization pose additional challenges. Some commercial platforms are closed systems that require manufacturer servicing or restrict access to internal hardware, making it difficult to troubleshoot failures during a study. Each additional robot also increases the burden of setup, calibration, software updates, storage, and repair. As a result, researchers may need to stagger sessions, reduce sample sizes, or limit deployment duration.

These constraints matter for clinical translation as well. When deployed outside of controlled lab settings, robots must be reliable, easy to maintain, and recover quickly from failure; otherwise, disruptions can reduce clinician trust and make integration into routine care less likely. Limited repairability or vendor dependence may also restrict access for under-resourced settings. For this reason, researchers and clinicians must weigh the expressive and technical affordances of high-end robots against the practical demands of sustained use, sometimes favoring simpler tablet-based or custom-built platforms that offer sufficient functionality at lower cost.

3.2 | Function: How Should the Robot Behave?

The behavioral design of SARs (how they speak, move, respond, and guide interaction) has prompted rich exploration.

Some systems emulate the structured, directive style of a clinician or interventionist (e.g., prompting a child to make eye contact or initiate turn-taking; Chung et al. 2025; Mishra and Conn Welch 2024), while others adopt more peer-like or playful interaction styles aimed at encouraging spontaneous engagement (e.g., storytelling, imitation games; Kozima et al. 2009; Kanda et al. 2004). We organize these considerations of the *role* a robot should function within the therapy context, and how SAR research has approached behavioral *autonomy* and *adaptation*.

3.2.1 | Roles of the Robot

The role a robot assumes in therapy shapes both its behavioral repertoire and how children perceive and engage with it. Across the corpus, robots most often function as instructors ($N=205$; 67.4%), followed by peers ($N=64$; 21.1%) and mediators or facilitators ($N=17$; 5.6%).[6] Instructor robots provide structured prompts, reinforcement, and correction, making them well suited for teaching specific skills such as joint attention, turn-taking, or emotion recognition. Peer-like robots emphasize playful, bidirectional engagement and may elicit more spontaneous behaviors such as smiling, vocalization, imitation, or shared attention. Mediator robots are positioned less as the central partner and more as a bridge between the child and other people, helping scaffold triadic interaction, shared activities, or communication with caregivers, clinicians, or peers.

Most SAR interventions still place the robot in an instructional role, which supports consistency and repetition but may limit opportunities for spontaneous interaction or generalization beyond the robot. A smaller subset of studies reverses this dynamic through *learning-by-teaching*, where the child becomes the instructor and the robot becomes the learner. This structure may increase motivation and self-efficacy by giving the child an active social role. For example, Zaraki et al. (2020) used a treasure-hunt game in which children taught a robot to associate toys with locations, while Barnes et al. (2021) designed a dance game in which the robot learned by imitating the child's movements. In both cases, the robot's learner role created opportunities for children to organize their knowledge, give feedback, initiate interaction, and sustain engagement over time.

3.2.2 | Balancing Autonomy and Adaptation

One common interpretation of "autonomy" in human–robot interaction refers to a system's ability to operate within expected parameters without requiring direct human involvement. Under this definition, autonomy is not synonymous with adaptiveness. A fully scripted robot may be autonomous if it can run without human control, while a highly adaptive system may still require human oversight if a therapist or researcher is interpreting and managing the interaction. Based on the 299 studies that provided sufficient detail, we categorized systems in our corpus as fully autonomous ($N=100$; 33.4%), semi-autonomous ($N=183$; 61.2%), or non-autonomous ($N=16$; 5.4%).

This distinction is important because systems on the scripted end of the spectrum are often more likely to meet criteria for autonomous operation: their behavior is predictable, rule-based, and easier to keep within expected bounds. In contrast, systems that interpret and respond to complex human behavior introduce greater variability, making it harder to define and guarantee appropriate outcomes using traditional if–then logic. Fully autonomous systems perceive, decide, and act without human intervention during the session, while semi-autonomous systems combine robot control with human oversight, often through Wizard-of-Oz control. Non-autonomous systems are fully teleoperated or manually controlled. Each approach reflects a tradeoff between control, flexibility, scalability, and ecological validity.

SAR interventions vary widely in their level of therapeutic contingency, or the degree to which the robot adapts its behavior to the user's state. At one end of the spectrum are fully scripted systems that follow fixed routines, offering consistency and predictability but little personalization. Of the 272 studies in our corpus with sufficient methodological detail, 97 (36%) used scripted designs in which the robot's behavior was identical across participants. These approaches are especially common in early intervention work, where fixed routines can help isolate target behaviors such as gaze or turn-taking.

More adaptive systems adjust aspects of the interaction in response to user behavior, such as changing the pace of the session, modifying prompts, or responding to detected engagement or affect. Some systems rely on therapist-in-the-loop control through Wizard-of-Oz paradigms, while others use autonomous sensing or algorithmic adaptation. For example, Lemaignan et al. (2024) describe a robot that modulates its emotional responses based on children's detected anxiety levels, while Clabaugh et al. (2019) adapt game difficulty to maintain an appropriate challenge level for each child. Other systems combine therapist oversight with affective modeling to support more nuanced interaction (Mazzei et al. 2011; Soleiman et al. 2014). Most of these systems remain reactive: the robot detects a behavior and then selects a predefined response.

Machine learning creates the possibility of moving from reactive adaptation toward *anticipatory guidance*. By combining current behavioral cues with patterns observed across earlier interactions, a SAR could estimate when a user is likely to disengage, become frustrated, or require additional support and intervene before the interaction breaks down (Huang and Mutlu 2016; Ramnauth et al. 2026). For example, the robot might adjust its pacing, simplify a task, offer a break, or invite support from a nearby caregiver. This capability could allow the robot to move more fluidly between instructor and mediator roles.

Even with these advances, most adaptive SARs personalize only a small set of predefined parameters, such as timing, prompt frequency, task difficulty, or feedback. Few can interpret the intent and context of a child's spoken input or adapt flexibly across sessions and social situations. Adaptation also rarely changes the structure of the interaction itself. As children acquire new skills, the robot may need to shift from being the primary social partner to facilitating interaction with another person—for example, by inviting a sibling into an activity or reducing its own involvement when the child turns toward a parent. No system in our corpus demonstrates this degree of structural flexibility beyond the child–robot dyad.

Finally, the rationale behind adaptation is often underdeveloped. Many systems assume that detecting a behavior, such as looking away or appearing frustrated, should trigger a fixed response. Yet these mappings are rarely grounded in a clear model of learning or social motivation. Similarly, feedback is often tied to task performance, such as earning points or completing a level, rather than to the quality of the user's social behavior. More targeted social feedback could help users connect their actions to the underlying goals of the intervention, while still preserving the value of implicit feedback through modeling and guided practice.

4 | Evaluation of Robot Therapy

Evaluating SAR interventions for autism requires balancing clinical standards with the practical realities of HRI. Small samples, short deployments, novelty effects, limited controls, and difficulties conducting longitudinal research are not unique to autism-focused SARs; they are common across HRI studies involving real users, particularly in naturalistic settings. These challenges are especially consequential in autism research, however, because interventions must accommodate substantial individual variation while demonstrating outcomes that extend beyond the immediate robot interaction. The limitation arises when findings from exploratory or technically focused work are interpreted as evidence of therapeutic efficacy or population-level generalizability.

Early SAR studies typically relied on in-session measures, such as eye contact, gesture imitation, or task compliance, as proxies for therapeutic benefit. Although these measures provide useful evidence of feasibility and immediate social influence, they may reflect novelty or exposure rather than lasting developmental change (Erel et al. 2024; Smedegaard 2019). The foundational reviews of 2012 accordingly highlighted small samples, limited controls, and minimal follow-up. Since then, the field has increasingly adopted baseline measures, comparison conditions, standardized outcomes, and longitudinal designs. This section examines that progress while distinguishing evidence of technical feasibility from evidence of therapeutic efficacy.

4.1 | Study Design and Sample Sizes

Where earlier work often amounted to anecdotal case studies or proof-of-concept pilots involving less than five participants, we now see substantially larger trials. Our review identified 19 randomized controlled trials (RCTs; 6.2% of our overall corpus), a remarkable increase from essentially zero true RCTs in 2012.[7] These RCTs also include sample sizes that were unheard of a decade ago. For example, van den Berk-Smeekens et al. (2022) enrolled 73 children in a 3-arm trial. Zheng et al. (2020) conducted an RCT with 20 toddlers with ASD to test a robot-mediated joint attention intervention. Marino et al. (2020) ran an RCT with 14 children to evaluate a robot-based socio-emotional skills training. Although these numbers remain modest by clinical trial standards (where sample sizes often range from several dozen to hundreds of participants), they represent a clear improvement over earlier SAR studies, which frequently included only a handful of participants.

In parallel with the rise of RCTs, many recent studies now incorporate control or comparison conditions—features that were often absent in earlier SAR research. Common experimental designs include comparisons between robot-assisted therapy and treatment-as-usual, or between robot-assisted and human-only versions of the same intervention. These designs aim to isolate the contribution of the robot itself. For example, Marino et al. (2020) compared a CBT-based emotional intervention delivered by the humanoid robot NAO versus the same content delivered by a human alone; children in the robot-assisted group demonstrated greater improvements in emotion understanding. Similarly, Zheng et al. (2020) evaluated a robot-based joint attention intervention against a no-robot control. Although the group differences were small and not statistically significant, the study nonetheless contributed valuable insights into ASD outcome variability and helped establish a framework for more rigorous evaluation.

Establishing a robust baseline is essential for assessing the impact of any intervention. In real-world settings outside controlled clinical or laboratory environments, however, implementing equivalent non-robotic control conditions is often impractical. As a result, many studies, especially those involving small samples, individualized interventions, or in-home deployments, adopt within-subject approaches in which each participant serves as their own control. This tradition is well established in autism research through single-subject experimental designs (e.g., A-B, A-B-A, or multiple-baseline designs), which explicitly structure baseline, intervention, and maintenance phases to support causal inference in the presence of substantial inter-individual variability.

While SAR studies frequently rely on within-subject comparisons, they often do so in ways that only partially align with established single-subject methodology. For example, baseline phases may be relatively brief or insufficiently characterized, phase transitions may be driven by logistical considerations rather than stability criteria, and intervention effects are sometimes inferred from aggregate trends rather than systematic within-case analysis. In addition, key features of single-subject designs (such as staggered intervention onset across behaviors or participants, explicit replication logic, or planned withdrawal or maintenance phases) are not consistently leveraged. As a result, SAR studies may capture promising behavioral change while falling short of the inferential clarity and clinical interpretability that single-subject designs are intended to provide. Greater alignment with this methodological tradition would not require larger samples, but rather more deliberate use of its existing structure and analytic logic.

Before questions of *efficacy* can be meaningfully addressed, many robot studies first confront the challenge of demonstrating *feasibility*. Deploying robots in real-world contexts—such as homes, clinics, or classrooms—requires overcoming significant technical barriers, including system autonomy, reliability, and context awareness (Tapus et al. 2007). Recruitment is also difficult, but sample size alone does not capture the central challenge. Autism encompasses substantial variation in communication, cognition, sensory processing, motor ability, co-occurring conditions, and support needs, as well as individual strengths that may shape how a person engages with a robot. A small sample may therefore contain considerable within-group variation, while restrictive protocols may disproportionately recruit verbally fluent participants with fewer support needs who can follow prompts and complete standardized assessments. Consequently, even larger studies may not be representative of the broader autism spectrum, and aggregate outcomes may obscure meaningful differences in who benefits from a particular intervention. Early-stage studies appropriately prioritize whether a system can operate safely, consistently, and acceptably, but stronger therapeutic claims require clear reporting of participant characteristics and, where possible, analysis of outcomes across relevant functional profiles.

In this early-stage context, conventional notions of evaluation rooted in clinical trial standards may not be the most appropriate or practical. In clinical practice, measuring progress in social skills is often subjective and infrequent, relying heavily on therapist observations or parent reports. In contrast, robots and their associated sensors (cameras, microphones, even wearables) can provide continuous, objective tracking of behaviors. For example, a robot's vision system can count how many times a child initiates eye contact each session, or how their latency to respond changes over time. These metrics can be graphed and used by clinicians to make data-driven decisions (much like a behavior analyst uses frequency counts in ABA). Where robotics brings the potential for more fine-grain detection, analysis, and prediction to the therapeutic context, it introduces an alternate view of "sample size." SAR researchers that aim to evaluate system feasibility would examine system performance over user outcomes. Therefore, "sample size" may refer to the number of system actions or interaction sessions, in contrast to the traditional clinical definition based on the number of human participants.

At the same time, effective SAR design is not only about capturing richer behavioral data, but about ensuring that these measures, learning processes, and robot behaviors are presented in ways that clinicians can readily interpret and act upon. Automated methods can assist observation and decision-making, but their outputs should be surfaced through clinician-facing interfaces that make underlying signals visible rather than reducing them to opaque scores or model decisions. Examples of this may include showing which behavioral cues were detected, how consistently they appeared over time, and how confident the system is in its assessments. Such interfaces can allow clinicians to verify, contextualize, and, when necessary, override automated inferences using established therapeutic frameworks. Developing transparency-oriented interfaces represents a near-term and underexplored opportunity to accelerate the safe and meaningful integration of automation into SARs. In the meantime, transparency, interpretability, and alignment with clinical protocols remain essential benchmarks for ASD-HRI research.

4.2 | Outcome Measures

Outcome evaluation in SAR research for autism spans a wide range of measures, including standardized clinical instruments, fine-grained behavioral coding, engagement metrics, and assessments of generalization and retention. Together, these approaches reflect a gradual maturation of the field toward more rigorous, clinically grounded evaluation practices.

4.2.1 | Standardized Clinical and Caregiver-Report Measures

Early studies often relied on qualitative observations (e.g., "the child smiled more with the robot" (Kozima et al. 2007; Wainer et al. 2014)) or bespoke metrics that lacked baseline comparisons or clinical validation. More recent work, however, has increasingly incorporated standardized instruments alongside objective behavioral coding. For example, parent- or teacher-report tools like the Social Responsiveness Scale (SRS) and the Vineland Adaptive Behavior Scales are now commonly used to assess changes in social functioning and adaptive behavior across everyday contexts (e.g., Lee and Nagae 2021; Feng et al. 2022; So et al. 2020). Some studies also report clinical diagnostic scores, such as ADI-R or ADOS, collected before and after intervention (e.g., Yun et al. 2017; Cao, Esteban, et al. 2019; Billing et al. 2020), although these measures are not designed to be highly sensitive to short-term change (Sterrett 2021; Kim et al. 2019). In response, several autism-specific instruments such as the Autism Impact Measure (AIM) (Kanne et al. 2014) and the Autism Behavior Inventory (ABI) (Bangerter et al. 2017), have been developed to better capture treatment-related change over shorter timescales.

4.2.2 | Proximal Behavioral Coding and Skill-Specific Measures

Increasingly, SAR researchers have also emphasized proximal behavioral measures that directly capture interaction quality, such as the frequency of eye contact, verbal initiations, or time spent in joint attention. For instance, Huijnen et al.'s Kaspar mediation study (Huijnen et al. 2021) employed detailed, human-coded micro-behavioral analysis to quantify non-verbal imitation, physical contact, attention span, and distraction during robot- versus teacher-led sessions. This fine-grained approach revealed longer attention spans and lower distraction rates in robot-mediated sessions. While such measures are not themselves standardized clinical assessments, they parallel outcome metrics commonly used in ABA and other behavioral intervention frameworks, and they provide a more transparent link between robot behavior and observable child responses.

4.2.3 | Engagement as an Outcome and Mediator

Engagement has likewise emerged as a central outcome variable in SAR research. Early work often treated engagement qualitatively or implicitly; more recent studies have increasingly operationalized it through formal behavioral indicators, such as interaction frequency, response latency, or sustained attention across sessions. For example, Jain et al. (2020) analyzed engagement trajectories across more than 20 sessions and developed predictive models to identify when a child was beginning to disengage. This progression reflects a broader maturation in the field, as engagement has shifted from a loosely defined experiential construct to a measurable and analyzable component of intervention design. At the same time, researchers increasingly acknowledge that engagement functions both as an outcome and as a mediator of learning, motivating the use of engagement measures alongside direct assessments of skill acquisition and generalization.[8] As a result, many interventions now explicitly target the maintenance of social engagement, such as through proxy measures of eye contact, turn-taking, and shared attention, as key therapeutic goals alongside traditional skill acquisition.

Despite this progress, operationalizing engagement remains a complex and ongoing challenge. Much like basic emotions of anxiety or frustration, engagement can manifest in highly individualized ways and may not always be easily inferred from surface-level behaviors. A nervous child may show a furrowed brow or a forced smile, and a disengaged child may appear still and compliant. For children with ASD, who may avoid eye contact or exhibit atypical gaze patterns, engagement might instead be expressed through body orientation, consistent verbal participation, or physical proximity to the robot. These variations highlight the limitations of relying on surface-level behaviors as proxies for internal states. Consequently, the selection of outcome variables that best reflect true engagement remains an active topic of methodological debate in SAR research, with no single metric universally accepted as sufficient. This stands in contrast to clinician observation, where the atypicality or nature of an atypical response can often be decoded through a subjective but holistic synthesis of cues.

4.2.4 | Retention and Generalization of Skills and Strategies

Retention and generalization have become increasingly prominent outcome measures for SAR impact, addressing concerns raised in early reviews about whether robot-mediated gains persist and extend beyond the interaction itself. Here, we distinguish between *skills*, which may become increasingly fluent or automatic through practice, and *strategies*, which are deliberate, goal-oriented behaviors used to achieve a particular outcome. Vocabulary acquisition, for example, may be treated as a learned skill, whereas joint attention and engagement are better understood as social strategies that must be applied flexibly across people and settings.

Earlier, it was unclear whether a child who practiced greeting a robot would later greet a person, or whether gains observed during the intervention would persist once the robot was removed. More recent studies have begun to address this through follow-up assessments and human-generalization probes. For example, Scassellati et al. (2018) evaluated children's joint attention with a clinician outside the robot context. Assessments were conducted before, during, and after a month-long robot intervention. Following the intervention, children demonstrated improved joint attention with adults, while caregivers reported fewer prompts and more spontaneous communication at home. These findings provided early evidence that social strategies practiced during robot-assisted interactions could generalize to new social partners and everyday contexts.

Retention is another critical outcome increasingly addressed in recent studies, often through follow-up assessments conducted weeks or months after the intervention. These assessments indicate whether users retain acquired skills or continue applying strategies introduced during the intervention. For example, Clabaugh et al. reported long-term retention of intervention content by the children, likely owing to the adaptive nature of the teaching (Clabaugh et al. 2019). Similarly, Trombly et al. (2022) used an emotionally adaptive robot to teach vocabulary to children with ASD and found that the children retained the target words more effectively than a control group. For deliberate social strategies, however, retention alone is not sufficient; repeated practice across diverse people, settings, and situations is necessary for flexible generalization beyond the SAR context.

5 | Discussion

Over the past two decades, robots have emerged as promising tools for supporting individuals with ASD, often eliciting engagement and novel social behaviors that may be difficult to achieve in traditional therapeutic settings. In revisiting the field after the two agenda-setting reviews published in 2012, we find a field that has grown substantially but has only partially resolved the central challenges those reviews identified. SAR research has moved beyond early proof-of-concept demonstrations toward more structured interventions, more autonomous systems, and, in some cases, longer-term deployments in homes, schools, and other real-world contexts. At the same time, many studies remain short, samples are often small, and evidence for retention, generalization, and clinically meaningful change is still limited.

One reason the literature remains difficult to interpret is that robots appear to support autism therapy through several overlapping mechanisms rather than through one clearly defined pathway. Across studies, robots vary widely in appearance, behavior, autonomy, interaction structure, and therapeutic role. Yet positive effects are reported across many of these designs. This suggests that the success of robots for autism therapy may not rely on a single feature, such as embodiment, predictability, novelty, or expressiveness. Instead, robots may be useful because they occupy a distinctive space on a spectrum of sociability: more socially evocative than inanimate toys or screen-based tools, yet often less complex and demanding than human partners. For some users, this middle ground may create a manageable context for practicing social attention, imitation, turn-taking, communication, or emotional expression.

However, engagement with a robot is not itself sufficient evidence of therapeutic benefit. A child may look at a robot, smile during an interaction, or complete a structured game without necessarily developing a behavior or strategy that carries over into everyday life. The central question is therefore not simply whether robots elicit social behavior, but whether those behaviors are retained, generalized, and used meaningfully with other people. For example, a robot that elicits joint attention during a game is most clinically meaningful if that interaction helps the child coordinate attention with caregivers, clinicians, teachers, or peers outside the robot session. Similarly, a robot that supports conversational practice should be evaluated not only by whether the user responds to the robot, but by whether the user can communicate more flexibly in human–human contexts.

This is why the field needs to treat robot-assisted autism therapy as a full intervention pipeline rather than as a collection of isolated robot interactions. As described throughout this review, every stage of SAR research involves design choices: what behavior or strategy the intervention should target, where the interaction should take place, who should be involved, how long and how often sessions should occur, how the robot should look and behave, and how outcomes should be measured. These choices are interdependent. A robot designed for a brief laboratory interaction may be very different from one intended for a month-long home deployment. A robot that models emotional expressions may require different sensing, feedback, and evaluation than a robot that mediates peer interaction. Without clearer alignment between intervention goals, robot capabilities, deployment context, and outcome measures, it remains difficult to determine whether mixed findings reflect differences in the robot, the user population, the intervention structure, or the evaluation design.

Importantly, these evaluation challenges are not unique to autism-focused SAR research. Much of HRI struggles with small samples, short deployments, novelty effects, and limited ecological validity, especially when studies involve real users in real-world settings. These challenges are intensified in ASD research because autism is profoundly heterogeneous and because the outcomes of interest are often subtle, context-dependent, and developmentally variable. A strategy that is meaningful for a verbally fluent child practicing conversation may not be appropriate for a minimally verbal child with different sensory, motor, or communication needs. Similarly, a social behavior that is useful in a clinic may not generalize to a playground, classroom, workplace, or home routine without deliberate opportunities for practice across settings.

The reviewed literature also remains narrow in who it represents. Most studies continue to focus on children, especially those who can follow structured prompts, participate in standardized tasks, and interact with the robot in ways that are easy to measure. Adolescents, adults, minimally verbal individuals, individuals with intellectual disability, and people with more complex sensory or communication profiles remain underrepresented. This limits our understanding of how robot-assisted interventions may need to change across the lifespan and across support needs. Future systems should not assume a single autism profile. They should be flexible enough to accommodate different communication modalities, sensory preferences, cognitive profiles, and goals for participation.

Overall, the field has made meaningful progress since 2012. Robots are no longer only novel stimuli used in brief laboratory demonstrations; they are increasingly being explored as adaptive, embodied systems that can support structured intervention in more naturalistic settings. Yet the field's central translational challenge remains: aligning what robots can do with what users with autism need and with what clinical evidence can meaningfully demonstrate. The next decade of SAR research should move beyond showing that robots can attract attention or elicit engagement. The more important goal is to determine how robot-assisted interventions can support durable, generalizable, and personally meaningful outcomes across the diversity of the autism spectrum.

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Conflicts of Interest

Frederick Shic is or has been a consultant for Definium Therapeutics (formerly MindMed Inc.), Janssen, and Roche Pharmaceutical companies.

Data Availability Statement

The data supporting the findings of this study are provided in the appendices of this article.

Endnotes

[1] For example, to date, Pepper ceased production in 2021, NAO has not had a major hardware revision since 2018, and platforms such as Jibo, Cozmo, and Vector became unsupported within only a few years of release following company closures or discontinued cloud/SDK support.

[2] This excludes studies focused solely on general task-oriented attention.

[3] We retain the term “high-functioning” when referring to participants because it remains widely used in the studies reviewed here, while recognizing that the term is contested and often reductive; where possible, we use alternatives such as “individuals with fewer or greater support needs” (Vivanti 2020).

[4] The Childhood Autism Rating Scale (CARS) is a clinician-rated measure of autism symptom severity, with scores above 37 indicating severe symptomatology. These scores index autism symptoms and should not be conflated with cognitive impairment, which is measured separately through IQ, developmental, or adaptive functioning assessments.

[5] These 20 studies are examined in greater depth in our separate review (Matheus et al. 2025), which situates them within the broader literature on long-term human–robot interaction.

[6] These categories are useful for organizing the literature, but they are not always mutually exclusive. A robot may engage in playful, peer-like exchanges while also guiding an activity or facilitating interaction with another person. For analysis, we assigned each study a single primary role based on the role described in the paper, the robot's behavior, and the interaction it predominantly supported.

[7] A *randomized controlled trial* is a rigorous experimental design in which participants are randomly assigned to either an intervention group (receiving the robot-assisted therapy) or a control group (receiving standard treatment or no intervention). This methodology minimizes selection bias and enables clearer attribution of observed effects to the intervention itself.

[8] While engagement is often considered a prerequisite for learning, it does not guarantee skill acquisition. Consequently, many SAR studies now pair engagement metrics with direct measures of learning outcomes and transfer.

References

Abu-Amara, F., H. Mohammad, and A. Bensefia. 2024. “Robot-Based Therapy for Improving Academic Skills of Children With Autism.” *International Journal of Information Technology* 16, no. 6: 3371–3380.

Ackovska, N., and B. Ilijoski. 2023. "Online Availability of a Robot Therapy for Children With Autism." In *SoutheastCon 2023*, 603–609. IEEE.

Alabdulkareem, A., N. Alhakbani, and A. Al-Nafjan. 2022. "A Systematic Review of Research on Robot-Assisted Therapy for Children With Autism." *Sensors* 22, no. 3: 944.

Albo-Canals, J., M. Heerink, M. Diaz, et al. 2013. "Comparing Two LEGO Robotics-Based Interventions for Social Skills Training With Children With ASD." In *The 22nd IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN)*, 638–643. IEEE.

Ali, S., F. Mehmood, Y. Ayaz, M. J. Khan, H. Sadia, and R. Nawaz. 2020. "Comparing the Effectiveness of Different Reinforcement Stimuli in a Robotic Therapy for Children With ASD." *IEEE Access* 8: 13128–13137.

Ali, S., F. Mehmood, Y. Ayaz, M. Sajid, H. Sadia, and R. Nawaz. 2022. "An Experimental Trial: Multi-Robot Therapy for Categorization of Autism Level Using Hidden Markov Model." *Journal of Educational Computing Research* 60, no. 3: 722–741.

Ali, S., F. Mehmood, D. Dancey, et al. 2019. "An Adaptive Multi-Robot Therapy for Improving Joint Attention and Imitation of ASD Children." *IEEE Access* 7: 81808–81825.

Ali, S., F. Mehmood, M. J. Khan, et al. 2020. "A Preliminary Study on Effectiveness of a Standardized Multi-Robot Therapy for Improvement in Collaborative Multi-Human Interaction of Children With ASD." *IEEE Access* 8: 109466–109474.

Alkhaldi, N., M. Faisal, and A. Mutawa. 2026. "Utilizing Human–Robot Interaction in Autism Therapy to Enhance Children's Social Skills: Literature Review." *ACM Transactions on Human-Robot Interaction* 15, no. 2: 1–29.

Al-Nafjan, A., N. Alhakbani, and A. Alabdulkareem. 2023. "Measuring Engagement in Robot-Assisted Therapy for Autistic Children." *Behavioral Science* 13, no. 8: 618.

Alnajjar, F., M. Cappuccio, A. Renawi, O. Mubin, and C. K. Loo. 2021. "Personalized Robot Interventions for Autistic Children: An Automated Methodology for Attention Assessment." *International Journal of Social Robotics (IJSR)* 13, no. 1: 67–82.

American Psychiatric Association. 2013. *Diagnostic and Statistical Manual of Mental Disorders (DSM-5)*. American Psychiatric Pub.

Amirabdollahian, F., B. Robins, K. Dautenhahn, and Z. Ji. 2011. "Investigating Tactile Event Recognition in Childrobot Interaction for Use in Autism Therapy." In *Annual International Conference of the IEEE Engineering in Medicine and Biology Society*, vol. 2011, 5347–5351. IEEE.

Amirova, A., N. Rakhymbayeva, A. Zhanatkyzy, Z. Telisheva, and A. Sandygulova. 2023. "Effects of Parental Involvement in Robot-Assisted Autism Therapy." *Journal of Autism and Developmental Disorders (JADD)* 53, no. 1: 438–455.

Andreae, H. E., P. M. Andreae, J. Low, and D. Brown. 2014. "A Study of Auti: A Socially Assistive Robotic Toy." In *Proceedings of the 2014 Conference on Interaction Design and Children*, 245–248. ACM.

Annunziata, S., L. Santos, A. Caglio, et al. 2024. "Interactive mirrOring Games wIth sOCial rObot (IOGIOCO): A Pilot Study on the Use of Intransitive Gestures in a Sample of Italian Preschool Children With Autism Spectrum Disorder." *Frontiers in Psychiatry* 15: 1356331.

Anzalone, S. M., E. Tilmont, S. Boucenna, et al. 2014. "How Children With Autism Spectrum Disorder Behave and Explore the 4-Dimensional (Spatial 3D+ Time) Environment During a Joint Attention Induction Task With a Robot." *Research in Autism Spectrum Disorders* 8: 814–826.

Arnold, A., R. J. Semple, I. Beale, and C. M. Fletcher-Flinn. 2000. "Eye Contact in Children's Social Interactions: What Is Normal Behaviour?" *Journal of Intellectual and Developmental Disability* 25, no. 3: 207–216.

Attawibulkul, S., N. Asawalertsak, P. Suwawong, P. Wattanapongsakul, W. Jutharee, and B. Kaewkamnerdpong. 2019. "Using a Daily Routine Game on the Bliss Robot for Supporting Personal-Social Development in Children With Autism and Other Special Needs." In *58th Annual Conference of the Society of Instrument and Control Engineers of Japan (SICE)*, vol. 2019, 695–700. IEEE.

Axelsson, M., M. Racca, D. Weir, and V. Kyrki. 2019. "A Participatory Design Process of a Robotic Tutor of Assistive Sign Language for Children With Autism." In *2019 28th IEEE International Conference on Robot and Human Interactive Communication (RO-MAN)*, 1–8. IEEE.

Aziz, A. A., F. F. M. Moganan, A. Ismail, and A. M. Lokman. 2015. "Autistic Children's Kansei Responses Towards Humanoid-Robot as Teaching Mediator." *Procedia Computer Science* 76: 488–493.

Bandura, A. 1962. "Social Learning Through Imitation."

Bangerter, A., S. Ness, M. G. Aman, et al. 2017. "Autism Behavior Inventory: A Novel Tool for Assessing Core and Associated Symptoms of Autism Spectrum Disorder." *Journal of Child and Adolescent Psychopharmacology* 27, no. 9: 814–822.

Baraka, K., M. Couto, F. S. Melo, A. Paiva, and M. Veloso. 2022. "Sequencing Matters: Investigating Suitable Action Sequences in Robot-Assisted Autism Therapy." *Frontiers in Robotics and AI* 9: 784249.

Baraka, K., F. S. Melo, M. Couto, and M. Veloso. 2020. "Optimal Action Sequence Generation for Assistive Agents in Fixed Horizon Tasks." *Autonomous Agents and Multi-Agent Systems* 34, no. 2: 33.

Barakova, E. I., P. Bajracharya, M. Willemsen, T. Lourens, and B. Huskens. 2015. "Long-Term Lego Therapy With Humanoid Robot for Children With ASD." *Expert Systems* 32, no. 6: 698–709.

Barnes, J. A., C. H. Park, A. Howard, and M. Jeon. 2021. "Child-Robot Interaction in a Musical Dance Game: An Exploratory Comparison Study Between Typically Developing Children and Children With Autism." *International Journal of Human–Computer Interaction* 37, no. 3: 249–266.

Bean, J. L., and I.-M. Eigsti. 2012. "Assessment of Joint Attention in School-Age Children and Adolescents." *Research in Autism Spectrum Disorders* 6, no. 4: 1304–1310.

Bearss, K., S.-J. Kim, and J. Locke. 2022. "Accessible, Equitable, and Personalized Care for Autistic Individuals." *Journal of Clinical Medicine* 11: 5217.

Begum, M., R. W. Serna, D. Kontak, et al. 2015. "Measuring the Efficacy of Robots in Autism Therapy: How Informative Are Standard HRI Metrics?" In *Proceedings of the Tenth Annual ACM/IEEE International Conference on Human-Robot Interaction (HRI)*, 335–342. ACM/IEEE.

Begum, M., R. W. Serna, and H. A. Yanco. 2016. "Are Robots Ready to Deliver Autism Interventions? A Comprehensive Review." *International Journal of Social Robotics* 8: 157–181.

Bekele, E., J. A. Crittendon, A. Swanson, N. Sarkar, and Z. E. Warren. 2014. "Pilot Clinical Application of an Adaptive Robotic System for Young Children With Autism." *Autism* 18, no. 5: 598–608.

Bekele, E., U. Lahiri, J. Davidson, Z. Warren, and N. Sarkar. 2011. "Development of a Novel Robot-Mediated Adaptive Response System for Joint Attention Task for Children With Autism." In *20th IEEE International Conference on Robot and Human Interactive Communication (RO-MAN)*, 276–281. IEEE.

Bharatharaj, J., L. Huang, A. Al-Jumaily, M. R. Elara, and C. Krägeloh. 2017. "Investigating the Effects of Robot-Assisted Therapy Among Children With Autism Spectrum Disorder Using Bio-Markers." In *IOP Conference Series: Materials Science and Engineering*, vol. 234, 12017. IOP Publishing.

Bharatharaj, J., L. Huang, A. Al-Jumaily, R. E. Mohan, and C. Krägeloh. 2017. "Sociopsychological and Physiological Effects of a Robot-Assisted

Therapy for Children With Autism." *International Journal of Advanced Robotic Systems* 14, no. 5: 1729881417736895.

Bharatharaj, J., L. Huang, A. M. Al-Jumaily, C. Krageloh, and M. R. Elara. 2016. "Effects of Adapted Model-Rival Method and Parrot-Inspired Robot in Improving Learning and Social Interaction Among Children With Autism." In *2016 International Conference on Robotics and Automation for Humanitarian Applications (RAHA)*, 1–5. IEEE.

Bharatharaj, J., L. Huang, R. E. Mohan, A. Al-Jumaily, and C. Krägeloh. 2017. "Robot-Assisted Therapy for Learning and Social Interaction of Children With Autism Spectrum Disorder." *Robotics* 6, no. 1: 4.

Bilaver, L. A., and J. Havlicek. 2013. "Foster Children With Autism Spectrum Disorder: Prevalence, Length of Stay, and Placement Patterns." *Journal of Public Child Welfare* 7, no. 5: 496–519.

Billard, A., B. Robins, J. Nadel, and K. Dautenhahn. 2007. "Building Robota, a Mini-Humanoid Robot for the Rehabilitation of Children With Autism." *Assistive Technology* 19, no. 1: 37–49.

Billing, E., T. Belpaeme, H. Cai, et al. 2020. "The DREAM Dataset: Supporting a Data-Driven Study of Autism Spectrum Disorder and Robot Enhanced Therapy." *PLoS One* 15, no. 8: e0236939.

Bird, G., J. Leighton, C. Press, and C. Heyes. 2007. "Intact Automatic Imitation of Human and Robot Actions in Autism Spectrum Disorders." *Proceedings of the Royal Society B: Biological Sciences* 274, no. 1628: 3027–3031.

Boccanfuso, L., and J. M. O'Kane. 2011. "Charlie: An Adaptive Robot Design With Hand and Face Tracking for Use in Autism Therapy." *International Journal of Social Robotics* 3, no. 4: 337–347.

Boccanfuso, L., S. Scarborough, R. K. Abramson, A. V. Hall, H. H. Wright, and J. M. O'Kane. 2017. "A Low-Cost Socially Assistive Robot and Robot-Assisted Intervention for Children With Autism Spectrum Disorder: Field Trials and Lessons Learned." *Autonomous Robots* 41, no. 3: 637–655.

Brienza, M., F. Laus, V. Guglielmi, et al. 2023. "HRI-Based Gaze-Contingent Eye Tracking for Autism Spectrum Disorder Treatment: A Preliminary Study Using a NAO Robot." In *2023 32nd IEEE International Conference on Robot and Human Interactive Communication (RO-MAN)*, 2665–2670. IEEE.

Bugnariu, N., C. Young, K. Rockenbach, et al. 2013. "Human-Robot Interaction as a Tool to Evaluate and Quantify Motor Imitation Behavior in Children With Autism Spectrum Disorders." In *2013 International Conference on Virtual Rehabilitation (ICVR)*, 57–62. IEEE.

Cabibihan, J.-J., H. Javed, M. Ang, and S. M. Aljunied. 2013. "Why Robots? A Survey on the Roles and Benefits of Social Robots in the Therapy of Children With Autism." *International Journal of Social Robotics* 5: 593–618.

Cai, H., Y. Fang, Z. Ju, et al. 2018. "Sensing-Enhanced Therapy System for Assessing Children With Autism Spectrum Disorders: A Feasibility Study." *IEEE Sensors Journal* 19, no. 4: 1508–1518.

Cañete Yaque, R., H. Svarrer Larsen, and M. E. Peralta Alvarez. 2021. "Pepe: An Adaptive Robot That Helps Children With Autism to Plan and Self-Manage Their Day." In *Proceedings of the 11th International Conference on the Internet of Things*, 223–227. ACM.

Cao, H.-L., P. G. Esteban, M. Bartlett, et al. 2019. "Robot-Enhanced Therapy: Development and Validation of Supervised Autonomous Robotic System for Autism Spectrum Disorders Therapy." *IEEE Robotics and Automation Magazine* 26, no. 2: 49–58.

Cao, H.-L., R. E. Simut, N. Krepel, B. Vanderborght, and J. Vanderfaeillie. 2022. "Could NAO Robot Function as Model Demonstrating Joint Attention Skills for Children With Autism Spectrum Disorder? An Exploratory Study." *International Journal of Humanoid Robotics* 19, no. 4: 2240006.

Cao, W., W. Song, X. Li, et al. 2019. "Interaction With Social Robots: Improving Gaze Toward Face but Not Necessarily Joint Attention in Children With Autism Spectrum Disorder." *Frontiers in Psychology* 10: 1503.

Casas-Bocanegra, D., D. Gomez-Vargas, M. J. Pinto-Bernal, et al. 2020. "An Open-Source Social Robot Based on Compliant Soft Robotics for Therapy With Children With ASD." *Actuators* 9, no. 3: 91.

Cervera, E., A. P. del Pobil, and M.-I. Cabezudo. 2019. "Playful Interaction With Humanoid Robots for Social Development in Autistic Children: A Pilot Study." In *2019 28th IEEE International Conference on Robot and Human Interactive Communication (RO-MAN)*, 1–6. IEEE.

Chang, Y.-C., and J. Locke. 2016. "A Systematic Review of Peer-Mediated Interventions for Children With Autism Spectrum Disorder." *Research in Autism Spectrum Disorders* 27: 1–10.

Chen, M., W. Xiao, L. Hu, Y. Ma, Y. Zhang, and G. Tao. 2021. "Cognitive Wearable Robotics for Autism Perception Enhancement." *ACM Transactions on Internet Technology (TOIT)* 21, no. 4: 1–16.

Chevalier, P., D. Ghiglino, F. Floris, T. Priolo, and A. Wykowska. 2022. "Visual and Hearing Sensitivity Affect Robotbased Training for Children Diagnosed With Autism Spectrum Disorder." *Frontiers in Robotics and AI* 8: 748853.

Chevalier, P., J.-C. Martin, B. Isableu, C. Bazile, D.-O. Iacob, and A. Tapus. 2016. "Joint Attention Using Humanrobot Interaction: Impact of Sensory Preferences of Children With Autism." In *25th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN)*, vol. 2016, 849–854. IEEE.

Chevalier, P., G. Raiola, J.-C. Martin, B. Isableu, C. Bazile, and A. Tapus. 2017. "Do Sensory Preferences of Children With Autism Impact an Imitation Task With a Robot?" In *Proceedings of the 2017 ACM/IEEE International Conference on Human-Robot Interaction (HRI)*, 177–186. ACM/IEEE.

Chung, E. Y.-h. 2019. "Robotic Intervention Program for Enhancement of Social Engagement Among Children With Autism Spectrum Disorder." *Journal of Developmental and Physical Disabilities* 31, no. 4: 419–434.

Chung, E. Y.-h. 2021. "Robot-Mediated Social Skill Intervention Programme for Children With Autism Spectrum Disorder: An ABA Time-Series Study." *International Journal of Social Robotics (IJSR)* 13, no. 5: 1095–1107.

Chung, E. Y.-H., K. K.-F. Sin, and D. H.-K. Chow. 2025. "Effectiveness of Robotic Intervention on Improving Social Development and Participation of Children With Autism Spectrum Disorder–a Randomised Controlled Trial." *Journal of Autism and Developmental Disorders* 55, no. 2: 449–456.

Clabaugh, C., K. Mahajan, S. Jain, et al. 2019. "Long-Term Personalization of an In-Home Socially Assistive Robot for Children With Autism Spectrum Disorders." *Frontiers in Robotics and AI* 6: 110.

Coeckelbergh, M., C. Pop, R. Simut, et al. 2016. "A Survey of Expectations About the Role of Robots in Robot-Assisted Therapy for Children With ASD: Ethical Acceptability, Trust, Sociability, Appearance, and Attachment." *Science and Engineering Ethics* 22: 47–65.

Conn, K., C. Liu, N. Sarkar, W. Stone, and Z. Warren. 2008. "Affect-Sensitive Assistive Intervention Technologies for Children With Autism: An Individual-Specific Approach." In *The 17th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN)*, 442–447. IEEE.

Conti, D., S. Di Nuovo, S. Buono, G. Trubia, and A. Di Nuovo. 2015. "Use of Robotics to Stimulate Imitation in Children With Autism Spectrum Disorder: A Pilot Study in a Clinical Setting." In *24th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN)*, vol. 2015, 1–6. IEEE.

Conti, D., G. Trubia, S. Buono, S. Di Nuovo, and A. Di Nuovo. 2019. "Affect Recognition in Autism: A Single Case Study on Integrating a

Humanoid Robot in a Standard Therapy." *QWERTY-Interdisciplinary Journal of Technology, Culture and Education* 14, no. 2: 66–87.

Coşkun, B., P. Uluer, E. Toprak, et al. 2022. "Stress Detection of Children With Autism Using Physiological Signals in Kaspar Robot-Based Intervention Studies." In *9th IEEE RAS/EMBS International Conference for Biomedical Robotics and Biomechatronics (BioRob)*, vol. 2022, 1–7. IEEE.

Costa, S., J. Resende, F. O. Soares, M. J. Ferreira, C. P. Santos, and F. Moreira. 2009. "Applications of Simple Robots to Encourage Social Receptiveness of Adolescents With Autism." In *Annual International Conference of the IEEE Engineering in Medicine and Biology Society*, vol. 2009, 5072–5075. IEEE.

Costa, S., C. Santos, F. Soares, M. Ferreira, and F. Moreira. 2010. "Promoting Interaction Amongst Autistic Adolescents Using Robots." In *Annual International Conference of the IEEE Engineering in Medicine and Biology*, vol. 2010, 3856–3859. IEEE.

Costescu, C. A., B. Vanderborght, and D. O. David. 2016. "Beliefs, Emotions, and Behaviors: Differences Between Children With ASD and Typically Developing Children. A Robot-Enhanced Task." *Journal of Evidence-Based Psychotherapies* 16, no. 2: 221–237.

Costescu, C. A., B. Vanderborght, and D. O. David. 2017. "Robot-Enhanced CBT for Dysfunctional Emotions in Social Situations for Children With ASD." *Journal of Evidence-Based Psychotherapies* 17, no. 2: 119–132.

da Luz Schreider, S., J. C. de Souza, É. V. da Silva Freitas, J. A. C. Panceri, E. M. de Oliveira Caldeira, and T. F. Bastos-Filho. 2024. "Psychomotor Intervention Through Serious Games in Children and Adolescents With Autism Spectrum Disorder Using a Therapeutic Robot." *Research on Biomedical Engineering* 40, no. 3: 485–497.

Dautenhahn, K., C. L. Nehaniv, M. L. Walters, et al. 2009. "KASPAR– A Minimally Expressive Humanoid Robot for Human–Robot Interaction Research." *Applied Bionics and Biomechanics* 6, no. 3–4: 369–397.

Dautenhahn, K., and I. Werry. 2002. "A Quantitative Technique for Analysing Robot-Human Interactions." In *IEEE/RSJ International Conference on Intelligent Robots and Systems*, vol. 2, 1132–1138. IEEE.

David, D. O., C. A. Costescu, S. Matu, A. Szentagotai, and A. Dobrean. 2018. "Developing Joint Attention for Children With Autism in Robot-Enhanced Therapy." *International Journal of Social Robotics (IJSR)* 10, no. 5: 595–605.

David, D., C. A. Costescu, and S. Matu. 2020. "Effects of a Robot-Enhanced Intervention for Children With ASD on Teaching Turn-Taking Skills." *Journal of Educational Computing Research* 58, no. 1: 29–62.

Dawson, G., S. Rogers, J. Munson, et al. 2010. "Early Behavioral Intervention Is Associated With Normalized Brain Activity in Young Children With Autism." *Journal of the American Academy of Child and Adolescent Psychiatry* 49, no. 11: 1150–1158.

De Korte, M. W., I. van den Berk-Smeekens, M. van Dongen-Boomsma, et al. 2020. "Self-Initiations in Young Children With Autism During Pivotal Response Treatment With and Without Robot Assistance." *Autism* 24, no. 8: 2117–2128.

De Silva, P. R. S., K. Tadano, A. Saito, S. G. Lambacher, and M. Higashi. 2009. "The Development of an Assistive Robot for Improving the Joint Attention of Autistic Children." In *2009 IEEE International Conference on Rehabilitation Robotics*, 694–700. IEEE.

Dehkordi, P. S., H. Moradi, M. Mahmoudi, and H. R. Pouretemad. 2015. "The Design, Development, and Deployment of RoboParrot for Screening Autistic Children." *International Journal of Social Robotics (IJSR)* 7, no. 4: 513–522.

Desideri, L., M. Negrini, M. C. Cutrone, et al. 2017. "Exploring the Use of a Humanoid Robot to Engage Children With Autism Spectrum Disorder (ASD)." In *Association for the Advancements of Assistive Technology (AAATE) Conference*, 501–509. IOS Press.

Desideri, L., M. Negrini, M. Malavasi, et al. 2018. "Using a Humanoid Robot as a Complement to Interventions for Children With Autism Spectrum Disorder: A Pilot Study." *Advances in Neurodevelopmental Disorders* 2, no. 3: 273–285.

Di Nuovo, A., D. Conti, G. Trubia, S. Buono, and S. Di Nuovo. 2018. "Deep Learning Systems for Estimating Visual Attention in Robot-Assisted Therapy of Children With Autism and Intellectual Disability." *Robotics* 7, no. 2: 25.

Dickstein-Fischer, L. A., D. E. Crone-Todd, I. M. Chapman, A. T. Fathima, and G. S. Fischer. 2018. "Socially Assistive Robots: Current Status and Future Prospects for Autism Interventions." *Innovation and Entrepreneurship in Health* 5: 15–25.

Diehl, J. J., L. M. Schmitt, M. Villano, and C. R. Crowell. 2012. "The Clinical Use of Robots for Individuals With Autism Spectrum Disorders: A Critical Review." *Research in Autism Spectrum Disorders* 6, no. 1: 249–262.

Dimitrova, M., N. Vegt, and E. Barakova. 2012. "Designing a System of Interactive Robots for Training Collaborative Skills to Autistic Children." In *2012 15th International Conference on Interactive Collaborative Learning (ICL)*, 1–8. IEEE.

DiSalvo, C. A., and D. P. Oswald. 2002. "Peer-Mediated Interventions to Increase the Social Interaction of Children With Autism: Consideration of Peer Expectancies." *Focus on Autism and Other Developmental Disabilities* 17, no. 4: 198–207.

Does, R. I., V. Nivedita, S. V. S. Reddy, D. L. F. Jana, M. Sudha, and R. R. Manjul. 2023. "Robot-Assisted Cognitive Training for Children With Autism Insights and Outcomes." In *2023 7th International Conference on Electronics, Communication and Aerospace Technology (ICECA)*, 139–144. IEEE.

Duquette, A., F. Michaud, and H. Mercier. 2008. "Exploring the Use of a Mobile Robot as an Imitation Agent With Children With Low-Functioning Autism." *Autonomous Robots* 24, no. 2: 147–157.

Ercolano, G., S. Rossi, D. Conti, and A. Di Nuovo. 2024. "Gesture Recognition With a 2d Low-Resolution Embedded Camera to Minimise Intrusion in Robot-Led Training of Children With Autism Spectrum Disorder." *Applied Intelligence* 54, no. 8: 6579–6591.

Erel, H., M. Vázquez, S. Sebo, N. Salomons, S. Gillet, and B. Scassellati. 2024. "RoSI: A Model for Predicting Robot Social Influence." *ACM Transactions on Human-Robot Interaction* 13, no. 2: 1–22.

Esteban, P. G., P. Baxter, T. Belpaeme, et al. 2017. "How to Build a Supervised Autonomous System for Robot-Enhanced Therapy for Children With Autism Spectrum Disorder." *Paladyn, Journal of Behavioral Robotics* 8, no. 1: 18–38.

Esubalew, T., U. Lahiri, A. R. Swanson, et al. 2012. "A Step Towards Developing Adaptive Robot-Mediated Intervention Architecture (ARIA) for Children With Autism." *IEEE Transactions on Neural Systems and Rehabilitation Engineering* 21, no. 2: 289–299.

Fachantidis, N., C. K. Syriopoulou-Delli, I. Vezyrtzis, and M. Zygopoulou. 2020. "Beneficial Effects of Robot-Mediated Class Activities on a Child With ASD and His Typical Classmates." *International Journal of Developmental Disabilities* 66, no. 3: 245–253.

Fachantidis, N., C. K. Syriopoulou-Delli, and M. Zygopoulou. 2020. "The Effectiveness of Socially Assistive Robotics in Children With Autism Spectrum Disorder." *International Journal of Developmental Disabilities* 66, no. 2: 113–121.

Febtriko, A., T. Rahayuningsih, D. Septiani, et al. 2018. "Effectiveness of Android-Based Mobile Robots for Children Asperger Syndrome." In *2018 International Conference on Applied Information Technology and Innovation (ICAITI)*, 208–212. IEEE.

Feil-Seifer, D., and M. Mataric. 2011. "Automated Detection and Classification of Positive vs. Negative Robot Interactions With Children With Autism Using Distance-Based Features." In *Proceedings of the 6th*

International Conference on Human-Robot Interaction (HRI)*, 323–330. ACM/IEEE.

Feil-Seifer, D., and M. J. Mataric. 2008. "B 3 ia: A Control Architecture for Autonomous Robot-Assisted Behavior Intervention for Children With Autism Spectrum Disorders." In *The 17th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN)*, 328–333. IEEE.

Feil-Seifer, D., and M. J. Matarić. 2009. "Toward Socially Assistive Robotics for Augmenting Interventions for Children With Autism Spectrum Disorders." In *Experimental Robotics: The Eleventh International Symposium*, 201–210. Springer.

Feil-Seifer, D., and M. J. Matarić. 2012. "Distance-Based Computational Models for Facilitating Robot Interaction With Children." *Journal of Human-Robot Interaction* 1, no. 1: 55–77.

Feng, H., M. H. Mahoor, and F. Dino. 2022. "A Music-Therapy Robotic Platform for Children With Autism: A Pilot Study." *Frontiers in Robotics and AI* 9: 855819.

Feng, Y., Q. Jia, M. Chu, and W. Wei. 2017. "Engagement Evaluation for Autism Intervention by Robots Based on Dynamic Bayesian Network and Expert Elicitation." *IEEE Access* 5: 19494–19504.

Fernaeus, Y., M. Håkansson, M. Jacobsson, and S. Ljungblad. 2010. "How Do You Play With a Robotic Toy Animal? A Long-Term Study of Pleo." In *Proceedings of the 9th International Conference on Interaction Design and Children*, 39–48. ACM.

Fournier, C., C. Michelon, V. Granit, et al. 2024. "Pilot Study Protocol Evaluating the Impact of Telerobotics Interactions With Autistic Children During a Denver Intervention on Communication Skills Using Single-Case Experimental Design." *BMJ Open* 14, no. 11: e084110.

Foxx, R. M. 2008. "Applied Behavior Analysis Treatment of Autism: The State of the Art." *Child and Adolescent Psychiatric Clinics of North America* 17, no. 4: 821–834.

François, D., S. Powell, and K. Dautenhahn. 2009. "A Long-Term Study of Children With Autism Playing With a Robotic Pet: Taking Inspirations From Non-Directive Play Therapy to Encourage Children's Proactivity and Initiativetaking." *Interaction Studies* 10, no. 3: 324–373.

Frenkel, J., S. Kirst, S. Naumann, et al. 2025. "Stakeholder Acceptance of a Robot-Assisted Social Training Scenario for Autistic Children Compared to a Tablet-Computer-Based Approach." *Scientific Reports* 15, no. 1: 11237.

Fuentes-Alvarez, R., A. Morfin-Santana, K. Ibañez, I. Chairez, and S. Salazar. 2023. "Energetic Optimization of an Autonomous Mobile Socially Assistive Robot for Autism Spectrum Disorder." *Frontiers in Robotics and AI* 9: 1053115.

Gaitán-Padilla, M., C. A. Cifuentes, and M. Múnera. 2022. "Three Study Cases of Social Robotics in Autism Spectrum Disorder Treatment: Personalization and Usability of Castor Robot." In *2022 International Conference on Rehabilitation Robotics (ICORR)*, 1–6. IEEE.

Galán-Mena, J., G. Ávila, J. Pauta-Pintado, D. Lima-Juma, V. Robles-Bykbaev, and D. Quisi-Peralta. 2016. "An Intelligent System Based on Ontologies and ICT Tools to Support the Diagnosis and Intervention of Children With Autism." In *IEEE Biennial Congress of Argentina (ARGENCON)*, vol. 2016, 1–5. IEEE.

Ghiglino, D., P. Chevalier, F. Floris, T. Priolo, and A. Wykowska. 2021. "Follow the White Robot: Efficacy of Robotassistive Training for Children With Autism Spectrum Disorder." *Research in Autism Spectrum Disorders* 86: 101822.

Ghorbandaei Pour, A., A. Taheri, M. Alemi, and A. Meghdari. 2018. "Human–Robot Facial Expression Reciprocal Interaction Platform: Case Studies on Children With Autism." *International Journal of Social Robotics (IJSR)* 10, no. 2: 179–198.

Giannopulu, I. 2013. "Multimodal Cognitive Nonverbal and Verbal Interactions: The Neurorehabilitation of Autistic Children via Mobile Toy Robots." *IARIA International Journal of Advances in Life Sciences* 5, no. 10: 1109.

Giannopulu, I., and G. Pradel. 2010. "Multimodal Interactions in Free Game Play of Children With Autism and a Mobile Toy Robot." *NeuroRehabilitation* 27, no. 4: 305–311.

Giannopulu, I., and G. Pradel. 2012. "From Child-Robot Interaction to Child-Robot-Therapist Interaction: A Case Study in Autism." *Applied Bionics and Biomechanics* 9, no. 2: 173–179.

Greczek, J., E. Kaszubski, A. Atrash, and M. Matarić. 2014. "Graded Cueing Feedback in Robot-Mediated Imitation Practice for Children With Autism Spectrum Disorders." In *The 23rd IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN)*, 561–566. IEEE.

Hirokawa, M., A. Funahashi, Y. Pan, Y. Itoh, and K. Suzuki. 2016. "Design of a Robotic Agent That Measures Smile and Facing Behavior of Children With Autism Spectrum Disorder." In *25th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN)*, vol. 2016, 843–848. IEEE.

Holeva, V., V. Nikopoulou, C. Lytridis, et al. 2024. "Effectiveness of a Robot-Assisted Psychological Intervention for Children With Autism Spectrum Disorder." *Journal of Autism and Developmental Disorders (JADD)* 54, no. 2: 577–593.

Huang, C.-M., and B. Mutlu. 2016. "Anticipatory Robot Control for Efficient Human-Robot Collaboration." In *2016 11th ACM/IEEE International Conference on Human-Robot Interaction (HRI)*, 83–90. IEEE.

Huijnen, C. A., H. A. Verreussel-Willen, M. A. Lexis, and L. P. de Witte. 2021. "Robot KASPAR as Mediator in Making Contact With Children With Autism: A Pilot Study." *International Journal of Social Robotics (IJSR)* 13, no. 2: 237–249.

Huskens, B., A. Palmen, M. Van der Werff, T. Lourens, and E. Barakova. 2015. "Improving Collaborative Play Between Children With Autism Spectrum Disorders and Their Siblings: The Effectiveness of a Robot-Mediated Intervention Based on Lego Therapy." *Journal of Autism and Developmental Disorders* 45, no. 11: 3746–3755.

Huskens, B., R. Verschuur, J. Gillesen, R. Didden, and E. Barakova. 2013. "Promoting Question-Asking in School-Aged Children With Autism Spectrum Disorders: Effectiveness of a Robot Intervention Compared to a Human-Trainer Intervention." *Developmental Neurorehabilitation* 16, no. 5: 345–356.

Hustyi, K. M., A. H. Ryan, and S. S. Hall. 2023. "A Scoping Review of Behavioral Interventions for Promoting Social Gaze in Individuals With Autism Spectrum Disorder and Other Developmental Disabilities." *Research in Autism Spectrum Disorders* 100: 102074.

Ilijoski, B., N. Ackovska, T. Zorcec, and Z. Popeska. 2022. "Extending Robot Therapy for Children With Autism Using Mobile and Web Application." *Sensors* 22, no. 16: 5965.

Ishak, N. I., H. M. Yusof, M. R. H. Ramlee, S. Na'im Sidek, and N. Rusli. 2019. "Modules of Interaction for ASD Children Using RERO Robot (Humanoid)." In *2019 7th International Conference on Mechatronics Engineering (ICOM)*, 1–6. IEEE.

Ismail, L. I., S. Shamsudin, H. Yussof, F. A. Hanapiah, and N. I. Zahari. 2012a. "Estimation of Concentration by Eye Contact Measurement in Robot–Based Intervention Program With Autistic Children." *Procedia Engineering* 41: 1548–1552.

Ismail, L. I., T. Verhoeven, J. Dambre, and F. Wyffels. 2019. "Leveraging Robotics Research for Children With Autism: A Review." *International Journal of Social Robotics* 11: 389–410.

Ismail, L. I., S. Shamsudin, H. Yussof, F. A. Hanapiah, and N. I. Zahari. 2012b. "Robot-Based Intervention Program for Autistic Children With

Humanoid Robot NAO: Initial Response in Stereotyped Behavior." *Procedia Engineering* 41: 1441–1447.

Ivani, A. S., A. Giubergia, L. Santos, et al. 2022. "A Gesture Recognition Algorithm in a Robot Therapy for ASD Children." *Biomedical Signal Processing and Control* 74: 103512.

Jain, S., B. Thiagarajan, Z. Shi, C. Clabaugh, and M. J. Matarić. 2020. "Modeling Engagement in Long-Term, In-Home Socially Assistive Robot Interventions for Children With Autism Spectrum Disorders." *Science Robotics* 5, no. 39: eaaz3791.

Javed, H., M. Jeon, and C. H. Park. 2018. "Adaptive Framework for Emotional Engagement in Child-Robot Interactions for Autism Interventions." In *2018 15th International Conference on Ubiquitous Robots (UR)*, 396–400. IEEE.

Javed, H., W. Lee, and C. H. Park. 2020. "Toward an Automated Measure of Social Engagement for Children With Autism Spectrum Disorder—A Personalized Computational Modeling Approach." *Frontiers in Robotics and AI* 7: 43.

Javed, H., and C. H. Park. 2019. "Interactions With an Empathetic Agent: Regulating Emotions and Improving Engagement in Autism." *IEEE Robotics and Automation Magazine* 26, no. 2: 40–48.

Jordan, K., M. King, S. Hellersteth, A. Wirén, and H. Mulligan. 2013. "Feasibility of Using a Humanoid Robot for Enhancing Attention and Social Skills in Adolescents With Autism Spectrum Disorder." *International Journal of Rehabilitation Research* 36, no. 3: 221–227.

Kaboski, J. R., J. J. Diehl, J. Beriont, et al. 2015. "Brief Report: A Pilot Summer Robotics Camp to Reduce Social Anxiety and Improve Social/Vocational Skills in Adolescents With ASD." *Journal of Autism and Developmental Disorders (JADD)* 45, no. 12: 3862–3869.

Kanda, T., T. Hirano, D. Eaton, and H. Ishiguro. 2004. "Interactive Robots as Social Partners and Peer Tutors for Children: A Field Trial." *Human-Computer Interaction* 19, no. 1–2: 61–84.

Kanne, S. M., M. O. Mazurek, D. Sikora, et al. 2014. "The Autism Impact Measure (AIM): Initial Development of a New Tool for Treatment Outcome Measurement." *Journal of Autism and Developmental Disorders* 44, no. 1: 168–179.

Karakosta, E., K. Dautenhahn, D. S. Syrdal, L. J. Wood, and B. Robins. 2019. "Using the Humanoid Robot Kaspar in a Greek School Environment to Support Children With Autism Spectrum Condition." *Paladyn, Journal of Behavioral Robotics* 10, no. 1: 298–317.

Karim, M., M. S. Mia, S. M. Tareeq, and M. Hasanuzzaman. 2023. "Evaluate Effectiveness of NAO Robot to Train Children With Autism Spectrum Disorder (ASD)." In *2023 IEEE 5th International Conference on Cognitive Machine Intelligence (CogMI)*, 165–174. IEEE.

Kim, E., R. Paul, F. Shic, and B. Scassellati. 2012. "Bridging the Research Gap: Making HRI Useful to Individuals With Autism." *Journal of Human-Robot Interaction* 1: 26–54.

Kim, E. S., L. D. Berkovits, E. P. Bernier, et al. 2013. "Social Robots as Embedded Reinforcers of Social Behavior in Children With Autism." *Journal of Autism and Developmental Disorders* 43: 1038–1049.

Kim, M.-G., I. Oosterling, T. Lourens, et al. 2014. "Designing Robot-Assisted Pivotal Response Training in Game Activity for Children With Autism." In *2014 IEEE International Conference on Systems, Man, and Cybernetics (SMC)*, 1101–1106. IEEE.

Kim, S., M. Hirokawa, A. Funahashi, and K. Suzuki. 2022. "Parental Influence in Disengagement During Robot-Assisted Activities: A Case Study of a Parent and Child With Autism Spectrum Disorder." *Multimodal Technologies and Interaction* 6, no. 5: 39.

Kim, S., M. Hirokawa, S. Matsuda, A. Funahashi, and K. Suzuki. 2021. "Smiles as a Signal of Prosocial Behaviors Toward the Robot in the Therapeutic Setting for Children With Autism Spectrum Disorder." *Frontiers in Robotics and AI* 8: 599755.

Kim, S., and Y. Iwai. 2024. "Students With Autism Spectrum Disorder and Intellectual Disability Teach a Robot." In *2024 33rd IEEE International Conference on Robot and Human Interactive Communication (RO-MAN)*, 1021–1028. IEEE.

Kim, S. H., R. Grzadzinski, K. Martinez, and C. Lord. 2019. "Measuring Treatment Response in Children With Autism Spectrum Disorder: Applications of the Brief Observation of Social Communication Change to the Autism Diagnostic Observation Schedule." *Autism* 23, no. 5: 1176–1185.

Kim, S. H., and C. Lord. 2018. "Autism Diagnostic Observation Schedule." In *Encyclopedia of Clinical Neuropsychology*, 1–6. Springer.

Koch, S. A., C. E. Stevens, C. D. Clesi, et al. 2017. "A Feasibility Study Evaluating the Emotionally Expressive Robot Sam." *International Journal of Social Robotics (IJSR)* 9, no. 4: 601–613.

Konishi, S., M. Kuwata, Y. Matsumoto, et al. 2024. "Self-Administered Questionnaires Enhance Emotion Estimation of Individuals With Autism Spectrum Disorders in a Robotic Interview Setting." *Frontiers in Psychiatry* 15: 1249000.

Korneder, J., W.-Y. G. Louie, C. M. Pawluk, I. Abbas, M. Brys, and F. Rooney. 2022. "Robot-Mediated Interventions for Teaching Children With ASD: A New Intraverbal Skill." *Assistive Technology* 34, no. 6: 707–716.

Kostrubiec, V., and J. Kruck. 2020. "Collaborative Research Project: Developing and Testing a Robot-Assisted Intervention for Children With Autism." *Frontiers in Robotics and AI* 7: 37.

Kostrubiec, V., C. Lajunta, P.-V. Paubel, and J. Kruck. 2024. "Does the Social Robot Nao Facilitate Cooperation in High Functioning Children With ASD?" *International Journal of Social Robotics* 16, no. 2: 281–298.

Kouroupa, A., K. R. Laws, K. Irvine, S. E. Mengoni, A. Baird, and S. Sharma. 2022. "The Use of Social Robots With Children and Young People on the Autism Spectrum: A Systematic Review and Meta-Analysis." *PLoS One* 17, no. 6: e0269800.

Kozima, H., M. P. Michalowski, and C. Nakagawa. 2009. "Keepon: A Playful Robot for Research, Therapy, and Entertainment." *International Journal of Social Robotics* 1: 3–18.

Kozima, H., C. Nakagawa, and Y. Yasuda. 2005. "Interactive Robots for Communication-Care: A Case-Study in Autism Therapy." In *IEEE International Workshop on Robot and Human Interactive Communication (RO-MAN)*, 341–346. IEEE.

Kozima, H., C. Nakagawa, and Y. Yasuda. 2007. "Children–Robot Interaction: A Pilot Study in Autism Therapy." In *Progress in Brain Research*, vol. 164, 385–400. Elsevier.

Kumazaki, H., T. Muramatsu, Y. Yoshikawa, et al. 2019. "Job Interview Training Targeting Nonverbal Communication Using an Android Robot for Individuals With Autism Spectrum Disorder." *Autism* 23, no. 6: 1586–1595.

Kumazaki, H., T. Muramatsu, Y. Yoshikawa, et al. 2021. "Enhancing Communication Skills of Individuals With Autism Spectrum Disorders While Maintaining Social Distancing Using Two Tele-Operated Robots." *Frontiers in Psychiatry* 11: 598688.

Kumazaki, H., T. Muramatsu, Y. Yoshikawa, et al. 2020. "Optimal Robot for Intervention for Individuals With Autism Spectrum Disorders." *Psychiatry and Clinical Neurosciences* 74, no. 11: 581–586.

Kumazaki, H., T. Muramatsu, Y. Yoshikawa, et al. 2022. "Differences in the Optimal Motion of Android Robots for the Ease of Communications Among Individuals With Autism Spectrum Disorders." *Frontiers in Psychiatry* 13: 883371.

Kumazaki, H., T. Muramatsu, Y. Yoshikawa, et al. 2019. "How the Realism of Robot Is Needed for Individuals With Autism Spectrum Disorders in an Interview Setting." *Frontiers in Psychiatry* 10: 486.

Kumazaki, H., T. Muramatsu, Y. Yoshikawa, et al. 2019. "Brief Report: A Novel System to Evaluate Autism Spectrum Disorders Using Two Humanoid Robots." *Journal of Autism and Developmental Disorders* 49, no. 4: 1709–1716.

Kumazaki, H., Z. Warren, B. A. Corbett, et al. 2017. "Android Robot-Mediated Mock Job Interview Sessions for Young Adults With Autism Spectrum Disorder: A Pilot Study." *Frontiers in Psychiatry* 8: 169.

Kumazaki, H., Z. Warren, T. Muramatsu, et al. 2017. "A Pilot Study for Robot Appearance Preferences Among High-Functioning Individuals With Autism Spectrum Disorder: Implications for Therapeutic Use." *PLoS One* 12, no. 10: e0186581.

Kumazaki, H., Z. Warren, A. Swanson, et al. 2019. "Brief Report: Evaluating the Utility of Varied Technological Agents to Elicit Social Attention From Children With Autism Spectrum Disorders." *Journal of Autism and Developmental Disorders (JADD)* 49, no. 4: 1700–1708.

Kumazaki, H., Y. Yoshikawa, Y. Yoshimura, et al. 2018. "The Impact of Robotic Intervention on Joint Attention in Children With Autism Spectrum Disorders." *Molecular Autism* 9, no. 1: 46.

Kwon, J. Y., B. H. Lee, K.-H. Mun, and J. S. Jung. 2015. "A Study on the Effects of Using an Eco-Friendly Cat Robot to Treat Children With Autism Spectrum Disorder." *Indian Journal of Science and Technology* 8, no. 23: 1.

Lakatos, G., L. J. Wood, D. S. Syrdal, B. Robins, A. Zaraki, and K. Dautenhahn. 2020. "Robot-Mediated Intervention Can Assist Children With Autism to Develop Visual Perspective Taking Skills." *Paladyn, Journal of Behavioral Robotics* 12, no. 1: 87–101.

Landa, R. J. 2018. "Efficacy of Early Interventions for Infants and Young Children With, and at Risk for, Autism Spectrum Disorders." *International Review of Psychiatry* 30, no. 1: 25–39.

LeBlanc, J. J., and M. Fagiolini. 2011. "Autism: a 'critical period' disorder?" *Neural Plasticity* 2011, no. 1: 921680.

Lecciso, F., A. Levante, R. A. Fabio, et al. 2021. "Emotional Expression in Children With ASD: A Pre-Study on a Two-Group Pre-Post-Test Design Comparing Robot-Based and Computer-Based Training." *Frontiers in Psychology* 12: 678052.

Lee, J., and T. Nagae. 2021. "Social Distance in Interactions Between Children With Autism and Robots." *Applied Sciences* 11, no. 22: 10520.

Lee, J., and G. Obinata. 2013. "Developing Therapeutic Robot for Children With Autism: A Study on Exploring Colour Feedback." In *2013 8th ACM/IEEE International Conference on Human-Robot Interaction (HRI)*, 173–174. IEEE.

Lee, J., G. Obinata, and H. Aoki. 2014. "A Pilot Study of Using Touch Sensing and Robotic Feedback for Children With Autism." In *Proceedings of the 2014 ACM/IEEE International Conference on Human-Robot Interaction (HRI)*, 222–223. ACM/IEEE.

Lee, J., G. Obinata, D. Stefanov, and C. Nagai. 2013. "A Preliminary Study on the Response of Autistic Persons to a Robot Feedback Based on Visual Stimuli." *Paladyn, Journal of Behavioral Robotics* 4, no. 2: 73–82.

Lee, J., H. Takehashi, C. Nagai, and G. Obinata. 2012. "Design of a Therapeutic Robot for Interacting With Autistic Children Through Interpersonal Touch." In *The 21st IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN)*, 712–717. IEEE.

Lee, J., H. Takehashi, C. Nagai, G. Obinata, and D. Stefanov. 2012. "Which Robot Features Can Stimulate Better Responses From Children With Autism in Robot-Assisted Therapy?" *International Journal of Advanced Robotic Systems* 9, no. 3: 72.

Lemaignan, S., N. Newbutt, L. Rice, and J. Daly. 2024. "'It's Important to Think of Pepper as a Teaching Aid or Resource External to the Classroom': A Social Robot in a School for Autistic Children." *International Journal of Social Robotics* 16, no. 6: 1083–1104.

Lin, J., J. Li, Y. She, et al. 2022. "Using a Social Robot for Children With Autism: A Therapist-Robot Interactive Model." *Computer Animation and Virtual Worlds* 33, no. 5: e2109.

Liu, C., K. Conn, N. Sarkar, and W. Stone. 2007. "Affect Recognition in Robot Assisted Rehabilitation of Children With Autism Spectrum Disorder." In *Proceedings 2007 IEEE International Conference on Robotics and Automation*, 1755–1760. IEEE.

Liu, C., K. Conn, N. Sarkar, and W. Stone. 2008. "Online Affect Detection and Robot Behavior Adaptation for Intervention of Children With Autism." *IEEE Transactions on Robotics* 24, no. 4: 883–896.

Liu, X., X. Zhou, C. Liu, et al. 2016. "An Interactive Training System of Motor Learning by Imitation and Speech Instructions for Children With Autism." In *2016 9th International Conference on Human System Interactions (HSI)*, 56–61. IEEE.

Locke, J., A. Olsen, R. Wideman, et al. 2015. "A Tangled Web: The Challenges of Implementing an Evidence-Based Social Engagement Intervention for Children With Autism in Urban Public School Settings." *Behavior Therapy* 46, no. 1: 54–67.

Lorenzo, G., and A. Lorenzo-Lledó. 2024. "The Use of Artificial Intelligence for Detecting the Duration of Autistic Students' Emotions in Social Interaction With the NAO Robot: A Case Study." *International Journal of Information Technology* 16, no. 2: 625–631.

Louie, W.-Y. G., J. Korneder, I. Abbas, and C. Pawluk. 2020. "A Study on an Applied Behavior Analysis-Based Robotmediated Listening Comprehension Intervention for ASD." *Paladyn, Journal of Behavioral Robotics* 12, no. 1: 31–46.

Lovaas, O. I. 1987. "Behavioral Treatment and Normal Educational and Intellectual Functioning in Young Autistic Children." *Journal of Consulting and Clinical Psychology* 55, no. 1: 3–9.

Lund, H. H., M. Dam Pedersen, and R. Beck. 2009. "Modular Robotic Tiles: Experiments for Children With Autism." *Artificial Life and Robotics* 13, no. 2: 394–400.

LuxAI. n.d. "QTrobot for At-Home Autism Support." Accessed August 4, 2025. https://luxai.com/robot-for-teaching-children-with-autism-at-home/.

Lytridis, C., V. G. Kaburlasos, C. Bazinas, et al. 2022. "Behavioral Data Analysis of Robot-Assisted Autism Spectrum Disorder (ASD) Interventions Based on Lattice Computing Techniques." *Sensors* 22, no. 2: 621.

Malik, N. A., S. Shamsuddin, H. Yussof, M. A. Miskam, and A. C. Hamid. 2013. "Feasibility of Using a Humanoid Robot to Elicit Communicational Response in Children With Mild Autism." In *IOP Conference Series: Materials Science and Engineering*, vol. 53, 12077. IOP Publishing.

Manner, M. D. 2015. "Using Small Humanoid Robots to Detect Autism in Toddlers." In *International Joint Conference on Artificial Intelligence (IJCAI)*, 4383–4384. AAAI Press.

Marathaki, K., M. Feidakis, C. Patrikakis, and E. Agrianiti. 2022. "Deploy Social Assistive Robot to Develop Symbolic Play and Imitation Skills in Students With Autism Spectrum Disorder." In *IEEE Global Engineering Education Conference (EDUCON)*, vol. 2022, 547–552. IEEE.

Marín, O. 2016. "Developmental Timing and Critical Windows for the Treatment of Psychiatric Disorders." *Nature Medicine* 22, no. 11: 1229–1238.

Marino, F., P. Chilà, S. T. Sfrazzetto, et al. 2020. "Outcomes of a Robot-Assisted Social-Emotional Understanding Intervention for Young Children With Autism Spectrum Disorders." *Journal of Autism and Developmental Disorders* 50, no. 6: 1973–1987.

Martínez, N., V. López, J. Albo-Canals, O. Sans, and L. Toppin. 2022. "Implementation of a Robotic Assistant to Develop and Monitor Learning Activities in Children With Autism." In *8th International*

Engineering, Sciences and Technology Conference (IESTEC), vol. 2022, 678–683. IEEE.

Matheus, K., R. Ramnauth, B. Scassellati, and N. Salomons. 2025. "Long-Term Interactions With Social Robots: Trends, Insights, and Recommendations." *ACM Transactions on Human-Robot Interaction* 14, no. 3: 1–42.

Mavadati, S. M., H. Feng, A. Gutierrez, and M. H. Mahoor. 2014. "Comparing the Gaze Responses of Children With Autism and Typically Developed Individuals in Human-Robot Interaction." In *2014 IEEE-RAS International Conference on Humanoid Robots*, 1128–1133. IEEE.

Mavadati, S. M., H. Feng, M. Salvador, S. Silver, A. Gutierrez, and M. H. Mahoor. 2016. "Robot-Based Therapeutic Protocol for Training Children With Autism." In *25th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN)*, vol. 2016, 855–860. IEEE.

Mayadunne, M., U. A. Manawadu, K. R. Abeyratne, and P. R. S. De Silva. 2020. "A Robotic Companion for Children Diagnosed With Autism Spectrum Disorder." In *2020 International Conference on Image Processing and Robotics (ICIP)*, 1–6. IEEE.

Mazzei, D., L. Billeci, A. Armato, et al. 2010. "The Face of Autism." In *19th International Symposium in Robot and Human Interactive Communication*, 791–796. IEEE.

Mazzei, D., A. Greco, N. Lazzeri, et al. 2012. "Robotic Social Therapy on Children With Autism: Preliminary Evaluation Through Multi-Parametric Analysis." In *2012 International Conference on Privacy, Security, Risk and Trust and 2012 International Confernece on Social Computing*, 766–771. IEEE.

Mazzei, D., N. Lazzeri, L. Billeci, et al. 2011. "Development and Evaluation of a Social Robot Platform for Therapy in Autism." In *2011 Annual International Conference of the IEEE Engineering in Medicine and Biology Society*, 4515–4518. IEEE.

Mehmood, F., H. Mahzoon, Y. Yoshikawa, et al. 2021. "Attentional Behavior of Children With ASD in Response to Robotic Agents." *IEEE Access* 9: 31946–31955.

Mehralizadeh, B., P. Soleiman, S. Nikkhoo, et al. 2023. "Multi-Modal ASD Screening System: A Preliminary Study." In *2023 11th RSI International Conference on Robotics and Mechatronics (ICRoM)*, 228–234. IEEE.

Melo, F. S., A. Sardinha, D. Belo, et al. 2019. "Project INSIDE: Towards Autonomous Semi-Unstructured Human–Robot Social Interaction in Autism Therapy." *Artificial Intelligence in Medicine* 96: 198–216.

Meltzoff, A. N., R. Brooks, A. P. Shon, and R. P. Rao. 2010. ""Social" "Robots Are Psychological Agents for Infants: A Test of Gaze Following"." *Neural Networks* 23, no. 8–9: 966–972.

Mengoni, S. E., K. Irvine, D. Thakur, et al. 2017. "Feasibility Study of a Randomised Controlled Trial to Investigate the Effectiveness of Using a Humanoid Robot to Improve the Social Skills of Children With Autism Spectrum Disorder (Kaspar RCT): A Study Protocol." *BMJ Open* 7, no. 6: e017376.

Mesa-Gresa, P., H. Gil-Gómez, J.-A. Lozano-Quilis, and J.-A. Gil-Gómez. 2018. "Effectiveness of Virtual Reality for Children and Adolescents With Autism Spectrum Disorder: An Evidence-Based Systematic Review." *Sensors* 18, no. 8: 2486.

Mishra, R., and K. Conn Welch. 2024. "Towards Scalable Robotic Intervention of Children With Autism Spectrum Disorder Using LLMs." *arXiv preprint arXiv*: 2402.00260.

Moorthy, R. S., and S. Pugazhenthi. 2016. "Imitation Based Training to Enhance Psychomotor Skills in Autistic Children Using a Snatcher Robot." In *2016 International Conference on Robotics and Automation for Hhumanitarian Applications (RAHA)*, 1–6. IEEE.

Nakadoi, Y. 2015. "Usefulness of Animal Type Robot Assisted Therapy for Autism Spectrum Disorder in the Child and Adolescent Psychiatric Ward." In *JSAI International Symposium on Artificial Intelligence*, 478–482. Springer.

Niderla, K., and M. Maciejewski. 2021. "Construction of a Zoomorphical Robot for Rehabilitation of Autistic Children." *Journal of Physics: Conference Series* 1782, no. 1: 012024.

Nie, G., Z. Zheng, J. Johnson, et al. 2018. "Predicting Response to Joint Attention Performance in Human-Human Interaction Based on Human-Robot Interaction for Young Children With Autism Spectrum Disorder." In *27th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN)*, vol. 2018, 1–4. IEEE.

Nie, G., Z. Zheng, A. R. Swanson, A. S. Weitlauf, Z. E. Warren, and N. Sarkar. 2024. "An Exploration Into the Design of Multi-Session Robot-Mediated Joint Attention Intervention for Young Children With Autism." In *2024 33rd IEEE International Conference on Robot and Human Interactive Communication (RO-MAN)*, 1836–1841. IEEE.

Nunez, E., S. Matsuda, M. Hirokawa, J. Yamamoto, and K. Suzuki. 2015. "Paired Robotic Devices to Mediate and Represent Social Behaviors." In *24th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN)*, vol. 2015, 722–727. IEEE.

O Palestra liver, J., R. Oliván, J. Shukla, et al. 2019. "Stakeholders Acceptance and Expectations of Robot-Assisted Therapy for Children With Autism Spectrum Disorder." In *2019 28th IEEE International Conference on Robot and Human Interactive Communication (RO-MAN)*, 1–7. IEEE.

Osaka University & Vstone Co., Ltd./Ishiguro Symbiotic HRI Project. 2015. "Development of Social Dialogue Robots CommU and Sota." Details on Design and Launch of CommU and Sota Tabletop Robots. https://resou.osaka-u.ac.jp/en/research/2015/20150120_2.

Paengkumhag, C., W. Jutharee, W. Limpornchitwilai, K. Chamnongthai, and B. Keawkamnerdpong. 2023. "Using Robot-Assisting Personalized Learning for Children With Autism: A Pilot Study of Robot's Actions." In *15th Biomedical Engineering International Conference (BMEiCON)*, vol. 2023, 1–5. IEEE.

Pakkar, R., C. Clabaugh, R. Lee, E. Deng, and M. J. Mataricć. 2019. "Designing a Socially Assistive Robot for Longterm In-Home Use for Children With Autism Spectrum Disorders." In *2019 28th IEEE International Conference on Robot and Human Interactive Communication (RO-MAN)*, 1–7. IEEE.

Palestra, G., D. Cazzato, F. Adamo, I. Bortone, and C. Distante. 2017. "Assistive Robot, RGB-D Sensor and Graphical User Interface to Encourage Communication Skills in ASD Population." *Journal of Medical Robotics Research* 2, no. 2: 1740002.

Palestra, G., B. De Carolis, F. Esposito, et al. 2017. "Artificial Intelligence for Robot-Assisted Treatment of Autism." In *Proceedings of the Workshop on Artificial Intelligence with Application in Health (WAIAH 2017)* edited by D. Impedovo and G. Pirlo, vol. 1982, 17–24. CEUR Workshop Proceedings. https://CEUR-WS.org.

Panceri, J. A. C., É. Freitas, J. C. de Souza, S. da Luz Schreider, E. Caldeira, and T. F. Bastos. 2021. "A New Socially Assistive Robot With Integrated Serious Games for Therapies With Children With Autism Spectrum Disorder and Down Syndrome: A Pilot Study." *Sensors* 21, no. 24: 8414.

Papazoglou, T., C. Karagiannidis, and S. Mavropoulou. 2021. "Educational Robotics Can Foster Social Inclusion and Social Status of Children With Autism." In *2021 International Conference on Advanced Learning Technologies (ICALT)*, 317–319. IEEE.

PARO Robots U.S., Inc. 2014. "PARO Therapeutic Robot." http://www.parorobots.com/.

Paul, R. 2008. "Interventions to Improve Communication in Autism." *Child and Adolescent Psychiatric Clinics of North America* 17, no. 4: 835–856.

Peca, A., R. Simut, S. Pintea, C. Costescu, and B. Vanderborght. 2014. "How Do Typically Developing Children and Children With Autism Perceive Different Social Robots?" *Computers in Human Behavior* 41: 268–277.

Pennisi, P., A. Tonacci, G. Tartarisco, et al. 2016. "Autism and Social Robotics: A Systematic Review." *Autism Research* 9, no. 2: 165–183.

Pérez-Vázquez, E., G. L. Lledó, A. L. Carreres, A. Lorenzo-Lledó, and A. Gilabert-Cerdá. 2023. "Application of the Bee-Bot Robot to Improve the Oral Expression of a Student With ASD: A Case Study." In *2023 XIII International Conference on Virtual Campus (JICV)*, 1–4. IEEE.

Peribañez, E., S. Bayona, J. San Martin, et al. 2023. "An Experimental Methodology for Introducing Educational Robotics and Storytelling in Therapeutical Activities for Children With Neurodevelopmental Disorders." *Machines* 11, no. 6: 629.

Peters-Scheffer, N., R. Didden, H. Korzilius, and P. Sturmey. 2011. "A Meta-Analytic Study on the Effectiveness of Comprehensive Aba-Based Early Intervention Programs for Children With Autism Spectrum Disorders." *Research in Autism Spectrum Disorders* 5, no. 1: 60–69.

Petric, F., D. Miklić, M. Cepanec, P. Cvitanović, and Z. Kovačić. 2017. "Functional Imitation Task in the Context of Robot-Assisted Autism Spectrum Disorder Diagnostics: Preliminary Investigations." In *26th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN)*, vol. 2017, 1471–1478. IEEE.

Pierno, A. C., M. Mari, D. Lusher, and U. Castiello. 2008. "Robotic Movement Elicits Visuomotor Priming in Children With Autism." *Neuropsychologia* 46, no. 2: 448–454.

Pinto-Bernal, M. J., N. Cespedes, P. Castro, M. Munera, and C. A. Cifuentes. 2022. "Physical Human-Robot Interaction Influence in ASD Therapy Through an Affordable Soft Social Robot." *Journal of Intelligent & Robotic Systems* 105, no. 3: 67.

Pioggia, G., R. Igliozzi, M. Ferro, A. Ahluwalia, F. Muratori, and D. De Rossi. 2005. "An Android for Enhancing Social Skills and Emotion Recognition in People With Autism." *IEEE Transactions on Neural Systems and Rehabilitation Engineering* 13, no. 4: 507–515.

Pioggia, G., R. Igliozzi, M. L. Sica, et al. 2008. "Exploring Emotional and Imitational Android-Based Interactions in Autistic Spectrum Disorders." *Journal of CyberTherapy & Rehabilitation* 1, no. 1: 49–61.

Pioggia, G., M. Sica, M. Ferro, et al. 2007. "Human-Robot Interaction in Autism: FACE, an Android-Based Social Therapy." In *The 16th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN)*, 605–612. IEEE.

Pliasa, S., and N. Fachantidis. 2019. "Can a Robot Be an Efficient Mediator in Promoting Dyadic Activities Among Children With Autism Spectrum Disorders and Children of Typical Development?" In *Proceedings of the 9th Balkan Conference on Informatics*, 1–6. ACM.

Pop, C. A., A. C. Petrule, S. Pintea, et al. 2013. "Imitation and Social Behaviors of Children With ASD in Interaction With Robonova. A Series of Single Case Experiments." *Transylvanian Journal of Psychology/ Erdélyi Pszichológiai Szemle* 14, no. 1: 71.

Pop, C. A., S. Pintea, B. Vanderborght, and D. O. David. 2014. "Enhancing Play Skills, Engagement and Social Skills in a Play Task in ASD Children by Using Robot-Based Interventions. A Pilot Study." *Interaction Studies* 15, no. 2: 292–320.

Pop, C. A., R. Simut, S. Pintea, et al. 2013. "Can the Social Robot Probo Help Children With Autism to Identify Situation-Based Emotions? A Series of Single Case Experiments." *International Journal of Humanoid Robotics* 10, no. 3: 1350025.

Pop, C. A., R. E. Simut, S. Pintea, et al. 2013. "Social Robots vs. Computer Display: Does the Way Social Stories Are Delivered Make a Difference for Their Effectiveness on ASD Children?" *Journal of Educational Computing Research* 49, no. 3: 381–401.

Pradel, G., P. Dansart, A. Puret, and C. Barthélemy. 2010. "Generating Interactions in Autistic Spectrum Disorders by Means of a Mobile Robot." In *IECON 2010-36th Annual Conference on IEEE Industrial Electronics Society*, 1540–1545. IEEE.

Puglisi, A., T. Caprì, L. Pignolo, et al. 2022. "Social Humanoid Robots for Children With Autism Spectrum Disorders: A Review of Modalities, Indications, and Pitfalls." *Children* 9, no. 7: 953.

Puyon, M., and I. Giannopulu. 2013. "Emergent Emotional and Verbal Strategies in Autism Are Based on Multimodal Interactions With Toy Robots in Free Spontaneous Game Play." In *The 22nd IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN)*, 593–597. IEEE.

Qidwai, U., S. B. A. Kashem, and O. Conor. 2020. "Humanoid Robot as a Teacher's Assistant: Helping Children With Autism to Learn Social and Academic Skills." *Journal of Intelligent & Robotic Systems* 98, no. 3: 759–770.

Rakhymbayeva, N., A. Amirova, and A. Sandygulova. 2021. "A Long-Term Engagement With a Social Robot for Autism Therapy." *Frontiers in Robotics and AI* 8: 669972.

Ramdoss, S., W. Machalicek, M. Rispoli, A. Mulloy, R. Lang, and M. O'Reilly. 2012. "Computer-Based Interventions to Improve Social and Emotional Skills in Individuals With Autism Spectrum Disorders: A Systematic Review." *Developmental Neurorehabilitation* 15, no. 2: 119–135.

Ramirez-Duque, A. A., T. Bastos, M. Munera, C. A. Cifuentes, and A. Frizera-Neto. 2020. "Robot-Assisted Intervention for Children With Special Needs: A Comparative Assessment for Autism Screening." *Robotics and Autonomous Systems* 127: 103484.

Ramirez-Duque, A. A., A. Frizera-Neto, and T. F. Bastos. 2018. "Robot-Assisted Diagnosis for Children With Autism Spectrum Disorder Based on Automated Analysis of Nonverbal Cues." In *2018 7th IEEE International Conference on Biomedical Robotics and Biomechatronics (Biorob)*, 456–461. IEEE.

Ramirez-Duque, A. A., A. Frizera-Neto, and T. F. Bastoss. 2019. "Robot-Assisted Autism Spectrum Disorder Diagnostic Based on Artificial Reasoning." *Journal of Intelligent & Robotic Systems* 96, no. 2: 267–281.

Ramnauth, R., E. Adéníran, T. Adamson, et al. 2022. "A Social Robot for Improving Interruptions Tolerance and Employability in Adults With ASD." In *2022 17th ACM/IEEE International Conference on Human-Robot Interaction (HRI)*, 4–13. IEEE.

Ramnauth, R., D. Brščić, and B. Scassellati. 2026. "To Help or Not to Help?: An Expanded Framework for Deciding Socially Appropriate Robot Assistance." *ACM Transactions on Human-Robot Interaction* 15, no. 3: 1–32.

Ramnauth, R., F. Shic, and B. Scassellati. 2024. "The Role of Social Robots in Autism Therapy." osf.io/rjhet.

Ranatunga, I., N. A. Torres, R. Patterson, N. Bugnariu, M. Stevenson, and D. O. Popa. 2012. "Rodica: A Humanrobot Interaction System for Treatment of Childhood Autism Spectrum Disorders." In *Proceedings of the 5th International Conference on Pervasive Technologies Related to Assistive Environments*, 1–6. ACM.

Ravindra, P., S. De Silva, K. Tadano, A. Saito, S. G. Lambacher, and M. Higashi. 2009. "Therapeutic-Assisted Robot for Children With Autism." In *2009 IEEE/RSJ International Conference on Intelligent Robots and Systems*, 3561–3567. IEEE.

Redefer, L. A., and J. F. Goodman. 1989. "Brief Report: Pet-Facilitated Therapy With Autistic Children." *Journal of Autism and Developmental Disorders* 19: 461–467.

Robins, B., and K. Dautenhahn. 2014. "Tactile Interactions With a Humanoid Robot: Novel Play Scenario Implementations With Children With Autism." *International Journal of Social Robotics (IJSR)* 6, no. 3: 397–415.

Robins, B., K. Dautenhahn, R. T. Boekhorst, and A. Billard. 2005. "Robotic Assistants in Therapy and Education of Children With Autism: Can a Small Humanoid Robot Help Encourage Social Interaction Skills?" *Universal Access in the Information Society* 4, no. 2: 105–120.

Robins, B., K. Dautenhahn, and P. Dickerson. 2009. "From Isolation to Communication: A Case Study Evaluation of Robot Assisted Play for Children With Autism With a Minimally Expressive Humanoid Robot." In *Second International Conferences on Advances in Computer-Human Interactions*, vol. 2009, 205–211. IEEE.

Robins, B., K. Dautenhahn, R. Te Boekhorst, and A. Billard. 2004. "Effects of Repeated Exposure to a Humanoid Robot on Children With Autism." In *Designing a More Inclusive World*, 225–236. Springer.

Robins, B., P. Dickerson, P. Stribling, and K. Dautenhahn. 2004. "Robot-Mediated Joint Attention in Children With Autism: A Case Study in Robot-Human Interaction." *Interaction Studies* 5, no. 2: 161–198.

Robles-Bykbaev, V., J. Galán-Mena, M. López-Nores, et al. 2018. "A Hybrid System to Support the Psychological Intervention for Children With Autism: A Proposal Based on Knowledge Modeling and Intelligent Technologies." *International Journal of E-Services and Mobile Applications (IJESMA)* 10, no. 4: 74–100.

Robokind. 2018. "Milo: The Facially Expressive Robot for Autism Intervention." Robokind. https://www.robokind.com.

Rodríguez-Quevedo, Á., G. L. Lledó, A. L. Carreres, and E. Pérez-Vázquez. 2023. "Emotion Recognition in ASD Students With Social Robotics: Case Study." In *2023 XIII International Conference on Virtual Campus (JICV)*, 1–4. IEEE.

Romero-García, R., R. Martínez-Tomás, P. Pozo, F. de la Paz, and E. Sarriá. 2021. "Q-CHAT-NAO: A Robotic Approach to Autism Screening in Toddlers." *Journal of Biomedical Informatics* 118: 103797.

Rosen, N. E., C. Lord, and F. R. Volkmar. 2021. "The Diagnosis of Autism: From Kanner to DSM-III to DSM-5 and Beyond." *Journal of Autism and Developmental Disorders* 51: 4253–4270.

Rudovic, O., J. Lee, M. Dai, B. Schuller, and R. W. Picard. 2018. "Personalized Machine Learning for Robot Perception of Affect and Engagement in Autism Therapy." *Science Robotics* 3, no. 19: eaao6760.

Rudovic, O., J. Lee, L. Mascarell-Maricic, B. W. Schuller, and R. W. Picard. 2017. "Measuring Engagement in Robot-Assisted Autism Therapy: A Cross-Cultural Study." *Frontiers in Robotics and AI* 4: 36.

Saadatzi, M. N., R. C. Pennington, K. C. Welch, and J. H. Graham. 2018a. "Effects of a Robot Peer on the Acquisition and Observational Learning of Sight Words in Young Adults With Autism Spectrum Disorder." *Journal of Special Education Technology* 33, no. 4: 284–296.

Saadatzi, M. N., R. C. Pennington, K. C. Welch, and J. H. Graham. 2018b. "Small-Group Technology-Assisted Instruction: Virtual Teacher and Robot Peer for Individuals With Autism Spectrum Disorder." *Journal of Autism and Developmental Disorders (JADD)* 48, no. 11: 3816–3830.

Saha, P., M. I. Tapotee, and M. A. R. Ahad. 2021. "Task Detection of ASD Children by Analyzing Robotic Enhanced and Standard Human Therapy." In *2021 Thirteenth International Conference on Mobile Computing and Ubiquitous Network (ICMU)*, 1–6. IEEE.

Saleh, M. A., F. A. Hanapiah, and H. Hashim. 2021. "Robot Applications for Autism: A Comprehensive Review." *Disability and Rehabilitation. Assistive Technology* 16, no. 6: 580–602.

Salter, T., K. Dautenhahn, and R. Te Boekhorst. 2006. "Learning About Natural Human–Robot Interaction Styles." *Robotics and Autonomous Systems* 54, no. 2: 127–134.

Salvador, M. J., S. Silver, and M. H. Mahoor. 2015. "An Emotion Recognition Comparative Study of Autistic and Typically-Developing Children Using the Zeno Robot." In *2015 IEEE International Conference on Robotics and Automation (ICRA)*, 6128–6133. IEEE.

Sandygulova, A., A. Amirova, Z. Telisheva, A. Zhanatkyzy, and N. Rakhymbayeva. 2022. "Individual Differences of Children With Autism in Robot-Assisted Autism Therapy." In *2022 17th ACM/IEEE International Conference on Human-Robot Interaction (HRI)*, 43–52. IEEE.

Sandygulova, A., Z. Zhexenova, B. Tleubayev, et al. 2019. "Interaction Design and Methodology of Robot-Assisted Therapy for Children With Severe ASD and ADHD." *Paladyn, Journal of Behavioral Robotics* 10, no. 1: 330–345.

Santos, L., A. Geminiani, I. Olivieri, J. Santos-Victor, and A. Pedrocchi. 2019. "Copyrobot: Interactive Mirroring Robotics Game for ASD Children." In *Mediterranean Conference on Medical and Biological Engineering and Computing*, 2014–2027. Springer.

Santos, L., B. Silva, F. Maddaloni, et al. 2022. "Sharing Worlds: Design of a Real-Time Attention Classifier for Robotic Therapy of ASD Children." In *2022 International Conference on Rehabilitation Robotics (ICORR)*, 1–6. IEEE.

Scassellati, B., H. Admoni, and M. Matarić. 2012. "Robots for Use in Autism Research." *Annual Review of Biomedical Engineering* 14, no. 1: 275–294.

Scassellati, B., L. Boccanfuso, C.-M. Huang, et al. 2018. "Improving Social Skills in Children With ASD Using a Long-Term, In-Home Social Robot." *Science Robotics* 3, no. 21: eaat7544.

Schadenberg, B. R., D. Reidsma, V. Evers, et al. 2021. "Predictable Robots for Autistic Children—Variance in Robot Behaviour, Idiosyncrasies in Autistic Children's Characteristics, and Child–Robot Engagement." *ACM Transactions on Computer-Human Interaction (TOCHI)* 28, no. 5: 1–42.

Schadenberg, B. R., D. Reidsma, D. K. Heylen, and V. Evers. 2020. "Differences in Spontaneous Interactions of Autistic Children in an Interaction With an Adult and Humanoid Robot." *Frontiers in Robotics and AI* 7: 28.

Shahverdi, P., K. Rousso, I. Bakhoda, N. Huang, K. Rohrbeck, and W.-Y. G. Louie. 2023. "Robot-Mediated Job Interview Training for Individuals With ASD: A Pilot Study." In *2023 32nd IEEE International Conference on Robot and Human Interactive Communication (RO-MAN)*, 564–570. IEEE.

Shamsuddin, S., H. Yussof, F. A. Hanapiah, and S. Mohamed. 2013. "A Qualitative Method to Analyze Response in Robotic Intervention for Children With Autism." In *The 22nd IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN)*, 324–325. IEEE.

Shamsuddin, S., H. Yussof, L. Ismail, et al. 2012. "Initial Response of Autistic Children in Human-Robot Interaction Therapy With Humanoid Robot NAO." In *2012 IEEE 8th International Colloquium on Signal Processing and Its Applications*, 188–193. IEEE.

Shamsuddin, S., H. Yussof, L. I. Ismail, S. Mohamed, F. A. Hanapiah, and N. I. Zahari. 2012a. "Humanoid Robot NAO Interacting With Autistic Children of Moderately Impaired Intelligence to Augment Communication Skills." *Procedia Engineering* 41: 1533–1538.

Shamsuddin, S., H. Yussof, L. I. Ismail, S. Mohamed, F. A. Hanapiah, and N. I. Zahari. 2012b. "Initial Response in HRI-a Case Study on Evaluation of Child With Autism Spectrum Disorders Interacting With a Humanoid Robot Nao." *Procedia Engineering* 41: 1448–1455.

She, T., X. Kang, S. Nishide, and F. Ren. 2018. "Improving Leo Robot Conversational Ability via Deep Learning Algorithms for Children With Autism." In *2018 5th IEEE International Conference on Cloud Computing and Intelligence Systems (CCIS)*, 416–420. IEEE.

She, T., X. Kang, S. Nishide, and F. Renss. 2014. "Response of Children With Autism to Robotic Intervention and Association With IQ Levels." In *4th International Conference on Development and Learning and on Epigenetic Robotics*, 387–393. IEEE.

She, T., and F. Ren. 2021. "Enhance the Language Ability of Humanoid Robot NAO Through Deep Learning to Interact With Autistic Children." *Electronics* 10, no. 19: 2393.

Shi, Z., T. R. Groechel, S. Jain, K. Chima, O. Rudovic, and M. J. Matarić. 2022. "Toward Personalized Affect-Aware Socially Assistive Robot Tutors for Long-Term Interventions With Children With Autism." *ACM Transactions on Human-Robot Interaction* 11, no. 4: 1–28.

Silva, B., L. Santos, C. Barata, et al. 2024. "Attention Analysis in Robotic-Assistive Therapy for Children With Autism." *IEEE Transactions on Neural Systems and Rehabilitation Engineering* 32: 2220–2229.

Silva, K., M. Lima, A. Santos-Magalhães, C. Fafiães, and L. de Sousa. 2019. "Living and Robotic Dogs as Elicitors of Social Communication Behavior and Regulated Emotional Responding in Individuals With Autism and Severe Language Delay: A Preliminary Comparative Study." *Anthrozoös* 32, no. 1: 23–33.

Silvera-Tawil, D., D. Bradford, and C. Roberts-Yates. 2018. "Talk to Me: The Role of Human-Robot Interaction in Improving Verbal Communication Skills in Students With Autism or Intellectual Disability." In *27th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN)*, vol. 2018, 1–6. IEEE.

Simut, R., G. Van de Perre, C. Costescu, et al. 2016. "Probogotchi: A Novel Edutainment Device as a Bridge for Interaction Between a Child With ASD and the Typically Developed Sibling." *Journal of Evidence-Based Psychotherapies* 16, no. 1: 91–112.

Simut, R. E., J. Vanderfaeillie, A. Peca, G. Van de Perre, and B. Vanderborght. 2016. "Children With Autism Spectrum Disorders Make a Fruit Salad With Probo, the Social Robot: An Interaction Study." *Journal of Autism and Developmental Disorders (JADD)* 46, no. 1: 113–126.

Singh, A., K. Raj, T. Kumar, S. Verma, and A. M. Roy. 2023. "Deep Learning-Based Cost-Effective and Responsive Robot for Autism Treatment." *Drones* 7, no. 2: 81.

Smedegaard, C. V. 2019. "Reframing the Role of Novelty Within Social Hri: From Noise to Information." In *2019 14th Acm/IEEE International Conference on Human-Robot Interaction (HRI)*, 411–420. IEEE.

Smith, I. M., and S. E. Bryson. 1994. "Imitation and Action in Autism: A Critical Review." *Psychological Bulletin* 116, no. 2: 259–273.

Snow, A. 2021. "Social Communication Questionnaire." In *Encyclopedia of Autism Spectrum Disorders*, 4427–4429. Springer.

So, W.-C., C.-H. Cheng, W.-Y. Lam, et al. 2020. "A Robot-Based Playdrama Intervention May Improve the Joint Attention and Functional Play Behaviors of Chinese-Speaking Preschoolers With Autism Spectrum Disorder: A Pilot Study." *Journal of Autism and Developmental Disorders* 50, no. 2: 467–481.

So, W.-C., C.-H. Cheng, W.-Y. Lam, et al. 2019. "Robot-Based Play-Drama Intervention May Improve the Narrative Abilities of Chinese-Speaking Preschoolers With Autism Spectrum Disorder." *Research in Developmental Disabilities* 95: 103515.

So, W.-C., C.-H. Cheng, W.-W. Law, et al. 2023. "Robot Dramas May Improve Joint Attention of Chinese-Speaking Low-Functioning Children With Autism: Stepped Wedge Trials." *Disability and Rehabilitation. Assistive Technology* 18, no. 2: 195–204.

So, W.-C., W.-W. Law, C.-H. Cheng, et al. 2023. "Comparing the Effectiveness of Robot-Based to Human-Based Intervention in Improving Joint Attention in Autistic Children." *Frontiers in Psychiatry* 14: 1114907.

So, W.-C., M. K.-Y. Wong, C. K.-Y. Lam, et al. 2018. "Using a Social Robot to Teach Gestural Recognition and Production in Children With Autism Spectrum Disorders." *Disability and Rehabilitation. Assistive Technology* 13, no. 6: 527–539.

So, W.-C., M. K.-Y. Wong, W.-Y. Lam, et al. 2019. "Who Is a Better Teacher for Children With Autism? Comparison of Learning Outcomes Between Robot-Based and Humanbased Interventions in Gestural Production and Recognition." *Research in Developmental Disabilities* 86: 62–75.

So, W.-C., M. K.-Y. Wong, W.-Y. Lam, et al. 2018. "Robot-Based Intervention May Reduce Delay in the Production of Intransitive Gestures in Chinese-Speaking Preschoolers With Autism Spectrum Disorder." *Molecular Autism* 9, no. 1: 34.

Soares, F. O., S. C. Costa, C. P. Santos, A. P. S. Pereira, A. R. Hiolle, and V. Silva. 2019. "Socio-Emotional Development in High Functioning Children With Autism Spectrum Disorders Using a Humanoid Robot." *Interaction Studies* 20, no. 2: 205–233.

Soft Interaction Lab. 2014. "Soft Robot for Non-Verbal Children With Autism."

SoftBank Robotics. 2022. "NAO Robot." https://www.softbankrobotics.com/emea/en/nao. Originally Developed by Aldebaran Robotics, Now Manufactured by SoftBank Robotics.

Soleiman, P., H. Moradi, B. Mehralizadeh, et al. 2023. "Fully Robotic Social Environment for Teaching and Practicing Affective Interaction: Case of Teaching Emotion Recognition Skills to Children With Autism Spectrum Disorder, a Pilot Study." *Frontiers in Robotics and AI* 10: 1088582.

Soleiman, P., S. Salehi, M. Mahmoudi, M. Ghavami, H. Moradi, and H. Pouretemad. 2014. "RoboParrot: A Robotic Platform for Human Robot Interaction, Case of Autistic Children." In *2014 Second RSI/ISM International Conference on Robotics and Mechatronics (ICRoM)*, 711–716. IEEE.

Solomon, O. 2010. "What a Dog Can Do: Children With Autism and Therapy Dogs in Social Interaction." *Ethos* 38, no. 1: 143–166.

Sorrentino, A., G. Mancioppi, L. Coviello, F. Cavallo, and L. Fiorini. 2021. "Feasibility Study on the Role of Personality, Emotion, and Engagement in Socially Assistive Robotics: A Cognitive Assessment Scenario." *Informatics* 8, no. 2: 23.

Spain, D., J. Sin, K. B. Linder, J. McMahon, and F. Happé. 2018. "Social Anxiety in Autism Spectrum Disorder: A Systematic Review." *Research in Autism Spectrum Disorders* 52: 51–68.

Sperati, V., B. Özcan, L. Romano, et al. 2020. "Acceptability of the Transitional Wearable Companion "+ Me" in Children With Autism Spectrum Disorder: A Comparative Pilot Study." *Frontiers in Psychology* 11: 951.

Srinivasan, S. M., I.-M. Eigsti, L. Neelly, and A. N. Bhat. 2016. "The Effects of Embodied Rhythm and Robotic Interventions on the Spontaneous and Responsive Social Attention Patterns of Children With Autism Spectrum Disorder (ASD): A Pilot Randomized Controlled Trial." *Research in Autism Spectrum Disorders* 27: 54–72.

Srinivasan, S. M., K. A. Lynch, D. J. Bubela, T. D. Gifford, and A. N. Bhat. 2013. "Effect of Interactions Between a Child and a Robot on the Imitation and Praxis Performance of Typically Devloping Children and a Child With Autism: A Preliminary Study." *Perceptual and Motor Skills* 116, no. 3: 885–904.

Srinivasan, S. M., I. K. Park, L. B. Neelly, and A. N. Bhat. 2015. "A Comparison of the Effects of Rhythm and Robotic Interventions on Repetitive Behaviors and Affective States of Children With Autism Spectrum Disorder (ASD)." *Research in Autism Spectrum Disorders* 18: 51–63.

Stanton, C. M., P. H. Kahn Jr., R. L. Severson, J. H. Ruckert, and B. T. Gill. 2008. "Robotic Animals Might Aid in the Social Development of Children With Autism." In *Proceedings of the 3rd ACM/IEEE International Conference on Human Robot Interaction*, 271–278. ACM/IEEE.

Sterrett, K. T. 2021. *Sensitivity and Expected Change of Commonly Used Social Communication Measures in Longitudinal Research of Children With Autism*. University of California, Los Angeles.

Stiehl, W. D., C. Breazeal, K.-H. Han, et al. 2006. "The Huggable: A Therapeutic Robotic Companion for Relational, Affective Touch." In *ACM SIGGRAPH 2006 Emerging Technologies*, 15–es. ACM.

Stribling, P., J. Rae, and P. Dickerson. 2009. "Using Conversation Analysis to Explore the Recurrence of a Topic in the Talk of a Boy With an Autism Spectrum Disorder." *Clinical Linguistics & Phonetics* 23, no. 8: 555–582.

Suzuki, R., and J. Lee. 2016. "Robot-Play Therapy for Improving Prosocial Behaviours in Children With Autism Spectrum Disorders." In *International Symposium on Micro-NanoMechatronics and Human Science (MHS)*, vol. 2016, 1–5. IEEE.

Syrdal, D. S., K. Dautenhahn, B. Robins, E. Karakosta, and N. C. Jones. 2020. "Kaspar in the Wild: Experiences From Deploying a Small Humanoid Robot in a Nursery School for Children With Autism." *Paladyn, Journal of Behavioral Robotics* 11, no. 1: 301–326.

Szymona, B., M. Maciejewski, R. Karpiński, et al. 2021. "Robot-Assisted Autism Therapy (RAAT). Criteria and Types of Experiments Using Anthropomorphic and Zoomorphic Robots. Review of the Research." *Sensors* 21, no. 11: 3720.

Taheri, A., A. Meghdari, M. Alemi, and H. Pouretemad. 2018a. "Clinical Interventions of Social Humanoid Robots in the Treatment of a Set of High-and Low-Functioning Autistic Iranian Twins." *Scientia Iranica* 25, no. 3: 1197–1214.

Taheri, A., A. Meghdari, M. Alemi, and H. Pouretemad. 2018b. "Human–Robot Interaction in Autism Treatment: A Case Study on Three Pairs of Autistic Children as Twins, Siblings, and Classmates." *International Journal of Social Robotics (IJSR)* 10, no. 1: 93–113.

Taheri, A., A. Meghdari, and M. H. Mahoor. 2021. "A Close Look at the Imitation Performance of Children With Autism and Typically Developing Children Using a Robotic System." *International Journal of Social Robotics (IJSR)* 13, no. 5: 1125–1147.

Taheri, A., A. Shariati, R. Heidari, M. Shahab, M. Alemi, and A. Meghdari. 2021. "Impacts of Using a Social Robot to Teach Music to Children With Low-Functioning Autism." *Paladyn, Journal of Behavioral Robotics* 12, no. 1: 256–275.

Takata, K., Y. Yoshikawa, T. Muramatsu, et al. 2023. "Social Skills Training Using Multiple Humanoid Robots for Individuals With Autism Spectrum Conditions." *Frontiers in Psychiatry* 14: 1168837.

Talaei-Khoei, A., L. Lewis, M. Kaul, J. Daniel, and R. Sharma. 2017. "Use of Lean Robotic Communication to Improve Social Response of Children With Autism." In *AMCIS 2017-America's Conference on Information Systems: A Tradition of Innovation*. Association for Information System (AIS).

Tapus, A., M. J. Mataric, and B. Scassellati. 2007. "Socially Assistive Robotics [Grand Challenges of Robotics]." *IEEE Robotics and Automation Magazine* 14, no. 1: 35–42.

Tartarisco, G., R. Bruschetta, F. Marino, et al. 2022. "Exploring Behavioural and Physiological Interactions in a Group-Based Emotional Skill Social Robotic Training for Autism Spectrum Disorders." In *2022 International Conference on Electrical, Computer, Communications and Mechatronics Engineering (ICECCME)*, 1–4. IEEE.

Telisheva, Z., A. Amirova, N. Rakhymbayeva, A. Zhanatkyzy, and A. Sandygulova. 2022. "The Quantitative Caseby-Case Analyses of the Socio-Emotional Outcomes of Children With ASD in Robot-Assisted Autism Therapy." *Multimodal Technologies and Interaction* 6, no. 6: 46.

Tleubayev, B., Z. Zhexenova, A. Zhakenova, and A. Sandygulova. 2019. "Robot-Assisted Therapy for Children With ADHD and ASD: A Pilot Study." In *Proceedings of the 2019 2nd International Conference on Service Robotics Technologies*, 58–62. ACM.

Trombly, M., P. Shahverdi, N. Huang, Q. Chen, J. Korneder, and W.-Y. G. Louie. 2022. "Robot-Mediated Group Instruction for Children With ASD: A Pilot Study." In *2022 31st IEEE International Conference on Robot and Human Interactive Communication (RO-MAN)*, 1506–1513. IEEE.

Urdanivia Alarcon, D. A., S. Cano, F. H. R. Paucar, R. F. P. Quispe, F. Talavera-Mendoza, and M. E. R. Zegarra. 2021. "Exploring the Effect of Robot-Based Video Interventions for Children With Autism Spectrum Disorder as an Alternative to Remote Education." *Electronics* 10, no. 21: 2577.

Valadão, C. T., C. Goulart, H. Rivera, et al. 2016. "Analysis of the Use of a Robot to Improve Social Skills in Children With Autism Spectrum Disorder." *Research on Biomedical Engineering* 32, no. 2: 161–175.

van den Berk-Smeekens, I., M. W. de Korte, M. van Dongen-Boomsma, et al. 2022. "Pivotal Response Treatment With and Without Robot-Assistance for Children With Autism: A Randomized Controlled Trial." *European Child & Adolescent Psychiatry* 31, no. 12: 1871–1883.

van den Berk-Smeekens, I., M. van Dongen-Boomsma, M. De Korte, et al. 2020. "Adherence and Acceptability of a Robot-Assisted Pivotal Response Treatment Protocol for Children With Autism Spectrum Disorder." *Scientific Reports* 10, no. 1: 8110.

van Otterdijk, M. T., M. W. de Korte, I. van den Berk-Smeekens, et al. 2020. "The Effects of Long-Term Child–Robot Interaction on the Attention and the Engagement of Children With Autism." *Robotics* 9, no. 4: 79.

van Straten, C. L., I. Smeekens, E. Barakova, J. Glennon, J. Buitelaar, and A. Chen. 2018. "Effects of Robots' Intonation and Bodily Appearance on Robot-Mediated Communicative Treatment Outcomes for Children With Autism Spectrum Disorder." *Personal and Ubiquitous Computing* 22, no. 2: 379–390.

Vanderborght, B., R. Simut, J. Saldien, et al. 2012. "Using the Social Robot Probo as a Social Story Telling Agent for Children With ASD." *Interaction Studies* 13, no. 3: 348–372.

Villano, M., C. R. Crowell, K. Wier, et al. 2011. "DOMER: A Wizard of Oz Interface for Using Interactive Robots to Scaffold Social Skills for Children With Autism Spectrum Disorders." In *Proceedings of the 6th International Conference on Human-Robot Interaction (HRI)*, 279–280. ACM/IEEE.

Vivanti, G. 2020. "Ask the Editor: What Is the Most Appropriate Way to Talk About Individuals With a Diagnosis of Autism?" *Journal of Autism and Developmental Disorders* 50, no. 2: 691–693.

Wainer, J., K. Dautenhahn, B. Robins, and F. Amirabdollahian. 2010. "Collaborating With Kaspar: Using an Autonomous Humanoid Robot to Foster Cooperative Dyadic Play Among Children With Autism." In *2010 10th IEEERAS International Conference on Humanoid Robots*, 631–638. IEEE.

Wainer, J., B. Robins, F. Amirabdollahian, and K. Dautenhahn. 2014. "Using the Humanoid Robot KASPAR to Autonomously Play Triadic Games and Facilitate Collaborative Play Among Children With Autism." *IEEE Transactions on Autonomous Mental Development* 6, no. 3: 183–199.

Wan, G.-B., F.-H. Deng, Z.-J. Jiang, et al. 2019. "Attention Shifting During Child—Robot Interaction: A Preliminary Clinical Study for Children With Autism Spectrum Disorder." *Frontiers of Information Technology & Electronic Engineering* 20, no. 3: 374–387.

Wanglavan, P., W. Jutharee, T. Maneewarn, and B. Kaewkamnerdpong. 2019. "The Development of Attention Detection Model From Child Behavior for Robot-Assisted Autism Therapy." In *2019 19th International Conference on Control, Automation and Systems (ICCAS)*, 775–780. IEEE.

Warren, Z., Z. Zheng, S. Das, et al. 2015. "Brief Report: Development of a Robotic Intervention Platform for Young Children With ASD." *Journal of Autism and Developmental Disorders (JADD)* 45, no. 12: 3870–3876.

Warren, Z. E., Z. Zheng, A. R. Swanson, et al. 2015. "Can Robotic Interaction Improve Joint Attention Skills?" *Journal of Autism and Developmental Disorders (JADD)* 45, no. 11: 3726–3734.

Waterhouse, L. H., and L. Waterhouse. 2012. *Rethinking Autism: Variation and Complexity*. Academic Press.

Weir, E., C. Allison, and S. Baron-Cohen. 2022. "Autistic Adults Have Poorer Quality Healthcare and Worse Health Based on Self-Report Data." *Molecular Autism* 13, no. 1: 23.

Welch, K. C., R. Pennington, S. Vanaparthy, et al. 2023. "Using Physiological Signals and Machine Learning Algorithms to Measure Attentiveness During Robot-Assisted Social Skills Intervention: A Case Study of Two Children With Autism Spectrum Disorder." *IEEE Instrumentation and Measurement Magazine* 26, no. 3: 39–45.

Werry, I., K. Dautenhahn, B. Ogden, and W. Harwin. 2001. "Can Social Interaction Skills Be Taught by a Social Agent? The Role of a Robotic Mediator in Autism Therapy." In *Cognitive Technology: Instruments of Mind: 4th International Conference, CT. 2001 Proceedings*, 57–74. Spring.

Wong, H., and Z. Zhong. 2016. "Assessment of Robot Training for Social Cognitive Learning." In *2016 16th International Conference on Control, Automation and Systems (ICCAS)*, 893–898. IEEE.

Wood, L. J., B. Robins, G. Lakatos, D. S. Syrdal, A. Zaraki, and K. Dautenhahn. 2018. "Piloting Scenarios for Children With Autism to Learn About Visual Perspective Taking." In *Annual Conference Towards Autonomous Robotic Systems*, 260–270. Springer.

Xie, B., and C. H. Park. 2024. "An Empathetic Social Robot With Modular Anxiety Interventions for Autistic Adolescents." In *2024 33rd IEEE International Conference on Robot and Human Interactive Communication (RO-MAN)*, 1148–1155. IEEE.

Yoshikawa, M., Y. Matsumoto, M. Sumitani, and H. Ishiguro. 2011. "Development of an Android Robot for Psychological Support in Medical and Welfare Fields." In *2011 IEEE International Conference on Robotics and Biomimetics*, 2378–2383. IEEE.

Yoshikawa, Y., H. Kumazaki, Y. Matsumoto, M. Miyao, M. Kikuchi, and H. Ishiguro. 2019. "Relaxing Gaze Aversion of Adolescents With Autism Spectrum Disorder in Consecutive Conversations With Human and Android Robot—A Preliminary Study." *Frontiers in Psychiatry* 10: 370.

Yun, S.-S., J. Choi, and S.-K. Park. 2016. "Robotic Behavioral Intervention to Facilitate Eye Contact and Reading Emotions of Children With Autism Spectrum Disorders." In *25th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN)*, vol. 2016, 694–699. IEEE.

Yun, S.-S., J. Choi, S.-K. Park, G.-Y. Bong, and H. Yoo. 2017. "Social Skills Training for Children With Autism Spectrum Disorder Using a Robotic Behavioral Intervention System." *Autism Research* 10, no. 7: 1306–1323.

Yun, S.-S., H. Kim, J. Choi, and S.-K. Park. 2016. "A Robot-Assisted Behavioral Intervention System for Children With Autism Spectrum Disorders." *Robotics and Autonomous Systems* 76: 58–67.

Yun, S.-S., S.-K. Park, and J. Choi. 2014. "A Robotic Treatment Approach to Promote Social Interaction Skills for Children With Autism Spectrum Disorders." In *The 23rd IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN)*, 130–134. IEEE.

Yussof, H., S. Shamsuddin, F. A. Hanapiah, L. I. Ismail, and M. A. Miskam. 2015. "IQ Level Assessment Methodology in Robotic Intervention With Children With Autism." In *10TH Asian Control Conference (ASCC)*, vol. 2015, 1–6. IEEE.

Zaraki, A., M. Khamassi, L. J. Wood, et al. 2020. "A Novel Reinforcement-Based Paradigm for Children to Teach the Humanoid Kaspar Robot." *International Journal of Social Robotics* 12, no. 3: 709–720.

Zaraki, A., L. Wood, B. Robins, and K. Dautenhahn. 2018. "Development of a Semi-Autonomous Robotic System to Assist Children With Autism in Developing Visual Perspective Taking Skills." In *27th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN)*, vol. 2018, 969–976. IEEE.

Zehnder, E., M. Jouaiti, and F. Charpillet. 2022. "Evaluating Robot Acceptance in Children With ASD and Their Parents." In *International Conference on Social Robotics*, 45–53. Springer Nature Switzerland.

Zhanatkyzy, A., Z. Telisheva, A. Amirova, N. Rakhymbayeva, and A. Sandygulova. 2023. "Multi-Purposeful Activities for Robot-Assisted Autism Therapy: What Works Best for Children's Social Outcomes?" In *Proceedings of the 2023 ACM/IEEE International Conference on Human-Robot Interaction (HRI)*, 34–43. ACM/IEEE.

Zhang, Y., W. Song, Z. Tan, et al. 2019. "Theory of Robot Mind: False Belief Attribution to Social Robots in Children With and Without Autism." *Frontiers in Psychology* 10: 1732.

Zhang, Y., W. Song, Z. Tan, et al. 2019. "Could Social Robots Facilitate Children With Autism Spectrum Disorders in Learning Distrust and Deception?" *Computers in Human Behavior* 98: 140–149.

Zheng, Z., S. Das, E. M. Young, A. Swanson, Z. Warren, and N. Sarkar. 2014. "Autonomous Robot-Mediated Imitation Learning for Children With Autism." In *2014 IEEE International Conference on Robotics and Automation (ICRA)*, 2707–2712. IEEE.

Zheng, Z., G. Nie, A. Swanson, A. Weitlauf, Z. Warren, and N. Sarkar. 2020. "A Randomized Controlled Trial of an Intelligent Robotic Response to Joint Attention Intervention System." *Journal of Autism and Developmental Disorders* 50, no. 8: 2819–2831.

Zheng, Z., E. M. Young, A. Swanson, A. Weitlauf, Z. Warren, and N. Sarkar. 2015. "Robot-Mediated Mixed Gesture Imitation Skill Training for Young Children With ASD." In *2015 International Conference on Advanced Robotics (ICAR)*, 72–77. IEEE.

Zheng, Z., L. Zhang, E. Bekele, et al. 2013. "Impact of Robotmediated Interaction System on Joint Attention Skills for Children With Autism." In *2013 IEEE 13th International Conference on Rehabilitation Robotics (ICORR)*, 1–8. IEEE.

Zheng, Z., H. Zhao, A. R. Swanson, A. S. Weitlauf, Z. E. Warren, and N. Sarkar. 2017. "Design, Development, and Evaluation of a Noninvasive Autonomous Robot-Mediated Joint Attention Intervention System for Young Children With ASD." *IEEE Transactions on Human-Machine Systems* 48, no. 2: 125–135.

Appendix A: Review Methodology

To improve transparency and reproducibility, this narrative synthesis was informed by a structured literature search. We report the identification, screening, and inclusion of studies in the final corpus using a PRISMAstyle flow diagram (Figure A1). Because the aim of this paper is to provide a narrative and translational synthesis rather than a systematic review or meta-analysis, we did not conduct a formal risk-of-bias assessment or pooled effect-size estimation. The search protocol was preregistered (Ramnauth et al. 2024).

Search Queries

The original corpus search covered publications from 2001 through 2024 and was conducted in January 2025.

The general search string used for title, abstract, and keyword searches was:

```
(“Autism” OR “Autism Spectrum Disorder” OR
“ASD”) AND (“Social Robot” OR “Humanoid Robot”
OR “Assistive Robot” OR “Robotic Companion” OR
“Robot*”) AND (“Therapy” OR “Social Skill*”
OR “Behavioral Support” OR “Education” OR
“Intervention” OR “Training”)
```

For PubMed, the search was adapted to title/abstract fields as follows:

```
(autism[tiab] OR "Autism Spectrum Disorder"[tiab]
OR ASD[tiab]) AND ("Social Robot"[tiab]OR
"Humanoid Robot"[tiab] OR "Assistive Robot"[tiab]
OR "Robotic Companion"[tiab] OR robot*[tiab])
AND (therapy[tiab] OR "Social Skill*"[tiab] OR
"Behavioral Support"[tiab] OR education[tiab] OR
intervention[tiab] OR training[tiab])
```

For IEEE Xplore, the search was adapted to title and abstract fields:

```
(“Title”:“Autism” OR “Abstract”:“Autism”
OR “Title”:“Autism Spectrum Disorder” OR
“Abstract”:“Autism Spectrum Disorder” OR
“Title”:“ASD” OR “Abstract”:“ASD”) AND
(“Title”:“Social Robot” OR “Abstract”:“Social
Robot” OR “Title”:“Humanoid Robot” OR
“Abstract”:“Humanoid Robot” OR “Title”:“Assistive
Robot” OR “Abstract”:“Assistive Robot” OR
“Title”:“Robotic Companion” OR “Abstract”:“Robotic
Companion” OR “Title”:“Robot*” OR
“Abstract”:“Robot*”)AND (“Title”:“Therapy” OR
“Abstract”:“Therapy” OR “Title”:“Social Skill*” OR
“Abstract”:“Social
Skill*” OR “Title”:“Behavioral Support”
OR “Abstract”:“Behavioral Support” OR
“Title”:“Education” OR “Abstract”:“Education” OR
“Title”:“Intervention” OR “Abstract”:“Intervention”
OR “Title”:“Training” OR “Abstract”:“Training”)
```

For Scopus, the same conceptual search terms were used. Source exclusions were applied to reduce duplicate indexing of records already captured through targeted IEEE and ACM searches and to reduce retrieval of review-oriented sources:

```
… AND NOT (SOURCE(“IEEE Transactions” OR “ACM
Computing Surveys” OR “IEEE Robotics and
Automation Magazine” OR “ACM Transactions on
Human-Robot Interaction”))
```

The database searches identified 734 unique records after source-level deduplication and filtering. An additional 28 records were identified through Google Scholar and citation chasing, yielding 762 unique records for title screening. Of these, 140 records were excluded after title

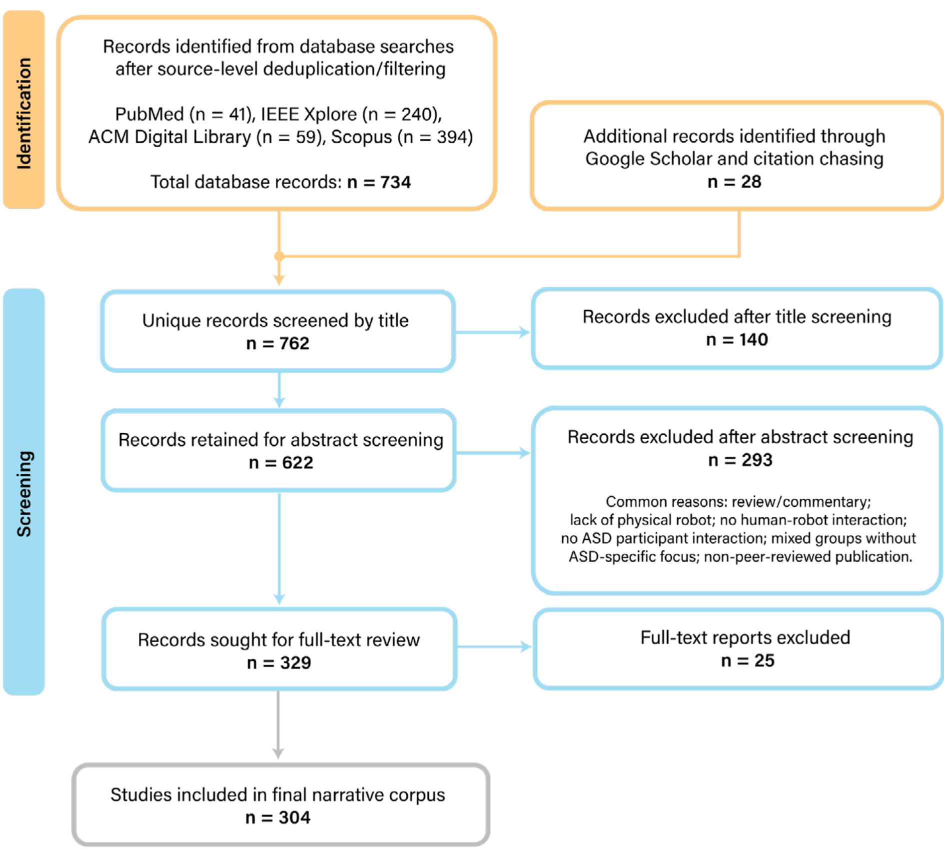

FIGURE A1 | PRISMA-style flow diagram for corpus construction.

screening, leaving 622 records for abstract screening. After abstract screening, 293 records were excluded, leaving 329 reports for full-text review. Twenty-five reports were excluded after full-text review. The final corpus consisted of 304 peer-reviewed empirical studies.

Eligibility Criteria

Studies were eligible for inclusion if they met all of the following criteria:

1. *Peer-reviewed publication type*: The study was published as a peer-reviewed journal article or peer-reviewed conference paper. Preprints, extended abstracts, posters, workshop abstracts, technical reports, dissertations, theses, and other non-peer-reviewed records were excluded.
2. *Target population*: The study involved participants with a formal diagnosis of autism spectrum disorder or a closely related diagnostic label used historically in the literature. Studies were included only when the diagnosis was explicitly stated, either through clinical diagnosis, standardized diagnostic instruments, or clear reporting by the authors.
3. *Physically embodied robot*: The intervention or interaction involved a physically present robot. Studies involving only virtual agents, screen-based avatars, simulated robots, or purely software-based systems were excluded.
4. *Direct human-robot interaction*: The study involved real-world interaction between at least one robot and at least one human participant with autism. Studies were excluded if they described robot design, simulation, technical architecture, or algorithmic development without direct interaction involving participants with ASD.
5. *Social or therapeutic role of the robot*: The robot played a direct role in social, communicative, behavioral, educational, or therapeutic interaction. Social interaction was defined broadly and included verbal or nonverbal communication, joint attention, imitation, emotion recognition or expression, cooperative tasks, turn-taking, social engagement, and robot-mediated interaction with another person. Studies were excluded when the robot was used only as a nonsocial mechanical aid, delivery device, reward system, or task platform without a direct role in social communication, social engagement, or autism-focused intervention.
6. *Autism-specific design or outcome relevance*: Studies involving mixed participant groups were included only when the design, analysis, or outcome focus was clearly relevant to participants with autism. Studies were excluded when individuals with autism were grouped with other populations and no clear autism-specific design rationale, analysis, or outcome focus was provided.

Appendix B: Review Corpus and Summary Table

The table below provides a high-level summary of the data and key study characteristics extracted from the review. To conserve space and improve readability, a set of standardized abbreviations is used throughout the table.

The "Venue" column indicates the domain of the publication, with **T** referring to technical venues (e.g., robotics, AI, HRI), **C** to clinical venues (e.g., medical or psychological journals), and **I** to interdisciplinary or other venues (e.g., education, rehabilitation).

Study design types are abbreviated as follows: **Case or SS** for case studies or single-subject designs, **Exp.|RCT** for randomized controlled trials and **Exp.|Non-RCT** for experimental design without a randomized control, **Obs.|CS** for observational cross-sectional studies, **Pilot** for pilot or feasibility studies, **Method** for methodological or validation work, and **System** for system/prototype descriptions. **Other|unk**. refers to study designs that were either unconventional or not clearly reported by the authors.

The "Targeted Skills" column reflects the focus of the intervention. **Cog**. refers to cognitive skills such as reasoning and problem-solving, **JA** to joint attention, **Eng**. to general social engagement, **Im**. to imitation, **Gaze** to visual attention or gaze-following, **Com.|NV** to non-verbal communication, and **Com.|V** to verbal communication. **Emo**. captures emotion recognition or expression, **TT** denotes turn-taking, **Motor** refers to motor skills or coordination, **Stereotypy** reflects efforts to reduce repetitive behaviors, and **Sensory** relates to sensory engagement.

Participant age groups are coded as **Early** for early childhood (0–5 years), **Middle** for middle childhood (6–12 years), **Teen** for adolescence (13–17 years), **Adult** for participants 18 years or older, and **Mixed** for studies spanning multiple age ranges.

The robot column lists either the robot platform (e.g., NAO, KASPAR, Keepon) or **Custom** for bespoke robots. **Other|G** refers to general-purpose platforms. Autonomy is marked as **A** for fully autonomous operation, **S** for partially or semi-autonomous, and **N** for non-autonomous control.

The robot's role is denoted as **Peer** (social companion), **Trainer** (instructor, therapist, or coach), **Mediator** (facilitator of social interaction), or **Other|G** for generalized roles.

Lastly, the "Interaction Structure" column describes the social configuration of the intervention: **Dyadic** indicates one-on-one interaction between the child and the robot; **Triadic|Ther**. involves a child–robot–therapist configuration; **Triadic|Peer** includes a peer who mediates or participates in the interaction; **Triadic|Parent** denotes caregiver involvement; and **Triadic|Other** refers to other triadic arrangements not captured by the previous categories. Group-based or nonstandard configurations are listed as **Other**.

The label **unk**. is used throughout to indicate missing or unreported data.

TABLE B1 | Summary of the review corpus.

Citation	Venue	Study design	Targeted skills	Location	Age group	Robot	Operation	Role	Structure
Abu-Amara et al. (2024)	T	Exp.|Non-RCT	Other|*unk.*	Clinic	Middle	NAO	S	Trainer	Dyadic
Ackovska and Ilijoski (2023)	T	Exp.|Non-RCT	Daily Living Skills, Gaze, Im., TT, Com.|V	Clinic	Mixed	KASPAR	S	Trainer	Dyadic
Urdanivia Alarcon et al. (2021)	T	Qualitative	Cog.	School	Middle	NAO	A	Trainer	Dyadic
Albo-Canals et al. (2013)	T	Exp.|Non-RCT	Eng., JA, Eng.	School	Middle	LEGO	S	Peer	Other
Ali et al. (2019)	T	Exp.|Non-RCT	Cog., Im., JA	Clinic	Mixed	NAO	A	Trainer	Dyadic
Ali, Mehmood, Khan, et al. (2020)	T	Exp.|Non-RCT	Cog., JA	Clinic	Mixed	NAO	S	Peer	Other
Ali, Mehmood, Ayaz, et al. (2020)	T	Exp.|Non-RCT	Gaze, JA	Clinic	Middle	NAO	S	Trainer	Dyadic
Ali et al. (2022)	C	Exp.|Non-RCT	Cog., Im., JA	Clinic	Early	NAO	S	Trainer	Dyadic
Al-Nafjan et al. (2023)	C	Exp.|Non-RCT	Emo., Eng.	Clinic	Middle	*unk.*	S	Trainer	Dyadic
Alnajjar et al. (2021)	T	Exp.|Non-RCT	Cog., JA, Eng.	Clinic	Middle	NAO	S	Trainer	Dyadic
Amirabdollahian et al. (2011)	T	Obs.|CS	Sensory	School	Early	KASPAR	S	Peer	Dyadic
Amirova et al. (2023)	C	Exp.|Non-RCT	Gaze, Eng.	Clinic	Middle	NAO	S	Peer	Triadic|Ther.
Pop, Simut, et al. (2013)	T	Exp.|Non-RCT	Emo.	Clinic	Early	Probo	S	Peer	Dyadic
Andreae et al. (2014)	I	Exp.|Non-RCT	Eng., Motor, Com.|V	Home	Middle	Auti	S	Peer	Dyadic
Annunziata et al. (2024)	C	Exp.|Non-RCT	Im., Motor, Com.|NV	Clinic	Early	NAO	S	Peer	Triadic|Ther.
Anzalone et al. (2014)	C	Exp.|Non-RCT	Gaze, Eng., JA, Eng.	Lab	Mixed	NAO	S	Trainer	Dyadic
Attawibulkul et al. (2019)	I	Exp.|Non-RCT	Other|*unk.*	School	Middle	BLISS	S	Peer	Triadic|Ther.
Axelsson et al. (2019)	T	Exp.|Non-RCT	Cog., Eng., Im., Com.|V	Clinic	Mixed	InMoov	S	Trainer	Dyadic
Aziz et al. (2015)	T	Exp.|Non-RCT	Other|*unk.*	Lab	Early	NAO	S	Peer	Dyadic
Baraka et al. (2020)	T	Case or SS	Other|*unk.*	Clinic	Early	NAO	A	Trainer	Dyadic
Baraka et al. (2022)	T	Exp.|Non-RCT	Cog., JA	Clinic	Early	NAO	N	Trainer	Triadic|Ther.
Barakova et al. (2015)	T	Case or SS	Eng., TT	School	Middle	NAO	S	Peer	Other
Barnes et al. (2021)	T	Exp.|Non-RCT	Cog., Im., Eng., Motor	Lab	Mixed	NAO	S	Other|G	Dyadic
Begum et al. (2015)	T	Case or SS	Eng.	Facility	Teen	NAO	S	Trainer	Triadic|Parent
Esubalew et al. (2012)	I	System	Cog., JA	Lab	Early	NAO	S	Trainer	Dyadic
Bekele et al. (2011)	T	Exp.|Non-RCT	Cog., JA	Lab	Early	NAO	S	Trainer	Triadic|Peer

(Continues)

TABLE B1 | (Continued)

Citation	Venue	Study design	Targeted skills	Location	Age group	Robot	Operation	Role	Structure
Bekele et al. (2014)	C	Case or SS	Gaze, JA	Clinic	Early	NAO	S	Trainer	Triadic|Peer
van den Berk-Smeekens et al. (2020)	I	Exp.|Non-RCT	Eng.	Clinic	Early	NAO	S	Trainer	Triadic|Parent
van den Berk-Smeekens et al. (2022)	C	Exp.|RCT	Eng.	Clinic	Early	NAO	S	Trainer	Triadic|Ther.
Bharatharaj et al. (2016)	T	Exp.|Non-RCT	Cog., Emo., Eng.	School	Middle	KiliRo	S	Peer	Triadic|Peer
Bharatharaj, Huang, Al-Jumaily, Elara, and Krägeloh (2017)	T	Exp.|Non-RCT	Cog., Im., JA	Other|*unk.*	Middle	KiliRo	S	Peer	Dyadic
Bharatharaj, Huang, Mohan, et al. (2017)	T	Pilot or Feasibility	Cog., Eng.	Clinic	Middle	KiliRo	S	Peer	Dyadic
Bharatharaj, Huang, Al-Jumaily, Mohan, and Krägeloh (2017)	I	Exp.|Non-RCT	Emo., Eng.	School	Middle	KiliRo	S	Peer	Dyadic
Billard et al. (2007)	T	Longitudinal	Cog., Im., JA, TT	Lab	Mixed	Robota	A	Peer	Triadic|Other
Billing et al. (2020)	I	Other|*unk.*	Cog., Im., JA, TT	Clinic	Early	NAO	A	Trainer	Triadic|Ther.
Bird et al. (2007)	I	Exp.|Non-RCT	Im.	Lab	Adult	*unk.*	A	Other|G	Dyadic
Boccanfuso et al. (2017)	T	Exp.|Non-RCT	Cog., Im., JA, TT, Com.|V	Lab	Early	CHARLIE	S	Peer	Triadic|Other
Brienza et al. (2023)	T	Case or SS	JA	Other|*unk.*	Early	NAO	S	Trainer	Dyadic
Bugnariu et al. (2013)	C	Exp.|Non-RCT	Im., JA, Motor	Clinic	Middle	NAO	N	Trainer	Triadic|Other
Cai et al. (2018)	T	Method	Cog., Im., JA, TT	Lab	Early	NAO	S	Trainer	Triadic|Peer
Cao, Song, et al. (2019)	T	Other|*unk.*	Cog., Eng., Im., Eng.	Clinic	Early	NAO	S	Trainer	Dyadic
Cao, Esteban, et al. (2019)	T	Exp.|Non-RCT	Cog., Im., JA, TT	Clinic	Early	NAO	S	Trainer	Triadic|Ther.
Cao et al. (2022)	T	Exp.|Non-RCT	Cog., Im.	Clinic	Early	NAO	S	Other|G	Dyadic
Casas-Bocanegra et al. (2020)	T	Case or SS	Cog., JA, Motor	Clinic	Middle	Custom	S	Peer	Dyadic
Cervera et al. (2019)	T	Exp.|RCT	Com.|NV, Com.|V	Clinic	Early	NAO	N	Trainer	Triadic|Parent
Chen et al. (2021)	T	System	Cog., Emo.	School	Mixed	Custom	A	Trainer	Dyadic
Chevalier et al. (2016)	T	Exp.|Non-RCT	Gaze, JA	Clinic	Middle	NAO	N	Trainer	Dyadic
Chevalier et al. (2017)	T	Exp.|Non-RCT	Im., Motor	Other|*unk.*	Middle	NAO	S	Trainer	Dyadic
Chevalier et al. (2022)	T	Exp.|Non-RCT	Cog., JA	Clinic	Early	Cozmo	S	Trainer	Dyadic
Chung (2019)	C	Exp.|Non-RCT	Gaze, Com.|V	School	Middle	NAO	S	Trainer	Triadic|Peer

(Continues)

TABLE B1 | (Continued)

Citation	Venue	Study design	Targeted skills	Location	Age group	Robot	Operation	Role	Structure
Chung (2021)	C	Exp.|Non-RCT	Cog., JA, Com.|V	School	Middle	NAO	S	Trainer	Triadic|Ther.
Clabaugh et al. (2019)	T	Exp.|Non-RCT	Other|*unk.*	Home	Early	Custom	A	Trainer	Dyadic
Conn et al. (2008)	T	Exp.|Non-RCT	Emo., Eng.	Lab	Teen	Custom	S	Other|G	Dyadic
Conti et al. (2015)	T	Case or SS	Cog., Im., Eng.	Clinic	Middle	NAO	A	Trainer	Triadic|Peer
Conti et al. (2019)	T	Exp.|Non-RCT	Emo.	Other|*unk.*	Middle	NAO	S	Trainer	Dyadic
Coşkun et al. (2022)	T	Exp.|Non-RCT	Emo.	Other|*unk.*	Middle	KASPAR	S	Peer	Triadic|Ther.
Costa et al. (2009)	T	Exp.|Non-RCT	Cog.	School	Teen	KASPAR	S	Other|G	Dyadic
Costa et al. (2010)	T	Exp.|Non-RCT	Cog., JA, Motor, Sensory, TT	School	Teen	LEGO	S	Peer	Triadic|Ther.
Costescu et al. (2016)	C	Other|*unk.*	Other|*unk.*	Other|*unk.*	Middle	Keepon	S	Other|G	Dyadic
Costescu et al. (2017)	C	Exp.|Non-RCT	Other|*unk.*	Facility	Middle	Keepon	S	Trainer	Dyadic
Dautenhahn and Werry (2002)	T	Exp.|Non-RCT	Gaze	School	Middle	Labo-1	A	Peer	Dyadic
David et al. (2018)	T	Case or SS	Cog., JA	Other|*unk.*	Early	NAO	S	Trainer	Triadic|Peer
David et al. (2020)	C	Exp.|Non-RCT	TT	Other|*unk.*	Early	NAO	S	Other|G	Triadic|Peer
Dehkordi et al. (2015)	T	Obs.|CS	Other|*unk.*	Facility	Early	Custom	S	Other|G	Dyadic
Desideri et al. (2017)	I	Exp.|Non-RCT	Im., Eng.	Clinic	Early	NAO	S	Trainer	Dyadic
Desideri et al. (2018)	C	Case or SS	Im., Motor, Com.|V	Clinic	Middle	NAO	N	Other|G	Dyadic
Dimitrova et al. (2012)	T	Exp.|Non-RCT	Eng., Im.	School	Mixed	AdMoVeo	S	Peer	Triadic|Peer
Does et al. (2023)	T	Other|*unk.*	Cog.	School	Mixed	*unk.*	S	Trainer	Dyadic
Duquette et al. (2008)	T	Case or SS	Cog., JA, Eng., Com.|NV	Clinic	Mixed	Custom	S	Peer	Triadic|Ther.
Ercolano et al. (2024)	I	Exp.|Non-RCT	Im., Motor, Com.|NV	Clinic	Mixed	NAO	S	Trainer	Dyadic
Esteban et al. (2017)	T	Exp.|Non-RCT	Cog., Im., JA, TT	Clinic	Mixed	NAO, Probo, iRobiQ, CARO	S	Trainer	Triadic|Other
Fachantidis, Syriopoulou-Delli, Vezyrtzis, and Zygopoulou (2020)	C	Other|*unk.*	Gaze, Eng.	School	Middle	Custom	S	Peer	Other
Fachantidis, Syriopoulou-Delli, and Zygopoulou (2020)	C	Case or SS	Gaze, Com.|V	Other|*unk.*	Middle	Daisy	S	Trainer	Dyadic
Febtriko et al. (2018)	T	Exp.|Non-RCT	Eng.	School	Mixed	Custom	S	Other|G	Dyadic
Feil-Seifer and Mataric (2008)	T	Case or SS	Cog., Eng., TT	Lab	Mixed	Custom	A	Peer	Dyadic

(Continues)

TABLE B1 | (Continued)

Citation	Venue	Study design	Targeted skills	Location	Age group	Robot	Operation	Role	Structure
Feil-Seifer and Matarić (2009)	T	Exp.|Non-RCT	Gaze, JA, Com.|V	Clinic	Mixed	Custom	S	Peer	Triadic|Ther.
Feil-Seifer and Mataric (2011)	T	Exp.|Non-RCT	Eng.	Lab	Mixed	Custom	A	Peer	Triadic|Other
Feil-Seifer and Matarić (2012)	T	Exp.|Non-RCT	Other|*unk.*	Lab	Mixed	Custom	A	Peer	Triadic|Other
Feng et al. (2017)	T	Other|*unk.*	Im., Eng.	Lab	Early	NAO	A	Trainer	Dyadic
Feng et al. (2022)	T	Exp.|Non-RCT	Emo., Motor, TT	Lab	Mixed	NAO	A	Trainer	Dyadic
Fournier et al. (2024)	I	Exp.|Non-RCT	Im.	Clinic	Early	Pepper	A	Trainer	Triadic|Ther.
François et al. (2009)	I	Longitudinal	Cog., Emo., JA	School	Mixed	Custom	A	Peer	Triadic|Other
Fuentes-Alvarez et al. (2023)	T	Case or SS	Other|*unk.*	Lab	Teen	AR4A	A	Trainer	Dyadic
Gaitán-Padilla et al. (2022)	T	Case or SS	Cog., Emo., Im.	Clinic	Middle	CASTOR	N	Peer	Dyadic
Galán-Mena et al. (2016)	T	System	Eng.	Clinic	Mixed	Custom	S	Trainer	Other
Ghiglino et al. (2021)	C	Exp.|RCT	Eng.	Clinic	Early	Cozmo	A	Peer	Dyadic
Giannopulu and Pradel (2010)	C	Case or SS	Gaze, Motor, Com.|NV	Clinic	Middle	Custom	A	Peer	Other
Giannopulu and Pradel (2012)	I	Case or SS	Emo.	Clinic	Early	Custom	A	Peer	Other
Giannopulu (2013)	I	Case or SS	Gaze, Motor, Com.|NV, Com.|V	Clinic	Middle	Custom	A	Peer	Triadic|Ther.
Greczek et al. (2014)	T	Exp.|Non-RCT	Im.	School	Middle	NAO	A	Trainer	Dyadic
Hirokawa et al. (2016)	T	Method	Emo., Eng.	Clinic	Middle	NAO	S	Peer	Dyadic
Holeva et al. (2024)	C	Exp.|RCT	Stereotypy, Emo., Eng.	Clinic	Mixed	NAO	S	Trainer	Triadic|Ther.
Huijnen et al. (2021)	T	Exp.|Non-RCT	Cog., Im., Motor, Com.|NV, Com.|V	School	Mixed	KASPAR	S	Trainer	Triadic|Other
Huskens et al. (2013)	C	Exp.|Non-RCT	Other|*unk.*	School	Middle	NAO	A	Trainer	Dyadic
Huskens et al. (2015)	C	Case or SS	TT, Com.|V	Clinic	Mixed	NAO	A	Trainer	Triadic|Peer
Ilijoski et al. (2022)	T	Other|*unk.*	Cog., Im., JA, Com.|NV	Clinic	Mixed	KASPAR	A	Trainer	Triadic|Ther.
Ishak et al. (2019)	T	Other|*unk.*	Im.	Clinic	Mixed	Rero	A	Trainer	Triadic|Ther.
Ismail et al. (2012a)	I	Exp.|Non-RCT	Gaze, Com.|V	Clinic	Mixed	NAO	A	Peer	Dyadic
Ismail et al. (2012b)	I	Exp.|Non-RCT	Motor	Clinic	Mixed	NAO	A	Trainer	Dyadic
Ivani et al. (2022)	I	System	Im., Motor, Com.|NV, TT	Clinic	Early	NAO	S	Trainer	Triadic|Ther.
Jain et al. (2020)	T	Longitudinal	Cog., Emo., Eng., Com.|V	Home	Mixed	Kiwi	A	Peer	Dyadic
Javed et al. (2018)	T	Pilot or Feasibility	Cog., Eng.	Clinic	Mixed	NAO	A	Trainer	Dyadic

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TABLE B1 | (Continued)

Citation	Venue	Study design	Targeted skills	Location	Age group	Robot	Operation	Role	Structure
Javed and Park (2019)	T	Exp.|Non-RCT	Im., Eng., TT	Clinic	Mixed	Romo	S	Trainer	Dyadic
Javed et al. (2020)	T	Other|*unk.*	Emo., Eng., Motor, Com.|NV	Clinic	Mixed	Romo	S	Trainer	Dyadic
Jordan et al. (2013)	C	Exp.|Non-RCT	Stereotypy, TT	School	Teen	iROBi-Q	S	Trainer	Triadic|Peer
Kaboski et al. (2015)	C	Other|*unk.*	Cog., JA, Eng., TT	School	Mixed	LEGO	A	Peer	Other
Karakosta et al. (2019)	T	Other|*unk.*	Gaze, Eng., Im., Eng., Motor, Com.|NV, Com.|V	School	Mixed	KASPAR	S	Peer	Triadic|Ther.
Karim et al. (2023)	T	Other|*unk.*	Com.|NV	Clinic	Mixed	NAO	S	Trainer	Dyadic
Kim et al. (2012)	C	Exp.|Non-RCT	Cog., Emo., Eng., TT, Com.|V	Clinic	Mixed	Pleo	S	Peer	Triadic|Peer
Kim et al. (2013)	T	Exp.|Non-RCT	Emo., Eng.	Clinic	Mixed	Pleo	S	Trainer	Dyadic
Kim et al. (2014)	T	Case or SS	Eng.	Clinic	Mixed	NAO	S	Trainer	Triadic|Ther.
Kim et al. (2021)	T	Case or SS	Eng.	Clinic	Mixed	NAO	S	Other|G	Triadic|Ther.
Kim et al. (2022)	T	Case or SS	Eng.	Clinic	Mixed	NAO	S	Other|G	Triadic|Parent
Kim and Iwai (2024)	T	Case or SS	Eng., Com.|V	School	Teen	Sota	S	Other|G	Triadic|Peer
Koch et al. (2017)	T	Exp.|Non-RCT	Emo.	Clinic	Mixed	SAM	A	Trainer	Dyadic
Konishi et al. (2024)	C	Exp.|Non-RCT	Emo., Eng.	Clinic	Adult	Android ST	S	Other|G	Dyadic
Korneder et al. (2022)	T	Case or SS	Com.|V	Clinic	Mixed	NAO	S	Trainer	Dyadic
De Korte et al. (2020)	C	Exp.|RCT	Other|*unk.*	School	Early	NAO	S	Other|G	Triadic|Ther.
Kostrubiec and Kruck (2020)	T	Other|*unk.*	TT	School	Mixed	Custom	A	Trainer	Triadic|Peer
Kostrubiec et al. (2024)	T	Exp.|Non-RCT	Eng.	Clinic	Mixed	Nao	S	Trainer	Triadic|Ther.
Kozima et al. (2007)	C	Case or SS	Emo., Gaze, JA, Eng.	Clinic	Early	Keepon	A	Other|G	Triadic|Parent
Kozima et al. (2009)	T	Case or SS	Emo., Gaze, Im., JA	School	Mixed	Keepon	A	Other|G	Triadic|Ther.
Kumazaki, Warren, Corbett, et al. (2017)	C	Exp.|Non-RCT	Other|*unk.*	Clinic	Adult	Actroid-F	S	Other|G	Dyadic
Kumazaki, Warren, Muramatsu, et al. (2017)	I	Exp.|Non-RCT	Other|*unk.*	Clinic	Teen	ACTROID-F, M3-Synchy	S	Other|G	Dyadic
Kumazaki et al. (2018)	C	Exp.|Non-RCT	Cog., JA	Clinic	Mixed	CommU	S	Trainer	Dyadic
Kumazaki, Muramatsu, Yoshikawa, Yoshimura, et al. (2019)	C	Exp.|Non-RCT	Cog., Eng., JA	Clinic	Mixed	CommU	A	Trainer	Triadic|Peer

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TABLE B1 | (Continued)

Citation	Venue	Study design	Targeted skills	Location	Age group	Robot	Operation	Role	Structure
Kumazaki, Warren, et al. (2019)	C	Exp.|Non-RCT	Cog., Eng.	Clinic	Early	Actroid-F, CommU	S	Other|G	Other
Kumazaki, Muramatsu, Yoshikawa, Matsumoto, et al. (2019)	C	Exp.|Non-RCT	Motor, Com.|NV, Com.|V	Clinic	Adult	Actroid-F	S	Other|G	Dyadic
Kumazaki, Muramatsu, Yoshikawa, Corbett, et al. (2019)	C	Exp.|Non-RCT	Cog., Eng.	Clinic	Adult	Actroid-F	S	Other|G	Dyadic
Kumazaki et al. (2021)	C	Exp.|Non-RCT	Other|*unk.*	Clinic	Adult	CommU	S	Peer	Triadic|Peer
Kumazaki et al. (2022)	C	Exp.|Non-RCT	Sensory	Clinic	Teen	A-Lab ST	S	Other|G	Dyadic
Kwon et al. (2015)	T	Case or SS	Gaze, Im., Motor, Com.|V	Clinic	Mixed	Custom	S	Other|G	Dyadic
Lakatos et al. (2020)	T	Exp.|Non-RCT	Other|*unk.*	School	Middle	KASPAR	S	Trainer	Dyadic
Lecciso et al. (2021)	C	Other|*unk.*	Com.|NV	Clinic	Middle	Zeno	S	Trainer	Dyadic
Lee, Takehashi, Nagai, and Obinata (2012)	T	Exp.|Non-RCT	Gaze, Com.|NV, Com.|V	Clinic	Middle	Ifbot	S	Trainer	Dyadic
Lee, Takehashi, Nagai, Obinata, and Stefanov (2012)	T	Exp.|Non-RCT	Motor	Clinic	Mixed	Custom	A	Trainer	Dyadic
Lee et al. (2013)	T	Exp.|Non-RCT	Cog., Gaze	Clinic	Adult	Custom	A	Other|G	Dyadic
Lee and Obinata (2013)	T	Exp.|Non-RCT	Motor	Clinic	Mixed	Custom	S	Other|G	Dyadic
Lee et al. (2014)	T	Exp.|Non-RCT	Emo., Eng., Motor	Clinic	Mixed	Ifbot	S	Trainer	Dyadic
Lee and Nagae (2021)	I	Exp.|Non-RCT	Other|*unk.*	Clinic	Mixed	NAO	S	Peer	Triadic|Ther.
Lemaignan et al. (2024)	T	Longitudinal	Eng.	School	Teen	Pepper	S	Peer	Triadic|Peer
Lin et al. (2022)	T	Case or SS	Other|*unk.*	Clinic	Early	Custom	S	Peer	Triadic|Ther.
Liu et al. (2007)	T	Exp.|Non-RCT	Eng.	Clinic	Teen	Custom	A	Other|G	Dyadic
Liu et al. (2008)	T	Exp.|Non-RCT	Emo., Eng.	Clinic	Teen	CRS Catalyst-5	A	Trainer	Dyadic
Liu et al. (2016)	T	Exp.|Non-RCT	Im., Motor	Clinic	Mixed	NAO	A	Peer	Triadic|Peer
Lorenzo and Lorenzo-Lledó (2024)	T	Exp.|Non-RCT	Emo., Eng.	School	Mixed	NAO	S	Peer	Triadic|Ther.
Louie et al. (2020)	T	Case or SS	Other|*unk.*	Clinic	Early	NAO	N	Trainer	Dyadic
Lund et al. (2009)	T	Case or SS	Other|*unk.*	Clinic	Mixed	Custom	A	Other|G	Triadic|Ther.
Lytridis et al. (2022)	T	Case or SS	Gaze, Eng.	Clinic	Mixed	NAO	A	Other|G	Triadic|Ther.

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TABLE B1 | (Continued)

Citation	Venue	Study design	Targeted skills	Location	Age group	Robot	Operation	Role	Structure
Malik et al. (2013)	I	Pilot or Feasibility	Cog., Im.	Clinic	Mixed	NAO	S	Trainer	Dyadic
Manner (2015)	T	Pilot or Feasibility	Cog., Eng., Im.	Clinic	Early	NAO	S	Trainer	Triadic|Parent
Marathaki et al. (2022)	C	Exp.|Non-RCT	Gaze, Im.	School	Mixed	NAO	S	Trainer	Triadic|Ther.
Marino et al. (2020)	C	Exp.|RCT	Other|*unk.*	Clinic	Mixed	NAO	S	Trainer	Other
Martínez et al. (2022)	T	Case or SS	Cog., Motor, Com.|NV	School	Mixed	Custom	S	Peer	Triadic|Peer
Mavadati et al. (2014)	T	Exp.|Non-RCT	JA, Com.|V	Clinic	Teen	NAO	S	Other|G	Dyadic
Mavadati et al. (2016)	T	Case or SS	Cog., JA, Com.|NV, Com.|V	Clinic	Mixed	NAO	S	Trainer	Triadic|Peer
Mayadunne et al. (2020)	T	Exp.|Non-RCT	Motor	Clinic	Mixed	Custom	S	Peer	Triadic|Ther.
Mazzei et al. (2010)	T	Case or SS	Emo., Emo., Im., Eng.	Lab	Mixed	FACE	S	Trainer	Triadic|Ther.
Mazzei et al. (2011)	T	Exp.|Non-RCT	Cog., Emo., Im.	Lab	Adult	FACE	S	Trainer	Triadic|Ther.
Mazzei et al. (2012)	T	Exp.|Non-RCT	Cog., Emo.	Lab	Mixed	FACE	A	Trainer	Triadic|Ther.
Mehmood et al. (2021)	T	Exp.|Non-RCT	Cog.	Clinic	Mixed	NAO	S	Trainer	Triadic|Ther.
Mehralizadeh et al. (2023)	T	Exp.|Non-RCT	Stereotypy, Eng., Sensory	Clinic	Mixed	Custom	S	Trainer	Triadic|Ther.
Melo et al. (2019)	I	Longitudinal	Cog., Eng., TT	Clinic	Mixed	Astro	A	Trainer	Triadic|Ther.
Meltzoff et al. (2010)	I	Exp.|RCT	Gaze, JA	Lab	Early	HOAP-2	A	Peer	Dyadic
Mengoni et al. (2017)	I	Exp.|RCT	Cog., Eng., Im., JA, TT	Clinic	Mixed	KASPAR	*unk.*	Trainer	Triadic|Ther.
Moorthy and Pugazhenthi (2016)	T	Exp.|Non-RCT	Im., Motor	Clinic	Mixed	LEGO	A	Trainer	Dyadic
Nakadoi (2015)	T	Case or SS	Emo.	Clinic	Mixed	PARO	A	Peer	Triadic|Peer
Niderla and Maciejewski (2021)	T	Pilot or Feasibility	Emo., Eng.	Clinic	Mixed	Custom	S	Peer	Triadic|Ther.
Nie et al. (2018)	T	Exp.|Non-RCT	Cog., JA	Clinic	Early	NAO	S	Trainer	Dyadic
Nie et al. (2024)	T	Exp.|RCT	JA, Eng.	Clinic	Early	NORRIS	A	Trainer	Triadic|Ther.
Nunez et al. (2015)	T	Case or SS	Eng., TT	Clinic	Mixed	Custom	S	Peer	Dyadic
Di Nuovo et al. (2018)	T	Other|*unk.*	Cog., Gaze, Im.	Clinic	Mixed	NAO	S	Trainer	Dyadic
Oliver et al. (2019)	T	Obs.|CS	Cog., Im., JA, TT	Clinic	Mixed	Cozmo	*unk.*	Trainer	Triadic|Parent
van Otterdijk et al. (2020)	T	Other|*unk.*	Cog., Eng.	Other|*unk.*	Early	NAO	S	Peer	Triadic|Parent
Paengkumhag et al. (2023)	I	Other|*unk.*	Cog., Eng.	Clinic	Mixed	BLISS	A	Trainer	Triadic|Peer
Pakkar et al. (2019)	T	Case or SS	Cog., Emo., JA	Home	Mixed	SPRITE	A	Trainer	Dyadic

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TABLE B1 | (Continued)

Citation	Venue	Study design	Targeted skills	Location	Age group	Robot	Operation	Role	Structure
Palestra, De Carolis, et al. (2017)	I	Case or SS	Cog., Gaze	Clinic	Middle	NAO	A	Trainer	Dyadic
Palestra, Cazzato, et al. (2017)	T	Exp.|Non-RCT	Cog., JA, Com.|V	Clinic	Mixed	NAO	S	Trainer	Triadic|Ther.
Panceri et al. (2021)	T	Exp.|Non-RCT	Stereotypy, Cog., JA, Motor, Com.|V	Clinic	Mixed	Custom	A	Trainer	Triadic|Ther.
Papazoglou et al. (2021)	T	Exp.|Non-RCT	Eng.	School	Mixed	LEGO	*unk.*	Peer	Other
Peca et al. (2014)	T	Exp.|Non-RCT	Cog.	School	Mixed	Keepon, Nao, Probo, Pleo, KASPAR, Rombo	A	Other|G	Dyadic
Pérez-Vázquez et al. (2023)	T	Case or SS	Com.|V	School	Mixed	Bee-Bot	*unk.*	Trainer	Dyadic
Peribañez et al. (2023)	T	Exp.|Non-RCT	Cog.	Clinic	Mixed	Ozobot	*unk.*	Trainer	Dyadic
Petric et al. (2017)	T	Exp.|Non-RCT	Cog., Im., JA, Com.|NV	Clinic	Mixed	NAO	S	Trainer	Triadic|Ther.
Pierno et al. (2008)	I	Exp.|Non-RCT	Im., Motor	Clinic	Mixed	Custom	S	Trainer	Dyadic
Pinto-Bernal et al. (2022)	T	Other|*unk.*	Gaze	Clinic	Mixed	CASTOR	S	Trainer	Triadic|Ther.
Pioggia et al. (2005)	T	Case or SS	Cog., Emo., Im.	Clinic	Middle	FACE	S	Trainer	Dyadic
Pioggia et al. (2007)	T	Exp.|Non-RCT	Gaze, Im.	Clinic	Mixed	FACE	A	Trainer	Dyadic
Pioggia et al. (2008)	C	Exp.|Non-RCT	Cog., Im.	Clinic	Mixed	FACE	S	Trainer	Dyadic
Tartarisco et al. (2022)	T	Exp.|Non-RCT	Other|*unk.*	Lab	Mixed	QT	S	Trainer	Other
Pliasa and Fachantidis (2019)	T	Exp.|Non-RCT	TT, Com.|V	School	Early	Daisy	S	Mediator	Triadic|Peer
Pop, Petrule, et al. (2013)	C	Case or SS	Cog., Im., Motor	Clinic	Early	Robonova-1	A	Trainer	Dyadic
Pop, Simut, et al. (2013)	C	Exp.|Non-RCT	Gaze, Eng., Com.|V	Clinic	Mixed	Probo	A	Trainer	Triadic|Ther.
Pop et al. (2014)	I	Exp.|Non-RCT	Gaze, Eng., Com.|V	Clinic	Mixed	Probo	A	Other|G	Triadic|Ther.
Ghorbandaei Pour et al. (2018)	T	Exp.|Non-RCT	Cog., Emo., Im., JA, Com.|NV	Clinic	Early	R50-Alice	S	Peer	Dyadic
Pradel et al. (2010)	T	Pilot or Feasibility	Cog., Im., Eng., Sensory	Clinic	Mixed	Custom	A	Mediator	Triadic|Ther.
Puyon and Giannopulu (2013)	T	Exp.|Non-RCT	Cog., Gaze, Com.|V	Clinic	Mixed	Custom	A	Mediator	Dyadic
Qidwai et al. (2020)	T	Exp.|Non-RCT	Cog.	School	Middle	NAO	S	Peer	Triadic|Other
Rakhymbayeva et al. (2021)	T	Exp.|Non-RCT	Gaze, Im., Eng.	Clinic	Mixed	NAO	A	Mediator	Triadic|Ther.
Ramirez-Duque et al. (2018)	T	Obs.|CS	Gaze, JA	Clinic	Mixed	ONO	S	Trainer	Triadic|Ther.

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TABLE B1 | (Continued)

Citation	Venue	Study design	Targeted skills	Location	Age group	Robot	Operation	Role	Structure
Ramirez-Duque et al. (2019)	T	Obs.|CS	Cog., Im., JA	Clinic	Mixed	ONO	S	Mediator	Triadic|Ther.
Ramirez-Duque et al. (2020)	T	Exp.|Non-RCT	Gaze, JA	Clinic	Mixed	ONO	S	Trainer	Triadic|Ther.
Ramnauth et al. (2022)	T	Exp.|Non-RCT	Cog.	Home	Adult	Jibo	A	Trainer	Dyadic
Ranatunga et al. (2012)	T	Exp.|Non-RCT	Im., Motor, Com.|NV	Clinic	Middle	Zeno	S	Trainer	Dyadic
Robins, Dautenhahn, et al. (2004)	T	Exp.|Non-RCT	Gaze, Im., TT	School	Mixed	Robota	A	Peer	Triadic|Peer
Robins, Dickerson, et al. (2004)	I	Exp.|Non-RCT	Gaze, JA, Motor, Com.|NV	School	Mixed	Robota	A	Peer	Triadic|Ther.
Robins et al. (2005)	I	Exp.|Non-RCT	Gaze, Im., JA, Motor, TT	School	Mixed	Robota	A	Peer	Triadic|Peer
Robins et al. (2009)	T	Obs.|CS	Gaze, Im., JA, Motor	School	Mixed	KASPAR	S	Mediator	Triadic|Ther.
Robins and Dautenhahn (2014)	T	Case or SS	Cog., Im., JA, TT	School	Mixed	KASPAR	S	Peer	Triadic|Ther.
Robles-Bykbaev et al. (2018)	I	Other|*unk.*	Cog.	School	Mixed	Custom	S	Trainer	Triadic|Ther.
Rodríguez-Quevedo et al. (2023)	T	Case or SS	Emo., Eng.	School	Mixed	NAO	S	Trainer	Triadic|Peer
Romero-García et al. (2021)	T	Other|*unk.*	Gaze, Motor, Com.|NV	Clinic	Early	NAO	S	Trainer	Triadic|Ther.
Rudovic et al. (2017)	T	Other|*unk.*	Cog., Emo., Im., Eng.	Clinic	Mixed	NAO	A	Trainer	Triadic|Ther.
Rudovic et al. (2018)	T	System	Cog., Emo., Eng.	Clinic	Mixed	NAO	S	Other|G	Triadic|Ther.
Saadatzi et al. (2018a)	C	Other|*unk.*	Cog.	School	Adult	NAO	S	Peer	Triadic|Peer
Saadatzi et al. (2018b)	C	Other|*unk.*	Cog.	Clinic	Early	NAO	S	Peer	Triadic|Other
Saha et al. (2021)	T	Other|*unk.*	Cog., Im., JA, TT	Clinic	Mixed	NAO	S	Trainer	Triadic|Ther.
Salter et al. (2006)	T	Obs.|CS	Eng., Motor	Lab	Early	Pekee	A	Other|G	Dyadic
Salvador et al. (2015)	T	Other|*unk.*	Emo.	Lab	Mixed	Zeno	S	Trainer	Dyadic
Sandygulova et al. (2019)	T	Other|*unk.*	Emo., Im., TT	Clinic	Mixed	NAO	S	Trainer	Triadic|Ther.
Sandygulova et al. (2022)	T	Obs.|CS	Emo., Emo., Im., Eng.	Clinic	Mixed	NAO	S	Peer	Triadic|Ther.
Santos et al. (2019)	I	Other|*unk.*	Cog., Im., Motor, Com.|NV	Clinic	Mixed	NAO	S	Trainer	Triadic|Ther.
Santos et al. (2022)	T	Other|*unk.*	JA	Clinic	Early	NAO	S	Peer	Triadic|Ther.
Scassellati et al. (2018)	T	Case or SS	Cog., Emo., JA	Home	Mixed	Jibo	A	Trainer	Triadic|Parent
Schadenberg et al. (2020)	T	Other|*unk.*	Com.|V	School	Mixed	Zeno/Milo	S	Trainer	Triadic|Ther.
Schadenberg et al. (2021)	T	Other|*unk.*	Cog., Gaze, Eng.	School	Mixed	Zeno	S	Trainer	Triadic|Peer
da Luz Schreider et al. (2024)	I	Exp.|Non-RCT	Motor	Other|*unk.*	Mixed	MARIA T21	S	Trainer	Triadic|Ther.

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TABLE B1 | (Continued)

Citation	Venue	Study design	Targeted skills	Location	Age group	Robot	Operation	Role	Structure
Shahverdi et al. (2023)	T	Exp.|Non-RCT	Gaze, Motor, Com.|NV	Clinic	Adult	Furhat	S	Trainer	Dyadic
Shamsuddin, Yussof, Ismail, Mohamed, et al. (2012a)	I	Case or SS	Stereotypy, Gaze, Eng.	Clinic	Mixed	NAO	A	Trainer	Triadic|Peer
Shamsuddin, Yussof, Ismail, Mohamed, et al. (2012b)	T	Obs.|CS	Gaze, Eng., Im., Motor, Com.|NV	Clinic	Mixed	NAO	S	Trainer	Triadic|Peer
Shamsuddin, Yussof, Ismail, Hanapiah, et al. (2012)	I	Case or SS	Emo., Motor, Com.|NV	Clinic	Mixed	NAO	A	Trainer	Dyadic
Shamsuddin et al. (2013)	T	Other|*unk.*	Gaze, Eng., Motor, Com.|NV, Com.|V	Clinic	Mixed	NAO	S	Trainer	Triadic|Ther.
She et al. (2014)	T	Exp.|Non-RCT	Eng.	Clinic	Mixed	NAO	A	Trainer	Triadic|Peer
She et al. (2018)	T	Other|*unk.*	Com.|V	Clinic	Middle	LEO	S	Trainer	Dyadic
She and Ren (2021)	I	System	Com.|V	Lab	Mixed	NAO	S	Trainer	Dyadic
Shi et al. (2022)	T	Exp.|Non-RCT	Eng.	Home	Early	Custom	A	Other|G	Dyadic
De Silva et al. (2009)	T	Other|*unk.*	Gaze, Im., JA	Clinic	Mixed	HOAP-3	S	Trainer	Triadic|Peer
Ravindra et al. (2009)	T	Other|*unk.*	Gaze, JA, Motor, Com.|NV	Clinic	Mixed	HOAP-3	S	Trainer	Triadic|Peer
Silva et al. (2019)	I	Exp.|Non-RCT	Emo., Gaze, Eng., TT	Clinic	Adult	Zoomer	A	Peer	Triadic|Ther.
Silva et al. (2024)	T	Exp.|Non-RCT	Cog., Im., Motor, Com.|NV	School	Middle	NAO	S	Trainer	Triadic|Ther.
Silvera-Tawil et al. (2018)	T	Case or SS	Com.|V	School	Teen	NAO	S	Peer	Other
Simut, Vanderfaeillie, et al. (2016)	C	Exp.|Non-RCT	Emo., Gaze, JA	School	Early	Probo	S	Trainer	Triadic|Ther.
Simut, Van de Perre, et al. (2016)	C	Case or SS	Stereotypy, Com.|V	Clinic	Middle	Probogotchi	A	Peer	Dyadic
Singh et al. (2023)	T	Case or SS	Other|*unk.*	School	Mixed	Custom	A	Trainer	Dyadic
So, Wong, Lam, Cheng, et al. (2018)	C	Exp.|RCT	Motor, Com.|NV	School	Early	NAO	A	Trainer	Dyadic
So, Wong, Lam, Lam, et al. (2018)	C	Exp.|RCT	Com.|NV	School	Middle	NAO	A	Trainer	Dyadic
So et al. (2020)	C	Exp.|RCT	Cog., JA	Other|*unk.*	Early	NAO	A	Trainer	Triadic|Other
So, Cheng, et al. (2019)	C	Exp.|RCT	Cog., Motor, Com.|NV	Other|*unk.*	Early	NAO	A	Trainer	Triadic|Other
So, Wong, et al. (2019)	C	Exp.|RCT	Com.|NV	School	Middle	NAO	A	Trainer	Dyadic
So, Cheng, et al. (2023)	C	Other|*unk.*	Cog., JA	School	Early	HUMANE	S	Trainer	Dyadic
So, Law, et al. (2023)	C	Exp.|RCT	Cog., JA	School	Middle	HUMANE	S	Trainer	Dyadic

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TABLE B1 | (Continued)

Citation	Venue	Study design	Targeted skills	Location	Age group	Robot	Operation	Role	Structure
Soares et al. (2019)	I	Case or SS	Emo., Emo., Im.	School	Middle	ZECA	S	Trainer	Triadic|Ther.
Soleiman et al. (2014)	T	Other|*unk.*	Cog., Gaze, Com.|V	Clinic	Early	RoboParrot	S	Peer	Triadic|Ther.
Soleiman et al. (2023)	T	Case or SS	Emo.	Other|*unk.*	Middle	RoboParrot, Red	S	Peer	Triadic|Peer
Sperati et al. (2020)	C	Pilot or Feasibility	Cog., Emo., Im., JA, Eng.	Clinic	Early	+me	S	Peer	Triadic|Parent
Srinivasan et al. (2013)	C	Exp.|Non-RCT	Im., Motor	Lab	Early	Isobot	A	Trainer	Dyadic
Srinivasan et al. (2015)	C	Exp.|RCT	Stereotypy, Emo.	Clinic	Middle	NAO, Rovio	S	Trainer	Triadic|Peer
Srinivasan et al. (2016)	C	Exp.|RCT	Cog.	Lab	Middle	NAO, Rovio	S	Other|G	Triadic|Ther.
Stanton et al. (2008)	T	Exp.|Non-RCT	Eng., Com.|V	Lab	Middle	AIBO	A	Peer	Triadic|Other
van Straten et al. (2018)	T	Exp.|Non-RCT	Eng.	Other|*unk.*	Early	NAO	S	Peer	Dyadic
Stribling et al. (2009)	C	Case or SS	Eng.	Clinic	Middle	Labo-1	A	Other|G	Dyadic
Suzuki and Lee (2016)	T	Obs.|CS	Emo., Im.	Clinic	Teen	NAO	A	Peer	Dyadic
Syrdal et al. (2020)	T	Longitudinal	Emo.	Other|*unk.*	Early	KASPAR	S	Peer	Triadic|Peer
Taheri et al. (2018a)	I	Case or SS	Gaze, Im., JA, Com.|NV, Com.|V	Clinic	Early	NAO, Alice-R50	S	Peer	Triadic|Ther.
Taheri et al. (2018b)	T	Case or SS	Cog., Im., JA, Com.|NV, Com.|V	Other|*unk.*	Early	NAO, Alice-R50	S	Trainer	Triadic|Peer
Taheri, Meghdari, and Mahoor (2021)	T	Exp.|Non-RCT	Cog., Im., JA, Motor	Clinic	Early	NAO	N	Trainer	Triadic|Peer
Taheri, Shariati, et al. (2021)	T	Exp.|Non-RCT	Cog., Im., JA, Eng.	Other|*unk.*	Early	NAO	S	Trainer	Triadic|Parent
Takata et al. (2023)	C	Exp.|Non-RCT	Emo.	Lab	Teen	A-Lab ST, CommU, Sota	S	Peer	Triadic|Other
Talaei-Khoei et al. (2017)	T	Case or SS	Cog., JA, TT	Lab	Middle	NAO	S	Peer	Dyadic
Telisheva et al. (2022)	T	Other|*unk.*	Cog., Emo., Im., JA, Eng., Com.|V	Clinic	Early	NAO	S	Peer	Triadic|Parent
Telisheva et al. (2022)	T	Other|*unk.*	Eng., Com.|V	Facility	Early	NAO	S	Trainer	Dyadic
Tleubayev et al. (2019)	I	Case or SS	Gaze, Im., Eng.	Facility	Middle	NAO	S	Peer	Dyadic
Trombly et al. (2022)	T	Exp.|Non-RCT	Emo., Eng.	Clinic	Early	Pepper	N	Trainer	Other

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TABLE B1 | (Continued)

Citation	Venue	Study design	Targeted skills	Location	Age group	Robot	Operation	Role	Structure
Valadão et al. (2016)	I	Other|*unk.*	Gaze, Im., Eng., Motor, Com.|V	Other|*unk.*	Early	Custom	N	Peer	Dyadic
Vanderborght et al. (2012)	I	Case or SS	Eng.	Other|*unk.*	Early	Probo	N	Trainer	Triadic|Ther.
Villano et al. (2011)	T	Case or SS	Eng.	Lab	Middle	NAO	N	Peer	Triadic|Ther.
Wainer et al. (2010)	T	Exp.|Non-RCT	Eng.	School	Middle	KASPAR	A	Peer	Dyadic
Wainer et al. (2014)	T	Exp.|Non-RCT	Emo.	School	Middle	KASPAR	A	Trainer	Triadic|Peer
Wan et al. (2019)	T	Other|*unk.*	Cog., Eng.	Facility	Early	Dabao, XiaoE, Mika	N	Peer	Triadic|Parent
Wanglavan et al. (2019)	T	Pilot or Feasibility	Cog., Eng.	School	Early	BLISS	S	Trainer	Dyadic
Warren, Zheng, Das, et al. (2015)	C	Exp.|Non-RCT	Cog., Im.	Lab	Early	NAO	A	Trainer	Dyadic
Warren, Zheng, Swanson, et al. (2015)	C	Other|*unk.*	JA	Lab	Early	NAO	N	Trainer	Dyadic
Welch et al. (2023)	T	Case or SS	Other|*unk.*	Other|*unk.*	Teen	NAO	N	Trainer	Dyadic
Werry et al. (2001)	T	Case or SS	Cog., Eng., Im., JA	School	Middle	Custom	A	Peer	Triadic|Peer
Wong and Zhong (2016)	T	Exp.|Non-RCT	Gaze, Im., JA, TT	School	Early	CuDDler	A	Trainer	Dyadic
Xie and Park (2024)	T	Exp.|Non-RCT	Other|*unk.*	Lab	Teen	Pepper	A	Peer	Dyadic
Cañete Yaque et al. (2021)	T	Exp.|Non-RCT	Eng., TT	Other|*unk.*	Early	Custom	S	Trainer	Dyadic
Yoshikawa et al. (2019)	C	Other|*unk.*	Gaze	Lab	Teen	Actroid-F	N	Peer	Dyadic
Yun et al. (2014)	T	Exp.|Non-RCT	Gaze, Im., Motor	Facility	Early	iRobi	A	Peer	Triadic|Ther.
Yun, Kim, et al. (2016)	T	Exp.|Non-RCT	Emo., Gaze	Facility	Early	iRobiQ, CARO	S	Peer	Triadic|Ther.
Yun, Choi, and Park (2016)	T	Exp.|Non-RCT	Emo., Gaze	Facility	Early	iRobiQ, CARO	S	Peer	Triadic|Ther.
Yun et al. (2017)	C	Exp.|RCT	Emo., Gaze	Clinic	Early	iRobiQ, CARO	S	Trainer	Dyadic
Yussof et al. (2015)	T	Exp.|Non-RCT	Stereotypy, Gaze, Im., Eng., Com.|NV, Com.|V	School	Middle	NAO	S	Peer	Dyadic
Zaraki et al. (2018)	T	System	Cog.	School	Teen	KASPAR	S	Peer	Triadic|Other
Zaraki et al. (2020)	T	Exp.|Non-RCT	Eng., TT	School	Mixed	KASPAR	A	Other|G	Triadic|Peer
Zhanatkyzy et al. (2023)	T	Exp.|Non-RCT	Cog., Emo., Im., JA, Motor, Sensory	Other|unk.	Early	NAO	S	Peer	Dyadic

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TABLE B1 | (Continued)

Citation	Venue	Study design	Targeted skills	Location	Age group	Robot	Operation	Role	Structure
Zhang, Song, Tan, Zhu, et al. (2019)	T	Other|*unk.*	Other|*unk.*	School	Early	NAO	A	Other|G	Dyadic
Zhang, Song, Tan, Wang, et al. (2019)	C	Other|*unk.*	Other|*unk.*	Lab	Early	NAO	A	Peer	Dyadic
Zheng et al. (2013)	T	Exp.|Non-RCT	Gaze, JA	Clinic	Early	NAO	S	Trainer	Dyadic
Zheng et al. (2014)	T	Exp.|Non-RCT	Cog., Im., Motor, Com.|NV	Clinic	Early	NAO	A	Trainer	Dyadic
Zheng et al. (2015)	T	Exp.|Non-RCT	Cog., Im., Motor, Com.|NV	Lab	Early	NAO	A	Trainer	Dyadic
Zheng et al. (2015)	T	Exp.|Non-RCT	Cog., Im., Motor, Com.|NV	Clinic	Early	NAO	A	Trainer	Dyadic
Zheng et al. (2017)	T	Exp.|Non-RCT	Gaze, JA	Lab	Early	NAO	A	Trainer	Dyadic
Zheng et al. (2020)	C	Exp.|RCT	Gaze, JA	Clinic	Early	NAO	A	Trainer	Dyadic