

Impact of Child-Centered Play Therapy on Children with Autism Spectrum Disorder: A Scoping Review

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Abstract Child-centered play therapy (CCPT) has shown significant potential in interventions for children with autism spectrum disorder (ASD). Long-term follow-up indicates that CCPT has positive effects on social interaction, speech and communication, stereotyped repetitive behaviors, and emotional regulation in children with ASD, and these effects can be generalized to daily life. Intelligent digital technologies, which are primarily based on virtual reality and AI techniques, have demonstrated significant potential in achieving personalized play therapy for children with ASD through the therapeutic process. In the age of AI, the “child-led + data-driven” two-dimensional CCPT paradigm is the development trend. The CCPT framework combines child-initiated participation with data-driven decision-making, supported by a hierarchical data architecture with dynamic feedback mechanisms.

Keywords child-centered play therapy, intelligent digital technology, personalized intervention, autism spectrum disorder, scoping review

1 Introduction

Autism spectrum disorder (ASD) is a neurodevelopmental disorder that is characterized by core features, which include social interaction impairments, language and communication disorders, stereotyped repetitive behaviors, and restricted interests (American Psychiatric Association, 2013). These disorders have a serious impact on children’s daily lives, learning, and social development (Shattuck et al., 2019). In the past decades, there has been more in-depth understanding of ASD, resulting in the enrichment and optimization of intervention methods, among which child-centered play

therapy (CCPT)—a child-centered intervention that emphasizes the promotion of children’s self-expression and growth through play—has received widespread attention (Müller & Donley, 2019; Schottelkorb et al., 2020).

CCPT is grounded in humanistic psychology theory. Virginia Axline, a key figure in this approach, has emphasized that children possess the potential for self-healing and growth (Axline, 1969; Bratton et al., 2005). Therapists create a safe and free play environment, allowing children to express their inner feelings, explore themselves, and solve problems. This process helps improve their emotions, behaviors, and social skills (Axline, 1969; Ray et al., 2015). In the field of ASD intervention, the therapy, with its unique child orientation and flexibility, provides a relatively easy and natural intervention pathway for children with ASD, helping alleviate their anxiety, enhance their motivation to engage in social interaction, and improve their emotional expression, among other favorable outcomes (Landreth et al., 2009).

However, traditional CCPT faces implementation challenges. Therapists need high-level professional expertise and keen observation skills to enable them to accurately interpret the complex information that children convey in play and to provide appropriate responses. Traditional CCPT has limitations in regard to personalized response, intervention accuracy, and effect quantification. Innovative technology integration is urgently needed to break through these existing bottlenecks. Moreover, the evaluation of intervention outcomes in traditional CCPT lacks objective and quantifiable metrics, thereby often relying on therapists’ subjective judgments. This limitation can hinder the therapy’s wider adoption and the accuracy of outcome assessment.

With the rapid development of technology, intelligent digital technologies (IDTs) have permeated various fields, offering new solutions to challenges in traditional intervention methods. In CCPT, IDTs such

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as virtual reality (VR) and AI can leverage their strengths in data processing, pattern recognition, and smart interaction to enable innovative breakthroughs in interventions for children with ASD. VR technology can create immersive learning platforms and scenarios for children with ASD, helping build efficient rehabilitation tools. It precisely targets interventions for these children, enabling them to achieve specific intervention goals (Ghanouni et al., 2021; Shahab et al., 2022). Computer vision technology can capture children's play behaviors in real time (Hashemi et al., 2021; McDuff et al., 2016) and analyze their movements and facial expressions (Basile et al., 2021; Fukuda et al., 2017), thereby providing therapists with comprehensive and objective behavioral data. Natural language processing technology can be employed to better understand children's verbal expressions, helping therapists accurately grasp their inner worlds (Cambria & White, 2014; Kocol et al., 2025). An intelligent game system based on AI can dynamically adjust the content and difficulty according to individual differences and real-time responses, enabling more personalized and precise interventions. Nevertheless, most existing studies focus on the application of a single technology and lack theoretical discussion and evaluation of the effects of the systematic integration of IDTs into the CCPT framework, thereby possibly leading to technology fragmentation and insufficient clinical applicability.

The purpose of this study is to systematically review the international literature on CCPT interventions for children with ASD and to analyze the integration of IDTs and CCPT to address three core questions: (1) the differences in the efficacy of CCPT interventions in relation to the core symptoms of ASD, (2) the application and current status of CCPT interventions, and (3) the potential of IDTs to facilitate CCPT interventions. This study will provide interdisciplinary researchers with an evidence map for technology selection and treatment design. It will also provide a rationale for standardization in the emerging field of digitally enhanced play therapy.

2 Methods

2.1 | Search Procedures

This review adheres to the PRISMA extension for scoping reviews (PRISMA-ScR). Literature searches were conducted across Web of Science, IEEE Xplore, APA PsycINFO, Psychology Database, APA PsycArticles, SocINDEX, Psychology & Behavioral Sciences Collection, ERIC (EBSCO), and PubMed. The following Boolean phrases were used: “child-centered play therapy,” “CCPT,” “non-directive play therapy,” “person-centered play therapy,” “humanistic play therapy,”

“autism,” “autism spectrum disorder,” and “ASD.” The search was conducted in April 2025. The articles included in the review had to meet the following four criteria:

- (a) children aged 12 and under;
- (b) explicit statement that the therapeutic approach was CCPT;
- (c) children with ASD;
- (d) exclusion of published reviews and meta-analyses not written in English.

The literature screening was conducted independently by two researchers. Initially, titles and abstracts were screened, followed by a full-text review of potentially eligible articles. Any disagreements during the screening process were first resolved through discussion. If consensus could not be reached, a third senior researcher was consulted for arbitration. Arbitration strictly adhered to predefined inclusion and exclusion criteria, with consensus serving as the final basis for decision-making.

The literature-screening process followed the PRISMA-ScR guidelines. Initially, 389 records were identified from the databases. After 235 duplicate records were removed, 154 records were screened based on titles and abstracts, of which 70 were excluded. The remaining 84 full-text articles were assessed for eligibility; of these, 71 were excluded for not meeting the inclusion criteria (20 for age, 15 for population, and 36 for intervention type). Finally, 13 studies were included in the systematic review. The specific reasons for and distribution of the exclusions during the full-text screening stage are detailed in PRISMA flow chart (Figure 1).

2.2 | Data Extraction

For each article included after the extended search, we extracted three major categories of core data: (1) children's information, including number of participants, gender, age, clinical presentation spectrum, treatment history, and family issues; (2) research protocol, including treatment goals, methods, therapist, duration and frequency, setting and materials, and monitoring; (3) intervention outcomes and effects, including outcome-measurement tools and intervention outcomes and effects.

3 Results

3.1 | Participant Data

3.1.1 Number, Gender, and Age of Participating Children

Significant differences in sample size were observed across studies, ranging from single-case to group

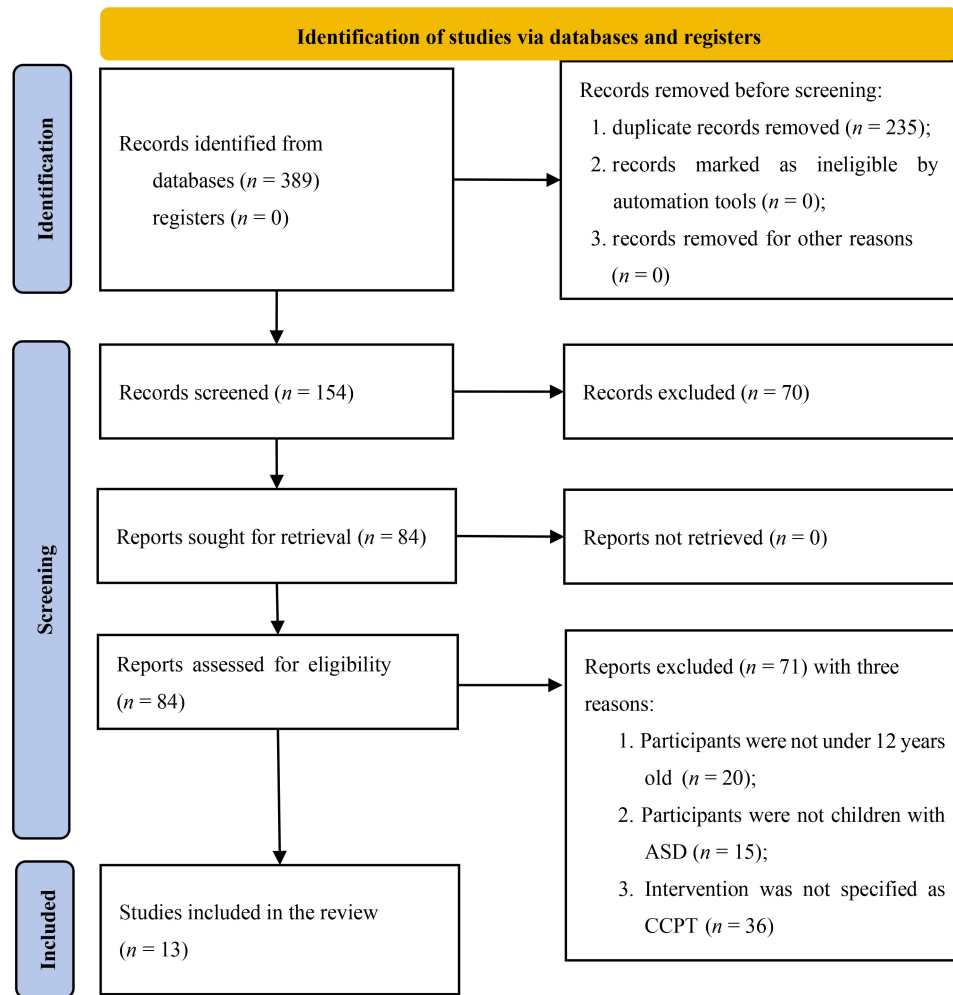


Figure 1 PRISMA flowchart. ASD: autism spectrum disorder, CCPT: child-centered play therapy. n indicates the number of studies.

studies, as shown in Table 1. A total of 130 children with ASD participated in CCPT. The gender distribution was predominantly male ($M = 87$), with only a small number of cases including females ($F = 43$). Ages were concentrated in the range of 3–11, with some studies describing them using means or ranges.

3.1.2 Clinical Presentation Spectrum

Language barriers are universally present, manifested as nonverbal communication (such as gestures and picture systems) or limited vocabulary. Stereotyped and repetitive behaviors (such as preference for mechanical toys and specific patterns of movement) have been mentioned in multiple cases. ASD is often accompanied by a variety of other neurodevelopmental disorders and psychological problems. Attention-deficit hyperactivity disorder (16 individuals) and anxiety disorder (5 individuals) are the most frequently co-occurring conditions. In addition, obsessive

compulsive disorder, oppositional defiant disorder, pica, and sensory issues have also been reported.

3.1.3 Treatment History

In terms of therapeutic interventions, a comprehensive strategy based on special education programs has primarily been adopted. Speech therapy, occupational therapy, applied behavior analysis, and biomedical medications were widely applied. Sensory integration training, off-campus feeding services, and physical therapy have also been reported. Some children have participated in two or three types of therapies simultaneously.

3.1.4 Family Issues

In terms of family education, some individual cases involve abandonment or risky family environments (such as abuse or drug abuse). Such issues may exacerbate the patient's behavioral disorders or social difficulties.

Table 1 Basic information for participating children

Reference	Number	Gender	Age	Clinical presentation spectrum	Treatment history	Family issues
Kenny & Winick (2000)	1	M = 1	11	Attach. issues (N = 1); SRB (N = 1); LC dis. (N = 1); ODD (N = 1); AD (N = 1); basic beh. prob. (N = 1)	Spec. ed. program (N = 1)	NR
Josefi & Ryan (2004)	1	M = 1	6	LC dis. (N = 1); emot. prob. (N = 1); soc. interact. imp. (N = 1); sep. anxiety (N = 1)	NR	NR
François et al. (2009)	6	M = 5; F = 1	7; 8; 7; 10; 10; 9	SRB (N = 2); LC dis. (N = 2)	NR	NR
Ware Balch & Ray (2015)	5	M = 3; F = 2	Mean = 7.2; range = 6–9	ADHD (N = 1); pica (N = 1); sensory issues (N = 1)	ST (N = 5); OT (N = 4); PT (N = 2); ABA (N = 5); biomed. meds. (N = 3)	Abandoned (N = 2); sensory issues (N = 1)
Vaiouli et al. (2015)	3	M = 2; F = 1	5; 5; 7	Soc. interact. imp. (N = 3); emot. prob. (N = 2); SRB (N = 1); LC dis. (N = 1)	spec. ed. program (N = 1); ST (N = 1)	NR
Salter et al. (2016)	3	M = 3	Mean = 5.8; range = 5.5–6.5	AD (N = 1); ADHD (N = 1); difficulties in self-care (N = 1); emot. prob. (N = 2)	NR	NR
Novita et al. (2017)	1	M = 1	3	Soc. interact. imp. (N = 1)	SIT (N = 1); ST (N = 1); OT (N = 1)	NR
Goodman et al. (2017)	1	M = 1	6	Basic beh. prob. (N = 1); soc. interact. imp. (N = 1); SRB (N = 1)	NR	NR
Guest & Ohrt (2018)	1	M = 1	5	Basic beh. prob. (N = 1); soc. interact. imp. (N = 1); LC dis. (N = 1); emot. prob. (N = 2); SRB (N = 1); ADHD (N = 1)	NR	AS (N = 1); substance abuse (N = 1); abuse (N = 1); witnessing drug use (N = 1)
Schottelkorb et al. (2020)	23	M = 19; F = 4	4–10	Basic beh. prob. (N = 1); soc. interact. imp. (N = 1); LC dis. (N = 1); SRB (N = 1); ADHD (N = 13); OCD (N = 3); AD (N = 2); pica (N = 1); ODD (N = 1)	ST (N = 16); OT (N = 11); biomed. meds. (N = 7); 1:1 support (N = 3); ext. feeding (N = 3)	NR
Chan & Ouyang (2024)	65	M = 34; F = 31	Experimental group = 7.5; waitlist group = 7.47	NR	NR	NR
Daniel et al. (2023)	1	M = 1	5	NR	NR	NR
Chung & Ray (2025)	19	M = 15; F = 4	5–8.25	LC dis. (N = 19)	ST (N = 16); ABA (N = 8); OT (N = 4)	

Notes. NR: not reported, F: female, M: male, N: number, ADHD: attention deficit hyperactivity disorder, SRB: stereotyped repetitive behaviors, ODD: oppositional defiant disorder, AD: anxiety disorder, LC dis.: language and communication disorders, attach. issues: attachment issues, basic beh. prob.: basic behavioral problems, emot. prob.: emotional problems, soc. interact. imp.: social interaction impairment, sep. anxiety: separation anxiety, ST: speech therapy, OT: occupational therapy, PT: physical therapy, ABA: applied behavior analysis, SIT: sensory integration training, biomed. meds.: biomedical medications, spec. ed. program: special education program, 1:1 support: one-on-one professional support, ext. feeding: extracurricular- and school-external feeding support, AS: Asperger's syndrome, OCD: obsessive compulsive disorder.

3.2 | Research Protocol

The research protocol included treatment goals, methods, therapist, duration and frequency, setting and materials, and monitoring.

3.2.1 Treatment Goals

The aims of all the studies are to enhance children's social interaction (13 studies), communication skills (7 studies), and emotional regulation (5 studies) and

reduce rigid or repetitive behaviors (4 studies). Some studies focus on joint attention, aggression, therapeutic alliances, or adverse childhood experiences.

3.2.2 Methods

The research methods are primarily based on CCPT, with some studies integrating innovative technologies (e.g., robotic pets, rhythm-based therapy, and electroencephalography (EEG)) to form combined therapies, reflecting a trend toward technological integration. In terms of research design, earlier studies often used single-case or case-study designs, while later studies incorporated randomized controlled trials (RCTs), thereby enhancing methodological rigor.

3.2.3 Therapist

There is a significant variation in the qualifications of practitioners, including professional therapists, doctoral students, and special education teachers. Some studies emphasize the professional certification of therapists (e.g., British Association of Play Therapists certification) or their extensive experience in play therapy.

3.2.4 Setting and Materials

Interventions typically took place in the controlled environments, such as playrooms (6 studies), dedicated therapy rooms within participants' schools (4 studies), and university clinics (3 studies). Some studies were conducted in rural or community settings, emphasizing environmental adaptability. For all studies, the playrooms were set up according to the materials recommended by Landreth (2012). Tools commonly used were categorized into three types: toys (puppets, robots, and blocks), art materials (paints and crayons), and structured tools. Some studies highlighted the use of age-appropriate materials, such as percussion instruments and posters, to stimulate children's interaction and imagination.

3.2.5 Duration and Frequency

According to the implementation details reported in the literature, the duration of a single intervention typically ranged from 30 to 60 minutes, with the total cycle varying from 4 weeks to 2 years. Specifically, there were 4 30-minute studies, 3 45-minute studies, 1 50-minute study, and 2 60-minute studies. One study had sessions shorter than 40 minutes, and another had sessions lasting 45–60 minutes.

3.2.6 Monitoring

Monitoring primarily includes video recordings, therapist observation notes, parent feedback logs, and regular meetings. Some studies introduced the third-party reviews by Association for Behavior Analysis International-certified personnel. Quality control measures involve regular group supervision, video review, and adherence to ethical standards (such as British Association of Play Therapists) for detailed note-taking and intervention fidelity. However, 4 studies had a “no reporting of process supervision” issue, marked as “NR” in Table 2, which may affect the verifiability of the results.

3.3 | Treatment Outcomes

Information regarding outcome-measurement tools and intervention effects is presented in Table 3.

3.3.1 Outcome-Measurement Tools

A total of 13 studies used different outcome-measurement tools to analyze information regarding children with ASD. These tools can be categorized into three types based on their measurement content. The first type consists of scales used to identify and assess the presence and severity of autism in children, such as the Childhood Autism Rating Scale (CARS), the Social Responsiveness Scale-2 (SRS-2), and the AQ-child (Autism Spectrum Quotient-child, social skills subscale). The second type includes scales designed to observe the performance of children with ASD during activities, such as the Vineland Adaptive Behavior Scales (1st edition). The third type comprises forms for documenting the intervention process, including written feedback from parent reports, therapist notes, customized observation, and interviews.

3.3.2 Intervention Effects

The cross-study findings from 2000 to 2025 indicate that following CCPT interventions, data from therapist and parental observations, clinical scales, and neurophysiological measures consistently show improvements in children with ASD. Specifically, participation in CCPT has been associated with enhancements in social interaction (12 studies), communication difficulties (6 studies), repetitive behaviors (6 studies), baseline behavioral functioning (4 studies), emotional issues (4 studies), and adverse childhood experiences (1 study). Overall, the findings suggest that interventions targeting ASD and related behavioral challenges lead to sustained improvements in core symptoms, behavioral

Table 2 Summary of CCPT intervention protocols and implementation characteristics

Reference	Treatment goals	Methods	Therapist	Duration and frequency	Setting and materials	Monitoring
Kenny & Winick (2000)	Reduce aggression; improve social, self-care, communication, and motor skills; reduce repetitive behaviors	CCPT; case	Therapist	11 sessions; 45 min/session	Playrooms; NR	NR
Josefi & Ryan (2004)	Enhance social interaction, attachment, autonomy, and symbolic play; improve parenting; reduce repetitive behaviors	CCPT; case	Therapist	5 months, 16 sessions; 60 min/session	School rooms; toys for 6-year-old children	Video; supervision
François et al. (2009)	Adapt to child's needs via progress in play, reasoning, and emotion	CCPT + robot; case	Researcher	10 sessions, < 40 min/session, 1 session/week	Multiple rooms; robotic dog	Video; notes
Ware Balch & Ray (2015)	Improve empathy, self-regulation, social skills, and compassion	CCPT; case (ABA)	Therapist (PhD, certified, 9 years exp.)	10 weeks, 20 sessions; 30 min/session, 2 sessions/week	University clinics; toys per Landreth	Video; fidelity review
Vaiouli et al. (2015)	Enhance social communication through joint attention phases	CCPT; case + interview	Teacher + assistant	18 weeks; 30 min/session, 1 session/week	Rural classroom; music instruments	Observations; logs
Salter et al. (2016)	Improve communication, self-care, social interaction, and motor skills; reduce destructiveness and anxiety	CCPT; case	Therapist	10 weeks, 10 sessions; 50 min/session, 1 session/week	NR	NR
Novita et al. (2017)	Improve joint attention and social interaction skills	CCPT; case (ABA)	Therapist	4 weeks, 20 sessions; 60 min/session, 5 sessions/week	NR	NR
Goodman et al. (2017)	Examine TA, symptom, adherence relations in HFASD	CCPT; case	Doctoral student	2 years, 53 sessions; 45 min/session, 1 session/week	Mental health clinic; CCPT toys	Video; coding
Guest & Ohrt (2018)	Improve social interaction, self-care, and communication; reduce aggression, anxiety, and trauma effects	CCPT; case	Counselor and play therapist	20 weeks, 40 sessions; 45–60 min/session, 2 sessions/week	NR	NR
Schottelkorb et al. (2020)	Improve social interaction, awareness, and communication; reduce repetitive behaviors, attention problems, and aggression	CCPT; RCT	Graduate therapist (certified)	6 weeks, 24 sessions; 30 min/session, 4 sessions/week	School playroom; materials per Landreth	Video; parent meetings
Chan & Ouyang (2024)	Improve social awareness and communication; reduce repetitive behaviors	CCPT + EEG; RCT	Certified therapist	8 weeks, 8 sessions; 45 min/session, 1 session/week	University classroom; toys per Landreth	Supervision; feedback
Daniel et al. (2023)	Assess CCPT + rhythm for emotion regulation	CCPT + rhythm; case	BAPT therapist	36 weeks, 25 sessions; 1 session/week	NR; toys and instruments	Clinical notes
Chung & Ray (2025)	Enhance social-emotional assets; reduce emotional and behavioral problems	CCPT + ABA	Doctoral counselor	16 sessions; 30 min/session, 2 sessions/week	School playrooms; therapeutic toys	Supervision; fidelity review

Notes. NR: not reported, CCPT: child-centered play therapy, ABA: applied behavior analysis, TA: therapeutic alliance, HFASD: high-functioning autism spectrum disorder, RCT: randomized controlled trial, EEG: electroencephalogram, BAPT: British Association of Play Therapists, exp.: experience.

problems, and emotional expression among children with ASD.

Almost all the studies confirmed that CCPT effectively enhances ASD children's social relationships, interactions, skills, and proactive social engagement. Anecdotal reports showed that participating children shifted from avoiding eye contact to self-affirmations, such as saying "I'm brave," and from minimal social interaction (except with their mothers) to increased engagement with therapists, reaching parent-satisfactory improvements as reported by parents (Kenny & Winick, 2000). Schottelkorb et al. (2020) demonstrated that the intervention group's SRS-2 total score decreased (78.83→70.58), while the control group's symptoms worsened (73.64→77.91), with a

large effect size $\eta p^2 = 0.47$. These scale results indicate significant improvements in children's social relationships, awareness, and interaction skills.

Following the application of CCPT in educational interventions for children with ASD, improvements in their social initiative have been observed. François et al. (2009) revealed a stepwise development in children's social and cognitive abilities, with shifts from isolated to cooperative and pretend play. Ware Balch and Ray (2015) showed that low-functioning children (e.g., children A and B) gradually transitioned from isolated play to simple imitative behaviors (e.g., touching sensors), while high-functioning children (e.g., children C, E, and F) proactively initiated complex interactions, such as rescue games and

Table 3 Summary of key findings from intervention outcomes and effects

Reference	Outcome-measurement tool(s)	Core intervention outcome(s)	Key statistical or qualitative findings
Kenny & Winick (2000)	VABS- I	Improved adaptive behaviors, reduced irritability, and enhanced social interaction	Therapist and parents reported noticeable improvements; child showed increased compliance and reduced tantrums
Josefi & Ryan (2004)	Custom observation	Enhanced attachment, autonomy, and symbolic play; limited reduction in ritualistic behaviors	Proactive physical contact was increased (0→5 times); playtime increased by 98%; and ritualistic behavior duration was reduced by 23%
François et al. (2009)	Play grid, affect coding	Increased proactive social interaction, emotional attribution, and symbolic play for high-functioning children	Children progressed from solitary to cooperative play; some attributed emotions to robots and engaged in complex role-play
Ware Balch & Ray (2015)	SEARS	Mixed effects on self-regulation, social competence, and empathy across participants	Effect sizes ranged from weak (0.14) to moderate (0.88); individual variability was prominent
Vaiouli et al. (2015)	Custom coding	Joint attention (responding and initiating) being enhanced through music therapy	Mean change in responding to joint attention was +6.55; effects were generalized to the home and classroom
Salter et al. (2016)	ABAS- II, DBC-P, GAS	Improvements in adaptive behavior and communication but significant individual differences	GAS scores varied (from -2 to +1); two participants showed no improvement or regression in some areas
Novita et al. (2017)	ESCS	Significant improvement in initiating joint attention (IJA); decrease in responding joint attention (RJA)	IJA score increased from 38.12 to 77.56 ($p < 0.05$); RJA score decreased from 27.5 to 10
Goodman et al. (2017)	S-WAI-O, CPQ, CARS2-HF	Therapist-dependent bidirectional relationships among therapeutic alliance, symptoms, and adherence	Simulation modeling showed therapist-specific variability in the temporal sequence of change
Guest & Ohrt (2018)	Clinical observation, parent report	Process trauma helped by CCPT, eliminating aggressive behaviors and improving social functioning	Child transitioned from withdrawn and aggressive to proactive socialization, with no further school suspensions
Schottelkorb et al. (2020)	SRS-2, CBCL	Significant improvement in social responsiveness and reduction in attention and aggression problems	SRS-2 total score decreased (78.83→70.58); 50% of children showed a one-level reduction in severity
Chan & Ouyang (2024)	SRS-2, AQ-child, ABAS- II,	Improvement in social skills, adaptive behavior, and neural relaxation (alpha wave increase)	ABAS- II social score increased ($p = 0.020$, $d = 0.420$); EEG alpha amplitude increased significantly ($p < 0.001$)
Daniel et al. (2023)	ERC	Significant improvement in emotional regulation and reduction in negative affect	ERC emotion regulation subscale increased by 26.32% ($p < 0.030$); children shifted from physical aggression to verbal expression
Chung & Ray (2025)	SEARS, ABC-2	Improvements in social competence, empathy, and reductions in irritability and social withdrawal	Large effect on social withdrawal after 16 sessions ($d = 1.090$); medium effect on irritability ($d = 0.480$)

Notes. VABS- I : Vineland Adaptive Behavior Scale (1st edition), SEARS: Social-Emotional Assets and Resilience Scales, ABAS- II : Adaptive Behavior Assessment System (2nd edition), DBC-P: Developmental Behavior Checklist-Parent/Carer, GAS: Goal Attainment Scale, ESCS: Early Social Communication Scales, S-WAI-O: Segmented Working Alliance Inventory-Observer form, CPQ: Child Psychotherapy Process Q-Set, CARS2-HF: Childhood Autism Rating Scale (2nd edition), High-Functioning Version, CCPT: child-centered play therapy, SRS-2: Social Responsiveness Scale-2, CBCL: Child Behavior Checklist, AQ-child: Autism Spectrum Quotient-child (social skills subscale), EEG: electroencephalogram, ERC: Emotion Regulation Checklist, ABC-2: Aberrant Behavior Checklist-Second Edition. p denotes p -value; d denotes Cohen's d .

role-playing (e.g., “Robots need to follow rules.”). The children also demonstrated imagination through symbolic play (e.g., “ghost dog”). Cognitively, they began exploring the nature of robots (“Will the robot dog bite?”) and attributed emotions to them (e.g., Child C said, “Make Alpo happy.”), indicating enhanced mentalization, which lays the foundation for emotional expression. Emotionally, child C initiated hugs with the robot and expressed, “I love Alpo.” while child E indirectly conveyed emotions through competitive games (e.g., “Tornado won; he’s happy.”). These findings highlight the potential of play therapy in promoting emotional externalization. Chung and Ray (2025) also demonstrated that following CCPT intervention, social withdrawal continued to lessen significantly after the 12th session (Cohen's $d = 0.600$) and the 16th session (Cohen's $d = 1.090$), with the greatest effect observed. This was manifested in children's increased initiative in

participating in group activities and enhanced interactions with peers, indicating that the improvement in emotional regulation supported their willingness to engage socially.

After CCPT interventions, children with ASD showed increased initiation of joint attention behaviors. Enhanced responsive joint attention is closely associated with the development of social cognition, marking the beginning of social competence (Salter et al., 2016). Novita et al. (2017) found that CCPT significantly improved initiating joint attention (IJA) scores in children with ASD, from 38.12 to 77.56 ($p < 0.050$), specifically manifested as more frequent displays of interest (e.g., refusing to let others take away their toys) and initiating sharing behaviors. The intervention effects remained stable in short-term follow-ups. However, responding joint attention (RJA) scores decreased from 27.5 to 10, indicating that although children's

willingness to actively explore their environment increased, their sensitivity to others' guidance still required further development. CCPT has been shown to significantly enhance IJA behaviors, such as showing interest. Daniel et al. (2023) further demonstrated that children became more proactive in social interactions, such as inviting peers to play with them and responding appropriately to emotions. Additionally, Schottelkorb et al. (2020) reported a significant decline in total SRS-2 scores in the intervention group (78.83→70.58), with parents noting improvements in eye contact frequency and parent-child interaction quality. However, some studies highlighted that these improvements in social skills may not fully generalize to real-world settings, such as schools, suggesting the need for complementary environment-adaptive training to consolidate intervention outcomes (Salter et al., 2016).

In the realm of language and communication, CCPT enhances nonverbal communication through unstructured play. Children who were initially reliant on Makaton sign language (fewer than 10 words) began to spontaneously verbalize their needs after CCPT, indicating language development. Vaiouli et al. (2015) found that music therapy, as a CCPT adjunct, significantly increased children's attention-seeking behaviors (mean change of 6.55), such as following pointers or sharing musical activities. Reuben, a 5-year-old autistic boy, shifted from expressing emotions by banging toys to using words such as "scared" and "sorry", demonstrating that language can replace aggressiveness (Daniel et al., 2023). However, language improvements varied individually. François et al. (2009) noted that children with weaker language abilities (children A and B) showed limited progress and needed structured language training (e.g., repetitive verbal prompts) to compensate for the shortcomings.

For repetitive and stereotyped behaviors, CCPT helps children release anxiety and integrate behavioral patterns through nondirective play. Such behaviors significantly hinder social integration, social skill acquisition, and functional behavior development in ASD children and show significant heterogeneity (Leekam et al., 2011). Josefi and Ryan (2024) found that ritualistic behavior time decreased from an average of 10.89 to 8.39 minutes per occurrence, but improvement was limited, which is likely owing to insufficient intervention frequency. Guest and Ohrt (2018) further showed in Joseph's case that CCPT via symbolic play (e.g., "fixing the past" and "time machine") helped integrate traumatic memories, eliminating aggressive behaviors and emotional outbursts. Chan and Ouyang (2024) conducted an EEG study and found that at the neural level, CCPT significantly boosted alpha wave activity ($p < 0.001$), indicating an improved ability to suppress distracting information in social situations; this may indirectly reduce stereotyped behavior episodes.

Regarding baseline behavior improvements, Josefi and Ryan (2024) found that attachment was strengthened through increased physical contact (from 0 to 5 times) and interaction time (from 1.89 to 9.12 minutes per session). Autonomy improved as children's independent activities lasted longer (from 11.20 to 21.22 minutes per session), and symbolic play (e.g., pretend-feeding, using dolls) was introduced, laying the foundation for future complex social skills. However, ritualistic behavior improvements were limited, with only a 23% reduction (from 10.89 to 8.39 minutes per occurrence).

Chan and Ouyang (2024) first linked neural mechanisms to behavioral improvements. Using EEG, they found a significant increase in alpha wave amplitude in the experimental group ($p < 0.001$), indicating that children were more relaxed in social settings (Chan & Ouyang, 2024). Behaviorally, Adaptive Behavior Assessment System-II (ABAS-II, social domain) scores increased significantly ($p = 0.020$), supporting CCPT's role in neural plasticity and showing improvements at both the neural and behavioral levels.

Regarding emotional regulation, Judy, an 11-year-old autistic girl, experienced reduced irritability, improved compliance, and significantly lower family stress (Kenny & Winick, 2000). Children also displayed enhanced autonomy, such as helping their younger siblings, indicating development in rule following and empathy within the family environment. Such as the case Joseph, there were significant reductions in aggressive behaviors and emotional outbursts (Guest & Ohrt, 2018). Emotional regulation abilities, measured by scales such as the Emotion Regulation Checklist (ERC), emotional regulation subscale, and adaptive behaviors showed sustained improvements, with increased self-regulation strategies, including proactively leaving conflict situations.

Chung and Ray (2025) found that CCPT can reduce children's irritability. Although the improvement in the self-regulation subdimension did not reach statistical significance ($p = 0.101$), teacher reports indicated that after the intervention, children exhibited less impulsive behavior in frustrating situations and improved their self-soothing abilities. The irritability subdimension of the Aberrant Behavior Checklist-Second Edition (ABC-2) scale showed a significant reduction in irritability after the intervention (Cohen's $d = 0.480$), with effects becoming evident after the 12th session, indicating that children learned to regulate their emotions through internal mechanisms rather than external stimuli. Additionally, children's ability to perceive and respond to others' emotions, such as comforting peers or recognizing emotion states, significantly improved after the intervention. This indirectly reflects the maturation of emotional regulation.

In trauma and complex symptom intervention, Guest and Ohrt (2018) demonstrated CCPT's unique role in integrating trauma memories through symbolic play, the case Joseph had processed early abuse-related anger, eliminated aggressive and anxious behaviors, joined a baseball team, and improved his academic performance. Daniel et al. (2023) further confirmed the effectiveness of multimodal intervention: Reuben, a 5-year-old autistic boy, showed a 26.32% increase in ERC, emotional regulation subscale, replaced aggression with verbal expression (e.g., "scared"), and had better social adaptation, although his mood fluctuations still required intervention. Nondirective play in CCPT provides a safe space for ASD children with trauma to express themselves, promotes trauma processing, and indirectly improves behavior, emotions, and social functioning, highlighting CCPT's potential in complex cases.

The study also showed individual differences in intervention outcomes. Ware Balch and Ray (2015) reported increased total scale scores for 5 participants. However, 3 showed decreased self-regulation/responsibility (SR/R) scores, and 2 had lower empathy scores. This indicates that although some improvements were seen, there may have been no progress or even regression in other areas. Overall, CCPT's impact on the 3 children's SR/R scores, social competence, and empathy was mixed.

Similarly, Salter et al. (2016) reported individual differences in intervention outcomes. Despite the authors noting substantial improvements across various domains, the data showed no significant changes in test scores for 3 participants in areas, such as self-direction, self-care, and social skills. Moreover, 2 participants experienced score reductions in communication, home living, community use, functional academics, and self-care. This may indicate challenges or regression in these areas.

However, it is important to note that Salter et al. (2016) also found that despite challenges in some areas, CCPT was helpful for enhancing expressive language and communication in children with ASD. Although 2 participants showed no improvement or negative effects in communication, parent reports on the Developmental Behavior Checklist-Parent/Carer indicated significant improvements in communication difficulties (Einfeld et al., 2002).

In summary, nearly all the studies indicate that CCPT is significantly effective in improving social interaction, expressive language and communication, repetitive behaviors, baseline behaviors, and emotional regulation in children with ASD. CCPT alleviates ASD symptoms by enhancing social, emotional, and cognitive functions, with effects generalizing to daily life. However, intervention outcomes may vary owing to individual differences, environmental changes during

assessment, the child's health, or other external factors. Therefore, with regard to intervention evaluation, these multifaceted factors must be considered and personalized analysis and support provided based on each child's specific condition.

4 Discussion

4.1 | Status of CCPT Research in Children with ASD

4.1.1 Heterogeneous Outcomes of CCPT for ASD

Although CCPT shows overall therapeutic efficacy, substantial individual differences in treatment response have been observed. Substantial evidence from the literature (2000–2024) confirms that the application of CCPT in educational interventions for children with ASD is associated with measurable improvements across their socialization, language and communication, repetitive stereotyped behaviors, and emotion regulation. However, despite the overall efficacy of CCPT in educational interventions for ASD, significant individual variability has been observed. The effectiveness of CCPT in children with ASD varies depending on factors, such as functional level, developmental domains, and personal history. High-functioning children demonstrate more pronounced improvements in social skills and empathy, whereas low-functioning children require extended periods to establish therapeutic rapport. Moreover, treatment outcomes differ across developmental domains within the same individual, with social competence showing consistent enhancement but empathy and self-regulation exhibiting inter-individual variability. Notably, children with trauma histories exhibit marked therapeutic gains in trauma memory integration through symbolic play.

4.1.2 High flexibility of the CCPT intervention model

CCPT can be employed either as a standalone intervention or in combination with other therapeutic approaches. François et al. (2009) incorporated robot-assisted play therapy, wherein children developed symbolic thinking and emotional expression through interactive tasks (e.g., caring for a robotic dog). Vaiouli et al. (2015) further extended this paradigm to music therapy, demonstrating significant improvements in joint attention skills among children with ASD (mean changes in responding to and IJA were 6.55 and 1.80, respectively), with intervention effects generalizing to both home and classroom settings. When CCPT was combined with rhythmic synchronization activities, Daniel et al. (2023) observed a 26.32% increase in total scores on the ERC ($p < 0.030$), suggesting that

synchronous interactions may enhance the physiological-behavioral synergy underlying emotional regulation. Music and rhythmic engagement were shown to potentiate both joint attention and affective modulation. Such cross-modal intervention strategies highlight the potential for integrating CCPT with complementary approaches to simultaneously target neuroplasticity and behavioral adaptation.

4.1.3 Limited Evidence Base Owing to the Paucity of High-Quality Studies

Among the 13 studies reviewed, only 2 were RCTs meeting high-quality criteria on the Physiotherapy Evidence Database Scale. This evidence gap stems from the following four methodological challenges:

Intervention complexity: CCPT's implementation faces inherent difficulties owing to its relational nature, requiring dynamic therapist-child interactions that resist standardization. Therapeutic outcomes are moderated by clinician competency and dyadic rapport, which are difficult variables to control in RCTs.

Population heterogeneity: ASD participants exhibit marked variability in symptom profiles, severity levels, and developmental trajectories, complicating the establishment of matched control groups essential for rigorous trials.

Resource constraints: Conducting RCTs necessitates substantial investments in specialized therapists, longitudinal assessments, and large samples. These requirements are often unfulfilled owing to funding limitations.

Technological limitations: Existing studies demonstrate inadequate use of digital tools and lack both technological integration and personalized adaptation frameworks.

4.2 | Using IDTs to Enhance the CCPT Intervention

4.2.1 Aspects of Therapist Training and Supervision

Goodman et al. (2017) employed simulation modeling analysis to reveal therapist-specific variability in treatment outcomes, challenging conventional assumptions (e.g., "Therapeutic ruptures invariably impair efficacy."). Their findings demonstrated significant differences in therapeutic alliance dynamics and intervention effectiveness when different therapists implemented CCPT with the same child, highlighting the subjective limitations of manual implementation and fragmented process data. IDTs offer novel solutions to these challenges. For therapist training, the development of virtual 3D patients and VR simulation systems can establish standardized clinical scenarios (Bloom

et al., 2023). Such simulations have proven effective in pediatric surgical care training across various medical education levels.

IDTs enhance therapist training by three approaches: (1) reducing operational costs and mitigating individual variability, (2) accelerating experiential learning while shortening training duration, and (3) improving competency in managing complex cases. Digital supervision platforms integrate machine learning to extract the behavioral signatures of high-efficacy therapists while coordinating training program directors, mental health researchers, and cross-sector stakeholders (Kohrt et al., 2025). This approach maintains CCPT's inherent flexibility while increasing therapeutic consistency.

Computer vision and automated behavioral coding systems enable the objective quantification of pediatric facial expressions, behavioral metrics, and response patterns during therapist-delivered interventions (Ramírez-Duque et al., 2019; Zaharieva et al., 2024), thereby establishing standardized assessment protocols. Algorithmically defined frequency criteria for following the child's lead can mitigate inter-therapist variability in CCPT principal interpretation. Real-time biofeedback systems utilizing wearable devices monitor physiological indicators (Nakai et al., 2023; Pereira et al., 2019), enabling early detection of potential therapeutic alliance ruptures.

Large language models can analyze historical treatment data to identify specific symptom patterns (Garg & Chauhan, 2024), providing therapists with personalized recommendations that reduce delays in human judgment. Future research should further explore noninvasive monitoring technologies to enhance scientific rigor and the reproducibility of CCPT implementation while maintaining the humanistic intervention. The appropriate application of IDTs will provide strong support for the standardized dissemination of CCPT.

4.2.2 Aspects of Intervention Design

The study designs primarily consisted of 10 case studies and 3 RCTs. Case studies offer the advantage of providing rich contextual details, thoroughly demonstrating to readers both "how CCPT was studied" and "why it was studied in this way," which are 2 fundamental questions. However, case studies also have limitations, including reduced external validity and potential researcher bias. In this review, the predominance of case studies may reflect that the effect of CCPT in educational interventions for children with ASD remains at an exploratory stage, which, along with the substantial heterogeneity among children, makes findings difficult to generalize. Nevertheless, the 3 recent

RCTs, though limited in number, represent valid evidence for CCPT's application in ASD educational interventions. This methodological imbalance suggests that future research should integrate both paradigms: Case studies may inform localized variables for RCTs, while rigorous RCTs could help correct over-interpreted associations from case studies.

Sander (2011), Benford and Standen (2009), and Brosnan and Gavin (2015) have argued that research design and implementation should acknowledge the strengths of individuals with autism by adopting participatory and inclusive approaches to technological design, development, and application; employing alternative starting points; and recognizing online communication as safe. Natural language processing can be employed to analyze children's linguistic patterns during therapy sessions, as demonstrated in Daniel et al.'s (2023) study, in which Reuben used the word "afraid" to express emotions, enabling the dynamic adjustment of CCPT. Subsequently, predictive models can be developed by training algorithms on historical data to forecast children's responsiveness to CCPT interventions, thereby optimizing treatment planning. Finally, a tiered intervention framework featuring graduated intervention protocols tailored to children's functional levels can be established, prioritizing therapeutic alliance formation for lower-functioning children while focusing on social reasoning training for higher-functioning children.

The play therapy room typically constitutes a relatively enclosed and specialized environment. These purpose-built intervention settings possess inherent limitations, as they may not fully simulate or reflect children's real-world contexts. Consequently, skills and experiences acquired within the playroom often demonstrate limited transferability to children's daily lives, thereby constraining the generalization of therapeutic outcomes. VR and augmented reality (AR) technologies address this gap by simulating authentic social scenarios (Ke et al., 2020; Parsons, 2016), effectively bridging the divide between therapeutic acquisition and the real-world application of skills.

Although Landreth (2012) has provided recommended material arrangements, the diverse backgrounds of children with ASD, including generational and cultural influences, should not be overlooked. The efficacy of play therapy varies significantly depending on factors, such as age, individual characteristics, and family environment (Elbeltagi et al., 2023). Different play materials yield distinct intervention outcomes for children with ASD, necessitating careful consideration of toy properties when configuring the playroom. To optimize therapeutic results, therapists should adapt play materials before each session in accordance with the child's specific needs.

It is encouraging that virtual environments based on VR technology, including virtual playrooms and toys, have already established a foundational framework. Currently available applications on the market include various skill-building games, including those for daily living skills—for example, independent showering (Kang & Chang, 2018); academic skills, such as geography learning (Bossavit & Parsons, 2018); motor skills, such as ball tapping (Vukićević et al., 2019); and complex emotion-recognition programs, such as the Junior Detective Training Program (Beaumont & Sofronoff, 2008; Chung & Ray, 2025). The integration of cutting-edge technologies, such as VR and AI, offers evident advantages. Virtual playrooms eliminate constraints imposed by physical time and space, allowing for feasible adjustments based on children's individual needs and feedback. Additionally, concerns about fatigue and emotional fluctuations affecting therapeutic outcomes are mitigated, ensuring stable and consistent treatment quality.

Our observations also indicate that varying session durations may yield differential intervention outcomes for children with ASD. Therapists typically select session lengths of 30, 45, or 60 minutes; however, to date, no researchers have reported how these specific durations were determined or standardized. Comparative analysis suggests that short-term, high-frequency CCPT (20 sessions over 4 weeks) may produce substantially different results from medium-term CCPT (16 sessions over 4 months). We propose that session duration should be dynamically adjusted based on therapeutic progress and the child's behavioral responses, optimizing developmental gains. Furthermore, the total cumulative intervention time, rather than fixed individual session lengths, should be considered, providing that the child achieves a stable, balanced state during treatment.

Notably, the therapeutic impact of 30–60-minute sessions remains limited, while continuous family involvement and support outside the playroom demonstrate unbounded potential. Family participation constitutes a critical component of effective treatment planning. As evidenced by the nonoverlap of all pairs (NAP) value range (0.43–0.83) in Ware Balch and Ray's (2015) study, IDTs could potentially assist in determining optimal session durations tailored to children's functional levels (high vs. low).

During intervention implementation, AI-assisted technologies, like therapist support, can enhance treatment through the real-time monitoring and analysis of behavioral data (including demographic information, play behaviors, and physiological indicators). This data-driven approach enables the precise identification of each child's unique needs and developmental trajectory while detecting key factors

influencing the individualized treatment response. By integrating these insights with the child's specific ASD profile, personalized intervention plans can be developed to effectively engage the child's interests while simultaneously promoting therapeutic goal attainment.

4.2.3 Aspects of Subject Characteristics

Participant characteristics have multifaceted impacts on CCPT research, requiring comprehensive consideration of factors including clinical presentation spectrum, age, treatment history, and family issues.

Clinical presentation spectrum, particularly the presence of comorbidities, may increase research complexity (Tsakanikos et al., 2006). Because the symptoms of different disorders may interact, it becomes difficult to evaluate CCPT effects in isolation. For example, when children with ASD also have concurrent psychosis, depression, or anxiety (Emerson & Adams, 2023), outcome measurement may require more refined tools to differentiate the intervention's effects on core versus comorbid symptoms.

Age represents another critical factor, as children at different developmental stages may exhibit markedly divergent responses to play therapy (Wang et al., 2022). Preschool-age children (3–6 years old) typically express emotions naturally through play, potentially enhancing CCPT effectiveness, although assessments relying on observer or parental reports may introduce subjective bias. School-age children (7–12 years old) demonstrate combined verbal and play-based expression; however, variability in cognitive abilities may influence their comprehension of therapeutic metaphors. Consequently, age stratification becomes methodologically essential in research design to prevent outcome confounding.

Individuals with ASD who also have comorbid psychiatric conditions exhibit distinct behavioral phenotypes, including higher intelligence quotient and less severe language impairment (Sipsock et al., 2021). For children with multiple diagnoses, treatment history similarly influences the effectiveness of CCPT implementation. Those with prior pharmacological treatments or other psychological interventions may present different symptom baselines, potentially obscuring CCPT's true therapeutic effects. Furthermore, participants who have undergone cognitive behavioral therapy or family therapy may demonstrate differential treatment responses compared to treatment-naïve children. Consequently, studies must establish clear inclusion criteria, control for or document prior treatment histories, and potentially implement washout periods to minimize confounding factors.

Family-related factors, including family functioning, parental involvement, and socioeconomic

status, exert profound influences on CCPT outcomes (Duvekot et al., 2017; Shek et al., 2015; ten Hoopen et al., 2023). High-conflict or low-support family environments may constrain therapeutic progress outside of clinical settings owing to insufficient generalization conditions, whereas actively engaged parents can potentiate intervention efficacy (Karst & Van Hecke, 2012). Furthermore, families with lower socioeconomic status often face treatment adherence challenges and incomplete follow-up owing to resource limitations (e.g., transportation and therapy costs). Consequently, studies should incorporate family-functioning assessments (e.g., Family Assessment Device) and consider providing necessary support to mitigate attrition rates.

4.2.4 Aspects of the Assessment System

Current studies employ highly heterogeneous outcome-measurement tools. We recommend that researchers adopt common outcome measures to reduce interpretive inconsistencies and facilitate cross-study comparisons. Detailed data reporting and experimental descriptions at each stage would be preferable. Single assessment results should be treated as nodal points in a continuous process, requiring periodic evaluation alongside supplementary information, such as school reports, medical records, and parental observations, to comprehensively understand a child's developmental profile.

Several studies exhibit excessive reliance on qualitative assessments. Guest and Ohrt's (2018) trauma research relied exclusively on clinical observations and parent reports while lacking standardized scales, potentially introducing evaluator bias. Integrating quantitative and qualitative tools—combining standardized measures with in-depth interviews—enhances assessment objectivity and ecological validity. Machine-assisted approaches incorporating wearable devices (e.g., smart wristbands) enable real-time physiological monitoring. Automatically analyzing the frequency of children's social interactions (e.g., number of unsolicited invitations) during play through computer vision is an alternative to traditional coding methods, such as François et al.'s (2009) play grid tool. IDTs can automatically quantify social behaviors through computer vision, reducing dependence on subjective qualitative evaluations while improving assessment efficiency and objectivity.

IDTs are promising for data pre-processing and analysis, video recording, and the presentation and sharing of research results. In terms of data pre-processing, IDTs can efficiently handle missing values and outliers, perform normalization and standardization to enhance data consistency, and simultaneously

improve the generalizability of the model through data augmentation operations while reasonably dividing the dataset to support model training. IDTs enable the automated, high-resolution recording of video, support real-time processing and storage, and can automatically trigger recording by setting conditions while collecting multidimensional data to improve recording efficiency and information integrity. The results of the stage-by-stage study are used to establish a case baseline for constructing interventions for children with ASD, and IDTs are used to recommend similar cases and match the best practices of case studies.

However, the high heterogeneity of assessment tools across current studies (e.g., SRS-2, CARS, and Vineland Adaptive Behavior Scale (1st edition)) and the lack of standardized outcome reporting—particularly the frequent omission of effect sizes, confidence intervals, or complete descriptive statistics—significantly hinder cross-study comparisons and evidence syntheses. To systematically enhance the comparability and cumulative value of CCPT research, future studies should advance in three key directions: (1) Promote consensus on core outcome measures by gradually adopting standardized assessment tools for key symptom domains, such as social interaction, emotion regulation, and behavioral functioning; (2) standardize outcome reporting by routinely including effect sizes, confidence intervals, means, standard deviations, and sample sizes in research publications; (3) deepen the integration of IDTs in objective assessment by leveraging sensor technologies and computational analytics to develop quantifiable, high-temporal-resolution digital phenotypes that complement the subjective and discrete limitations of traditional scales.

4.3 | Theoretical Framework for Constructing a “Child-Led + Data-Driven” Two-Dimensional CCPT Paradigm

Child agency remains the central tenet of this approach. Children maintain autonomy in selecting physical or virtual toys, determining play themes, and freely transitioning between VR and AR environments. Within VR systems, they may employ “magic brush” tools to customize virtual world and create personalized exploratory spaces (Chen et al., 2022). Therapists persist in their roles as observers and empathic companions, strictly adhering to nondirective principles by avoiding explicit guidance or interference with play sequences. Technological tools refrain from prescribing “correct” play modalities, instead following the child’s natural rhythm to preserve spontaneous play experiences. Emotional and internal states are expressed through

metaphorical toy use, with symbolic representation prioritized over verbal explanation (Chang et al., 2018; Rutherford et al., 2007). AR technology provides enriched visual information and novel multimodal interactive experiences, which researchers have demonstrated can enhance the social, behavioral, academic, and attentional skills of children with ASD (Taryadi & Kurniawan, 2018; Vahabzadeh et al., 2018).

The real-time capture and analysis of behavioral, physiological, and affective data provide objective therapeutic benchmarks (Belpaeme et al., 2013; Lombardo et al., 2019). Multimodal data collection includes behavioral data documenting play duration, toy selection frequency, and interaction modalities with virtual objects (e.g., hitting and gentle touching) to analyze play preferences and behavioral patterns (Sanghvi et al., 2011; Wilder, 2019); physiological data using eye-tracking technology to monitor gaze distribution, with heart rate variability and galvanic skin response assessing emotional arousal levels (Kanhirakadavath & Chandran, 2022); and affective computing, whereby AI analyzes facial micro-expressions and vocal affect (e.g., pitch and pause frequency) to identify emotional states (e.g., anxiety and pleasure) (Anzalone et al., 2015; Kim et al., 2017). Dynamic modeling establishes individualized baseline profiles (e.g., anxiety indices and social avoidance thresholds) from collected data, with machine learning identifying deviations as “critical behavioral nodes.” This enables the development of intelligent tutoring systems that incorporate natural language processing, educational robotics, learning analytics, discourse analysis, neural networks, affective computing, and recommendation systems (Belpaeme et al., 2013; He & Cao, 2018; Rudovic et al., 2018).

Child-led approaches and data-driven strategies are not mutually exclusive but, rather, interact dynamically through intelligent systems to ensure that interventions respect children’s autonomy while precisely meeting their needs. Data systems provide indirect guidance through environmental fine-tuning rather than direct instruction. When AI detects an increase in a child’s anxiety (e.g., as evidenced by the repeated discarding of virtual toys), the VR scenario automatically dims the lighting, plays soothing music, or summons a docile virtual pet to help calm the child’s emotions. AI generates real-time prompts (such as “Child has avoided social non-player characters 3 times in 10 minutes, suggesting the introduction of a cooperative task.”), but the ultimate decision regarding whether and how to intervene is still made by the therapist based on their professional judgment to avoid overreliance on technology.

The findings of this review provide three key pieces of guidance for the systematic design of digital educational tools and learning environments for

children with ASD. First, the significant individual differences revealed by the research necessitate tools with deep personalization capabilities—specifically, the ability to dynamically adjust task difficulty and support strategies by capturing behavioral and physiological data in real time through IDTs. Second, the effectiveness of CCPT in stimulating social initiative, joint attention, and symbolic play clarifies core intervention targets. This suggests that digital environments should prioritize constructing open-ended interactive narratives and game scenarios that foster these abilities, rather than isolated skills-training modules. Third, to overcome the limitation of insufficient generalization in traditional interventions, we suggest the development of a blended learning ecosystem: seamlessly integrating quantifiable, adaptable personalized digital practice based on IDTs with opportunities for skill application and generalization within safe, supportive real or virtual social environments. This creates a complete closed loop from personalized training to socialized application. This design philosophy—combining a “data-driven personalized core” with a “child-led interactive shell”—constitutes the systemic blueprint for implementing the “child-led + data-driven” paradigm.

5 Conclusions and Limitations

This literature review demonstrates the efficacy of CCPT in interventions for children with ASD. CCPT is an intervention approach that facilitates the holistic development of children with ASD and has shown significant effects in addressing the three core deficits: social interaction, communication, and restricted interests and repetitive behaviors. It also holds considerable promise for promoting foundational behaviors, emotional regulation, and overall development in complex cases involving trauma. Notably, although CCPT exhibits strong therapeutic outcomes, individual differences exist, yielding varying effects depending on the functional level, specific aspects, and individual experiences of each child. CCPT is highly flexible, demonstrating robust efficacy when used independently and synergized effectively with other intervention methods, making it a play therapy with untapped potential. However, CCPT application is constrained by factors such as the heterogeneity of individuals with ASD, the requirement for therapists with exceptional skills and extensive experience, and limitations in research resources and conditions.

IDTs have the potential to mitigate challenges in therapist training, reduce observational and procedural biases during interventions, and address issues in intervention design and implementation, thereby enhancing the efficacy of CCPT. In supporting the

treatment of children with ASD, these technologies demonstrate substantial promise in facilitating therapist training and decision-making, enabling personalized play-based interventions, creating virtual scenarios and roles, and automating assessment processes. This potential is reflected not only in the dual educational and recreational nature of such games but also in their ability to grant children greater autonomy, streamline data collection, and tailor learning content and intervention strategies to individual needs. Further research in this domain is highly anticipated.

Therefore, to establish a dual-dimensional CCPT paradigm integrating child-led and data-driven approaches could effectively address the challenges encountered in applying CCPT to educational interventions for children with ASD. This dual-dimensional dynamic interaction model should adhere to three core principles: maintaining the child-led dimension, strengthening the data-driven dimension, and implementing a robust bidirectional interaction mechanism between these dimensions.

We rigorously implemented the screening process by excluding non-English literature. The currently available evidence is indeed limited in quality, with a notably small number of studies meeting the inclusion criteria, resulting in particularly scarce accessible literature resources. This undoubtedly constrained the breadth and depth of the literature review. Some studies reported children’s changes qualitatively without employing standardized assessment scales. Substantial variability existed among participants regarding behavioral problems and comorbidities across studies, compounded by inconsistent research designs and measurement tools. All these factors significantly increased the complexity of our review. Additionally, insufficient data completeness in certain studies directly restricted the comprehensiveness and accuracy of our analysis, leading to inherent limitations in the conclusions.

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peer-review process and all editorial decisions related to the acceptance and publication of this article. Peer-review was handled independently by the other editors to minimize bias.

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