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A systematic review of observational, naturalistic, and neurophysiological outcome measures of nonpharmacological interventions for autism – Godoy PBG et al.

Table S1 Summary of studies investigating the effects of interventions for ASD

First author	Study design	Intervention	Population	Sample size (for analysis)	Measure(s) for ASD diagnosis/core symptom characterization at baseline	Intervention outcome measure(s) related to ASD core symptoms
Aldred, 2004	Pilot parallel-groups RCT	Parents and child attended monthly sessions over 6 months + 6 months of 2-monthly sessions of social communication intervention + 30 min/day of parent-child practice vs. community treatment as usual	Autistic children aged 2-6 years	n=14 intervention; n=14 non-intervention	ADOS; ADI-R	ADOS; VABS; MB-CDI; 30 min parent-child play interaction with standardized toys
Aldred, 2011	Parallel-groups RCT	6 months of monthly clinic sessions and 6 months of bi-monthly maintenance sessions of parent-mediated communication-focused treatment vs. 12 months of community treatment as usual	Autistic children aged 2-5 years	n=14 intervention; n=14 non-intervention	VABS; MB-CDI	10-min PCI with a standard set of toys; ADOS; MB-CDI
Almirall, 2016	Sequential multiple assignment randomized trial (SMART)	24 weeks of three options of adaptive interventions: JA, SP, engagement and regulation JASP + enhanced milieu teaching EMT followed by intensified JASP + EMT for slow responders vs. JASP + EMT followed by JASP + EMT + SGD for slow responders vs. JASP + EMT + SGD followed by intensified JASP + EMT + SGD for slow responders	Autistic children aged 5-8 years	n=30 JASP + EMT; n=31 JASP + EMT + SGD	ADOS	Standardized naturalistic interaction between the child and an adult; ESCS; video-recorded PCI
Amatachaya, 2015	Crossover placebo RCT	Two sessions of 1 mA anodal transcranial direct current stimulation for 20 min vs. sham transcranial direct current stimulation	Autistic children aged 5-8 years with mild to moderate autistic symptoms	n=10 intervention; n=10 non-intervention	CARS	Resting-state EEG; Autism Treatment Evaluation Checklist

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Arabi, 2019	Parallel-groups RCT	Three sessions/week over 10 weeks of visuomotor training vs. three sessions/week over 10 weeks of motor training vs. three sessions/week over 10 weeks of visual training vs. three sessions/week over 10 weeks of treatment as usual	Autistic children aged 6-12 years with non-verbal IQ > 60	n=15 visuomotor intervention; n=15 motor intervention; n=15 visual intervention; n=15 non-intervention	ADI-R	ADOS; video records from the classroom during break time; Test of Gross Motor Development
Bauminger, 2002	Within-group study	3 h/week of cognitive behavioral intervention social-emotional understanding and social interaction over 7 months	Autistic children and adolescents aged 8-17 years with IQ ≥ 69	n=15	ADI-R	Emotion inventory;1 min play interaction with peers during school recess; SSRS – Teacher Report
Ben-Itzchak, 2008	Within-group study	45 h/week center-based intensive early-intervention program vs. 1-2 weekly community treatment as usual	Autistic children (intervention group); autistic children + children with global developmental delay + children with cerebral palsy (non-intervention group) aged 16-35 months	n=44 intervention; n=37 non-intervention	ADI-R	Bayley Scales of Infant Development; ADOS
Bem-Itzchak, 2009	Non-randomized study	12 months of center-based BEI vs. 12 months of center-based eclectic combination of several treatment approaches (EI)	Autistic toddlers aged 18-35 months	n=40 BEI; n=28 EI	ADOS; ADI-R	VABS; MSEL; ADOS
Ben-Sasson, 2012	Within-group study	Two monthly sessions of a collaborative puzzle game – free play mode in which partners could independently move puzzle pieces followed by enforced collaboration mode in which partners could only move puzzle pieces together	Autistic children aged 8-11 years with IQ ≥ 80	n=12	ADOS; SRS	Video-recorded observation of the autistic children with autistic peers

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Bölte, 2002	Parallel-groups RCT	5 weeks of 2-h/week training with a computer-based program to teach and test the ability to identify basic facially expressed emotions using 1,000 photographs of female and male adult faces expressing a large spectrum of affect vs. community treatment as usual	Autistic adolescents and adults aged 17-27 years with mean IQ 104.2	n=10	ADOS-G; ADI-R	Computerized emotion identification task/emotion matching task; event-related fMRI
Boyd, 2018	Parallel-groups RCT	Classroom staff received two 2-to-6-h trainings over the course of the school year on Advancing Social communication and Play intervention vs. regular classes as usual	Autistic children aged 3-5 years enrolled in a public preschool classroom	n=40 intervention; n=38 non-intervention	ADOS-G; MSEL	ADOS-G; video-recorded PCI
Byford, 2015	Parallel-groups RCT	6 months of fortnightly 2.5-h one-to-one sessions of the PACT, a developmental oriented, parent-directed and video-aided intervention, followed by monthly booster sessions for 6 months vs. community treatment as usual	Autistic children aged 2-4 years with nonverbal age > 12 months	n=77 intervention; n=75 non-intervention	ADOS-G; ADI-R; MSEL	ADOS-G; video recorded PCI; PLS; VABS – Teacher Form
Carr, 2006	Non-randomized study	15 h of PECS instruction during school class activities vs. children attending special education classrooms or units for autism	Autistic children aged 3-7 years	n=5 intervention; n=5 non-intervention	VABS; PLS	Video-recorded teacher-child free interaction in naturalistic classroom setting
Carter, 2011	Parallel-groups RCT	8 group parent educational sessions + three parent-child home individualized sessions of More Than Words intervention, a parent training intervention that teaches parents how to better understand their children's communication vs. no intervention	Autistic toddlers or toddlers at risk for ASD aged 15-25 months	n=32 intervention; n=30 non-intervention	Developmental Play Assessment; Screening Tool for Autism in Two-year-olds	MSEL; VABS; ESCS; Parent-child free play interaction; Parent Interview for Autism – Clinical Version

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Chan, 2009	Parallel-groups RCT	30 5-to-10-min sessions over 6 weeks of seven-star needle stimulation (stimulation of the skin) at the front and back sides of the body and the head vs. WLC	Autistic children	n=16 intervention; n=16 WLC	Community clinical diagnosis	Parent's Rating Questionnaire (specially designed questionnaire assessing language, social interaction, behavioral problems, and motor functioning); resting-state EEG
Chan, 2013	Parallel-groups RCT	4 weeks of 1-h twice weekly sessions of a mind-body exercise intervention named nei yang gong, which comprised sets of slow movements that emphasize smooth, gentle, and calm movements vs. 4 weeks of 1-h twicely week sessions of training on progressive muscle relaxation	Autistic children and adolescents aged 6-17 years	n=20 exercise; n=20 muscle relaxation	ADI-R	Tower of London Test; Children's Color Trails Test; Five Point Test; Autism Treatment Evaluation Checklist; Parent's Rating Questionnaire (specially designed questionnaire - language, social interaction, behavioral problems, and motor functioning); event-related EEG
Choque Olsson, 2017	Parallel-groups RCT	12 weekly sessions of "kontakt" social skills group training vs. standard care only	Autistic children and adolescents aged 8-17 years with IQ ≥ 60	n=150 intervention; n=146 non-intervention	ADOS	SRS; ABAS; CGAS; Ohio State University Global Severity Scale for Autism
Corbett, 2013	Within-group study	2 weeks of summer camp using the sense peer-mediated theater intervention	Autistic children and adolescents aged 8-17 years with mean IQ of 82	n=12	ADOS; SCQ; SRS.	Affect recognition, memory for faces subtest of the Developmental NEuroPSYchological Assessment; ABA; Companionship Scale; 20-min playground interaction with two novel peers
Corbett, 2015	Parallel-groups RCT	10 4-h sessions of group sense theater intervention vs. WLC	Autistic children and adolescents aged 8-14 years with IQ ≥70	n=17 intervention; n=13 WLC	ADOS	SRS – Parent Report; ABAS; 20-min playground interaction with two novel peers; Developmental NEuroPSYchological Assessment subtests of memory for faces (immediate and delayed) and theory of mind; event-related EEG

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Deckers, 2016	Parallel-groups RCT	12 weekly 1-h group sessions of social skills training with the child + three 1-h sessions with parents vs. WLC	Autistic children aged 8-12 years	n=26 intervention; n=26 WLC	Children's Social Behavior Questionnaire	Social skills observation; Loneliness and Aloneness Scale for Children and Adolescents
Dolan, 2016	Parallel-groups RCT	14 weekly 90-min sessions of the PEERS vs. WLC	Autistic adolescents aged 11-16 years	n=28 intervention; n=25 WLC	ADOS	Contextual Assessment of Social Skills; TASSK
Estes, 2015	Follow-up to parallel-groups RCT	2 years of intensive, home-based Early Start Denver Model vs. community treatment as usual	Autistic toddlers aged 18-30 months with IQ ≥ 70	n=21 intervention; n=18 non-intervention	ADOS; ADI-R	DAS; VAB; ADOS; RBS-R; Aberrant Behavior Checklist; ADI-R
Faja, 2011	Parallel-groups RCT	Eight sessions of face training protocol with 24 novel grayscale digital photos of faces vs. eight sessions of house training protocol with 24 novel grayscale digital photos of houses	Autistic adults with IQ ≥ 85	n=18 face training; n=18 house training	ADOS; ADI-R	Benton Facial Recognition Test; immediate and delayed facial memory tasks of the Wechsler Memory Scale; computerized experimental measure of face processing measuring accuracy and reaction time; event-related EEG
Fletcher-Watson, 2015	Parallel-groups RCT	2 months of a therapeutic iPad app targeting basic social communication skills + community treatment as usual vs. community treatment as usual	Autistic children younger than 6 years old	n=27 intervention; n=27 non-intervention	ADOS	ADOS; Brief Observation of Social Communication Change; MB-CDI; CSBS
Furukawa, 2018	Non-randomized study	Eight 60-to-75-min weekly sessions over 10 to 12 weeks of child-directed interaction training, the first phase of Parent-Child Interaction Therapy, vs. WLC	Autistic children aged 4-7 years	n=12 intervention; n=9 WLC	ADOS	SRS; Eyberg Child Behavior Inventory; video-recorded PCI
Gengoux, 2015	Parallel-groups RCT	12 weekly sessions (eight parent-only 90-min group sessions and four 60-min individual parent-child dyad sessions) of PRT vs. a parent psychoeducation control group	Autistic children aged 2-6 years	n=25 intervention; n=22 psychoeducation	ADOS; ADI-R	10-min PCI with a standardized set of toys; MSEL; PLS; MB-CDI; VABS; SRS

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Goods, 2012	Pilot parallel-groups RCT	12 weeks of 30-min twice weekly JASPER sessions vs. 30 h of ABA-based therapy as usual	Autistic children aged 3-5 years	n=7 intervention; n=8 non-intervention	ADOS; ADI-R; MSEL	Reynell Developmental Language Scales; video-recorded PCI; ESCS; video-recorded observation of the children during their classroom routines
Gordon, 2011	Parallel-groups RCT	PECS training vs. WLC vs. no intervention at all	Autistic children aged 4-10 years	n=26 intervention; n=30 WLC; n=28 non-intervention	ADOS	15-min videotaped observation during class snack sessions
Grahame, 2015	Parallel-groups RCT	Eight weekly 2-h sessions of a parent-group intervention to manage restricted and repetitive behaviors vs. WLC	Autistic children aged 3-7 years	n=25 intervention; n=20 WLC	ADOS; SRS; VABS	CGI-I; target behavior Vignette – caregiver report of two repetitive behaviors of most concern; Repetitive Behavior Questionnaire – Parent and Teacher Report; video recorder parent-child play interaction
Green, 2010	Parallel-groups RCT	Fortnightly 25-h one-to-one sessions of PACT, a developmental oriented, parent-directed and video-aided intervention, over 6 months followed by monthly booster sessions for a further 6 months vs. community treatment as usual	Autistic children aged 2-5 years	n=77 intervention; n=75 non-intervention	ADOS-G; ADI-R; MSEL	ADOS-G; PCI during naturalistic play; PLS; MB-CDI; CSBS – Caregiver Questionnaire
Gutstein, 2007	Within-group study	Relationship development intervention (6 days of intensive workshops with parents + weekly or biweekly consultation meetings with a relationship development intervention consultant)	Autistic children aged 20-96 months with IQ between 70-118	n=16	ADOS; ADI-R	ADOS; ADI-R

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Hardan, 2014	Parallel-groups RCT	12 90-min weekly sessions of (PRT) group for parents vs. 12 90-min weekly sessions of psychoeducational groups for parents	Autistic children aged 2-6 years with language development delay	n=25 intervention; n=23 non-intervention	ADOS; ADI-R; PLS	10-min PCI with a standardized set of toys; MB-CDI; VABS; SRS; CGI
Herbrecht, 2015	Within-group study	18 days of 6-h a day of EI for autistic children (*Frühintervention bei autistischen Störungen*) focused on developing children's social motivation	Autistic toddlers aged 25-48 months	n=12	ADOS; ADI-R	10 min of therapist-child interaction; CGAS; ADOS
Hopkins, 2011	Parallel-groups RCT	12 25-min twice-weekly sessions of a computer-based social SS called FaceSay focused on emotion recognition and social skills vs. 12 25-min twice-weekly sessions of SuccessMaker, which uses open-source drawing software for children to supplement regular classroom reading instruction	Autistic children aged 6-10 years with IQ ≥ 70	intervention: n=24; non-intervention: n25	CARS	Benton Facial Recognition Test; SSRS; 5-min social skills observation with peers during the school recess.
Howlin, 2007	Parallel-groups RCT	13 h of PECS training for school staff and parents + monthly PECS consultant visits to teachers during classes over 5 months vs. attendance at autism-specific schools (WLC) vs. attendance at autism-specific schools as usual only	Autistic children aged 4-11 years with little or no functional language	n=26 intervention; n=30 WLC; n=28 non-intervention	ADOS-G	15 min observation of the children during their classroom snack session; Expressive One Word Picture Vocabulary Test; British Picture Vocabulary Scales; ADOS-G
Ichikawa, 2013	Pilot parallel-groups RCT	20 2-h sessions over 6 months of group Treatment and Education of Autistic and Communication related handicapped Children (TEACCH) training vs. WLC	Autistic children aged 5-6 years with IQ ≥ 75	n=5 intervention; n=6 WLC	CARS	Strengths and Difficulties Questionnaire; 5 min video recorded PCI

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Jonsson, 2018	Parallel-groups RCT	24 weekly sessions of social skills group training “kontakt” vs. community treatment as usual	Autistic children and adolescents aged 8-17 years with IQ > 70	n=23 intervention; n=27 non-intervention	ADOS; SRS	SRS – Parent and Teacher Report; ABAS; Autism CGI; CGAS
Kaale, 2014	Follow-up to parallel-groups RCT	8 weeks of preschool-based social communication treatment for autistic children + standard preschool program vs. 8 weeks of standard preschool program only	Autistic children aged 29-60 months	n=34 intervention; n=27 non-intervention	ADOS; ADI-R	Video-recorded teacher-child and mother-child interactions; ESCS; Reynell Developmental Language Scales; SCQ
Kasari, 2006	Parallel-groups RCT	30 min daily for 5-6 weeks of JA intervention vs. 30 min daily for 5-6 weeks of SP intervention vs. no intervention	Autistic children aged 3-4 years	n=20 JA; n=21 SP; n=17 non-intervention	ADOS; ADI-R; MSEL	ESC; 15 min parent-child play interaction with a standard set of toys
Kasari, Gulsrud, 2012	Follow-up to parallel-groups RCT	30 min daily of JA intervention for 5-6 weeks vs. 30 min daily of SP intervention for 5-6 weeks vs. no intervention	Autistic children aged 3-4 years	n=20 JA; n=19 SP; n=17 non-intervention	ADOS; ADI-R; MSEL	ESCS; video-recorded PCI
Kasari, Rotheram-Fuller, 2012	Parallel-groups RCT	12 sessions over 6 weeks of a peer-mediated approach in which typically developing children from the target child’s classroom were taught strategies for engaging children with social challenges on the playground vs. 12 sessions over 6 weeks of child-assisted approach in which autistic children met with a trained interventionist for 20 min twice weekly to develop strategies to engage socially with their peers vs. 12 sessions over 6 weeks of peer + child assisted approach vs. no-intervention	Autistic children aged 6-11 years with IQ ≥ 65	n=15 peer-assisted; n=15 child-assisted; n=15 peer + child; n=15 non-intervention	ADOS; ADI-R	Social network survey; 15 min observation of the child in play interaction with peers in the playground; Teacher Perception of Social Skill

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Kasari, 2008	Follow-up to parallel-groups RCT	30 h of JA intervention vs. 30 h of SP intervention vs. no intervention	Autistic children younger than 5 years	n=15 JA; n=14 SP; n=11 non-intervention	ADOS; ADI-R	ADOS; Expressive Vocabulary Test; DAS; ESCS; video-recorded PCI
Kasari, Lawton, 2014	SMART	24 weeks of three options of adaptive interventions: JA, SP, engagement and regulation (JASP) + EMT followed by intensified JASP + EMT for slow responders vs. JASP + EMT followed by JASP + EMT + SGD for slow responders vs. JASP + EMT + SGD followed by intensified JASP + EMT + SGD	Autistic children aged 5-8 years with fewer than 20 spontaneous different words used during 20 min	n=30 JASP + EMT; n=31 JASP + EMT + SGD	ADOS-G; PPVT; Test of Early Language Development	Video-recorded child-examiner interaction
Kasari, Kaiser, 2014	Parallel-groups RCT	Two 1-h sessions per week of home-based CMM intervention (parent + child training) based on JASPER treatment for 12 weeks vs. group-based caregiver-only training	Autistic children aged 2-5 years with mental age above 12 months	n=60 CMM intervention; n=52 caregiver education module intervention	ADOS; MSEL	Video-recorded caregiver-child interaction; Caregiver Quality of Involvement Scale; ESCS; Symbolic Play and Language Comprehension in Autistic Children
Kasari, 2016	Parallel-groups RCT	Eight weeks (16 sessions) of SS – targeted a specific set of social skills vs. 8 weeks (16 sessions) of engage intervention – targeted peer engagement and acceptance	Autistic children aged 6-11 years with IQ ≥ 65	n=66 SS; n=82 engage intervention	ADOS; SCQ	The Friendship Survey; 15 min observation of the child during play interaction with peers in the playground
Kenworthy, 2013	Parallel-groups RCT	28 30-40 min sessions (1 school-year) of group UOT – executive function training intervention vs. 28 30-40 min sessions (1 school-year) of group social communication SS	Autistic children with IQ ≥ 70	n=47 UOT; n=20 SS	ADOS	SRS; classroom and intervention observation measures; Behavior Rating Inventory of Executive Function
Koegel, 1996	Parallel-groups RCT	Parent training in PRT vs. parent training in ITB intervention	Autistic children in the preschool/early elementary age range	n=7 PRT; n=10 ITB	VABS	5-min interaction during dinnertime at the child's home

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Kouijzer, 2012	Parallel-groups RCT	40 twice weekly individual sessions of EEG-biofeedback vs. 40 twice weekly individual sessions of skin conductance – biofeedback vs. WLC	Autistic adolescents aged 12-18 years with IQ ≥ 80	n=13 EEG-biofeedback; n=12 skin conductance biofeedback; n=13 WLC	ADI-R	SCQ; Trail Making Test; Stroop Test; Tower of London Test; Test of Sustained Selective Attention; subtest digit span of the Wechsler Intelligence Scale for Children; event-related EEG; CGI-I
Lawton, 2012	Parallel-groups RCT	6 weeks of 30-min twice weekly sessions of JA and SP/engagement and regulation intervention (JASPER) vs. WLC	Autistic children aged 3-5 years	n=9 intervention; n=7 WLC	ADOS-G	ESCS; 10 min of classroom playtime observation; 10 min teacher-child interaction with a standardized set of toys
LeGoff, 2004	Within-group study	12 weekly sessions of LEGO therapy	Autistic children and adolescents aged 6-16 years	n=47	Community clinical diagnosis	Observation of participants in unstructured situations with peers; GARS
Lerna, 2012	Parallel-groups RCT	6 months of 30-min individual therapy sessions, three times a week of PECS vs. 6 months of 30-min individual therapy sessions, three times a week, CLT	Autistic children aged 18-60 months with < five spontaneous words according to parents report	n=9 PECS; n=9 CLT	ADOS	GMDS; ADOS; VABS; unstructured free play with examiner
Lerna, 2014	Parallel-groups RCT	6 months of 30-min individual therapy sessions, three times a week, of PECS vs. 6 months of 30-min individual therapy sessions, three times a week, CLT	Autistic toddlers aged 18-60 months	n=7 PECS; n=7 CLT	ADOS	GMDS; ADOS; VABS; unstructured free play with examiner
Locke, 2013	Within-group study	169 lessons of strategies for teaching (teacher training) based on autism research – ABA-based intervention	Autistic children aged 5-8 years with mean (SD) IQ = 50.7 (25.1)	n=192	ADOS	ADOS; DAS; ABAS – Parent Report; Pervasive Developmental Disorder Behavior Inventory – Teacher Report

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Martins, 2012	Non-randomized study	6 weeks of speech-language intervention with the mother's (or primary caregiver's) presence followed by 6 weeks of an educational software program (G1) vs. 6 weeks of therapy with an educational software program followed by 6 weeks of speech-language intervention with the mother's (or primary caregiver's) presence (G2)	Autistic children aged 2-12 years	n=10 G1; n=11 G2	Unspecified instruments	15-min interaction sessions between the child and a speech-language pathologist
Maximo, 2017; Murdaugh, 2017	Parallel-groups RCT	10 weeks of 4 h per day of a reading intervention training program (Visualizing and Verbalizing for Language Comprehension and Thinking) vs. WLC	Autistic children aged 8-13 years, with verbal ability of at least three intelligible words, communication, social, and adaptive skills of at least a 36-month-old level, basic reading skills of sentences of at least three words in length and IQ ≥ 75	n=14 intervention; n=14 WLC	ADOS; ADI-R	Event-related fMRI (Murdaugh, 2017), resting-state fMRI (Maximo, 2017)
Mcduffie, 2012	Parallel-groups RCT	6 months of three times a week, 20-min sessions of RPMT vs. 6 months of three times a week, 20-min sessions of PECS	Autistic children aged 18-60 months with < 10 spontaneous words during initial communication samples	n=16 RPMT; n=16 PECS	Unspecified instruments	15-min unstructured free play session with an examiner
Oosterling, 2010	Parallel-groups RCT	12 months (four weekly 2-h sessions with a group of parents, followed by individual 3-h home visits every 6 weeks) of nonintensive focus parent training + community treatment as usual vs. 12 months of community treatment as usual only	Autistic toddlers aged 12-42 months with developmental age younger than 12 months	n=36 intervention; n=31 no intervention	Early Screening of Autistic Traits Questionnaire; ADOS; ADI-R	MB-CDI; ADOS; Erickson Child Scales; CGI-I

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Ortiz-Sánchez, 2018	Parallel-groups RCT	18 sessions (three sessions/week) of 45 min of assisted therapy with dolphins vs. 45 min of play activities with a therapist without dolphins	Autistic children aged 4-5 years	n=22 intervention with dolphins; n=22 intervention without dolphins	ADOS; ADI-R	Resting-state EEG
Owens, 2008	Parallel-groups RCT	1 h/week over 18 weeks of group LEGO therapy vs. 1 h/week over 18 weeks of the SULP, a direct teaching approach based around stories, group activities and games vs. no intervention	Autistic children aged 6-11 years with IQ > 70	n=16 LEGO intervention; n=15 SULP intervention; n=16 no intervention	ADI-R; SCQ.	VABS, GARS; 10-min observation of interaction with peers during class break
Parsons, 2018	Parallel-groups RCT	3 months of 20 min daily tablet-based information communication technology intervention (Toby app) vs. therapy-as-usual	Verbally fluent autistic children aged 2-6 years with a verbal IQ ≥70	n=30 intervention; n=29 WLC	MSEL; SPT; CSBS; 20-min video of spontaneous interaction with a neurotypical person	MSEL; CSBS; SPT; 20-min video of spontaneous interaction with a neurotypical person
Paul, 2012	Non-randomized study	36 45-min sessions for 12 weeks of RMIA vs. 36 45-min sessions for 12 weeks of MCT	Autistic children aged 2-6 years with < 15 spontaneous words according to parent report	n=10 RMIA; n=12 MCT	ADOS; CSBS; MSEL.	ADOS; CSBS; motor imitation assessment,VABS; MB-CDI; 10 min parent-child play interaction with a standard set of toys.
Rahman, 2016	Parallel-groups RCT	12 sessions of parent-mediated intervention for ASD in south Asia (Parent Autism Support Service) delivered by non-specialist health workers + community treatment as usual vs. community treatment as usual only	Autistic children aged 2-9 years	n=32 intervention; n=33 no intervention	M-CHAT; INCLEN diagnostic tool for ASD; VABS	Video-recorded parent-child play interaction; VABS; MB-CDI; CSBS

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Rogers, 2006	Parallel-groups RCT	12 1-h weekly sessions of DENVER model therapy + daily 1-h home intervention delivered by parents vs. 12 1-h weekly sessions of PROMPT, a neuro-developmental approach for speech production disorders + daily 1-h home intervention delivered by parents	Autistic children aged 20-65 months with < five spontaneous functional words/day according to parent report	n=5 DENVER model; n=5 PROMPT model	SCQ; ADOS	ADOS; SCQ; MSEL; VABS; MB-CDI
Saaybi, 2019	Non-randomized study	5 days/week of nursery school + 6-10 h/week of ABA sessions in homes and/or nurseries + 1 h each of speech, occupational, and psychomotor therapy vs. TD children	Autistic children aged 18-48 months	n=17 autistic children; n=7 TD	ADOS	Diffusion tensor imaging; Verbal Behavior Assessment and Placement Program
Schertz, 2018	Parallel-groups RCT	32 weekly home-based sessions of JA mediated learning intervention vs. community control conditions	Toddlers aged 16-30 months with autistic symptoms	n=73 intervention; n=71 non-intervention	M-CHAT; ADOS; CSBS; MSEL; VABS; RBS-R; 10-min video recording of parent-child interaction	10-min video recording of parent-child play interaction
Sharda, 2018	Parallel-groups RCT	8-12 weeks of music therapy vs. 8-12 weeks of behavioral intervention implemented in a non-musical context	Autistic children aged 6-12 years	n=26 intervention; n=25 non-intervention	ADOS, ADI-R, or CARS; Clinical Evaluation of Language Fundamentals; PPVT; SRS; VABS	SRS, Children's Communication Checklist, PPVT, VABS, resting-state fMRI
Shih, 2014	Parallel-groups RCT	8 weeks (16 sessions) of SS, targeted a specific set of social skills, vs. 8 weeks (16 sessions) of engage intervention, which targeted peer engagement and acceptance	Autistic children with IQ ≥ 65	n=40 skills; n=52 engage	ADOS	15-min observation of the child in play interaction with peers in the playground
Siller, 2012	Parallel-groups RCT	12 90-min weekly sessions of FPI, a parent education program + three 90-min monthly sessions of PAC vs. four 90 min monthly sessions of PAC only	Autistic children aged 2-6 years with fewer than 25 words and no phrases based on parent report	n=36 intervention; n=34 non-intervention	ADOS-G; ADI-R	MSEL; ESCS; video-recorded mother-child play interaction

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Siller, 2014	Parallel-groups RCT	12 90-min weekly sessions of, a parent education program + three 90-min monthly sessions of PAC vs. four 90 min monthly sessions of PAC only	Autistic children aged 2-6 years with fewer than 25 words and no phrases based on parent report	n=36 PAC + FPI; 34 PAC	ADOS; ADI-R; MSEL; ESCS	Video-recorded PCI and brief separation-reunion episode; Maternal Perceptions of Child Attachment Questionnaire
Sokhadze, 2009	Within-group study	3 weeks of twice weekly sessions of 0.5 Hz repetitive transcranial magnetic stimulation applied over the left dorsolateral prefrontal cortex	Autistic children, adolescents and adults aged 9-27 years with IQ > 80	n=13	ADI-R	Event-related EEG; Aberrant Behavior Checklist; SRS; RBS-R
Sokhadze, 2012	Non-randomized study	12 weekly sessions of 1 Hz repetitive transcranial magnetic stimulation applied bilaterally over the dorsolateral prefrontal cortex vs. WLC	Autistic children and adolescents aged 9-21 years	n=20 intervention; n=20 WLC	ADI-R	Event-related EEG
Solomon, 2014	Parallel-groups RCT	Consultants coached caregivers monthly for 12 months on Play Project Home Consultation program, a parent-mediated intervention focused on improving PCI vs. community treatment as usual	Autistic children aged 2-6 years	n=64 intervention; n=64 non-intervention	ADOS; SCQ	ADOS-G; SCQ; video-recorded parent-child play interaction; MSEL; MB-CDI; Functional Emotional Assessment Scale
Stadnick, 2015	Non-randomized study	12 1-h weekly sessions of Project ImPACT intervention focused on social communication skills training vs. community treatment as usual	Autistic children aged 18 months and 8 years	n=16 intervention; n=14 non-intervention	SRS; M-CHAT; SCQ	10 min parent-child play interaction; VABS

First author	Study design	Intervention	Population	Sample size (for analysis)	Measure(s) for ASD diagnosis/core symptom characterization at baseline	Intervention outcome measure(s) related to ASD core symptoms
Sun, 2017	Non-randomized study	10-12 weeks of home SEF intervention implemented by parent/s, with close monitoring by the speech-language pathologist, vs. 10-12 weeks of SEF implemented by the speech-language pathologist during regular speech-language therapy individual sessions	Autistic children aged 5-12 years with IQ ≥ 50 and without abnormalities on brain magnetic resonance imaging scan or EEG	n=6 SEF by parents; n=14 SEF by therapist	Community clinical diagnosis	15-min interaction between the child and a speech-language pathologist
Tsiouri, 2011	Non-randomized study	36 50-min sessions of RMIA + four 2-h sessions of parent training vs. no intervention	Autistic children aged 3-6 years with < 10 spontaneous expressive words according to parent report	n=5 intervention; n=7 non-intervention	MSEL; MB-CDI; VABS; CSBS	ADOS; CSBS; motor imitation assessment; VABS; MB-CDI
Van Hecke, 2013	Parallel-groups RCT	14 90-min weekly group sessions of PEERS vs. WLC	Autistic adolescents aged 11-16 years with IQ ≥ 70	n=28 intervention; n=29 WLC; n=30 TD	ADOS-G	SRS; Quality of Socialization Questionnaire – Revised; TASSK; resting-state EEG
Venker, 2011	Pilot RCT	More Than Words intervention, a parent training intervention that teaches parents how to better understand their child's communication (five 2-h group parent educational sessions + two 45-min individual coaching sessions + 14 1-h twice weekly group parent-child coaching sessions) vs. WLC	Autistic children aged 28-68 months	n=7 intervention; n=7 WLC	ADOS: PLS; MB-CDI; MSEL	Parent-child play interaction
Ventola, Friedman, 2014	Non-randomized study	16 weeks (7-h/week) of PRT (5-h/week of direct intervention with the child and 2h/week of parent training) vs. no intervention	Autistic children aged 5-7 years	n=10 intervention; n=5 non-intervention	ADOS; ADI-R; DAS	SRS; CBCL; event-related fMRI

First author	Study design	Intervention	Population	Sample size (for analysis)	Measure(s) for ASD diagnosis/core symptom characterization at baseline	Intervention outcome measure(s) related to ASD core symptoms
Ventola, Yang, 2014	Within-group study	8 h per week of PRT (6 h of direct child training and 2 h of parent training) for 16 weeks	Autistic children aged 4-6 years	n=10	DAS; ADOS; ADI-R	ADOS; SRS; VABS; Clinical Evaluation of Language Fundamentals; CGI-I
Verschuur, 2016	Within-group study	Four 6-h sessions of inpatient treatment facility staff-delivered training on PRT	Autistic children aged 7-13 years with IQ > 70	n=14	ADOS; SCQ	10-min interaction with examiner during age-appropriate everyday activities
Wetherby, 2014	Parallel-groups RCT	Three sessions per week for 6 months and two sessions per week for 3 months of individual parent training vs. one session per week for 9 months of group-based parent educational playgroups	Autistic toddlers aged 16-20 months	n=42 individual intervention; n=40 group intervention	ADOS; CSBS	CSBS; ADOS; VABS; MSEL
White, 2012	Parallel-groups RCT	12 or 13 individual 60-70 min sessions of multimodal anxiety and social SS (a cognitive-behavioral therapy intervention) vs. WLC	Autistic adolescents aged 12-17 years with IQ ≥ 70	n=15 intervention; n=15 WLC	ADOS-G; ADI-R; Disorders Interview Schedule for Children/Parents; VABS	SRS; CGI-I; CGAS
Wong, 2009	Pilot parallel-groups RCT	Two weeks (10 30-min sessions) of Autism-1-2-3 EI (a short and intensive child and parent intervention focused on eye contact, gesture, and vocalization/words) vs. no intervention at all	Autistic toddlers aged 17-36 months	n=9 intervention; n=8 non-intervention	ADOS; ADI-R; CARS	ADOS; RFRLRS; SPT
Wong, 2010	Parallel-groups RCT	40 sessions over 8 weeks of tongue acupuncture vs. 40 sessions over 8 weeks of sham tongue acupuncture	Autistic children	n=25 intervention; n=25 sham intervention	CARS	GMDS; Ritvo-Freeman Real Life Rating Scale; Reynell Language Developmental Scale; SPT; Functional Independence Measure for Children

First author	Study design	Intervention	Population	Sample size (for analysis)	Measure(s) for ASD diagnosis/core symptom characterization at baseline	Intervention outcome measure(s) related to ASD core symptoms
Wood, 2014	Parallel-groups RCT	32 90-min weekly sessions of cognitive behavioral therapy (30 min separately with the youth and parent and 30 min jointly with the child and parent) focused on coping skills and *in vivo* exposure vs. community psychosocial treatment as usual	Autistic children aged 7-11 years with co-occurring anxiety and IQ ≥ 70	n=7 intervention; n=6 non-intervention	ADOS; ADI-R	Video-recorded play interaction with peers during school recess
Yoder, 2009	Parallel-groups RCT	6 months of thrice weekly, 20-min sessions of RPMT vs. 6 months of thrice weekly, 20-min sessions of PECS	Autistic children aged 18-60 months with < 20 different words used cumulatively during three communication samples	n=17 RPMT; n=19 PECS	ADOS	15 min semistructured free play with examiner
Yoo, 2014	Parallel-groups RCT	14 90-min weekly sessions of PEERS vs. WLC	Autistic adolescents aged 12-18 years with IQ ≥ 65	n=23 intervention; n=24 WLC	ADOS; ADI-R	VABS; ADOS; TASSK; Quality of Play Questionnaire; SSRS; SCQ; SRS; CBCL
Yun, 2017	Parallel-groups RCT	Eight sessions of 30-40 min of robot-assisted behavioral intervention vs. eight sessions of 30-40 min of human-assisted identical behavioral intervention	Autistic children aged 4-7 years with verbal IQ ≥ 60	n=8 robotic intervention; n=7 human intervention	ADOS; ADI-R	ADOS; VABS; SCQ; SRS; CBCL
Zhao, 2018	Parallel-groups RCT	Twice weekly 60-min sessions over 12 weeks of structured physical activity program using the TEACCH model vs. 12 weeks of regular physical activity	Autistic children aged 5-8 years	n=21 intervention; n=20 non-intervention	Unspecified instruments	Assessment of Basic Language and Learning Skills – Revised; Social Skills Improvement System
Zlomke, 2017	Within-group study	19 60-90 min weekly sessions of Parent-Child Interaction Therapy, a behaviorally based play therapy which targets the parent-child relationship	Autistic children aged 2-8 years	n=17	ADOS; GARS	Eyberg Child Behavior Inventory; Behavior Assessment System for Children – Parent Rating Scale; video-recorded PCI

ABA = applied behavior analysis; ABAS = Adaptive Behavior Assessment; ADI-R = Autism Diagnostic Interview – Revised; ADOS = Autism Diagnostic Observation Schedule; ADOS-G = ADOS-generic; ASD = autism spectrum disorder; BEI = behavioral early intervention; CARS = Childhood Autism Rating Scale; CBCL = Child Behavior Checklist; CGAS = Children's Global

Assessment Scale; CGI-I = Clinical Global Impression – Improvement Scale; CLT = conventional language therapy; CMM = caregiver-mediated module; CSBS = Communication and Symbolic Behavior Scales; DAS = Differential Ability Scales; EEG = electroencephalography; EI = early intervention; EMT = enhanced milieu teaching; ESCS = Early Social Communication Scales; fMRI = functional magnetic resonance imaging; FPI = focused playtime intervention; GARS = Gilliam Autism Rating Scale; GMDS = Griffiths' Mental Developmental Scale; IQ = intelligence quotient; ITB = individual target behavior; JA = joint attention; JASP = joint attention symbolic play; JASPER = joint attention symbolic play engagement and regulation; MB-CDI = MacArthur-Bates Communicative Development Inventory; M-CHAT = Modified Checklist for Autism in Toddlers; MCT = milieu communication training; MSEL = Mullen Scales of Early Learning; PAC = Parent Advocacy Coaching; PACT = Pre-School Autism Communication Trial; PCI = parent-child interaction; PECS = Picture Exchange Communication System; PEERS = Program for the Education and Enrichment of Relational Skills; PLS = Preschool Language Scales; PPVT = Peabody Picture Vocabulary Test; PROMPT = Prompts for Restructuring Oral Muscular Phonetic Targets; PRT = pivotal response treatment; RBS-R = Repetitive Behavior Scale – Revised; RCT = randomized controlled trial; RMIA = rapid motor imitation antecedent training; RPMT = responsive education prelinguistic milieu teaching; SCQ = Social Communication Questionnaire; SD = standard deviation; SEF = Stimulation of Executive Functions; SGD = speech-generating device; SP = symbolic play; SPT = Symbolic Play Test; SRS = Social Responsiveness Scale; SS = skills intervention; SSRS = Social Skills Rating System; SULP = Social Use of Language Program; TASSK = Test of Adolescent Social Skills Knowledge; TD = typical developing; TEACCH = Treatment and Education of Autistic and Communication related handicapped Children; UOT = unstuck and on target; VABS = Vineland Adaptive Behavior Scales; WLC = waitlist control.

Table S2 Demographic information for the samples of each study included in the systematic review

Author, year	Age at intervention, years (mean [SD] unless otherwise noted)	Sex (% female)	Race and ethnicity	Socioeconomic status (SES)
Aldred, 2004	Median 4 years intervention; Median 4.25 years non-intervention (mean and SD not reported)	7.14% intervention; 14.28% non-intervention	All participants (n): African-Caribbean 2; Caucasian 26	Not reported
Aldred, 2011	4.28 (0.98) intervention; 4.24 (1.35) non-intervention	7.14% intervention; 14.28% non-intervention	Not reported	Not reported
Almirall, 2016	6.18 (1.08) JASP + EMT; 6.44 (1.23) JASP + EMT + SGD	13% JASP + EMT; 21% JASP + EMT + SGD	JASP + EMT: White 47%; Non-white 53%/JASP + EMT + SGD: White 48%; Non-white 52%	Not reported
Amatachaya, 2015	5-8 years (mean and SD not reported)	All male	Not reported	Not reported
Arabi, 2019	8.59 (2.12) visuomotor intervention; 8.40 (2.01) motor intervention; 8.63 (2.33) visual intervention; 8.44 (1.94) non-intervention	33.33% visuomotor intervention; 20% motor intervention; 20% visual intervention; 26.66% non-intervention	Not reported	Not reported
Bauminger, 2002	11.25 (26.57)	26.66%	Not reported	Not reported
Ben-Itzchak, 2008	2.27 intervention; 2.01 non-intervention	2.27% intervention; 37.83% non-intervention	Not reported	Not reported
Bem-Itzchak, 2009	2.11 (0.33) all participants (age by group not reported)	8.82% all participants (sex by group note reported)	Not reported	Not reported
Ben-Sasson, 2012	9.28 (0.94)	All male	n=6 Russian immigrant families; all participates were born in Israel	Not reported
Bölte, 2002	27.2 (7.0)	All male	Not reported	Not reported

Author, year	Age at intervention, years (mean [SD] unless otherwise noted)	Sex (% female)	Race and ethnicity	Socioeconomic status (SES)
Boyd, 2018	4.08 (0.61) intervention; 4.17 (0.61) non-Intervention	11.11% intervention; 18.18% non-intervention	Intervention: Black 35.06%; White 51.95; Other 12.99%; Hispanic 25.97%/Non-Intervention: Black 15.28%; White 59.72%; Other 25.00%; Hispanic 22.22%	Family annual income: Intervention: < 20,000 33.33%; 20,000-39,999 27.54%; 40,000-59,999 11.59%; 60,000-79,999 4.35%; 80,000-99,999 5.80%; > 100,000 17.39%/Non-Intervention: < 20,000 9.84%; 20,000-39,999 19.67%; 40,000-59,999 11.59%; 60,000-79,999 4.35%; 80,000-99,999 5.80%; > 100,000 17.39%
Byford, 2015	4 (median) intervention; 4 (median) non-Intervention	8% intervention; 10% non-intervention	Intervention: both parents white 61%/Non-intervention: both parents white 55%	Not reported
Carr, 2006	3-7 years (mean and SD not reported), all participants	Not reported	Not reported	Not reported
Carter, 2011	1.75 (0.23) intervention; 1.79 (0.23) non-intervention	17.74% all participants (sex by group not reported)	Not reported	Not reported
Chan, 2009	6.85 (1.76) intervention; 6.89 (1.77) WLC	18.75% intervention; 18.75% WLC	Not reported	Not reported
Chan, 2013	11.28 (3.90) intervention; 12.42 (3.25) non-intervention	5% intervention; 15% non-intervention	Not reported	Not reported
Corbett, 2007	3-6 years (mean and SD not reported)	16.66% intervention; 20% placebo	Intervention: Caucasian 16%; Caucasian/Native American/Hispanic 16.66%; Caucasian/Hispanic 33.33%; Hispanic 16.66%; Pacific Islander 16.66%/Placebo: Caucasian 60%; Caucasian/Native American 20%; Hispanic 20%	Not reported
Corbett, 2013	Mean 12.17 (SD not reported)	25%	Not reported	Not reported

Author, year	Age at intervention, years (mean [SD] unless otherwise noted)	Sex (% female)	Race and ethnicity	Socioeconomic status (SES)
Corbett, 2015	11.27 (2.51) intervention; 10.74 (1.89) WLC	23.52% intervention; 15.38 WLC	Intervention: Caucasian 70.5% African American 5.88%; Asian 5.88%; Latino/Hispanic 5.88%; Multiracial 11.76%/WLC: Caucasian 69.23%; African American 0; Asian 7.69%; Latino/Hispanic 23.07%; Multiracial 0	Not reported
Deckers, 2016	10.2 (1.43) intervention; 10.0 (1.10) WLC	7.69% intervention; 11.53% WLC	Not reported	Not reported
Dolan, 2016	13.64 (1.28) intervention; 13.16 (1.67) WLC	All male	Intervention: Caucasian 85.7%/WLC: Caucasian 90.0%	Intervention: $50-75k or higher 52.0%/$50-75k or higher 48.0%
Estes, 2015	6.07 (0.21) all participants (age by group not reported)	23.8% intervention; 22.22% non-intervention	White 72% all participants (ethnicity by group not reported)	Median annual income – Intervention: $90,000; non-intervention: $85,000
Faja, 2011	22.4 (4.4) intervention; 21.5 (5.6) non-intervention	Not reported	Not reported	Not reported
Fletcher-Watson, 2015	4.10 (0.9) intervention; 4.16 (1.1) non-intervention	22% intervention; 19% non-intervention	Intervention: White 85%; Other 15%/Non-intervention: White: 89%; Other 11%	Intervention: bottom 20% in Scotland 15%; middle 60% in Scotland 46%; top 20% in Scotland 39%/Non-intervention: bottom 20% in Scotland 19%; middle 60% in Scotland 52%; Top 20% in Scotland 29%
Furukawa, 2018	5.49 (1.03) intervention; 4.91 (0.88) WLC	16.66% intervention; 21.22% WLC	Intervention: 100% Japanese; WLC: 100% Japanese	Not reported
Gengoux, 2015	4.1 (1.2) PRT; mean age and SD of the non-intervention group not reported	24% PRT; sex of the non-intervention group not reported	Not reported	Not reported
Goods, 2012	4.06 (0.97) intervention; 4.55 (0.85) non-intervention	Not reported	All participants: over half of the children identified as African American, Hispanic, or Asian (% not reported)	Not reported
Gordon, 2011	6.8 (1.26), all participants (age by group not reported)	13.09%, all participants (sex by group not reported)	Not reported	Not reported

Author, year	Age at intervention, years (mean [SD] unless otherwise noted)	Sex (% female)	Race and ethnicity	Socioeconomic status (SES)
Grahame, 2015	5.03 (1.12) intervention; 5.22 (1.40) WLC	4% intervention; 25% WLC	Intervention: White background 88%; Other background 12%/WLC: White background 80%; Other 20%	Townsend index of deprivation Mean (SD) – intervention 2.82 (3.14); WLC 2.39 (2.88)
Green, 2010	Mean 3.75, all participants (mean and SD by group not reported)	8% intervention; 11% non-intervention	Intervention: Both parents White: 60%; Mixed: 6%; Non-white: 34%/Non-intervention: Both parents White: 55%; Mixed: 12%; Non-white: 33%	At least one parent in professional or administrative occupation – intervention 66%; non-intervention 59%
Gutstein, 2007	5.04 (1.70)	6.25%	Not reported	Not reported
Hardan, 2014	4.1 (1.2) intervention; 4.1 (1.3) non-intervention	24% intervention; 26.08% non-intervention	Not reported	Not reported
Herbrecht, 2015	3.03 (0.67)	25%	Not reported	Not reported
Hopkins, 2011	Intervention: 10.31 (3.31) low-functioning; 10.05 (2.30) high-functioning/Non-intervention: 10.57 (3.2) low-functioning; 9.85 (2.87) high-functioning	Intervention: 9.1% low-functioning; 7.7% high-functioning/Non-intervention: 7.1% low-functioning; 18.2% high-functioning	Intervention: African American 27.3% low-functioning, 23.1% high-functioning; Caucasian 72.7% low-functioning, 76.9% high-functioning/Non-intervention: African American 28.6% low-functioning, 27.3% high-functioning; Caucasian 71.4% low-functioning, 63.3% high-functioning; other 9.1% high-functioning	Not reported
Howlin, 2007	6.09 (1.31) intervention; 7.21 (1.05) WLC; 7.13 (1.13) non-intervention	19.23% intervention; 10% WLC; 10.71%	Not reported	Not reported
Ichikawa, 2013	5-6 years, all participants (mean and SD not reported)	20% intervention; 16.66% WLC	Not reported	Not reported
Jonsson, 2018	13.04 (2.58) intervention; 12.63 (2.83) non-intervention	22% intervention; 37% non-intervention	Not reported	Not reported
Kaale, 2014	3.96 (0.69) intervention; 4.19 (0.69) non-intervention	23.5% intervention; 18.5% non-intervention	Not reported	Not reported

Author, year	Age at intervention, years (mean [SD] unless otherwise noted)	Sex (% female)	Race and ethnicity	Socioeconomic status (SES)
Kasari, 2006	3.6 (0.58) JA; 3.55 (0.57) SP; 3.49 (0.41) non-intervention	25% JA; 23.8% SP; 11.76% non-intervention	JA: Caucasian: 65%; minority: 15%/SP: Caucasian: 66.66%; minority: 28.57%/Non-intervention: Caucasian: 58.8%; minority: 41.17%	Not reported
Kasari, 2008	3.6 (0.58) JA; 3.55 (0.57) SP; 41.94 (4.93) non-intervention	20.68%, all participants (sex by group not reported)	Caucasian 36.20%	Not reported
Kasari, 2012	Mean 8 years, all participants (SD not reported)	18%, all participants	All participants: African American 3%; White 69%; Hispanic 3%; Asian 13%; Other 15%	Not reported
Kasari, 2016	8.23 (1.63) SKILLS intervention; 8.13 (1.55) ENGAGE intervention	15.79% SKILLS intervention; 23.75% ENGAGE intervention	SKILLS intervention: African American 11.32%; Caucasian 40.35%; Hispanic 14.04%; Asian 24.56%; Other 3.51%; Did not disclose 7.02% /ENGAGE intervention: African American 5.00%; Caucasian 48.75%; Hispanic 15.00%; Asian 17.5%; Other 6.25%; Did not disclose 7.5%	Not reported
Kasari, Kaiser, 2014	6.18 (1.08) JASP + EMT; 6.44 (1.23) JASP + EMT + SGD	13% JASP + EMT; 21% JASP + EMT + SGD	JASP + EMT: White 47%; Non-white 53%/JASP + EMT + SGD: White 48%; Non-white 52%	Not reported
Kasari, Lawton, 2014	3.49 (0.83) Caregiver Mediated Module Intervention; 3.56 (0.85) Caregiver Education Module Intervention	16.6% Caregiver Mediated Module Intervention; 17.3% Caregiver Education Module Intervention	Caregiver Mediated Module Intervention: White 16 38.3%; Hispanic 15.0%; African American 21.7%; Asian 8.3%; Multi-ethnic/other 16.7%/Caregiver Education Module Intervention: White 30.8%; Hispanic 13.5%); African American 34.6%; Asian 7.7%; Multi-ethnic/other 13.5%)	Caregiver Mediated Module Intervention: Low income No 31.7%; Yes 63.3%; Unknown 5.0%/Caregiver Education Module Intervention: Low income 36.5%; Yes 59.6%; Unknown 3.9%
Kenworthy, 2013	9.49 (1.00) intervention; 9.58 (1.10) non-intervention	13% intervention; 10% non-intervention	Intervention: White 70%; Non-Intervention: 55%	Not reported
Koegel, 1996	3-9 years PRT; 3-6 years ITB (mean and SD not reported)	28.57% intervention; 50% non-intervention	Not reported	Not reported
Kouijzer, 2012	15.3 (1.5) EEG; 14.5 (1.5) SC; 15.9 (1.5) WLC	23.07% EEG; 25% SC; 15.38% WLC	Not reported	Not reported

Author, year	Age at intervention, years (mean [SD] unless otherwise noted)	Sex (% female)	Race and ethnicity	Socioeconomic status (SES)
Lawton, 2012	3.83 (0.41) intervention; 3.58 (0,5) WLC	Not reported	Caucasian-minority ratio: Intervention: 4:5/WLC: 5:2	Not reported
LeGoff, 2004	10.6 (2.8)	27.65%	Not reported	Not reported
Lerna, 2012	3.23 (0.6) intervention; 3.42 (0.72)	5.55%, all participants	Not reported	Not reported
Lerna, 2014	5.92 (0.99) PECS; 5.51 (0.98) CLT	Not reported	Not reported	Not reported
Locke, 2013	6.1 (0.9), all participants	14.1%, all participants	All participants: African American 41.9%; Caucasian 17.8%; Asian 2.6%; Latino 7.3%; Multiethnic 4.2%; Unknown 26.2%	Not reported
Martins, 2012	2-12 years, all participants (mean and SD not reported)	Not reported	Not reported	Not reported
Maximo, 2017; Murdaugh, 2017	11.0 (1.2) intervention; 10.0 (1.6) WLC	16.6% intervention; 16;6% WLC	Not reported	Not reported
Mcduffie, 2012	2.66 (0.5) RPMT; 3.0 (0.83)	Not reported	Not reported	Not reported
Oosterling, 2010	2.93 (0.45) intervention; 2.77 (0.53) non-intervention	25% intervention; 19.4% non-intervention	Non-western immigrants: 91.7% intervention; 83.9% non-intervention	Not reported
Ortiz-Sánchez, 2018	4-5 years (mean not reported)	Not reported	Not reported	Not reported
Owens, 2008	8.26 (1.67) LEGO; 8.11 (1.86) SULP; 8.81 (1.33) non-intervention	0 LEGO; 6.66% SULP; 0 non-intervention	Not reported	Not reported
Parsons, 2018	5.36 (1.89) intervention; 5.06 (1.28) WLC	16.7% intervention; 20.7% WLC	Not reported	Socio-Economic Index for Areas – mean (SD): intervention: 5.5 (1.76); WLC: 6.0 (1.65)
Paul, 2012	4.3 (1.2) RMIA; 3.5 (0.8) MCT	36.4% RMIA; 9.1% MCT	Not reported	Not reported
Rahman, 2016	5.31 (1.82) intervention; 5.55 (1.96) WLC	19% intervention; 18% non-intervention	Not reported	Not reported

Author, year	Age at intervention, years (mean [SD] unless otherwise noted)	Sex (% female)	Race and ethnicity	Socioeconomic status (SES)
Rogers, 2006	1-5 years (SD not reported), all participants	All male	All participants (ethnicity by group not reported): Caucasian 80%; African American 10%; Hispanic/biracial 10%	Not reported
Saaybi, 2019	1-4 years (mean and SD not reported)	29.4% autistic children; 42.9% TD	Not reported	Not reported
Sharda, 2018	10.30 (1.91) intervention; 10.20 (1.87) non-intervention	15.68%	Not reported	Annual income (in $): intervention: mean 39,760; non-intervention: mean 43,300
Shih, 2014	8.1 (1.46) SKILLS intervention; 8.17 (1.34) ENGAGE intervention	20% SKILLS intervention; 17.3% ENGAGE intervention	SKILLS intervention: African American 10.00%; Caucasian 45.00%; Hispanic 12.50%; Asian 20.00% other 5.00%; missing 7.50%/ENGAGE intervention: African American 11.54%; Caucasian 40.38%; Hispanic 21.15%; Asian 15.38%; other 3.85%; missing 7.69%	Not reported
Siller, 2012	4.85 (1.05) intervention; 4.65 (0.99) non-intervention	8.57%, all participants (sex by group not reported)	Not reported	Not reported
Siller, 2014	4.85 (1.05) intervention; 4.65 (0.99) non-intervention	8.57%, all participants (age by group not reported)	All participants (ethnicity by group not reported): Hispanic/Latino 44%; White 20%; Asian 19%, Black 7%; mixed ethnic/racial origin 10%	All participants (SES by group not reported): median annual household income $65,000
Sokhadze, 2009	15.6 (5.8)	7.69%	Not reported	Not reported
Sokhadze, 2012	13.5 (2.5) intervention; 14.1 (2.4) WLC	20% intervention; 20% WLC	Not reported	Not reported
Solomon, 2014	4.15 (0.86) intervention; 4.21 (0.83) non-intervention	20.3% intervention; 15.6% non-intervention	Children of color – intervention: 29.7%; non-intervention: 18.8%	Family annual income> Intervention: $60,000 56.3%; Non-intervention: 54.0%
Stadnick, 2015	3.89 (2.15) intervention; 5.33% (1.86) non-intervention	19% intervention; 21% non-intervention	Intervention: Caucasian/White 31%; Hispanic/Latino 6%; Asian/Pacific Islander 13%; African American 6%; Multiracial 44%; other 0/Non-intervention: Caucasian/White 29%; Hispanic/Latino 14%; Asian/Pacific Islander 0; African American 0; Multiracial 50%; other 7%	Annual family income: intervention: 0-$25,000 14%; $25-50,000 36%; $50-75,000 14%; $75-$100,000 29%; > $100,000 7%/non-intervention: 0-$25,000 7%; $25-50,000 21%; $50-75,000 7%; $75-$100,000 57%; > $100,000 7%

Author, year	Age at intervention, years (mean [SD] unless otherwise noted)	Sex (% female)	Race and ethnicity	Socioeconomic status (SES)
Sun, 2017	5-12 years (mean not reported)	Not reported	Not reported	Not reported
Tsiouri, 2011	3-6 years, all participants (mean and SD not reported)	Not reported	Not reported	Not reported
Van Hecke, 2013	14.1 (1.3) intervention; 13.3 (1.7) WLC; 13.3 (1.3) TD	21.4% intervention; 20.7% WLC; 6.7% TD	Intervention: Asian 0%; African American 3.6%; Biracial 0%; Caucasian 92.9%; Unreported 3.6%/WLC: Asian 3.4%; African American 6.9%; Biracial 0; Caucasian 89.7; Unreported 0/TD: Asian 0; African American 0; Biracial 3.3; Caucasian 96.7% unreported 0	Annual income: intervention: Under 50 k 14.3%; 50-75 k 32.1%; 75-100 k 14.3%; 100 k plus 35.7%; Unreported 3.6%/WLC: Under 50 k 20.6%; 50-75 k 13.8%; 75-100 k 10.3%; 100 k plus 48.3%/Unreported 3.4%/TD: Under 50 k 10.0%; 50-75 k 20.0%; 75-100 k 13.3%; 100 k plus 56.7%; unreported 0
Venker, 2011	3.42 (0.86), all participants (age by group not reported)	Not reported	Not reported	Not reported
Ventola, Friedman, 2014	5.4 (0.71), all participants	20%, all participants	Not reported	Not reported
Ventola, Yang, 2014	Mean 5.48 intervention; mean overall 6.2 (SD not reported)	20% intervention; 60% non-intervention	Not reported	Not reported
Verschuur, 2016	7-13 years (mean and SD not reported)	7.14%	Not reported	Not reported
Wetherby, 2014	1.63 (0.16) individual intervention; 1.63 (0.11) group intervention	19% individual intervention; 7.5% group intervention	Individual intervention: White 73.8%; Black 7.1%; other 14.3%/Group intervention: White 72.5%; Black 10.0%; other 15.0%	Not reported
White, 2012	Mean 14 years intervention; 15 years WLC (SD not reported)	27% intervention; 20% WLC	Intervention: Caucasian 80%; Asian/Pacific Islander 7%; African American 7%/WLC: Caucasian 93%; Asian/Pacific Islander 0; African American 7%	Not reported
Wong, 2009	2.11 (0.5) intervention; 2.32 (0.46) non-intervention	11% intervention; 0 non-intervention	Not reported	Not reported

Author, year	Age at intervention, years (mean [SD] unless otherwise noted)	Sex (% female)	Race and ethnicity	Socioeconomic status (SES)
Wong, 2010	6.23 (1.87) intervention; 6 (1.99) non-intervention	Male-to-female ratio 7.3:1	Not reported	Not reported
Wood, 2014	8.7 (1.8) intervention; 8.8 (1.47) non-intervention	29% intervention; 17% non-intervention	Intervention: Caucasian 86%; Asian/Pacific Islander 14%; African American 0 Latino 0 Multiracial 0/Non-Intervention: Caucasian 50% Asian/Pacific Islander 0 African American 17%; Latino 17% Multiracial 17%	Not reported
Yoder, 2009	3.1 (0.8) PECS; 2.7 (0.5) RPMT	Not reported	Not reported	Not reported
Yoo, 2014	14.04 (1.64) intervention; 13.54 (1.50) WLC	8.70% intervention; 4.20 WLC	Not reported	SES 5-point Likert scale from Child Behavior Checklist: 3.13 (0.69) intervention; 2.96 (0.64) WLC
Young, 2011	4-8 years, all participants (mean and SD by group not reported)	Not reported	Not reported	Not reported
Yun, 2017	5.75 (0.88) robotic intervention; 6.32 (1.23) human intervention	All male	Not reported	Not reported
Zhao, 2018	6.14 (0.96) intervention; 6.1 (0.98) non-intervention	33.34% intervention; 25% non-intervention	Not reported	Not reported
Zlomke, 2017	4.87 (1.27)	17.6%	White 58.8%; African American 17.6%	Not reported

CLT = conventional language therapy; EEG = electroencephalogram biofeedback; EMT = enhanced milieu teaching intervention; ITB = individual target behaviors intervention; JA = joint attention intervention; JASP = joint attention, symbolic play, engagement and regulation intervention; LEGO = LEGO® therapy; MCT = milieu communication training; PECS = picture exchange communication system; PRT = pivotal responses intervention; RMIA = rapid motor imitation antecedent training; RPMT = responsive education and prelinguistic milieu teaching intervention; SC = skin conductance biofeedback; SD = standard deviation; SGD = speech-generating device; SP = symbolic play intervention; SULP = social use of language programme; TD = typical development; WLC = waitlist controls.