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# Pivotal Response Treatment for Children with Autism Spectrum Disorders: A Systematic Review

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**Abstract** Intervention studies evaluating pivotal response treatment (PRT) were systematically identified and analyzed. Forty-three studies were summarized in terms of (a) participant characteristics, (b) dependent variables, (c) intervention procedures, (d) intervention outcomes, and (e) certainty of evidence. The majority of the reviewed studies (56.4 %) had serious methodological limitations. However, the reviewed studies that provided conclusive or preponderant evidence (43.6 %) indicated that PRT results in increases in self-initiations and collateral improvements in communication and language, play skills, affect and reductions in maladaptive behavior for a number of children. Furthermore, the reviewed studies suggested that the majority of caregivers and staff members were able to implement PRT techniques, but evidence for collateral improvements in caregivers' and staff members' behaviors remains sparse. Implications for future research are discussed.

**Keywords** Autism spectrum disorders · Pivotal response treatment · Children · Systematic review

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The term autism spectrum disorder (ASD) refers to a class of pervasive developmental disorders characterized by impairments in social interaction, deficits in speech/language and communication development, and restricted, repetitive, and stereotyped behaviors (American Psychiatric Association 2013). The number of children diagnosed with ASD has increased in recent years (Baird et al. 2006; Baron-Cohen et al. 2009; Fombonne 2009) and this increase is associated with growing demands for effective educational services (Kogan et al. 2008). There is thus an increasing need for effective and cost efficient educational interventions for children with ASD.

Currently, there are numerous intervention methods that claim to be effective for educating children with ASD, including various medications, speech/language therapy, assistive technology interventions, sensory integration therapy, music therapy, visual schedules, gentle teaching, holding therapy, special diets, and vitamin supplements (e.g., Goin-Kochel et al. 2007; Green et al. 2006; Hess et al. 2008; Howlin 2005; Simpson 2005). There is insufficient evidence to support the use of most of these interventions (e.g., Howlin 2005; Lang et al. 2012; Mulloy et al. 2010; Simpson 2005; Simpson and Keen 2011). However, a large body of research has demonstrated positive effects from interventions based on the principles of applied behavior analysis (ABA), especially for teaching functional skills and reducing problem behavior in children with ASD (e.g., Matson et al. 1996; Matson and Smith 2008; National Research Council [NRC] 2001; Smith et al. 2007; Vismara and Rogers 2010).

ABA-based approaches often involve teaching single responses in a structured one-to-one teaching paradigm (Duker et al. 2004). This approach, sometimes referred to as discrete-trial training (DTT), has been associated with gains in intellectual functioning, language, and social skills of children with ASD and with reductions in problem behavior (e.g., Eldevik et al. 2009; Lovaas 1987; Peters-Scheffer et al. 2011; Smith 2001; Vismara and Rogers 2010). However, the DTT approach

also has some potential disadvantages. First, it has been noted to be relatively time-consuming and costly (Koegel et al. 2003b, 1999c; Smith 2001; Vismara and Rogers 2010). Second, stimulus and response generalization may not occur, without additional generalization programming (Lovaas et al. 1973; Smith 2001; Steege et al. 2007; Stokes and Baer 1977; Vismara and Rogers 2010).

To address these potential limitations of DDT, more naturalistic interventions have been developed (Allen and Cowan 2008). The latter approaches are generally considered to be naturalistic in the sense that they (a) are typically conducted in a variety of natural settings, (b) tend to be more loosely structured than interventions following a DTT format, (c) involve the use of a variety of motivational strategies, such as following the child's lead, (d) incorporate a variety of stimuli, prompts, and natural reinforcers, and (e) target clusters of responses rather than teaching skills involving a single response (Allan and Cowan 2008; Delprato 2001; Koegel et al. 1987a, 1999c). Naturalistic approaches typically include a package of teaching procedures that are often referred to as involving (a) incidental teaching (e.g., McGee et al. 1983, 1985), (b) milieu teaching (e.g., Hancock and Kaiser 2006), (c) the Natural Language Paradigm, or (d) Pivotal Response Treatment (e.g., Koegel et al. 1987b; Koegel and Koegel 2006).

Pivotal Response Treatment (PRT), which evolved from the Natural Language Paradigm (NLP), is described as a comprehensive naturalistic intervention model based on ABA. PRT aims to teach pivotal behaviors to children with ASD in order to achieve generalized improvements in their functioning (Koegel et al. 2006). Pivotal behaviors are described as behaviors that, when targeted, lead to collateral improvements in other—often untargeted—aspects of functioning. Pivotal responses are conceptually related to behavioral cusps. Rosales-Ruiz and Baer (1997) describe behavioral cusps as behaviors in which changes have far-reaching consequences, because those behavior changes expose the individual to new reinforcers, contingencies, and environments. The concepts of pivotal responses and behavioral cusps are similar in that they both aim to facilitate further development by prioritizing target behaviors that lead to widespread behavior change.

So far, research has focused on four aspects of functioning that appear to be pivotal: (a) motivation, (b) self-initiations, (c) responding to multiple cues, and (d) self-management (Koegel et al. 1999a, c, 2001). Motivational procedures are incorporated to teach pivotal behaviors and include: (a) following the child's lead and offering choices, (b) gaining the child's attention, (c) providing clear opportunities to respond, including shared control and turn taking, (d) varying tasks and interspersing maintenance and acquisition tasks, (e) using contingent and natural reinforcement, and (f) reinforcing attempts at target skills (e.g., Dunlap and Koegel 1980; Koegel et al. 1999a, c, 1987a; Koegel and Koegel 2006; Koegel et al. 2001, 1988). A critical feature of PRT is implementation of the

intervention in the child's natural environment to promote generalization (Stokes and Baer 1977). Family involvement, in the form of teaching parents and other caregivers to implement the motivational procedures, is also emphasized (Koegel and Koegel 2006).

The extent to which PRT can be considered to be an evidence-based practice has been examined. For example, Simpson (2005) evaluated 33 treatments for children with ASD and concluded that PRT is a scientifically based practice for the education of children with autism. In 2009, the National Autism Center (NAC) also concluded that PRT is an established intervention. Another synthesis of research on PRT concluded that PRT effectively improved social and emotional behaviors of young children with ASD (Masiello 2003). A comparative review, involving studies that compared naturalistic interventions (including NLP and PRT) with DTT, concluded that naturalistic interventions were more effective in teaching language to young children with ASD (Delprato 2001).

Surprisingly, none of these reviews addressed the claim that PRT leads to improvements in untargeted behaviors via the targeting of pivotal behaviors. Thus, it remains unclear as to whether pivotal behaviors are in fact pivotal (Koegel et al. 2001). It is also unclear whether the research on PRT supports the theoretical model of PRT. Furthermore, none of the previous reviews referenced above systematically considered caregiver or staff variables that might impact on PRT implementation (e.g., the extent to which parents can learn to use the techniques and the effects on parental affect or stress). This is a limitation because such variables could influence PRT's effectiveness (Koegel and Koegel 2006; Schreibman et al. 1991; Steiner 2011). In recent years, a large number of studies on the effectiveness of PRT have been conducted, which have not yet been included in previous systematic reviews. Given the limitations of previous reviews and the recent growth in the number of PRT studies, a systematic review on PRT was considered important and timely.

The purpose of this systematic review was to analyze the research on PRT in order to (a) document the range of skills that have been targeted for improvement with PRT, (b) assess the success of PRT for improving the skills of children with ASD (i.e., pivotal skills and untargeted skills), (c) assess the success of PRT for improving the skills of caregivers and staff, (d) evaluate the certainty of evidence arising from these studies, (e) identify limitations of the existing evidence base, and (f) suggest directions for future research.

## Method

### Search Procedures

To identify studies for inclusion in this review, we searched five electronic databases: Education Resources Information

Center (ERIC), Linguistics and Language Behavior Abstracts, Medline, PubMed, and PsychINFO. Publication year was not restricted, but searches were limited to peer-reviewed studies. Within each database, the following parenthetical terms were entered as free text into the keywords field (PRT or pivotal response treatment or pivotal response training or pivotal response therapy or pivotal response intervention or pivotal response teaching or pivotal response or NLP or natural language paradigm) and combined with autism\* or ASD or pervasive developmental disorder or PDD-NOS or Asperger.

The abstracts of the studies returned from the electronic database searches were reviewed to determine if the study met the inclusion criteria (see [Inclusion and Exclusion Criteria](#)). In addition, following the database searches, hand searches—covering December 2012 to June 2013—were conducted on the journals that had published at least two studies identified for the review from the electronic database searches. Finally, the reference lists of the studies meeting the inclusion criteria were reviewed to identify additional studies for inclusion. Searches of databases, journals, and reference lists occurred from February to June 2013. A total of 441 abstracts were screened for inclusion (see [Reliability of Search and Coding Procedures](#)).

#### Inclusion and Exclusion Criteria

To be included in this review, studies had to meet the following predetermined criteria. First, at least one of the participants had to have been diagnosed with Autistic Disorder, Asperger's Disorder, or Pervasive Developmental Disorder Not Otherwise Specified. Second, the study had to have included an empirical evaluation of either PRT or NLP. In order to meet this criterion, the study had to involve implementation of at least one antecedent motivational technique (i.e., following the child's lead, getting the child's attention, providing a clear opportunity for responding, or interspersing maintenance and acquisition tasks) and one consequent motivational technique (i.e., contingent and natural reinforcement or reinforcement of attempts) and the study had to refer to the intervention as PRT or NLP or explicitly state the specific motivational techniques that were implemented (Koegel and Koegel 2006; Koegel et al. 2010c, 1987b). Third, the study has to have been written in English, Dutch, or German (i.e., languages understood by the authors of this review). Studies were excluded if the motivational techniques of PRT and NLP were implemented, but the intervention evaluated was not referred to as PRT or NLP. For example, Hancock and Kaiser (2002) examined the effects of Enhanced Milieu Teaching (EMT) for developing social communication skills of preschool children with ASD. The milieu teaching procedures included following the child's lead and giving the child access to requested objects (i.e., natural reinforcement). The approach thus shared some of the motivational techniques associated with PRT and NLP.

However, the Hancock and Kaiser study was excluded because it did not specifically evaluate either PRT or NLP and because EMT includes additional intervention components not commonly considered inherent to PRT. Studies were also excluded if the motivational techniques of PRT or NLP were implemented, but the purpose of the study was not to evaluate PRT or NLP. For example Sherer and Schreibman (2005) investigated whether a behavioral profile predicted children's response to PRT. Although PRT was implemented, the purpose of the study was not to evaluate PRT. The study was therefore excluded. Ultimately, 43 studies met the inclusion criteria.

#### Data Extraction

Included studies were summarized in terms of (a) participant characteristics (i.e., characteristics of the children with ASD and characteristics of parents or staff that implemented PRT), (b) dependent variables, (c) intervention procedures, (d) intervention outcomes, including measures on follow-up, generalization and, social validity, and (e) certainty of evidence. Various procedural aspects were also noted, including method of data-collection, implementer, experimental design, inter-observer agreement, and treatment fidelity.

Intervention outcomes of PRT were first summarized as reported by the study's authors. Further, intervention outcomes of PRT were classified as positive, mixed, or negative (e.g., Lang et al. 2012; Machalicek et al. 2008; Palmen et al. 2012). Results were classified as positive in single-case design studies if visual analysis of graphed data revealed that all participants improved on all dependent variables. In studies using a group design, results were classified as positive if the PRT group made statistically significant improvements on all dependent variables. Results were classified as mixed in single-case design studies if some, but not all participants or dependent variables improved. In studies using a group design, results were classified as mixed if the PRT group statistically significant improved on some, but not all dependent variables. Results were classified as negative in single-case studies if none of the participants improved on any dependent variable. In studies using a group design, results were classified as negative if the PRT group did not make statistically significant improvements on any dependent variable.

Certainty of evidence was evaluated for each study by considering several methodological characteristics (e.g., research design) in order to provide an overview of the quality of evidence of research on PRT (Schlosser and Sigafoos 2007). The certainty of evidence for each study was rated as either “suggestive”, “preponderant” or “conclusive”, using the classification system as described by Lang et al. (2012), Palmen et al. (2012), Ramdoss et al. (2011) and Ramdoss et al. (2012). The lowest level of certainty was suggestive evidence. Studies classified as “suggestive” did not evaluate the intervention with an experimental design (e.g., AB-design or intervention-only

design). The second level was preponderant evidence. Studies classified as ‘preponderant’ had the following qualities: (a) the study used an experimental design (e.g., group design with random assignment, ABAB-design or multiple baseline design), (b) adequate inter-observer agreement and treatment fidelity were reported (i.e., measured during at least 20 % of the sessions with at least 80 % agreement and fidelity), (c) operational definitions for dependent variables were provided and (d) sufficient details for replication of intervention procedures were provided. However, studies at the preponderant level were limited in their ability to control for alternative explanations for treatment outcomes. For example, if two coinciding interventions (e.g., PRT and DTT) were targeting the same dependent variable and no design feature controlled for the effect of DTT, the study was classified as “preponderant”. The highest level was conclusive evidence. Studies classified as “conclusive” contained all the attributes of the preponderant level, but the study’s design also provided at least some control for alternative explanations for treatment outcomes (e.g., a group design with appropriate randomization and blinding or a concurrent multiple baseline design).

#### Reliability of Search and Coding Procedures

The first and last author of this review independently conducted the database search to check agreement. The reliability of the database search was determined by calculating the percentage of articles identified by both authors out of the total number of identified articles (99 % initial agreement on the database search). A total of 436 articles were identified during the initial database search. The first and last author then independently screened the abstracts of the 436 articles for possible inclusion. The resulting lists of abstracts were compared across co-authors. Agreement as to whether a study should be considered for inclusion was 90 % (i.e., agreement was obtained on 393 of the 436 studies). A total of 136 studies were further screened for possible inclusion in this review applying the inclusion and exclusion criteria. Agreement as to whether a study should be included or excluded was obtained on 114 of the 136 studies (i.e., agreement was 84 %). The disputed articles were then discussed by the co-authors until 100 % agreement was achieved. Next, hand searches, covering December 2012 to June 2013 were conducted for journals that published at least two included studies. This journal search identified one additional study for inclusion. Finally, the reference lists of the included studies were searched and another four studies were identified for inclusion. Agreement on the inclusion of the studies identified via hand searches and reference list searches was 100 %. Ultimately, 43 studies were included in this review.

After the list of included studies was agreed upon, the first author extracted information to develop an initial summary of the 43 included studies. In cases where two studies presented results from the same group of participants, the data from both

studies were consolidated into one summary (e.g., Pierce and Schreibman 1997a, b). A total of 39 summaries were developed. To ensure the accuracy of these summaries and to calculate inter-coder agreement on the extraction of data, the last author used a checklist containing five questions: (a) Is this an accurate description of the participants? (b) Is this an accurate description of the dependent variables? (c) Is this an accurate description of the intervention procedures? (d) Is this an accurate description of the intervention outcomes? and, (e) Is this an accurate description of the certainty of evidence? There were 195 items on which there could be agreement of disagreement (i.e., 39 studies with five items per study). Initial agreement was obtained on 184 items (94 %). If a summary was considered inaccurate, the co-authors discussed the study and the summary and made changes. This process was continued until consensus was achieved.

## Results

Table 1 summarizes each of the included studies in terms of (a) participant characteristics, (b) dependent variables, (c) intervention procedures, (d) intervention outcomes, and (e) certainty of evidence.

#### Participant Characteristics

In 37 of the summarized studies, data on child characteristics were reported. A total of 420 children participated in these studies. The sample size of participants ranged from 2 to 158 with 14 studies involving more than 6 children. Of the 420 children, 298 (71.0 %) were male, 65 (15.4 %) were female and the sex of 57 children (13.6 %) was not reported. Children ranged in age from 1;0 to 12;7 years; months ( $M=4;7$  years). The majority of the children ( $n=221$ ; 52.6 %) were identified as having ASD, but a specific diagnosis was not stated. One-hundred eighty-one children were diagnosed with autism (43.1 %), six with PDD-NOS (1.4 %) and two with Asperger’s syndrome (0.5 %). Ten children (2.4 %) did not have a formal diagnosis of ASD, but met the cutoff score for an ASD on the Autism Diagnostic Observation Schedule or Autism Diagnostic Interview—Revised. In addition to ASD, one child also had developmental delays and mental retardation.

Nine studies reported data on caregiver characteristics. A total number of 121 caregivers participated in these studies. Of the 121 caregivers, 22 (18.2 %) were male, 75 (62.0 %) were female and the sex of 24 caregivers (19.8 %) was not reported. The caregivers were mainly the children’s parents, but three studies also included a grandparent or one-to-one interventionist (Koegel et al. 2002; Randolph et al. 2011; Symon 2005). Caregiver education level was reported in six studies and ranged from high school to a graduate degree.

**Table 1** Summary of included studies

Citation	Participant characteristics	Dependent variables	Intervention procedures	Intervention outcomes	Certainty of evidence
Baker-Ericzén et al. (2007)	<i>Children:</i> $N=158$ (83 % male, 17 % female), $M$ age=49.36 months; with autistic disorder or PDD-NOS; with various ethnic backgrounds	<i>Child behaviors:</i> Pivotal behaviors: NR Other behaviors: adaptive functioning (Vineland Adaptive Behavior Scales; VABS)	<i>Intervention:</i> 12-week parent education program (12 1-h individual sessions), consisting of a manual, teaching of PRT techniques, completing teaching activities, discussing strategies and weekly home assignments. <i>PRT techniques:</i> child's choice; clear opportunities and shared control; interspersal of maintenance and acquisition tasks; natural reinforcement; reinforcement of attempts. <i>Implementer:</i> PRT-trained therapists (i.e., master's level developmental specialists or doctoral level clinical psychologists) (parent training), parents (PRT)	<i>Children:</i> positive <i>Adaptive functioning:</i> statistically sign. improvement on the ABC and each sub domain of the VABS; no statistically sign. differences between boys and girls or ethnic backgrounds; statistically sign. difference between age groups at pretest and posttest (children $\leq$ 3 years were less impaired at pretest and showed most improvement at posttest), but improvement was statistically sign. for all age groups; FU: NR, Gen: NR, SV: NR	Suggestive: pre-experimental design (pretest-post design, without control group); IOA and TF were NR; operational definition of dependent variable; insufficient details on intervention procedures (i.e., parent training); limited control for alternative outcomes due to pre-experimental design
Bernard-Opitz et al. (2004)	<i>Children:</i> $N=8$ (gender NR); aged 28–44 months; 7 children met cutoff score for autism on ADI-R; 2 groups, matched on age, ADI-R, PL-ADOS and Symbolic Play Test (SPT)	<i>Child behaviors:</i> Pivotal behaviors: NR Other behaviors: autism symptoms (PL-ADOS); symbolic play (SPT); compliance; attending behavior; communication (observation)	<i>Intervention:</i> 6 h of training per week during 5 weeks for behavioral (DTT) and play (NLP) condition; 10 h of therapy by parents per week during both conditions <i>PRT techniques:</i> child's choice; natural reinforcement <i>Implementer:</i> psychology (honors) graduate (behavioral or play); parent (both); coordinator (pre- and post-intervention sessions)	<i>Children:</i> mixed (play condition) <i>Autism symptoms:</i> reduced communication and interaction scores for 7 children, reduced play scores for 5 children and reduced stereotyped behavior scores for 7 children after both conditions (play condition separately was NR) <i>Symbolic play:</i> increase for 5 children after both conditions <i>Communication:</i> increase for all 4 verbal children across communication partners after both conditions <i>Compliance:</i> increase for 2 children with coordinators and for 4 children with parents (play) <i>Attending behavior:</i> increase for 1 child with coordinators and for 5 children with parents (play) FU: NR, Gen: Yes, SV: Yes	Suggestive: quasi-experimental design (i.e., counterbalanced crossover design, with too small number of pre- and post-intervention data points); IOA was inadequate for attending behavior and TF was NR, however, intervention conditions were validated; no operational definitions some dependent variables (i.e., compliance, attending behavior and communication); insufficient details on intervention procedures (i.e., content of sessions); limited control for alternative explanations due to quasi-experimental design
Coolican et al. (2010)	<i>Children:</i> $N=8$ (7 males, 1 female); aged 2;4–4;8 years; with autism <i>Parents:</i> $N=8$ (3 fathers, 5 mothers); middle to upper-middle socioeconomic class	<i>Child behavior:</i> Pivotal behaviors: type of utterance (observation of initiations) Other behaviors: functional verbal utterances (observation); type of utterances (observation of appropriate/inappropriate utterances, degree to which utterances were prompted and no response); disruptive behavior	<i>Intervention:</i> 3 2-h individual PRT training sessions, consisting of a manual, instruction, modeling, practice and in vivo feedback <i>PRT techniques:</i> clear opportunities; child's choice; contingent reinforcement; natural reinforcement; reinforcement of attempts	<i>Children:</i> mixed <i>Initiations:</i> no statistically sign. change <i>Functional verbal utterances:</i> statistically sign. increase, but minimal gains for 2 children; maintained during FU; but (slight) decreases for 5 children <i>Type of utterances:</i> statistically sign. increase in appropriate utterances and indirectly prompted responses	Preponderant: true experimental design (i.e., non-concurrent multiple baseline design across participants); adequate IOA and TF (PRT) for 5 parents, but TF (parent training) was NR; operational definitions of dependent variables; sufficient details on intervention procedures; limited control alternative explanations due to non-concurrent

**Table 1** (continued)

Citation	Participant characteristics	Dependent variables	Intervention procedures	Intervention outcomes	Certainty of evidence
Gianoumis et al. (2012)	<p><i>Children:</i> N=6 (3 males, 3 females); aged 3–4 years; with ASD  <i>Staff:</i> N=3 (3 females), preschool teacher assistants; experience: 1–2 years</p>	<p>(observation); expressive and receptive language (Preschool Language Scale 4th edition, PLS-4; Peabody Picture Vocabulary Test 3rd edition, PPVT-3).  <i>Parent behavior:</i> fidelity of PRT implementation (observation); parental self-efficacy (Parental Self-Efficacy Scale)</p>	<p><i>Implementer:</i> parents (PRT) and NR for parent training</p>	<p>and decrease in no responses, maintained during FU; no statistically sign. change in model prompted and inappropriate responses  <i>Disruptive behavior:</i> no statistically sign. decrease due to low level of disruptive behavior during baseline  <i>Expressive language:</i> no statistically sign. increase on Expressive Communication (EC) of PLS-4, but large gains for 2 children  <i>Receptive language:</i> no statistically sign. increase on Auditory Comprehension (AC), but large gains for 2 children; no statistically sign. increase on PPVT-3, but increase in single word receptive vocabulary for 3 children  <i>Parents:</i> mixed  <i>Fidelity of implementation:</i> sign. increase in fidelity of implementation, maintained during FU; 5 parents met criterion post-training  <i>Parental self-efficacy:</i> no statistically sign. increase                      FU: Yes. Gen: NR. SV: Yes  <i>Children:</i> mixed  <i>Appropriate vocalization:</i> increase for 4 children  <i>Maladaptive behavior:</i> decrease for 4 children  <i>Staff:</i> positive  <i>Performing SPA:</i> increase for all 3 staff  <i>Conducting NLP:</i> increase for all 3 staff                      FU: NR. Gen: Yes (generalization of staff's skills to another child); SV: Yes</p>	<p>multiple baseline design (i.e., limited control for history)</p>
Gillet et al. (2007)	<p><i>Children:</i> N=3 (3 males); aged 4–5 years; with autism  <i>Parents:</i> N=3 (3 females); aged 34–38 years; education level: high school—PhD</p>	<p><i>Child behaviors:</i>                      Pivotal behaviors: spontaneous vocalizations (observation)  <i>Other behaviors:</i> prompted vocalizations; mean length of utterance (MLU); appropriate play; inappropriate play (observation)  <i>Parent behaviors:</i> NLP implementation (observation)</p>	<p><i>Intervention:</i>                      Parent training: training sessions consisting of instruction, video model, practice, immediate/delayed feedback until 3 sets of 10 NLP trials were conducted with 90 % correct implementation for each component and 2 sets of 10 NLP trials were scored at 90 % accuracy</p>	<p><i>Children:</i> mixed  <i>Spontaneous vocalizations:</i> increase for 2 children and slight increase for 1 child  <i>Prompted vocalizations:</i> increase for 1 child                      MLU: increase for 2 children  <i>Appropriate play:</i> increase for 2 children</p>	<p>Preponderant: true experimental design (i.e., non-concurrent multiple baseline design across dyads); adequate IOA and TF (NLP implementation), TF (parent training) was NR, however, parent training was successfully replicated with 3 parents (i.e., all 3 met criterion for fidelity of implementation), suggesting TF</p>

Table 1 (continued)

Citation	Participant characteristics	Dependent variables	Intervention procedures	Intervention outcomes	Certainty of evidence
Harper et al. (2008)	<p>Children: <math>N=2</math> (2 males); aged 8;6 and 9;1 years; with autism</p> <p>Peers: <math>N=6</math> (2 males, 4 females); aged 8–9 years; without disabilities</p> <p>Child behaviors: Pivotal behaviors: gaining attention (observation: <math>N=1</math>); initiations to play (observation: <math>N=1</math>) Other behaviors: turn taking (observation: <math>N=2</math>) Peer behaviors: NR</p>	<p>NLP implementation: 3–6 10-min sessions 1–2 times a week (number of weeks NR), consisting of PRT techniques and modeling of appropriate vocalizations and play opportunities (turn taking); immediate and contingent reinforcement; natural reinforcement; reinforcement of attempts (loose shaping)</p> <p>Implementer: psychologist (parent training), parents (NLP)</p> <p>Intervention: Peer training: 7 20-min training sessions consisting of strategy instruction, visual training cards, cue cards, modeling, role-play, reinforcement, assessment of understanding and generalization to playground</p> <p>PRT intervention: 20-min morning recess period on 7 consecutive days involving 2 peers per child implementing PRT techniques and narrative play</p> <p>PRT techniques: child's attention; clear opportunities (i.e., turn taking); task variation; reinforcement of attempts</p> <p>Implementer: study's first author (peer training), peers (PRT intervention)</p> <p>Intervention: 2 8-h PRT group training days consisting of instruction, video models, assignments and role-play; 3 15-min individual video feedback sessions</p> <p>PRT techniques: follow child; clear opportunity; immediate and contingent reinforcement; natural reinforcement; reinforcement of attempts</p> <p>Implementer: psychologist (staff training), staff (PRT)</p>	<p><i>Inappropriate play</i>: decrease for 1 child; no play decreased for 2 children</p> <p>Parents: positive</p> <p>NLP implementation: all 3 parents reached criterion level in minimum number of sessions, which was maintained during NLP implementation</p> <p>FU: NR. Gen: Yes (for 1 child, to home situation). SV: Yes</p> <p>Children: positive</p> <p>Gaining attention: increase for participant 1, maintained during generalization</p> <p>Initiations of play: slight increase for participant 2, maintained during generalization</p> <p>Turn taking: increase for participant 1 and slight increase for participant 2, maintained during generalization</p> <p>FU: NR. Gen: Yes (to baseline condition). SV: NR</p>	<p>(parent training) was adequate; operational definition of dependent variables; sufficient details on intervention procedures; limited control alternative explanations due to non-concurrent multiple baseline design (i.e., limited control for history)</p> <p>Suggestive: quasi-experimental design (i.e., multiple baseline design across 2 children); adequate IOA and TF(except for 1 peer scoring below criterion on narrating play); operational definitions of dependent variables; sufficient details on intervention procedures; limited control for alternative explanations due to quasi-experimental design</p>	
Huskens et al. (2012)	<p>Children: <math>N=5</math> (4 males, 1 female); aged 10;3–12;4 years; 4 with PDD-NOS and 1 with Asperger's disorder</p> <p>Staff: <math>N=5</math> (5 female); direct care staff of day treatment facility; experience: 8 months–7 years</p> <p>Child behavior: Pivotal behaviors: child initiations following a learning opportunity and spontaneous child initiations (observation)</p> <p>Other behaviors: NR</p> <p>Staff behavior: creating learning opportunities (observation)</p>	<p>Child initiations following a learning opportunity: sign. increase for 2 children from baseline to post-instruction (<math>TAU_{nov/lap} = 1</math> resp. 0.82), for 1 child from video feedback to FU (<math>TAU_{nov/lap} = 1</math>)</p> <p>Spontaneous child initiations: sign. increase for 1 child from post-instruction to feedback (<math>TAU_{nov/lap} = 1</math>)</p> <p>Staff: mixed</p> <p>Creating learning opportunities: sign. increase for 3 staff members from baseline to post-instruction (overall <math>TAU_{nov/lap} = 0.85</math>) and for 1 staff member from post-instruction to video feedback (overall <math>TAU_{nov/lap} =</math></p>	<p>Conclusive: true experimental design (i.e., multiple baseline design across dyads; starting point of intervention (video feedback) were staggered); adequate IOA and TF (video feedback); operational definitions of dependent variables; sufficient details on intervention procedures; control for alternative explanations</p>		

**Table 1** (continued)

Citation	Participant characteristics	Dependent variables	Intervention procedures	Intervention outcomes	Certainty of evidence
Koegel et al. (1998a)	Children: N=3 (2 males, 1 female); aged 3;75–5;42 years; with autism (N=2) and with developmental delays, mental retardation and autism (N=1)	Child behaviors: Pivotal behaviors: number of spontaneously asked questions (observation) Other behaviors: number of new stimulus items labeled correctly (observation)	Intervention: 30-min sessions, consisting of PRT techniques, prompting, time delay and fading (from preferred to neutral items; from opaque bag to visible items) PRT techniques: child's choice; clear opportunities; task variation and interspersal of maintenance and acquisition tasks; natural reinforcement Implementer: clinician and child's mother (generalization)	FU: Yes. Gen: NR. SV: Yes Children: positive Spontaneously asked questions: increase for all 3 children during intervention; some decrease during fading, but children continued to spontaneously ask questions Correctly labeled new stimulus items: increase for all 3 children FU: NR. Gen: Yes (across stimuli, settings and people). SV: NR	Preponderant: true experimental design (i.e., multiple baseline design across participants; starting points of intervention were staggered); adequate IOA, TF was NR, despite multi component intervention; operational definitions of dependent variables; sufficient details on intervention procedures; control for alternative explanations
Koegel et al. (2003a, b)	Children: N=2 (2 males); aged 6;3 and 4;4 years; with autism	Child behaviors: Pivotal behaviors: number of productions of self-initiated query (observation) Other behaviors: number of occurrences of targeted morpheme; percentage correct productions of target morpheme; MLU; generalized use of child-initiated query; total number of verbs; diversity of verbs (observation)	Intervention: 2–30-min sessions a week, consisting of PRT techniques and prompting PRT techniques: child's choice; clear opportunities; natural reinforcement Implementer: interventionist	Children: positive (for reported outcomes) Number of productions of query and occurrences of targeted morpheme: NR Percentage correct productions of targeted morpheme: increase for both children MLU: increase for both children Generalized use of child-initiated query: increase for both children Total number of verbs: increase for both children Diversity of verbs: increase for both children FU: NR. Gen: Yes (across verbs and settings). SV: NR	Suggestive: quasi-experimental design (i.e., multiple baseline design across only 2 children); adequate IOA, but TF was NR; no operational definitions of some dependent variables (i.e., MLU, generalized use of child-initiated query and diversity of verbs); insufficient details on intervention procedures (i.e., duration of intervention, prompting); limited control for alternative explanations due to quasi-experimental design
Koegel et al. (2010a)	Children: N=3 (3 males); aged 3;2–4;8 years; with autism	Child behavior: Pivotal behaviors: percentage of unprompted 'where' questions (observation of social initiations) Other behaviors: number of correct individually targeted prepositions/ordinal markers (observation)	Intervention: twice weekly 60-min sessions, including hiding of desired items, prompting, reinforcement and prompt fading PRT techniques: child's; clear opportunities; contingent reinforcement; natural reinforcement Implementer: clinician	Children: positive Unprompted where questions: increase in unprompted where questions for all 3 children; generalization to home setting Prepositions/ordinal markers: increase in language structures for all 3 children FU: NR. Gen: Yes (generalization to home setting). SV: NR	Preponderant: true experimental design (multiple baseline design across participants; starting points of intervention were staggered); adequate IOA, but TF was NR; operational definitions of dependent variables; sufficient details on intervention procedures; control for alternative explanations
Koegel et al. (1999b)	Children (phase 2), N=4 (gender NR); aged 2;7–3;11 years; with autism	Child behaviors (phase 2): Pivotal behaviors: number of spontaneous initiations (observation) Other behaviors: language age (Brown's stages of development), pragmatic ratings (9-point Likert rating scale), adaptive functioning	Intervention: 60-min 1-to-1 sessions twice weekly during an average of 2;6 years, consisting of PRT techniques, prompting and fading PRT techniques: child's choice; clear opportunities; task variation; natural reinforcement Implementer: clinician	Children: positive Spontaneous initiations: increase for all 4 children Language age: change was NR Pragmatic ratings: increase for all 4 children to appropriate pragmatic behavior	Suggestive: pre-experimental design (i.e., pretest–posttest design, without control group); adequate IOA for most dependent variables (i.e., only IOA for pragmatic ratings was 79 %), but TF was NR; operational definitions of dependent variables; sufficient details on

Table 1 (continued)

Citation	Participant characteristics	Dependent variables	Intervention procedures	Intervention outcomes	Certainty of evidence
Koegel et al. (2012)	Children: $N=3$ (2 males, 1 female); aged 5–6 years; 2 with autism and 1 with Asperger's disorder	(VABS), social and community functioning (records from school files etc.)  <i>Child behavior:</i> Pivotal behaviors: unprompted peer-directed initiations (observation) Other behaviors: social engagement (observation); affect (observation)	<i>Intervention:</i> weekly 10-min sessions consisting of facilitated social play without initiations training for 2 children (prompting peers, encouragement of play; prompting responses to peers; game supervision) and/or facilitated social play with initiations training for all 3 children (prompting initiations and responses to peers) <i>PRT techniques:</i> child's choice; task variation; natural reinforcement <i>Implementer:</i> (undergraduate university students in psychology writing ( $N=4$ ) or math ( $N=2$ ) activity and PRT techniques <i>PRT techniques:</i> child's choice; task variation and interspersal of easy and difficult tasks; contingent reinforcement; natural reinforcement <i>Implementer:</i> NR	<i>Adaptive functioning:</i> increase for all 4 children to level close to calendar age <i>Social/community functioning:</i> regular education, (above) average grades, social circles with typically developing peers outside school, extracurricular activities and no diagnosis of autism post-intervention for all 4 children FU: NR. Gen: NR. SV: NR <i>Children:</i> positive <i>Unprompted peer-directed initiations:</i> increase for all 3 children; large effect ( $d=1.1$ resp. 1.2 resp. 1.2) <i>Social engagement:</i> increase for all 3 children; large effect ( $d=2.5$ resp. 4.9 resp. 1.2) <i>Affect:</i> increase for all 3 children; large effect ( $d=4.2$ resp. 4.0 resp. 4.3) FU: Yes (for 1 participant). Gen: Yes (generalization to no-interventionist condition); SV: NR	intervention procedures; no control for alternative explanations due to pre-experimental design  Preponderant: true experimental design (i.e., non-concurrent multiple baseline design across children; starting points of intervention were staggered); adequate IOA and TF; operational definitions of dependent variables; sufficient details on intervention procedures; limited control for alternative explanations due to non-concurrent multiple baseline design (i.e., limited control for history)
Koegel et al. (2010b)	Children: $N=4$ (3 males, 1 female); aged 4;3–7;8 years; with autism	<i>Child behavior:</i> Pivotal behaviors: interest (5-point Likert rating scale) Other behaviors: latency (to begin a task), rate (productivity) and disruptive behavior (observation)	<i>Intervention:</i> sessions including a writing ( $N=4$ ) or math ( $N=2$ ) activity and PRT techniques <i>PRT techniques:</i> child's choice; task variation and interspersal of easy and difficult tasks; contingent reinforcement; natural reinforcement <i>Implementer:</i> NR	<i>Children:</i> positive <i>Interest:</i> increase for all 4 children and during both tasks, maintained during post-intervention <i>Latency:</i> decrease for all 4 children and during both tasks, maintained during post-intervention <i>Rate:</i> increase for all 4 children and during both tasks, maintained during post-intervention <i>Disruptive behavior:</i> decrease for all 4 children and during both tasks, maintained during post-intervention FU: NR. Gen: NR. SV: NR	Suggestive: true experimental design (non-concurrent multiple baseline design across participants and behaviors; starting points of intervention were staggered); adequate IOA, but TF was NR; operational definitions of dependent variables; insufficient details on intervention procedures; limited control for alternative explanations due to non-concurrent multiple baseline design (i.e., limited control for history)
Koegel et al. (1996)	Children: $N=17$ (10 males, 7 females); aged 3–9; with autism; in 2 groups; PRT ( $N=7$ ) and Individual Target Behavior (ITB; $N=10$ ); groups similar with regard to age and adaptive functioning <i>Parents:</i> $N$ and gender were NR; wide range of socioeconomic levels	<i>Child behavior:</i> NR <i>Parent behavior:</i> interactional patterns (6-point Likert rating scales for happiness, interest, stress level and communication style)	<i>Intervention:</i> manualized procedures, (video) modeling, practice and feedback until criterion of 80 % correct implementation was met for both conditions. ITB: present discrete trials and clear instructions, select functional reinforcers, present reinforcers only after correct response and use shaping and prompting. PRT: PRT techniques	<i>Parents (PRT only):</i> positive <i>Interactional patterns:</i> increase from neutral to positive rating on all 4 scales; statistically sign. greater increase on all 4 scales in PRT condition FU: NR. Gen: NR. SV: NR	Suggestive: pre-experimental design (pretest–posttest design for 2 interventions without control group); adequate IOA and TF (intervention) was NR, but parent training continued until criterion was met, suggesting adequate TF (intervention). TF (parent training) was NR; operational definitions of dependent variables; insufficient details on intervention procedures

**Table 1** (continued)

Citation	Participant characteristics	Dependent variables	Intervention procedures	Intervention outcomes	Certainty of evidence
Koegel et al. (1998b)	Children: N=5 (4 males, 1 female); aged 3;8–7;6 years; with autism	<p><i>Child behaviors:</i> Pivotal behaviors: percentage correct production of target sounds during conversation (observation); overall intelligibility (6-point Likert rating scale)</p>	<p><i>PRT techniques:</i> child's choice; interspersal of maintenance and acquisition tasks; natural reinforcement; reinforcement of attempts; multiple cues</p> <p><i>Implementer:</i> therapists (parent training), parents (PRT or ITB)</p> <p><i>Intervention:</i> Analogue condition: 2 45-min sessions a week until 80 % criterion level was met for each step (target sound prompted, target sound spontaneous, word prompted, word spontaneous, sentence), including modeling, prompting, reinforcement and shaping</p> <p>Naturalistic condition: 2 45-min sessions a week to teach target sound in words, including PRT techniques and modeling of target sound</p> <p><i>PRT techniques:</i> child's choice; clear opportunities; reinforcement of attempts</p> <p><i>Implementer:</i> clinician</p>	<p>Children: mixed</p> <p><i>Percentage correct production of target sounds during conversation:</i> increase to high level of correctly produced target sounds in naturalistic condition for all 5 children, low levels of correctly produced target sounds in analogue condition for all 5 children</p> <p><i>Overall intelligibility:</i> 1- to 2-point improvement for 4 of 5 children from pre- to posttest (naturalistic condition separately was NR)</p> <p>FU: NR. Gen: Yes (across settings). SV: NR</p>	<p>(i.e., duration and intensity of intervention were NR); limited control for alternative explanations due to pre-experimental design</p> <p>Preponderant: true experimental design (i.e., ABA design with counterbalanced order of conditions across participants, including baseline measures prior to each condition: ABACAB or ACABAC; B = analogue and C = naturalistic); IOA was adequate for production of target sounds, but not for intelligibility; adequate TF; operational definitions of dependent variables; sufficient details on intervention procedures; limited control for alternative explanations (i.e., interaction effects)</p>
Koegel et al. (1992)	Children: N=3 (2 males, 1 female); aged 3;4–4;6 years; with autism Clinician: NR	<p><i>Child behaviors:</i> Pivotal behaviors: NR Other behaviors: disruptive behavior; individual language targets (observation)</p> <p><i>Clinician behaviors:</i> instruction pertaining task-related and disruptive behavior; presentation of reinforcement (observation)</p>	<p><i>Intervention:</i> 1–3 10-min sessions on 1 day a week during 3 months in either analogue condition (consisting of instruction, prompting, shaping and reinforcement) or NLP condition (consisting of PRT techniques and modeling of target response)</p> <p><i>PRT techniques:</i> child's choice; task variation; natural reinforcement; reinforcement of attempts</p> <p><i>Implementer:</i> clinician (advanced doctoral student)</p>	<p>Children: positive</p> <p><i>Disruptive behavior:</i> less disruptive behavior during NLP for all 3 children</p> <p><i>Individual language targets:</i> more correct target language behavior during NLP</p> <p><i>Clinician:</i> mixed</p> <p><i>Task-related:</i> more task-related instruction during NLP</p> <p><i>Disruptive behavior:</i> less instruction pertaining disruptive behavior during NLP</p> <p><i>Reinforcement:</i> slightly less reinforcement during NLP</p> <p>FU: NR. Gen: Yes (to parents); SV: NR</p> <p>Children: positive</p>	<p>Suggestive: quasi-experimental design (i.e., repeated reversals design with 2 conditions (analogue and NLP) with order of conditions and number of sessions varied across and within subjects, without baseline condition); adequate IOA and TF; operational definitions of dependent variables; sufficient details on intervention procedures; control for alternative explanations due to quasi-experimental design</p>
Koegel et al. (1987b)	Children: N=2 (gender NR); aged 4;5 and 5;8 years; with autism	<p><i>Children:</i> Pivotal behaviors: spontaneous speech (observation) Other behaviors: immediate and deferred imitative utterances (observation)</p>	<p><i>Intervention:</i> 2-h NLP sessions consisting of PRT techniques and modeling of target response</p> <p><i>PRT techniques:</i> child's choice; task variation; natural reinforcement; reinforcement of attempts</p> <p><i>Implementer:</i> clinician</p>	<p><i>Imitative utterances:</i> increase in immediate and deferred imitative utterances for both children; increase in immediate imitative utterances in generalization setting</p> <p><i>Spontaneous speech:</i> increase for both children; slight increase for both children in generalization setting</p>	<p>Suggestive: quasi-experimental design (i.e., multiple baseline design across 2 children and analogue teaching during baseline); IOA inadequate in generalization settings and TF was NR; operational definitions of dependent variables; insufficient details on intervention procedures (i.e., treatment duration); limited</p>

Table 1 (continued)

Citation	Participant characteristics	Dependent variables	Intervention procedures	Intervention outcomes	Certainty of evidence
Koegel et al. (2002)	<p>Children: N=5 (2 males, 3 females); aged 3;10–5;7 years; with ASD</p> <p>Parents: N=9 (5 mothers, 3 fathers, 1 grandmother); 8 parents had post-high school education degrees</p>	<p>Child behaviors:</p> <p>Pivotal behaviors: NR</p> <p>Other behaviors: functional verbal responses (observation)</p> <p>Parent behaviors: fidelity of PRT implementation (observation); parental affect (observation)</p>	<p>Intervention: 5 consecutive 5-h parent training days, consisting of a manual, modeling and feedback to teach PRT techniques</p> <p>PRT techniques: child's choice; clear opportunities; task variation and interspersal of maintenance and acquisition tasks; immediate and contingent reinforcement; natural reinforcement; reinforcement of attempts</p> <p>Implementer: parent educator (i.e., advanced doctoral student) and parents (PRT)</p>	<p>FU: Yes (for 1 child). Gen: Yes (across settings). SV: NR</p> <p>Children: positive</p> <p>Functional verbal response: increase for all 5 children, maintained during FU</p> <p>Parents: positive</p> <p>Fidelity of implementation: increase for all parents, maintained during FU</p> <p>Parental affect: increase to positive affect level during intervention for 4 parents, maintained during FU; increase to positive level during FU for 1 parent</p> <p>FU: Yes. Gen: Yes (to home situation). SV: NR</p>	<p>control for alternative explanations due to quasi-experimental design</p> <p>Preponderant: true experimental design (non-concurrent multiple baseline design across children); IOA was adequate for most dependent variables for all children, TF (PRT) was adequate, TF (parent education) was NR, however, parent education was successfully replicated with 3 parents (i.e., all 3 met criterion for fidelity), suggesting TF (parent education) was adequate; operational definitions of dependent variables; sufficient details on intervention procedures; limited control for alternative explanations due to non-concurrent multiple baseline design (i.e., limited control for history)</p>
Kuhn et al. (2008)	<p>Children: N=2 (2 males); aged 7 and 8 years; with autism</p> <p>Peers: N=5 (4 males, 1 female); aged 6–8 years; 3 with specific learning disabilities, 1 with mild mental retardation and 1 with a developmental disability; divided in 2 peer groups (A and B)</p>	<p>Child behaviors:</p> <p>Pivotal behaviors: initiations (observation)</p> <p>Other behaviors: responses to peer prompts (observation); rate of responses to prompts (observation)</p> <p>Peer behaviors: interaction opportunities (observation)</p>	<p>Intervention:</p> <p>Peer training: 8 20-min training, consisting of picture prompts, modeling, role-play and feedback</p> <p>Generalization (PRT implementation): 3–4 10-min sessions including play with target child and fading of picture prompts, using PRT techniques, extended conversation and narrative play</p> <p>PRT techniques: child's attention; child's choice; clear opportunities (i.e., turn taking); reinforcement of attempts</p> <p>Implementer: investigators (peer training), peers (PRT implementation)</p>	<p>Children: mixed</p> <p>Initiations: increase for both children with peer group A and for 1 child with peer group B</p> <p>Responses: increase for both children with peer group A; slight increase for both children with peer group B</p> <p>Rate of responses: increase for both children with peer group A and for 1 child with peer group B</p> <p>Peers: positive</p> <p>Interaction opportunities: increase for both peer groups with both children</p> <p>FU: NR. Gen: Yes (to baseline condition). SV: NR</p>	<p>Suggestive: quasi-experimental design (i.e., multiple baseline design across 2 peer groups); adequate IOA and TF; no operational definition of some dependent variables (i.e., interaction opportunities); sufficient details on intervention procedures; limited control for alternative explanations due to quasi-experimental design</p>
Laski et al. (1988)	<p>Children: N=8 (7 males, 1 female); aged 5–9;6 years; with autism; 4 nonverbal and 4 echolalic speech</p> <p>Comparison children: N=6 (gender NR); aged 2;2–9;8; matched on chronological and mental age</p> <p>Siblings: N=3 (gender NR); aged 2;8–3;10 years</p> <p>Parents: NR</p>	<p>Child behaviors:</p> <p>Pivotal behaviors: child vocalizations (observation of spontaneous speech)</p> <p>Other behaviors: child vocalizations (observation of imitations and answers); echolalia (observation)</p> <p>Parent behaviors: parent verbalizations (observation)</p>	<p>Intervention: 5–9 15-min individual NLP parent training sessions consisting of instruction, modeling, in vivo training and feedback, until criterion was met; 15-min NLP sessions with child at home, 4 times a week</p> <p>PRT techniques: clear opportunities (i.e., shared control and turn taking); task variation and multiple exemplars; natural reinforcement; reinforcement of attempts</p>	<p>Children: mixed</p> <p>Child vocalizations: increase in combined vocalizations in both play setting and break room for all 8 children; increase in imitations for all 8 children, in answers for 4 children and slight increases in spontaneous speech for 4 children; no change in comparison children; increase in imitations and spontaneous speech for 1 sibling and answers for 2 siblings</p>	<p>Conclusive: true experimental design (i.e., multiple baseline design across children; starting points of intervention were staggered); adequate IOA and TF; operational definitions of dependent variables; sufficient details on intervention procedures; control for alternative explanations</p>

**Table 1** (continued)

Citation	Participant characteristics	Dependent variables	Intervention procedures	Intervention outcomes	Certainty of evidence
Lydon et al. (2011)	<p>Children: N=5 (5 males); aged 3;10–6;1 years; with autistic disorder</p>	<p>Child behavior: Pivotal behaviors: NR Other behaviors: duration of interaction with toys (observation); number of play actions (observation); number of play verbalizations (observation)</p>	<p>Implementer: therapist (parent training); parents (NLP)</p> <p>Intervention: Video modeling; 10–15 8-min sessions conducted twice daily, consisting of watching the video model twice and 4-min play PRT: 20 30-min sessions, consisting of PRT techniques and modeling of symbolic play PRT techniques: child's choice; clear opportunities (i.e., turn taking); task variation and interspersal of maintenance and acquisition tasks; natural reinforcement; reinforcement of attempts Implementer: experimenter</p>	<p>Echolalia: no echolalia for 4 children; slight decrease for 3 children in play setting; no change in break room</p> <p>Parents: mixed</p> <p>Parent verbalizations: increase in play setting for all 8 parents; increase in break room for 7 parents; increase with siblings</p> <p>FU: NR. Gen: Yes (across settings and children). SV: NR</p> <p>Children: mixed</p> <p>Duration of interaction with toys: no statistically sign. increase for VM and PRT</p> <p>Number of play actions: statistically sign. increase for VM and PRT in training setting; statistically sign. increase PRT in generalization setting, but not for VM; no statistically sign. difference between VM and PRT in training setting, but statistically sign. difference in generalization setting, favoring PRT</p> <p>Number of verbalizations: no statistically sign. increase for VM and PRT in training setting and generalization setting; no statistically sign. difference between VM and PRT in training setting and generalization setting</p> <p>FU: Yes. Gen: Yes. SV: NR</p> <p>Children: positive</p> <p>Functional verbal utterances: statistically sign. increase in functional verbal utterances</p> <p>Parents: mixed</p> <p>Fidelity of PRT implementation: statistically sign. improvement in fidelity of PRT implementation</p> <p>Parental stress: statistically sign. decrease in total stress and parent-child dysfunctional interaction; no statistically sign. decrease in parental distress and difficult child empowerment. statistically sign. increase at all levels</p> <p>FU: NR. Gen: NR. SV: NR</p> <p>Children: positive</p>	<p>Suggestive: quasi-experimental design (i.e., counterbalanced design with random assignment to sequence of conditions, but too small number of baseline and follow-up probes after each condition); adequate IOA, but TF was NR; operational definitions of dependent variables; sufficient details on intervention procedures; limited control for alternative explanations due to quasi-experimental design</p>
Minjarez et al. (2011, 2013)	<p>Children: N=17 (17 males); aged 2;5–6;7 years; 16 with autistic disorder, 1 with PDD-NOS</p> <p>Parents: N=24 (9 fathers, 15 mothers of 17 families)</p>	<p>Child behavior: Pivotal behaviors: NR Other behaviors: functional verbal utterances (observation) Parent behavior: fidelity of PRT implementation (observation); parental stress (Parenting Stress Index/Short Form: total stress, parental distress, parent-child dysfunctional interaction and difficult child); empowerment (Family Empowerment Scale: family, services and community level)</p>	<p>Intervention: 10-week PRT group training (10 90-min group sessions, 1 50-min individual session) consisting of manuals, lectures, exercises, video models and video feedback; parents were taught in 3 groups PRT techniques: child's attention; clear opportunities and shared control; child's choice; task variation and interspersal of maintenance and acquisition tasks; immediate and contingent reinforcement; natural reinforcement; reinforcement of attempts Implementer: licensed psychologist (parent training), parents (PRT) Intervention: self-directed learning program (SDLP) consisting of an</p>	<p>Suggestive: pre-experimental design (i.e., pretest-posttest design, without control group); adequate IOA and TF (PRT implementation), but TF (parent training) was NR; operational definitions of dependent variables; sufficient details on intervention procedures; limited control for alternative explanations due to pre-experimental design</p>	<p>Suggestive: pre-experimental design (i.e., pretest-posttest design, without control group); adequate IOA and TF (PRT implementation), but TF (parent training) was NR; operational definitions of dependent variables; sufficient details on intervention procedures; limited control for alternative explanations due to pre-experimental design</p>
Nefft et al. (2010)	<p>Children: N=27 (92.6 % male, 7.4 % female), M age (treatment group, Preponderant : true experimental design (pretest-posttest control</p>	<p>Child behaviors: Pivotal behaviors: NR</p>	<p>Implementer: licensed psychologist (parent training), parents (PRT) Intervention: self-directed learning program (SDLP) consisting of an</p>	<p>Preponderant : true experimental design (pretest-posttest control</p>	<p>Preponderant : true experimental design (pretest-posttest control</p>

Table 1 (continued)

Citation	Participant characteristics	Dependent variables	Intervention procedures	Intervention outcomes	Certainty of evidence
Pierce and Schreibman (1995)	TG)=38.92 months, <i>M</i> age (waitlist control group, WCG)=38.43 months; with ASD; with ASD; no statistically sign. differences between TG ( <i>N</i> =13) and WCG ( <i>N</i> =14) at pretest <i>Parents</i> : <i>N</i> =27 (12 % male, 88 % female); education level: graduate degree (15 %), college degree (51 %), some college (29 %) and high school (4 %); no statistically sign. difference between TG and WCG at pretest	Other behaviors: functional verbal utterances (observation) <i>Parent behaviors</i> : fidelity of PRT implementation (observation); language opportunities (observation); parent confidence (6-point Likert rating scale)	interactive 66-min DVD and a manual. DVD consisted of instruction in ABA and PRT techniques, video models, multiple choice tests and interactive learning tasks <i>PRT techniques</i> : child's choice; clear opportunities; immediate and contingent reinforcement; natural reinforcement; reinforcement of attempts <i>Implementer</i> : parents (PRT)	<i>Functional verbal utterances</i> : significant difference between TG and WCG at posttest; TG increased functional verbal utterances following SDLP <i>Parents</i> : positive <i>Fidelity of implementation</i> : significant difference between TG and WCG at posttest; TG implemented PRT following SDLP <i>Language opportunities</i> : significant difference between TG and WCG at posttest; TG provided more language opportunities following SDLP <i>Parent confidence</i> : significant difference between TG and WCG at posttest; TG was more confident during interactions following SDLP FU: NR. Gen: NR. SV: Yes	group design, with random group assignment and no sign. difference between groups at pretest (i.e., randomized clinical trial); adequate IOA, TF (SDLP) was NR, however, a checklist was used to ensure all parents viewed DVD in similar manner; no operational definitions of some dependent variables (i.e., functional verbal utterances and parent confidence); sufficient details on intervention procedures; control for alternative explanations
Pierce and Schreibman (1997a, b)	<i>Children</i> : <i>N</i> =2 (2 males); aged 10 years; with autism <i>Peers</i> : <i>N</i> =2 (2 males), aged 10 years	<i>Child behaviors</i> : Pivotal behaviors: initiations (observation) Other behaviors: maintaining interactions (observation); joint attention behaviors (i.e., nonengagement, onlooking, object engagement, supported joint attention and coordinated joint attention); language use (observation); social behavior (Walker-McConnell Scale of Social Competence)	<i>Intervention</i> : 4 30-min sessions consisting of a manual, modeling and role-play; 10-min sessions consisting of practice and feedback until criterion of 80 % correct implementation was met, including PRT techniques, modeling of appropriate social behavior and narrative play <i>PRT techniques</i> : child's attention; child's choice; clear opportunities (i.e., encourage and extend conversation; turn taking); task variation; multiple cues; reinforcement of attempts <i>Implementer</i> : therapist (peer training), peers (PRT)	<i>Children</i> : mixed <i>Initiations</i> : increase for both children, maintained during FU <i>Maintaining interactions</i> : increase for both children, maintained during FU <i>Joint attention behaviors</i> : increase in supported and coordinated joint attention <i>Language use</i> : increase in number of words for both children; increase in sentence length for 1 child <i>Social behavior</i> : increase in peer-preferred social behavior for both children; increase in teacher-preferred social behavior for 1 child FU: Yes. Gen: Yes (across toys and settings for both children and peers for 1 child). SV: NR <i>Children</i> : mixed <i>Initiations</i> : increase for both children <i>Maintaining interactions</i> : increase for both children across peers <i>Language use</i> : increase for both children in frequency and quality of language <i>Play</i> : no change in number of toys played with per session, but range of toys increased across sessions	<i>Suggestive</i> : quasi-experimental design (i.e., multiple baseline design across 2 children); adequate IOA and TF (PRT) was NR, however, post-PRT phase only started after at least 80 % correct implementation, TF (peer training) was not reported; operational definitions of dependent variables; sufficient details on intervention procedures; limited control for alternative explanations due to quasi-experimental design
Pierce and Schreibman (1997a, b)	<i>Children</i> : <i>N</i> =2 (2 males); aged 7–8 years; with autism <i>Peers</i> : <i>N</i> =8 (gender NR); aged 7–9 years	<i>Child behaviors</i> : Pivotal behaviors: initiations (observation) Other behaviors: maintaining interactions; language use; play (observation)	<i>Intervention</i> : 4 30-min sessions consisting of a manual, modeling and role-play, 10-min sessions consisting of practice and feedback until criterion of 80 % correct implementation was met, including PRT techniques, modeling of appropriate social behavior and narrative play <i>PRT techniques</i> : child's attention; child's choice; clear opportunities (i.e., encourage and extend conversation; turn taking); task variation; multiple cues; reinforcement of attempts <i>Implementer</i> : therapist (peer training), peers (PRT)	<i>Children</i> : mixed <i>Initiations</i> : increase for both children <i>Maintaining interactions</i> : increase for both children across peers <i>Language use</i> : increase for both children in frequency and quality of language <i>Play</i> : no change in number of toys played with per session, but range of toys increased across sessions	Preponderant: true experimental design (i.e., multiple baseline design across peers, replicated across 2 children; starting points of intervention were staggered across peers); adequate IOA, TF (PRT) was NR, however, post-PRT phase only started after at least 80 % correct implementation, suggesting TF (PRT) was adequate, TF (peer training) was NR; operational definitions of dependent

**Table 1** (continued)

Citation	Participant characteristics	Dependent variables	Intervention procedures	Intervention outcomes	Certainty of evidence
<p>Randolph et al. (2011)</p>	<p><i>Children:</i> N=3 (2 males, 1 female); aged 3–7 years; with autism  <i>Caregivers:</i> N=3 (1 male, 2 females); 1 in-home care provider, 1 biological father and 1 grandmother; without college degrees</p>	<p><i>Child behavior:</i>                      Pivotal behaviors: social communication behavior (observation of frequency of communicative initiations)                      Other behaviors: social communication behavior (observation of frequency of communicative responses) and play behavior (observation), adaptive functioning (Vineland-II)  <i>Parent behavior:</i> fidelity of PRT implementation (observation)</p>	<p>(i.e., encourage and extend conversation; turn taking); task variation; multiple cues; reinforcement of attempts  <i>Implementer:</i> therapist (peer training), peers (PRT)  <i>Intervention:</i> 10 individual PRT training sessions (1 30-min and 9 45 to 55-min sessions), consisting of instruction, modeling, guided practice, independent practice and feedback  <i>PRT techniques:</i> child's attention; clear opportunities (i.e., shared control); multiple cues; immediate and contingent reinforcement; natural reinforcement; reinforcement of attempts  <i>Implementer:</i> therapist (caregiver training), caregivers (PRT)</p>	<p>FU: Yes; Gen: Yes (across peers, toys and settings). SV: NR</p> <p><i>Children:</i> mixed  <i>Social communication behaviors:</i> increase in total response percentage from baseline to training for all 3 children, increase from training to FU for 2 children; increase in frequency of communicative initiations and responses for 2 children  <i>Play behavior:</i> decrease in varied play for 2 children; increase in appropriate play for all 3 children, 1 child maintained increase during FU  <i>Adaptive functioning:</i> no meaningful differences for all 3 children  <i>Parents:</i> mixed  <i>Fidelity of PRT implementation:</i> increase in level of fidelity for all 3 caregivers during training; 2 caregivers maintained criterion level during FU                      FU: Yes; Gen: NR. SV: Yes  <i>Children:</i> mixed  <i>Target social-communicative behaviors:</i> increase in target behaviors for all 4 children; target behaviors generalized and were maintained during FU  <i>Child affect:</i> increase in affect across phases to a positive level for 1 child  <i>Staff:</i> positive  <i>Fidelity of implementation:</i> increase in fidelity of implementation, which generalized across students and activities and was maintained during FU  <i>Level of involvement:</i> decrease in hovering and uninvolved from baseline to treatment and increase in monitoring and implementing, which generalized across students and activities and was maintained during FU</p>	<p>variables; sufficient details on intervention procedures; limited control for alternative explanations due to unstable baselines</p> <p>Conclusive: true experimental design (i.e., multiple baseline design across participants; starting points of intervention were staggered); adequate IOA and TF (caregiver training); operational definitions of dependent variables; sufficient details on intervention procedures; control for alternative explanations</p>
<p>Robinson (2011)</p>	<p><i>Children (focal):</i> N=4 (4 males); aged 3–8 years; with autism  <i>Children (generalization):</i> N=4 (3 males, 1 female); aged 3–10 years; 3 with autism and 1 with Down syndrome  <i>Staff:</i> N=4 (4 females), paraprofessionals at educational institutions; experience 3 months–17 years</p>	<p><i>Child behavior:</i>                      Pivotal behaviors: NR                      Other behaviors: individual target social-communicative behaviors (observation); child affect (6-point Likert rating scales)  <i>Staff behavior:</i> fidelity of implementation (observation); level of involvement (observation); duration of training program (observation)</p>	<p><i>Intervention:</i> 3 15-min sessions including modeling and 15-min sessions involving video feedback until 80 % fidelity of implementation was achieved  <i>PRT techniques:</i> child's choice; clear opportunities and shared control; contingent reinforcement; natural reinforcement  <i>Implementer:</i> author (staff training), paraprofessionals (PRT)</p>	<p>FU: Yes; Gen: NR. SV: Yes  <i>Children:</i> mixed  <i>Target social-communicative behaviors:</i> increase in target behaviors for all 4 children; target behaviors generalized and were maintained during FU  <i>Child affect:</i> increase in affect across phases to a positive level for 1 child  <i>Staff:</i> positive  <i>Fidelity of implementation:</i> increase in fidelity of implementation, which generalized across students and activities and was maintained during FU  <i>Level of involvement:</i> decrease in hovering and uninvolved from baseline to treatment and increase in monitoring and implementing, which generalized across students and activities and was maintained during FU</p>	<p>Conclusive: true experimental design (i.e., multiple baseline design across participants; starting points of intervention were staggered); adequate IOA and TF (PRT implementation), TF (staff training) was NR, however, staff training was successfully replicated with 3 staff members (i.e., all 3 met criterion for fidelity of implementation), suggesting TF (staff training) was adequate; operational definitions of dependent variables; sufficient details on intervention procedures; control for alternative explanations</p>

Table 1 (continued)

Citation	Participant characteristics	Dependent variables	Intervention procedures	Intervention outcomes	Certainty of evidence
Schreibman et al. (1991)	<p>Children: <math>N=19</math> (gender NR); aged 2;8–12;7 years; with autism</p> <p>Parents: <math>N=19</math> (2 fathers, 17 mothers); <math>M</math> age=37;1 years</p> <p>Raters: <math>N=120</math> (gender NR); undergraduate students</p>	<p>Child behaviors: NR</p> <p>Parent behaviors: affect (6-point Likert rating scales for enthusiasm, interest and happiness)</p>	<p>Intervention: parent training, consisting of manuals, video modeling and feedback for Individual Target Behavior (repeated trials, prompting, shaping and reinforcement) and/or PRT (PRT techniques)</p> <p>PRT techniques: child's choice; clear opportunities (i.e., turn taking); multiple cues; interspersal of maintenance and acquisition tasks; natural reinforcement; reinforcement of attempts</p> <p>Implementer: therapist (parent training); parents (ITB and/or PRT)</p> <p>Intervention: 3–4 30-min NLP staff training sessions consisting of behavioral skills training (i.e., feedback, instructions, rehearsal, modeling and assessment) and general case training (i.e., use of scripts to simulate child behavior)</p> <p>PRT techniques: child's choice; clear opportunities; immediate and contingent reinforcement; natural reinforcement; reinforcement of attempts</p> <p>Implementer: experimenter (staff training) and staff (NLP)</p>	<p>Duration of program: mean time required to meet criterion was 91.25 min (range: 60–115 min)</p> <p>FU: Yes. Gen: Yes (generalization across activities and students). SV: Yes</p> <p>Parents: positive</p> <p>Affect: more positive affect on all scales and overall during PRT condition</p> <p>FU: NR. Gen: NR. SV: NR</p>	<p>Suggestive: pre-experimental design (posttest only design); IOA was NR, but TF was adequate; operational definition of dependent variable; insufficient details on intervention procedures (i.e., treatment duration and intensity); no control for alternative explanations due to pre-experimental design</p>
Seiverling et al. (2010)	<p>Children: <math>N=3</math> (2 males, 1 female); aged 40–49 months; with ASD</p> <p>Staff: <math>N=3</math> (1 male, 2 females); 2 teacher assistants and 1 staff training coordinator; experience: NR</p>	<p>Child behaviors:</p> <p>Pivotal behaviors: NR</p> <p>Other behaviors: proportion of opportunities with correct vocal responding for each of 3 vocal chaining links across 5 items (observation)</p> <p>Staff behaviors: NLP staff behavior (observation of room setup and performing NLP procedures)</p>	<p>Intervention: 3–4 30-min NLP staff training sessions consisting of feedback, instructions, rehearsal, modeling and assessment) and general case training (i.e., use of scripts to simulate child behavior)</p> <p>PRT techniques: child's choice; clear opportunities; immediate and contingent reinforcement; natural reinforcement; reinforcement of attempts</p> <p>Implementer: experimenter (staff training) and staff (NLP)</p>	<p>Children: mixed</p> <p>Proportion of opportunities with correct vocal responding for each of 5 items: increase for 2 children; complexity of vocal chains increased for these 2 children</p> <p>Staff: positive</p> <p>NLP staff behavior: increase to criterion of 90 % for all staff within 3–4 sessions, maintained during post-training</p> <p>FU: NR. Gen: NR. SV: Yes</p>	<p>Conclusive: true experimental design (i.e., multiple baseline design across dyads; starting points of intervention were staggered); adequate IOA and TF (staff training); operational definitions of dependent variables; sufficient details on intervention procedures; control for alternative explanations</p>
Smith et al. (2010) (including program description of Byrson et al. 2007)	<p>Children: <math>N=45</math> (33 males, 12 females); <math>M</math> calendar age=50 months; with autism</p> <p>Parents: NR</p>	<p>Child behaviors:</p> <p>Pivotal behaviors: NR</p> <p>Other behaviors: expressive and receptive language subscale of the Merrill–Palmer–Revised; communication (Vineland-II); receptive and expressive (Merrill–Palmer–Revised); cognitive ability (Merrill–Palmer–Revised); adaptive behavior (Vineland-II); autism symptoms (Social Responsiveness Scale); behavioral problems (Child Behavior Checklist, ages 1 1/2–5)</p>	<p>Intervention: 5 6-h group workshop days for parents and staff including instruction, guided practice, feedback and small group discussions; one-to-one interventionist implemented PRT for child 15 h a week during 12 months; parents implemented PRT during daily routines</p> <p>Cohort 2: 1-week in vivo parent training (group workshop or individual); one-to-one interventionist implemented PRT for child 15 h a week during</p>	<p>Children: mixed</p> <p>Results are reported separately for lower (&lt;50) and higher (&gt;50) IQ groups</p> <p>Expressive language: statistically significant increase after 6 and 12 months for lower IQ (<math>\eta_p^2=0.45</math>) and higher IQ (<math>\eta_p^2=0.76</math>); greater gain for higher IQ group</p> <p>Receptive language: statistically significant increase after 6 and 12 months for lower IQ (<math>\eta_p^2=0.40</math>) and higher IQ (<math>\eta_p^2=0.60</math>); greater gain for higher IQ group</p>	<p>Suggestive: pre-experimental design (i.e., pretest–posttest design, without control group and (quasi) random selection); IOA and TF (parent/staff training) were NR, but TF (PRT implementation) was adequate; operational definitions of dependent variables; insufficient details on intervention procedures (i.e., parent training cohort 2); limited control for alternative explanations due to pre-experimental design</p>

**Table 1** (continued)

Citation	Participant characteristics	Dependent variables	Intervention procedures	Intervention outcomes	Certainty of evidence
<p>Stahmer (1995); Stahmer et al. (2006)</p>	<p>Children: <math>N=7</math> (7 males); aged 4;3–7;2 years; with autism                      Typical developing children: <math>N=7</math> (gender NR); <math>M</math> age=3;2 years; matched on expressive language</p>	<p><i>Parent behaviors</i>: parental stress (Parenting Stress Index/Short Form)   <i>Child behaviors</i>:                      Pivotal behaviors: initiations (observation)                      Other behaviors: play behavior (observation of symbolic play, complexity and creativity); language (PPVT-R, EOWPVT and MacArthur CDI); responses to other's initiations (observation); play ability (6-point Likert rating scales for child's overall play ability, creativity, enjoyment, social interaction and play complexity)</p>	<p><i>Intervention</i>: 1-h PRT sessions (symbolic play training, SPT) 3 times weekly, preceded or followed by 1-h PRT sessions (language training, LT) 3 times weekly for 8 weeks consisting of PRT techniques targeting symbolic play or language and modeling of symbolic play  <i>PRT techniques</i>: child's choice; clear opportunities (i.e., turn taking); task variation and interspersal of maintenance and acquisition tasks; natural reinforcement;                      reinforcement of attempts  <i>Implementer</i>: therapist (PRT), parents and peer (generalization)</p>	<p><i>Expressive communication</i>: statistically sign. increase after 6 or 12 months for lower IQ (<math>\eta_p^2=0.57</math>) and after 6 and 12 months for higher IQ (<math>\eta_p^2=0.73</math>)  <i>Receptive communication</i>: statistically sign. increase after 12 months for lower IQ (<math>\eta_p^2=0.43</math>) and after 6 and 12 months for higher IQ (<math>\eta_p^2=0.73</math>)  <i>Adaptive behavior</i>: modest growth in adaptive behavior (sub domains and ABC of Vineland-II) after 6 and 12 months for lower IQ and higher IQ (<math>\eta_p^2=0.27</math>)  <i>Cognitive abilities</i>: statistically sign. increase after 6 and 12 months for both groups (<math>\eta_p^2=0.61</math>); greater gains in first 6 months for higher IQ  <i>Behavioral problems</i>: statistically sign. decrease after 6 or 12 months for both groups (<math>\eta_p^2=0.31</math>)  <i>Autism symptoms</i>: statistically sign. decrease after 6 and 12 months for higher IQ (<math>\eta_p^2=0.33</math>), but not for lower IQ                      Parents: NR                      FU: NR, Gen: NR, SV: NR</p>	<p>Suggestive: true experimental design (multiple baseline design across children plus control condition (i.e., language training) to assess whether symbolic play training was necessary to increase symbolic play or whether language training was sufficient); IOA was not adequate for all dependent variables (i.e., play complexity and initiations) and TF was NR; no operational definitions of some dependent variables (creativity, initiations and responses to other's initiations); insufficient details on intervention procedures (i.e., language training); control for alternative explanations</p>

Table 1 (continued)

Citation	Participant characteristics	Dependent variables	Intervention procedures	Intervention outcomes	Certainty of evidence
Stahmer and Gist (2001)	<p>Children: <math>N=22</math> (gender NR); with ASD; in 2 groups: parent education + support group (<math>M</math> age=35 months); parent education only (<math>M</math> age=35.6 months)</p> <p>Parents: <math>N=22</math> (families, gender NR); middle-to-high socioeconomic level</p>	<p>Child behaviors: Pivotal behaviors: NR Other behaviors: vocabulary (observation); MacArthur CDI Parent behaviors: use of PRT techniques (observation)</p>	<p>Intervention: 12 weekly 1-h individual parent education sessions, consisting of a manual and training in PRT techniques for both groups; 12 weekly 1-h support group meetings, consisting of information on ASD, group process and building relationships for support for parent education + support group</p> <p>PRT techniques: child's choice and shared control; clear opportunity; interspersal of maintenance and acquisition tasks; natural reinforcement; reinforcement of attempts</p> <p>Implementer: parent educator (parent training), parents (PRT)</p>	<p>post-training; individual data: (slight) increase for 4 children FU: Yes; Gen: Yes (play behavior; across toys and persons for 6 children); SV: NR</p> <p>Children: positive Vocabulary: MacArthur CDI: statistically sign. increase in words learned for children whose parents met criteria for PRT use; statistically sign. difference between groups in words produced and understood, favoring children whose parents met criteria for PRT use, no difference between groups in communicative gestures; observation: statistically sign. increase in number of words used for all children</p> <p>Parents: mixed PRT use: increase for majority of parents; statistically sign. better performance of parents in parent education+support group (i.e., 8 parents met criterion of 75% correct use vs. 4 parents in parent education only group)</p>	<p>Suggestive: true experimental design (i.e., pretest–posttest control group design); adequate IOA, but TF (parent training) was NR; no operational definitions of dependent variables (i.e., vocabulary); insufficient details on intervention procedures (i.e., components parent training); limited control for alternative explanation due to no random assignment to groups</p>
Steiner et al. (2013)	<p>Children: <math>N=2</math> (gender NR); aged 12 months; no formal diagnosis of ASD, but moderate/severe concern on ADOS-T. One participant with little/no concern on ADOS-T was in the study, but was omitted from this analysis</p> <p>Parents: NR</p>	<p>Child behavior: Pivotal behaviors: NR Other behaviors: functional communication (observation); cognitive functioning (Mullen Scales of Early Learning); diagnostic impression (ADOS) Parent behavior: fidelity of implementation of PRT (observation)</p>	<p>Intervention: 10-week PRT parent training (10 1-h sessions: 8 clinic and 2 home sessions) consisting of manuals, instruction, live modeling, guided practice and feedback</p> <p>PRT techniques: clear opportunity; child's choice; interspersal of maintenance and acquisition tasks; immediate and contingent reinforcement; natural reinforcement; reinforcement of attempts</p> <p>Implementer: clinician (parent training and PRT); parents (PRT)</p>	<p>FU: NR; Gen: NR; SV: NR</p> <p>Children: mixed Functional communication: increase for both children, maintained post-treatment Cognitive functioning: increase for 1 child Diagnostic impression: decrease in severity of ASD symptoms to non-significant level for 1 child Parents: positive Fidelity of implementation of PRT: increase for both children, maintained post-treatment FU: NR; Gen: NR; SV: Yes</p>	<p>Suggestive: quasi-experimental design (i.e., multiple baseline design across children, but too small number of baseline probes); adequate IOA, but TF (PRT implementation) was not adequate for all parents post-treatment and TF (parent training) was NR; operational definitions of dependent variables; sufficient details on intervention procedures; limited control for alternative explanations due to quasi-experimental design</p>
Suhrheinrich (2011)	<p>Children: <math>N=NR</math> (gender NR); aged 3–8 years; with autism Staff: <math>N=20</math> (20 females); teachers in special education settings; 10 self-selected, 10 district-selected; experience: <math>M</math> (self-selected) = 6.7 years, <math>M</math> (district-selected) = 5.6 years; groups differed in hours</p>	<p>Child behavior: NR Staff behavior: fidelity of PRT implementation (observation)</p>	<p>Intervention: 6-h group workshop training in PRT, consisting of a manual, instruction, video model, practice and feedback plus coaching sessions, consisting of video feedback and modeling (self-selected); 1–4 coaching sessions</p>	<p>FU: NR; Gen: NR; SV: Yes Staff: positive Fidelity of implementation: increase in number of PRT components implemented; 15% of teacher mastered all PRT components at post-training, 30% after 1 coaching session and 40% after 2 coaching sessions; on completion of</p>	<p>Suggestive: pre-experimental design (i.e., pretest–posttest design without control group); IOA was not adequate for all observation categories (i.e., turn taking) and TF (staff training) was NR; operational definitions of dependent variables; sufficient details on intervention</p>

**Table 1** (continued)

Citation	Participant characteristics	Dependent variables	Intervention procedures	Intervention outcomes	Certainty of evidence
Suhrenrich et al. (2007)	reading educational literature favoring self-selected teachers  Staff: N=10 (10 females); teachers in early intervention classrooms in public schools (N=4) and specialized programs (N=6); teaching experience: 1–16 years	Staff behaviors: fidelity of PRT implementation (observation)	until criterion was met; district-selected: 3 coaching sessions) PRT techniques: child attention; clear opportunities and turn taking; child's choice; contingent reinforcement; natural reinforcement; reinforcement of attempts  Implementer: teachers (PRT) and NR for teacher training  Intervention: Staff training: low level (manual and modeling, N=2), moderate level (manual, instruction and modeling, N=2), high level (manual, instruction, modeling and feedback, N=6)  PRT implementation: 2 10-min one-to-one sessions and 2 10-min group sessions in a counterbalanced order  PRT techniques: child's attention; child choice's; clear opportunities and turn taking; contingent reinforcement; natural reinforcement; reinforcement of attempts  Implementer: teachers (PRT) and NR for staff training	coaching, 100 % of self-selected teachers mastered all PRT components vs. 10 % of district-selected teachers  FU: NR. Gen: NR. SV: NR	procedures; limited control for alternative explanations due to pre-experimental design
Symon (2005)	Children: N=3 (3 males); aged 2; 10–5;4 years; with autism Primary caregivers: N=3 (3 mothers), with at least college degree Significant caregivers: N=3 (1 male, 2 gender NR); 1 father and 2 one-to-one interventionists	Child behaviors: Pivotal behaviors: NR Other behaviors: functional verbal utterances; appropriate behaviors (observation) Primary/significant caregiver behaviors: fidelity of implementation (observation)	Intervention: 5 consecutive 5-h parent training days, consisting of manuals, modeling and feedback to teach PRT techniques; significant caregiver training ranged from 3–25 h and consisted of video models, modeling, feedback and/or manuals PRT techniques: child's choice; clear opportunities; task variation and interspersal of maintenance and acquisition tasks; immediate and contingent reinforcement; natural reinforcement; reinforcement of attempts  Implementer: clinician (parent education); primary caregivers (PRT); significant caregiver training; significant caregivers (PRT)	Children: positive Functional verbal utterances and appropriate behaviors: increase for all 3 children Primary and significant caregivers: positive Fidelity of implementation: increase to criterion level (80 %) during intervention for all 3 primary caregivers, maintained during FU; increase for all 3 significant caregivers FU: Yes; Gen: Yes (to home situation). SV: NR	Preponderant: true experimental design (i.e., non-concurrent multiple baseline design across participants); adequate IOA and TF (PRT), TF (parent education and significant caregiver training) were NR, however, parent education and significant caregiver training were both successfully replicated with 3 caregivers (i.e., all caregivers met criterion for fidelity of implementation), suggesting that TF was adequate; operational definitions of dependent variables; sufficient details on intervention procedures; limited control for alternative explanations due to non-concurrent multiple baseline design (i.e., limited control for history)
Thorp et al. (1995)	Children: N=3 (3 males); aged 5;4–9;9 years; with autism	Child behaviors: Pivotal behaviors: initiations (observation)	Intervention: 16-h socio-dramatic play training during which the child was encouraged to develop a play	Children: mixed Initiations: increase for 2 children. Language: no change on PPVT-R	Preponderant: true experimental design (i.e., multiple baseline probe design across children; starting points of

Table 1 (continued)

Citation	Participant characteristics	Dependent variables	Intervention procedures	Intervention outcomes	Certainty of evidence
Vismara and Lyons (2007)	Children: $N=3$ (3 males); aged 26–38 months; with autism	Other behaviors: language (PPTV-R, EOWPVT-R), play skills (play history interview and observation of role-playing, make-believe transformations and persistence); positive and negative responses (observation); verbal communication (observation of spontaneous speech, other speech and inappropriate speech)	theme, adopt a role appropriate to this theme and to assign a role to the experimenter, consisting of PRT techniques and modeling of appropriate socio-dramatic play <i>PRT techniques</i> : child's choice; clear opportunities (i.e., turn taking); task variation and interspersal of maintenance and acquisition tasks; natural reinforcement; reinforcement of attempts <i>Implementer</i> : experimenter (PRT), parent (generalization)	and increase on EOWPVT-R for all 3 children <i>Play skills</i> : increase in role-play, make-believe transformations and persistence for all 3 children; increase in imaginary play at home for all 3 children and in play/social behavior with siblings for 2 children <i>Responses</i> : increase in positive responses and decrease in negative responses for all 3 children <i>Verbal communication</i> : increase in spontaneous speech for all 3 children; decrease in inappropriate speech for 2 children; other speech was NR FU: Yes; Gen: Yes (across toys and settings); SV: NR	intervention were staggered); adequate IOA and TF was NR, despite multi component intervention; operational definitions of dependent variables; sufficient details on intervention procedures; control for alternative explanations
Vismara and Lyons (2007)	Children: $N=3$ (3 males); aged 26–38 months; with autism	<i>Child behaviors</i> : Pivotal behaviors: NR Other behaviors: number of joint attention initiations; contingencies to joint attention initiations (observation); affect during child-caregiver interaction (6-point Likert rating scale)	<i>Intervention</i> : 2 1/2-h sessions a week for 12 weeks; each session: 1 h modeling by principal investigator and 1 1/2 h guided practice for parents plus feedback Perseverative Interest (PI) condition: 4 2 1/2-h sessions, using PI stimuli (i.e., letter and number toys) Non-perseverative Interest (NP) condition: 4 2 1/2-h sessions for 2 children and 8 2 1/2-h sessions for 1 child, using NP stimuli Alternating condition: 16 2 1/2-h sessions for 2 children and 12 2 1/2-h sessions for 1 child; each session half PI and half NP in rotated order <i>PRT techniques</i> : child's choice; task variation and interspersal of maintenance and acquisition tasks; immediate and contingent reinforcement; natural reinforcement; reinforcement of attempts <i>Implementer</i> : principal investigator (parent training and PRT); parents (PRT)	<i>Children</i> : mixed <i>Number of joint attention initiations</i> : immediate increase for all 3 children during PI condition; low level for all 3 children during NP condition; increase for both PI and NP stimuli for all 3 children during alternating condition, suggesting generalization to NP stimuli <i>Contingencies to joint attention</i> : gains in joint attentions initiations were a collateral result of PI stimuli and PRT and not a result of contingent prompting or reinforcement <i>Affect during child-caregiver interaction</i> : increase to positive affect for all 3 children during PI condition; negative ( $N=2$ ) or neutral ( $N=1$ ) affect during NP condition; positive affect for PI stimuli for all 3 children and for NP stimuli for 1 child during alternating condition, 2 children increased to positive affect during final 2–3 sessions FU: NR; Gen: Yes (to NP stimuli); SV: NR	Suggestive: quasi-experimental design (i.e., baseline, followed by counterbalanced phase reversal of PI and NP conditions, however, no return to baseline condition, alternating treatment condition in final phase); adequate IOA and TF; operational definitions of dependent variables; sufficient details on intervention procedures; limited control for alternative explanations due to quasi-experimental design
Voos et al. (2013)	Children: $N=2$ (1 male, 1 female); aged 5;5 and 5;1 years; 1 with autistic disorder and 1 with PDD-NOS	<i>Child behavior</i> : Pivotal behaviors: NR Other behaviors: ASD symptoms (ADOS); adaptive skills (Vineland-II); pragmatic skills (pragmatic	<i>Intervention</i> : individual PRT sessions with child and PRT parent training for 8–10 h per week during 4 months <i>PRT techniques</i> : NR	<i>Children</i> : mixed <i>ASD symptoms</i> : decrease for 1 child <i>Adaptive skills</i> : increase on some, but not all sub domains for both children	Suggestive: pre-experimental design (i.e., case series design); IOA and TF were NR; dependent variables not fully operationally defined; insufficient details on intervention

**Table 1** (continued)

Citation	Participant characteristics	Dependent variables	Intervention procedures	Intervention outcomes	Certainty of evidence
		profile of the CELF-4); communication behaviors (observation); face processing (eye tracking); neural response (fMRI)	<i>Implementer</i> : clinician (parent training and PRT)	<i>Pragmatic skills</i> : increase for both children <i>Communication behaviors</i> : increase on some, but not all communication behaviors for both children <i>Face processing</i> : improvement towards more typical face processing pattern for 1 child <i>Neural response</i> : increased activation in 3–4 brain regions utilized by typically developing children for both children FU: NR; Gen: NR; SV: NR	procedures; no control for alternative explanations due to pre-experimental design

*N* total number of participants in study, *PDD-NOS* pervasive developmental disorder not otherwise specified, *NR* not reported, *FU* follow-up, *Gen* generalization, *SV* social validity, *IOA* inter-observer agreement, *TF* treatment fidelity

In six studies data on staff member characteristics were reported. A total number of 45 staff members participated in these studies. Of the 45 staff members, 1 (2.2 %) was male and 44 (97.8 %) were female. Staff members' years' of experience working in this field was reported in five studies and ranged from 3 months to 17 years. Staff members worked in an educational ( $n=40$ ; 88.9 %) or clinical ( $n=5$ ; 11.1 %) setting.

Four studies reported data on peer characteristics. A total number of 21 peers participated in these studies. Of the 21 peers, 8 (38.1 %) were male, 5 (23.8 %) were female and the sex of 8 peers (38.1 %) was not reported. Peers were most often typically developing children, but five peers were diagnosed with a specific learning disability, mental retardation or a developmental disability (Kuhn et al. 2008).

### Dependent Variables

In 35 studies, child behaviors were targeted. Of these 35 studies, 18 studies targeted a pivotal skill. Seventeen studies targeted self-initiations (e.g., Koegel et al. 2012) and one study targeted motivation (Koegel et al. 2010b). Across studies, a variety of untargeted skills or collateral changes were measured. Thirty-one studies evaluated the effects of PRT on communication and language skills, such as functional verbal utterances (e.g., Minjarez et al. 2011), receptive and expressive language (e.g., Coolican et al. 2010), responding to others (e.g., Kuhn et al. 2008) and maintaining interactions (e.g., Pierce and Schreibman 1997a). Six studies evaluated collateral changes in play skills as a result of PRT (Gillet and LeBlanc 2007; Lydon et al. 2011; Randolph et al. 2011; Stahmer 1995; Pierce and Schreibman 1997b; Thorp et al. 1995). For example, Lydon et al. measured the duration of interaction with toys and the number of play actions and verbalizations. Five studies evaluated the effects of PRT on adaptive functioning (e.g., Baker-Ericzén et al. 2007; Koegel et al. 1999b; Randolph et al. 2011; Smith et al. 2010; Voos et al. 2013), using the Vineland Adaptive Behavior Scales (Sparrow et al. 1984, 2005). Five studies evaluated collateral changes in maladaptive behavior as a result of PRT (Coolican et al. 2010; Gianoumis et al. 2012; Koegel et al. 1992, 2010b; Smith et al. 2010). For example, Gianoumis et al. measured the percentage of trials with maladaptive behaviors (e.g., screaming, crying, and hitting) and Smith et al. used the Child Behavior Checklist (Achenbach and Rescorla 2000) to measure problem behavior. Four studies evaluated the effects of PRT on autism symptoms (Bernard-Opitz et al. 2004; Smith et al. 2010; Steiner et al. 2013; Voos et al. 2013). For example, Smith et al. used the Social Responsiveness Scale (Constantino and Gruber 2005) to identify changes in autism symptoms. Three studies evaluated collateral changes in affect as a result of PRT using rating scales (Koegel et al. 2012; Robinson 2011; Vismara and Lyons 2007). Two studies evaluated collateral changes in cognitive functioning as result of PRT (Smith et al. 2010; Steiner et al. 2013),

using the Mullen Scales of Early Learning or the Merrill–Palmer-Revised Scales of Development (Mullen 1995; Roid and Sampers 2004). Two studies evaluated the effects of PRT on academic functioning (Koegel et al. 2010b, 1999b). For example, Koegel et al. (2010b) measured the children's productivity (i.e., rate of assignment units completed) and latency (i.e., number of minutes it took children to begin a task) during writing or math activities. Finally, one study evaluated the effects of PRT on face processing and neural response (Voos et al. 2013) and another study evaluated the effects of PRT on attendance and compliance (Bernard-Opitz et al. 2004).

In 13 studies caregiver behaviors were targeted. Of these studies, nine studies evaluated the effects of caregiver training on caregivers' fidelity of implementation of PRT or NLP (Coolican et al. 2010; Gillet and LeBlanc 2007; Koegel et al. 2002; Minjarez et al. 2013; Nefdt et al. 2010; Randolph et al. 2011; Stahmer and Gist 2001; Steiner et al. 2013; Symon 2005). Additionally, two studies evaluated collateral changes in parental stress as a result of PRT (Minjarez et al. 2013; Smith et al. 2010), using the Parenting Stress Index/Short Form (Abidin 1995). Two studies evaluated the effects of PRT on parental affect using rating scales (Koegel et al. 2002; Schreibman et al. 1991). Two studies evaluated collateral changes in self-efficacy as result of PRT (Coolican et al. 2010; Nefdt et al. 2010) and one study measured empowerment (Minjarez et al. 2013). Finally, one study evaluated the effects of PRT on interactional patterns (Koegel et al. 1996) and another study evaluated the effects of PRT on parent verbalizations (Laski et al. 1988).

Staff behaviors were targeted in seven studies. Of these studies, six studies evaluated the effects of staff training on staff members' fidelity of implementation of PRT or NLP (Gianoumis et al. 2012; Huskens et al. 2012; Robinson 2011; Seiverling et al. 2010; Suhrheinrich 2011; Suhrheinrich et al. 2007). Additionally, Gianoumis et al. (2012) evaluated the effect of staff training on staff members' ability to conduct a stimulus preference assessment. Robinson (2011) measured the duration of staff training and staff members' level of involvement and Koegel et al. (1992) evaluated the instruction and reinforcement provided by a clinician. Kuhn et al. (2008) measured effects of peer training on the number of interaction opportunities created by peers.

### Intervention Procedures

PRT was implemented in 25 studies and NLP in seven studies. In two studies, other interventions were implemented; however, these interventions included PRT techniques. Specifically, Koegel et al. (2012) used facilitated social play training and Thorp et al. (1995) implemented socio-dramatic play training. Five studies did not indicate whether PRT or NLP was implemented, but these studies explicitly stated that the specific

motivational techniques inherent to PRT were implemented (Koegel et al. 1998a, 2003a, 2010a, b, 1998b).

In 26 studies caregivers, staff members or peers were taught to implement PRT or NLP. The total duration of their training ranged from 66 min to 60 h. In six studies training continued until a mastery criterion was met (e.g., Gillet and LeBlanc 2007). Two studies did not report the duration of training (Schreibman et al. 1991; Suhrheinrich et al. 2007). Caregivers, staff members, or peers were taught individually in 15 studies and in a group in seven studies. Three studies combined group and individual training (e.g., Huskens et al. 2012). In one study, the training format was not reported (Suhrheinrich et al. 2007). The training was implemented by a clinician (i.e., psychologist or therapist) in 16 studies and by an experimenter in six studies. Nefdt et al. (2010) used a self-directed learning program to teach parents to implement PRT consisting of an interactive DVD. Three studies did not report who implemented training. Caregiver, staff, or peer training involved a variety of instructional strategies. In 14 studies, a manual was incorporated (e.g., Minjarez et al. 2011) and 15 studies reported to use didactic instruction (e.g., Coolican et al. 2010). Eight studies incorporated video modeling as an instructional strategy and 16 studies incorporated in vivo modeling. Nineteen studies reported to use some form of practice, such as assignments (e.g., Minjarez et al. 2011), role-play (e.g., Pierce and Schreibman 1995) and guided practice (e.g., Randolph et al. 2011). Video feedback was used in four studies and in vivo feedback in 18 studies. Several studies incorporated additional instructional strategies, such as small group discussions (Smith et al. 2010), assessments (e.g., Seiverling et al. 2010), picture prompts (e.g., Harper et al. 2008) and reinforcement (Kuhn et al. 2008). Stahmer and Gist (2001) investigated the addition of a parent information support group to PRT parent training.

In 23 studies, the PRT or NLP intervention was implemented by caregivers, staff members or peers. In ten studies, a clinician implemented the intervention and in two studies an experimenter. In three studies, the intervention was implemented by a parent as well as a clinician. One study did not report the implementer (Koegel et al. 2010b). Across studies a variety of PRT techniques were used. In 35 studies following the child's choice was incorporated. Nine studies incorporated getting the child's attention. In 29 studies, providing clear opportunities for responding was used. Twenty-four studies used task variation and interspersal of maintenance and acquisition tasks. Natural reinforcement was incorporated in 33 studies. Of these studies, 18 studies also incorporated contingent reinforcement and 15 studies did not report whether contingent reinforcement was used. In 29 studies, reinforcement of attempts at target behaviors was used. Two studies incorporated all seven PRT techniques (Minjarez et al. 2011; Suhrheinrich 2011). Several studies incorporated additional intervention strategies, such as multiple cues (e.g., Pierce and Schreibman 1997b), modeling of target response (Stahmer

1995), prompting (e.g., Koegel et al. 2012), prompt fading (e.g., Koegel et al. 2010a), time delay (Koegel et al. 1998a), and narrative play (e.g., Harper et al. 2008).

### Intervention Outcomes

Of the 35 studies targeting child behaviors, 15 studies (42.9 %) reported positive outcomes and 20 studies (57.1 %) reported mixed outcomes. Of the 13 studies targeting caregiver behaviors, 7 studies (53.8 %) reported positive outcomes and 5 studies (38.5 %) reported mixed outcomes. One study did not report intervention outcomes concerning caregivers (Smith et al. 2010). Of the seven studies targeting staff behavior, four studies (57.1 %) reported positive outcomes and three studies (42.9 %) reported mixed outcomes. The study targeting peer behaviors reported positive outcomes. None of the included studies reported negative outcomes.

Thirteen of the 39 studies (33.3 %) included data on follow-up. The length of the period between intervention and follow-up ranged from 2 weeks to 11 months. Generalization of intervention outcomes was measured in 22 studies (56.4 %). Generalization was measured across stimuli in eight studies (e.g., Thorp et al. 1995), across persons in eight studies (e.g., Robinson 2011), across conditions in three studies (e.g., Koegel et al. 2012) and across settings in 13 studies (e.g., Symon 2005). In ten studies (25.6 %) measures of social validity were conducted. All studies used a questionnaire to measure social validity (e.g., Huskens et al. 2012).

### Certainty of Evidence

Six studies (15.4 %) were classified as providing a conclusive level of certainty (Gianoumis et al. 2012; Huskens et al. 2012; Laski et al. 1988; Randolph et al. 2011; Robinson 2011; Seiverling et al. 2010). All six studies reported mixed intervention outcomes for children. These studies targeted self-initiations ( $n=3$ ), communication and language skills ( $n=5$ ), play skills ( $n=1$ ), adaptive functioning ( $n=1$ ), maladaptive behavior ( $n=1$ ), and affect ( $n=1$ ). Adaptive functioning did not improve and only one child improved on affect, but improvements on the other targeted skills were reported for the majority of the children across studies. The two studies targeting caregiver behaviors also reported mixed intervention outcomes. These studies targeted fidelity of implementation and parent verbalizations. Of the four studies targeting staff behavior, three studies reported positive intervention outcomes and one study reported mixed outcomes with regard to fidelity of implementation. One study reported positive intervention outcomes with regard to level of involvement.

Eleven studies (28.2 %) were rated as providing a preponderant level of certainty (Coolican et al. 2010; Gillet and LeBlanc 2007; Koegel et al. 1998a, b, 2010a, 2012, 2002; Nefdt et al. 2010; Pierce and Schreibman 1997a; Symon 2005;

Thorp et al. 1995). Of these studies, seven studies were classified as “preponderant”, because they provided limited control for alternative explanations of intervention outcomes. Specifically, five of these studies did not control for history due to use of a non-concurrent multiple baseline design (Carr 2005). One study did not control for interaction effects due to the small number of baseline probes between treatment conditions (Koegel et al. 1998b) and one study did not control for several threats to internal validity due to unstable baselines (Pierce and Schreibman 1997a). Four studies were classified as “preponderant”, because treatment fidelity was not reported or operational definitions for some dependent variables were not provided, although the study’s design controlled for alternative explanations (e.g., Nefdt et al. 2010). Of the 11 studies classified as “preponderant”, six studies reported positive intervention outcomes for children and five studies reported mixed intervention outcomes for children. The studies reporting positive outcomes targeted self-initiations ( $n=3$ ), communication and language skills ( $n=6$ ), and affect ( $n=1$ ). The studies reporting mixed outcomes targeted self-initiations ( $n=4$ ), communication and language skills ( $n=5$ ), play skills ( $n=3$ ), and maladaptive behavior ( $n=1$ ). Of the five studies classified at this level targeting caregiver behaviors, four studies reported positive intervention outcomes. These studies targeted fidelity of implementation ( $n=4$ ), self-efficacy ( $n=1$ ), and parental affect ( $n=1$ ). One study reported mixed intervention outcomes and targeted fidelity of implementation and self-efficacy.

Twenty-two studies (56.4 %) were classified as providing a suggestive level of certainty. Of these studies, 19 studies were classified as “suggestive”, because they used a pre-experimental ( $n=9$ ) or quasi-experimental ( $n=10$ ) design. For example, Harper et al. (2008) used a multiple baseline design across only two participants, but a multiple baseline design should include at least three participants to demonstrate experimental control (Horner et al. 2005). Therefore, the design was rated as “quasi-experimental” and the study was classified as “suggestive”. Three studies used an experimental design, but were nevertheless classified as “suggestive”, because some dependent variables were not operationally defined, details on intervention procedures were insufficient to enable replication, treatment fidelity was not reported and/or inter-observer agreement was not adequate (Koegel et al. 2010b; Stahmer 1995; Stahmer and Gist 2001). Of the 22 studies classified as “suggestive” that targeted child behaviors, nine studies reported positive intervention outcomes and nine studies reported mixed outcomes. Three of the five studies that were classified as “suggestive” and targeted caregiver behaviors reported positive intervention outcomes and two studies reported mixed outcomes. Of the three studies classified as “suggestive” that targeted staff behaviors, one study reported positive interventions outcomes and two studies reported mixed outcomes. The study targeting peer behaviors reported mixed outcomes.

## Discussion

This systematic review aimed to evaluate the evidence base of PRT for improving the skills of children with ASD, caregivers and staff members, to identify limitations of the existing evidence-based, and to suggest directions for future research. A systematic search identified 43 studies, indicating that the effectiveness of PRT has been extensively investigated. The majority of these studies were classified as providing a suggestive level of evidence. Below, the results of this systematic review are discussed for children with ASD and caregivers and staff members.

### Children with ASD

The results of this systematic review indicate that the majority of children with ASD that were included in the reviewed studies were taught to self-initiate through PRT. However, there is yet insufficient evidence to conclude that PRT results in improvements in non-targeted pivotal skills, because motivation was evaluated in only one study that provided a suggestive level of evidence (i.e., Koegel et al. 2010b) and responding to multiple cues and self-management were not evaluated in any of the included studies. Furthermore, the results of this systematic review suggest that PRT results in collateral improvements in language and communication skills (e.g., functional verbal utterances, language, and maintaining interactions) and play skills for the majority of children with ASD. Moreover, for some children, PRT also resulted in changes in affect and reductions of maladaptive behavior. However, there is insufficient evidence to conclude that adaptive functioning, autism symptoms, cognitive functioning, and academic functioning improve as a result of PRT, because none of the studies that were classified as proving conclusive or preponderant evidence reported improvements in these skills.

The results of this systematic review provide insight into what extent research supports the theoretical model of PRT (i.e., targeting pivotal skills using PRT techniques results in widespread improvements in other aspects of functioning). Of the four skills that are considered to be pivotal, only self-initiations have been studied in detail. This systematic review indicates that for a number of children with ASD, increases in self-initiations as a result of PRT are accompanied by collateral improvements (i.e., increases in communication and language skills, play skills and affect and reductions in maladaptive behavior). Thus, the research reviewed here does provide some support for the theoretical model of PRT. However, as motivation, responding to multiple cues, and self-management were rarely measured in the studies included in this review, it is not clear whether these skills improve as a result of PRT, whether improvements in these skills are accompanied by collateral changes, and thus whether these skills could be considered pivotal.

It should be noted that motivation itself is difficult to define operationally, which could explain why motivation was rarely measured. Koegel et al. (2001) defined motivation in terms of the effects of improved motivation (i.e., increased responsiveness to social and environmental stimuli), such as increases in the number of responses to teaching stimuli, decreases in response latency, and changes in affect. However, none of the studies that evaluated these behaviors considered these behaviors as an effect of improved motivation. There is no clear explanation for the lack of studies that evaluated responding to multiple cues. However, some studies implemented “using multiple cues” as a PRT technique (e.g., Pierce and Schreibman 1997b), suggesting that this pivotal skill was targeted, but seemingly not measured. The lack of studies that evaluated self-management can be explained by the fact that the studies identified during the database search that involved self-management did not refer to their intervention as PRT or NLP nor did they implement the PRT techniques (e.g., Koegel and Frea 1993; Loftin et al. 2008). It could be considered a limitation of this systematic review that the inclusion criteria did not comprise studies regarding self-management. However, self-management is also considered a separate intervention that incorporates specific techniques (e.g., NAC 2009), suggesting that self-management is not a distinguishing component of PRT.

Although the skills of many children improved as a result of PRT, it should be noted that a considerable number of children did not improve significantly, as indicated by the large number of studies that reported mixed results. This variability in outcomes is not unique to PRT and is consistent with results of evaluations of behavioral interventions more generally (Peters-Scheffer et al. 2011; Reichow 2012). Research on predictors of outcomes from behavioral interventions suggests that outcomes are related to children's age (e.g., Granpeesheh et al. 2009; Perry et al. 2013), language proficiency (e.g., Sallows and Graupner 2005), pre-treatment IQ (Perry et al. 2013), severity of autism symptoms (e.g., Ben-Itzhak and Zachor 2011), parental stress (Osborne et al. 2008; Strauss et al. 2012), and parental treatment fidelity (Strauss et al. 2012). Research concerning predictors of outcomes of PRT is limited, but a study by Sherer and Schreibman (2005) suggested that response to PRT was predicted by toy contact, approach, and avoidant behaviors, and verbal and nonverbal self-stimulatory behaviors. However, in order to estimate whether a child is likely to benefit from PRT, additional research is warranted to confirm the influence of these potential predictor variables and to identify other predictors of PRT outcomes.

The results of this systematic review further demonstrated a large variability in the PRT techniques that were implemented across studies and revealed that only two studies incorporated all PRT techniques (i.e., Minjarez et al. 2011; Suhrheinrich 2011). In particular, “gaining the child's attention and using contingent reinforcement” were often not incorporated or not

specifically reported. This could be explained by the fact that researchers do often consider these techniques as techniques that are automatically implemented when a clear opportunity to respond or natural reinforcement are provided (e.g., Koegel et al. 2002; Symon 2005). However, when assuming that the studies that incorporated these techniques also incorporated “gaining the child's attention” respectively “using contingent reinforcement”, the number of studies that incorporated all PRT techniques only slightly increases to five studies, suggesting that there is notable variability and/or flexibility regarding the combination of intervention components that constitute PRT.

Overall, with respect to the effect of PRT on child's behavior, we found evidence that supports the effectiveness of PRT and the theoretical model of PRT. However, future research should strengthen and extend the existing evidence base and provide additional support to the theoretical model of PRT. There are several specific directions for future research. First, studies should use true experimental designs to improve the certainty of evidence. Specifically, researchers should ensure that single-case designs replicate intervention effects across at least three participants and that group designs include a control group and randomly assign participants to groups to demonstrate experimental control (Horner et al. 2005; Black 1999). Second, pivotal skills should be defined operationally and measured systematically across studies. Third, future research should rigorously evaluate collateral changes in skills that are currently not investigated or investigated without using true experimental designs. Evidence for changes in these skills would extend the evidence base of PRT and support the claim that PRT results in widespread improvements in children (Koegel and Koegel 2006). Fourth, future research should investigate which characteristics predict the effectiveness of PRT. Finally and possibly most important, future research should seek to determine the components that define PRT and distinguish PRT from other interventions (e.g., EMT), because of the variability in the combination of PRT techniques across studies and the overlap between PRT and other interventions.

### Caregivers and Staff Members

The results of this systematic review suggest that caregivers and staff members can be taught to implement PRT techniques effectively using an individualized training approach that combines several well-used instructional strategies (e.g., modeling, guided practice, reinforcement/feedback). This finding is consistent with results of previous reviews on caregiver and staff training (e.g., Lang et al. 2009; Patterson et al. 2012; Rispoli et al. 2011). However, the results of this systematic review also indicate a number of gaps in the current existing evidence base. First, the duration of training varied

greatly across studies, indicating that it is unclear how much training caregivers and staff members need to correctly implement PRT techniques. Second, as studies incorporated a combination of instructional strategies or demonstrated mixed results with regard to the effectiveness of a single strategy (Huskens et al. 2012), it is not clear if certain instructional strategies are more effective than others to teach PRT techniques. Finally, it is not clear whether group training is effective, because the studies that evaluated the effectiveness of group training separately provided a suggestive level of evidence (Minjarez et al. 2013; Stahmer and Gist 2001). To increase the effectiveness and cost efficiency of caregiver and staff training in PRT, future research should seek to determine which training format, instructional strategies, and duration of training are most effective and efficient to teach caregivers and staff members to correctly implement PRT techniques.

Although most caregivers and staff members were able to correctly implement PRT techniques, some caregivers and staff members within some studies did not meet the criterion for fidelity of PRT implementation or did not maintain the use of PRT techniques (Coolican et al. 2010; Huskens et al. 2012; Randolph et al. 2011). These mixed results cannot be explained by training characteristics, because these characteristics did not vary within studies. However, research shows that fidelity of intervention implementation can be affected by certain staff characteristics, such as personality, attitude towards an intervention and individuals with disabilities, and perceived child–staff member relationship (Durlak and DuPre 2008; Peters-Scheffer et al. 2013), but it is not clear whether these staff characteristics also predict the fidelity of PRT implementation. Currently, research regarding the influence of parent characteristics on treatment fidelity is limited (Randolph et al. 2011). Research demonstrates that parent's level of education, family income or socioeconomic status, and parental stress affect children's intervention outcomes (e.g., Osborne et al. 2008; Reyno and McGrath 2006; Strauss et al. 2012), but it is unclear whether these caregiver characteristics also affect caregivers' fidelity of implementation. Therefore, future research should investigate whether certain caregiver and staff member characteristics predict the fidelity of PRT implementation.

The results of this systematic review indicate that there is limited evidence for collateral changes in caregivers' affect, verbalizations and self-efficacy, and staff members' level of involvement as a result of PRT. There is yet insufficient evidence to conclude that PRT results in collateral changes in caregivers' stress, empowerment, and interactional patterns. Because the current evidence base is limited, additional research regarding collateral changes in caregiver and staff behavior is warranted.

## Conclusion

This systematic review found evidence to support the use of PRT for increasing self-initiations. Collateral improvements were found in communication and language, play skills, affect, and reductions in maladaptive behavior for a number of children. The overall results of this review provide some support for the claimed effectiveness of PRT and for the theoretical model of PRT. However, the majority of studies (56.4 %) provided only suggestive evidence due to methodological limitations. Also, while this systematic review suggests that caregivers and staff members were able to implement PRT techniques, evidence for collateral improvements in caregivers' and staff members' behaviors remains sparse. Future research that uses true experimental designs is necessary to strengthen and extend the evidence base for PRT, to determine child, caregiver, and staff characteristics that predict the effectiveness of PRT and the fidelity of implementation of PRT and to determine the components that define PRT and distinguish PRT from other interventions.

**Conflict of interest** The authors declare that they have no conflict of interest.

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