The Effects of Parent-Implemented Language Interventions on Child Linguistic Outcomes: A Meta-Analysis

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Abstract

Intervening early is important to minimize persistent difficulties in language and related domains in young children with or at-risk for language impairment (LI; Rescorla, 2009). Because language is first learned in caregiver-child interactions, parent-implemented interventions are potentially an important early intervention for children with or at-risk for LI. Previous meta-analyses have examined outcomes of parent-implemented interventions for children with primary and secondary LI, but have not included children at-risk for LI due to low SES. A systematic review of the literature identified 25 randomized controlled trials of parent-implemented language interventions examining linguistic outcomes for young children. Studies included 1734 participants (M=3.7 years) with or at-risk for LI due to low SES. Results of these meta-analyses indicated modest improvements in expressive vocabulary and small improvements in expressive language for children with or at-risk for LI. The effect size for expressive vocabulary outcomes was significant for shared book reading interventions (g=0.37, 95% CI [0.15-0.59]) and interventions implemented in play and/or routines (g=0.50, 95% CI [0.05-0.95]). The effect size for expressive language was significant (g=0.42, 95% CI [0.19-0.65]), but not for receptive language (g=0.07, ns), and the effect size for receptive vocabulary was not significant (g=0.18, ns). Sub-group analyses for expressive vocabulary and expressive language indicated moderate to large significant effects for children with or at-risk for primary LI and smaller, non-significant effects for children with Autism Spectrum Disorder. Findings are generally consistent with a previous meta-analysis (Roberts & Kaiser, 2011), indicating parent-implemented language interventions may have positive effects on linguistic outcomes for young children with or at-risk for LI. Limited measures of parent training procedures and varied measures of parent outcomes limited the analysis of how child outcomes were achieved.

Keywords: language intervention, parent training, meta-analysis

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One of the most frequent recommendations for closing the word gap between children from low SES and middle-income backgrounds is to begin by improving parent talk and interactions with their children (Hoff, 2013). In addition, a common recommendation for all children with language delays is to strengthen parent skills for teaching language in caregiver-child interactions (Roberts & Kaiser, 2011). Nearly all children learn language and communication first in the context of caregiver-child interactions. Children learn language most efficiently when they actively engage with adults who support the language learning process (Kuhl et al., 2003; Schreibman, 2015; Yurovsky et al., 2013).

Language learning interactions are transactional (Song, Spier, & Tamis-Lemonda, 2014). This process can be disrupted by differences in children's developmental trajectory, caregiver skills, interactions, and linguistic abilities, and by the extent to which the context of interaction is supportive or stressful (Kochanksa & Aksan, 2004; Tamis-LeMonda et al., 2014). For children with significant delays or differences in early language development, typical caregiver-child interactions may not provide sufficient support for rapid language learning. For example, children with Autism Spectrum Disorder (ASD) often have difficulties initiating and maintaining joint attention; their challenges in sustaining reciprocal interactions with a communication partner disrupts both the flow of contingent responding and the provision of language models that address children's focus of attention (Mundy et al., 1986; Stone & Yoder, 2001; Wetherby et al., 2007). Based on observed differences in caregiver-child interactions, researchers have developed interventions to specifically teach caregiver language-facilitating behaviors and to provide targeted support to improve children's communication skills.

Early communication interventions involving parents also are important because language abilities during the preschool years are foremost predictors of children's performance across developmental domains and over time (Justice, Bowles, Turnbull, & Skibbe, 2009; Skibbe et al., 2008; Rescorla, 2009). Language development in early childhood provides an essential foundation for future literacy skills (see Dickinson, Golinkoff, & Hirsch-Pasek, 2010). Persistent early delays in language development place children at increased risk for difficulties with pre-literacy and literacy tasks such as: reading decoding and comprehension, spelling, and written language (Catts, Fey, Tomblin, & Zhang, 2002; Skibbe et al., 2008). In addition, children with language difficulties may be at increased risk for engaging in higher rates of challenging behaviors (Qi & Kaiser, 2003; Tomblin, Zhang, Buckwalter, & Catts, 2000; Van Daal et al., 2007) and for delayed social competence relative to their typically developing peers (Cohen & Mendez, 2009; McCabe & Marshall, 2006). The effects of early language delays may persist through adolescence and into adulthood (Johnson et al., 1999; Rescorla, 2009), with a high likelihood of persistent social, emotional, and learning difficulties continuing throughout the lifespan (Beitchman, 2001). The combination of risks associated with persistent language delays strongly suggests that providing effective early intervention may be critical for children's long-term learning and development.

Caregiver Strategies for Supporting Language

Principles of parent-child interactions that support positive language outcomes in typically developing children have been the primary basis for parent-implemented language intervention for young children with and without intellectual disabilities (ID; Roberts & Kaiser, 2011). The overall goal of parent-implemented language intervention is to increase parent behaviors that support language learning. These are: non-verbal and verbal turn-taking, responding to child bids for joint attention and gestures, following the child's focus of attention,

modeling language during shared attention, responding to child vocalizations with words, and expanding child utterances by modeling more complete or complex language while maintaining the child's meaning (Schreibman et al., 2015). These behaviors comprise two broad classes of language support: (a) contingent responsivity and (b) linguistic modeling (Schreibman et al., 2015; Tamis-LeMonda & Bornstein, 2002; Tamis-LeMonda, Bornstein, & Baumwell, 2001).

The premise of parent-implemented language interventions is that increasing or improving parent strategies that support language development in naturally occurring routines and activities will accelerate children's learning in contexts where learning typically occurs and when the child is motivated to engage with the parent. Parent training helps parents embed opportunities for children to learn new language skills within familiar routines; thereby increasing children's opportunities to practice language skills in functional contexts (Schreibman et al., 2015). Most parent-implemented language interventions have been developed for use in shared book reading (e.g., Lonigan & Whitehurst, 1998) or play and home routines (e.g., Roberts & Kaiser, 2012; Siller et al., 2013).

Previous Reviews

There is a substantive body of research highlighting the effects of parents as intervention agents for young children with language impairment (LI). Both meta-analyses and systematic reviews have examined the outcomes of parent-implemented interventions for young children with LI (Barton & Fettig, 2013; Law et al., 2004; Roberts & Kaiser, 2011). The target populations, as well as the purposes and methods of these reviews have varied.

In one of the first systematic reviews and meta-analyses of speech and language interventions, Law and colleagues (2004) reviewed group design studies examining linguistic outcomes resulting from early language intervention. Of the 13 speech and language intervention studies conducted with children with primary LI, only three employed parents as the primary

intervention agents. Results indicated that parent-implemented interventions did not result in significant changes in expressive vocabulary or syntax; however, only two parent-implemented studies measured expressive vocabulary (*d*=1.06, 95% CI [-0.14-2.52]), and three measured expressive syntax (*d*=0.83, 95% CI [-0.96-2.63]). Although these results were not significant, the overall magnitude of effect was large for both outcomes. However, it is difficult to draw conclusions from the three studies conducted before 2004.

Roberts and Kaiser (2011) examined the effect of parent-implemented language interventions conducted in play and routines on linguistic outcomes in 18 studies employing group experimental designs and including children with a range of language and cognitive abilities. Overall, parent-implemented language interventions resulted in positive effects for expressive vocabulary relative to a no treatment comparison. The overall pooled effect size for expressive vocabulary (*g*=0.48, 95% CI [0.24-0.43]) was significant. When the effect size was analyzed separately for children with primary and secondary LI, the effect size became non-significant for children with secondary LI (*g*=0.23, 95% CI [-0.04-0.50]), but remained significant for children with primary LI (*g*=0.80, 95% CI [0.50-1.10]). The overall effect size for receptive vocabulary was also significant (*g*=0.38, 95% CI [0.10-0.66]). The effect size for expressive language was significant and larger than the effect size for expressive vocabulary (*g*=0.61, 95% CI [0.00-1.21]). Moderate and significant results were found for global receptive language (*g*=0.35, 95% CI [0.05-0.65]). Additionally, there was a large and significant effect for parent language-facilitating behavior; significant changes were reported for parental responsiveness (*g*=0.73, 95% CI [0.26-1.20]). The description of training methods and measurement of fidelity of parent training were limited across studies; 72% of the studies did not measure the fidelity with which parents provided intervention to their children (parent implementation fidelity) and 50% did not describe parent training procedures sufficiently.

Barton and Fettig (2013) conducted a systematic review examining outcomes of parent-implemented interventions across a range of child skills (e.g., language, literacy, play) in 24 experimental studies of young children with disabilities. Both single-case and group design studies were included. Twelve studies examined language and communication outcomes. Overall, these studies reported positive child language outcomes, although methodological issues across the studies were noted. While the majority of studies (79%) measured parent implementation fidelity, most studies (71%) did not report the fidelity of procedures for training parents to provide intervention to their children.

Taken together, results from these systematic reviews and meta-analyses indicate that parent-implemented interventions resulted in positive changes in children's language; however, there is a need for analysis of more recent studies of these interventions. The most recent meta-analysis (Roberts & Kaiser, 2011) included studies conducted through 2010; however, they did not include studies enrolling children at-risk for LI due to low SES. Considerable research on parent-implemented interventions for language and communication has been published since 2010 with a range of child populations including children at-risk for LI due to low SES and children with or at-risk for ASD. While Roberts and Kaiser (2011) included studies using either quasi-experimental or true experimental group designs, randomized control trials (RCTs) have become the gold standard for evaluating the effects of interventions (What Works Clearinghouse, 2017). Although RCTs may vary in quality of method and potential risk of bias, overall, RCTs comprise the ideal experimental design for evaluating the effects of parent-implemented language interventions as they produce the most robust results. Given the relatively small sample of parent-implemented intervention studies that had both comparable control groups and met design standards for identifying evidence based practices, we allowed for variability in the

population. Further, theoretical and empirical differences in the literature suggest that population might moderate the effects of intervention, which was our *a priori* prediction.

The current meta-analysis extends previous systematic reviews and meta-analyses in several ways. First, we included studies published after 2010. Second, we analyzed the effect of child outcomes in two common contexts for parent-implemented language interventions: (a) shared book reading and (b) play/routines. Third, we included children at-risk for LI due to low SES. Fourth, we included only RCTs and analyzed risk of bias factors to assess the overall methodological quality of the studies. Finally, we analyzed two levels of fidelity: (a) the training of parents and (b) parent use of language support strategies. This is consistent with the cascading model of effects of parent training (e.g., Roberts & Kaiser, 2013). The emphasis on fidelity in the current meta-analysis was based, in part, on the fidelity concerns identified in previous systematic reviews and meta-analyses (Barton & Fettig, 2013; Roberts & Kaiser, 2011).

The research questions guiding the current meta-analysis were: (1) Are parent-implemented language interventions effective for improving children's receptive and expressive vocabulary? (2) Do the effects of parent-implemented language intervention on expressive vocabulary vary by the context of intervention (shared book reading vs. play/routine based intervention)? (3) Are parent-implemented language interventions effective for improving children's global expressive and receptive language skills? (4) Do parent-implemented language interventions increase parent use of language-facilitating behaviors? (5) Do the effects of parent-implemented language interventions vary by the etiology of children's LI? In addition, one descriptive question was posed for qualitative review: (6) What were the sources of risk of bias in the reported studies?

Method

This meta-analysis was conducted as part of a comprehensive literature review of early language interventions implemented by parents, caregivers, and teachers conducted by members of the Health Resources and Services Administration Grant (HRSA) Research Network on Bridging the Word Gap (BWG) (HRSA UA6MC 27762). The goal of the BWG comprehensive review was to evaluate the evidence supporting communication interventions for children 0-8 years with identified LI or at-risk for LI due to environmental factors including poverty. The studies included in the current review were identified in a search independent from the comprehensive literature review.

Search Procedures

The final comprehensive search was conducted on November 6, 2016 using ERIC, Academic Search Premier, PsycInfo, PsycAudio, and PubMed. The search terms used to identify studies for this review are shown in Table 1. Additional forward and ancestral searches were conducted; this included examining reference lists and other publications by the authors of identified studies.

Eligibility Criteria and Study Selection

This review was informed by the systematic reviews and meta-analyses guidelines (PRISMA; Moher et al., 2009). The studies identified were screened by four members of the BWG Parent Work Group 1. This screening was conducted in three steps: (1) duplicate removal and title screening, (2) abstract screening, and (3) initial full text screening to identify experimental studies examining parent-implemented language interventions. The studies included single case and group design studies.

Criteria related to participants, intervention, counterfactual, outcomes, and study design were established for inclusion in the meta-analysis. A second full text screening of the group design parent-implemented language intervention studies was conducted by the first and second

authors to select only the subset of parent-implemented studies meeting these criteria for inclusion. Verification was conducted on 100% of studies screened at the second full text level. Twenty-five studies met criteria for inclusion. These studies are listed in Table 2.

Studies were included that met the following criteria: (a) child participants were between 0 and 8 years of age; (b) interventions were parent-implemented language interventions (parents received explicit training to implement specific language-facilitating strategies with their children); (c) at least one measure of a linguistic outcome (i.e., expressive vocabulary, receptive vocabulary, receptive language, expressive language) was reported. Studies were included in this review if they measured any one of these linguistic outcomes however many studies included multiple outcomes. In addition, (d) all studies implemented random assignment to treatment or a non-treatment comparison group, and (e) non-treatment comparison groups included business as usual (BAU) in the community, waitlist control, or general parent education for a small number of sessions.

Coding of Variables

The first and second author coded the 25 selected studies. A code book (available from the first author) listing and defining all study variables was followed to ensure consistency across coders. Coding of all variables was verified by two coders for 100% of studies. If disagreements occurred, coders met to discuss the disagreement, a consensus agreement was reached, and consensus coded variable was used in the analysis.

The studies meeting inclusion criteria were coded for: population descriptors, intervention characteristics, and design features that might contribute to risk of bias. Intervention characteristics that were coded included: intervention name, context of intervention (i.e., play/routine, shared book reading), format of training (i.e., individual, group, both), strategies used to train parents, sample size, weeks in intervention, intervention session length in minutes,

and total number of sessions provided. Population descriptors included: child etiology (e.g., ASD, LI), mean child age, age range, and standard deviation of child age, as well as the percentage of the sample that was male, percentage of the sample that was minority, and parent education level and SES. Risk of bias was assessed by coding the methodological characteristics that may indicate elevated risk of producing biased effect size estimates: the use of blinded assessors, inclusion of a measure of parent training fidelity, quantified reporting of the parent training fidelity, (a number or percentage reported), inclusion of a measure of parent implementation fidelity, and quantified reporting of the fidelity of parent implementation (a number or percentage reported). Particular emphasis was placed on analyzing fidelity at two levels in the cascading model of parent training. Fidelity was emphasized because of overall low reporting of fidelity identified in previous systematic reviews and meta-analyses (Barton & Fettig, 2013; Roberts & Kaiser, 2011). Analysis of blinded assessors was conducted because un-blinded measurement increases the risk of producing inflated effect sizes (Hróbjartsson et al., 2013).

Several studies included multiple outcome measures of child vocabulary and language. For each construct (i.e., receptive vocabulary, expressive vocabulary, receptive global language, expressive global language) measures were selected based on a hierarchy of presumed validity and reliability. For example, if a study reported a standardized measure (direct child assessment), that measure was selected for analysis over other measures, based on the assumption that standardized measures would be more valid and reliable for synthesis across studies. If a study did not report a standardized measure, an observational measure (e.g., number of different words derived from a semi-structured adult-child interaction) was included in the analysis. If no observational measure was available, a parent report measure was included (e.g., vocabulary checklist filled out by the parent).

While several studies measured caregiver behaviors related to the intervention, adult contingent responsiveness was the only caregiver behavior that was commonly defined across studies (five of the 25 studies measured this variable). For the purpose of this review, contingent responsiveness was defined as the adult providing linguistic input in response to child-initiated actions or non-verbal or verbal communication. The post-test means, standard deviation, and sample size for the treatment and control groups were coded from each study for adult contingent responsiveness and each child measure. If post-test means and standard deviations were unavailable, the F-test was coded. Additionally, the type of measure was coded (i.e., standardized measure, observational measure, parent report measure).

Summary Measures

Effect sizes were calculated from individual studies using the post-test mean, standard deviation, and sample size for the treatment and control groups. Given the range of different measures of child and adult outcomes and the relatively small sample of studies, the dependent measures were converted to a Hedges' *g* standardized mean difference, corrected for potential small sample bias (Hedges, 1981). If post-test means and standard deviations were unavailable, the sample size and F-test were used to extract effect sizes.

Analytic Strategies

Synthesis of effect sizes. A random effects meta-analysis (Borenstein, Hedges, Higgins, & Rothstein, 2009) was conducted to examine the overall pooled effect size and confidence interval based on the hypothesis that variability in the measure of effect across studies was attributable to variation in the focus of intervention, population, and dosage. To examine heterogeneity in the pooled effect size, the Q, I^2, and τ^2 statistics were examined (Borenstein et al., 2009). The Q statistic was examined to determine if there was a significant amount of variance attributable to differences in effect sizes across studies, the τ^2 statistic was examined to

determine the amount of variance between studies, and the I^2 statistic reflected the proportion of variance attributable to true differences in effect rather than measurement error (Borenstein et al., 2009).

Publication bias and sensitivity analysis. Two techniques were used to determine if there was evidence of publication bias in results of the meta-analyses. First, a funnel plot was constructed and visually examined for asymmetry. In a funnel plot, the individual effect size from each study is plotted relative to the standard error of that study. Examining the funnel plot for asymmetry can help to identify the potential for small study bias in the sample of studies identified for a meta-analysis. Second, in order to statistically test for funnel plot asymmetry, an Egger's test was conducted. The Egger's test specifically tests the null hypothesis that there is no evidence of small study bias (Egger, Smith, Schneider, & Minder, 1997). To examine how much impact the small study bias may have had on the pooled effect size estimate, a trim and fill analysis was conducted. A trim and fill analysis corrects small sample bias by filling the funnel plot with studies that were potentially not published so that the funnel plot is no longer asymmetric (Duval & Tweedie, 2000). The trim and fill analysis also provides a corrected effect size estimate and confidence interval accounting for the studies that were filled in the funnel plot, allowing you to examine changes in the overall pooled effect size estimate and confidence interval relative to the original estimates. Additionally, due to variability in the type of expressive vocabulary measure reported across studies (parent report, standardized, observational), an additional sensitivity analysis was conducted to examine the impact of measurement type on the pooled effect size estimate.

Moderator analyses. Although the variance between studies was non-significant among studies conducted in shared book reading, there was significant variability in studies conducted in play/routines. *A priori* random effects ANOVA subgroup moderator analyses were conducted

to explore residual heterogeneity in studies in which the intervention was conducted in play/routines to examine the impact of population (e.g., ASD, LI) on child linguistic outcomes and adult contingent responsivity.

Results

Study Selection

The process for conducting the systematic review of the literature is illustrated in Figure 1. A total of 4524 records were identified through the primary search conducted by members of the BWG Work Group 1; 1040 records remained after duplicate records were removed and titles were screened. A total of 234 records remained after abstract screening, and 138 records met the broad criteria for inclusion after the initial full text screening. Of these records, 31 studies were excluded because the studies employed single-case research designs. At the second full text level screening, the remaining 107 group design articles were screened relative to the inclusion criteria developed for this review. Of these group design studies, 32 were excluded due to use of a quasi-experimental design, 25 were excluded because the design compared two or more treatments, 17 were excluded due to a lack of linguistic outcomes, five were excluded because the studies analyzed within-group comparisons, and three were excluded because parents were not the primary intervention agents. We identified 25 peer-reviewed studies that met inclusion criteria.

Study Characteristics

Descriptive statistics. The characteristics of the included studies are summarized in Tables 2 and 3. The 25 studies published between 1992 and 2015 included 1434 child participants (*M*=3.7 years). Child participants varied in etiology, with about half (52%) of studies describing the sample as with identified LI or at-risk for LI due to low SES and a little over a third (36%) of studies including samples of children with or at-risk for ASD. The remaining studies included child participants with varying etiologies: one study included participants

characterized as being with or at-risk for developmental delay, one included participants who were typically developing, and one included participants with hearing impairment.

The majority (78.9%) of the studies that reported parent education included parent participants with at least a high school education. Only 13 of the 25 studies reported SES; six of the 13 studies included participants who were primarily middle class, six studies specifically targeted participants with low SES, and one study reported including participants who were both middle and lower-class.

All studies included a no treatment comparison group. Almost half (48%) compared treatment to a business as usual (BAU) control group and 40% compared treatment to a waitlist control group. Three studies (12%) provided minimal parent education to the control group.

The format for training parents varied across studies. Fifty-six percent of studies provided individual parent training, 24% of studies provided group and individual parent training, and 20% of studies provided group training only. The size of groups varied from 6-12 parents in the two studies that reported the size of the groups.

The dosage of intervention varied across studies. The average time spent in session was 91.2 min (median=90 min), with session length ranging from 20 min to 180 min. The total number of sessions provided was variable across studies, with a mean of 15.3 sessions (median=12 sessions), and a range of 1 to 55 sessions. The mean number of weeks spent in intervention was 33.5 weeks (median=12 weeks), ranging from 6 to 130 weeks.

The context of the language intervention varied across studies, however, interventions were classified broadly into two categories based on the context that language-facilitating strategies were embedded: shared book reading interventions and play/routine based interventions. Eight studies examined the effects of shared book reading interventions. The remaining 17 studies targeted caregiver-child interactions during play/routines. Most of the

studies (75%) including shared book reading interventions were conducted with children with identified LI or at-risk for LI due to low SES. While child age did not vary significantly between the two contexts of intervention (t=0.08, p=0.932), the percentage of the males in the two samples was significantly different (t=2.8, p=0.01). More boys and more children with ASD were in studies implemented in play/routines. No studies were conducted with children with ASD in the shared book reading context.

Parent training strategies. All 25 studies provided some form of training to parents about language-facilitating strategies. Although most studies described the procedures for teaching parents the intervention, too few studies reported sufficient data on the parent training procedures to allow statistical analysis of this variable. All studies conducted in a shared book reading context described the format of training provided to parents. The most widely used strategy in these studies was video instruction (k=5), followed by role play (k=5), and handouts (k=3). Five out of eight studies utilized a combination of 2 or more parent training strategies. Studies of interventions conducted in play/routines used a greater variety of parent training strategies (M=2.6) than studies of shared book reading interventions (M=1.0). Over half of the studies (k=10) reported using coaching to train parents, and the majority of the sample (12 of 17 studies) reported reviewing parent performance of the language intervention strategies.

Measures of Linguistic Outcomes

The effects of intervention on four child linguistic outcomes (expressive vocabulary, receptive vocabulary, global expressive language, global receptive language) were examined across studies. Thirteen (52%) studies measured expressive vocabulary as an outcome, however, studies varied in type of vocabulary measure. The following vocabulary measures were used: MacArthur-Bates Communicative Development Inventory (MCDI; Fenson et al., 2007) (4), ELFRA-2 (German version of MCDI; Grim & Doil, 2000) (1), Expressive One-Word Picture

Vocabulary Test (EOWPVT; Gardner, 1990) (3), and the Number of Different Words (NDW) produced in a standardized language sampling context (5). Both studies that focused on shared book reading (6 of 13) and studies focused on interactions in play and routines (7 of 13) measured expressive vocabulary. Seven studies measured receptive vocabulary; three of these studies were shared book reading interventions, and four were play/routine based intervention. Measures of receptive vocabulary included the MCDI (Fenson et al., 2007) (4) and the Peabody Picture Vocabulary Test (PPVT; Dunn & Dunn, 1997) (3).

Thirteen studies measured global expressive language. The measures used were: Mullen Scales of Early Learning (MSEL; Mullen, 1995) (5), Preschool Language Scale (PLS; Zimmerman, Steiner, & Pond, 1992) (4), Test of Early Language Development (TELD; Hresko, Hammill, & Reid, 1991) (2), and SETK-2 (German test of expressive language; Grimm, 2000) (1). Most of the studies measuring global expressive language (11 of 13) were conducted in play and routines. Two studies conducted in shared book reading contexts measured global expressive language. Eight studies conducted in play and routines measured receptive language; no studies of shared book reading measured receptive language. The following measures of receptive language were used: MSEL (Mullen, 1995) (4), Test of Early Language Development (TELD; Hresko, Hammill, & Reid, 1991) (1), PLS (Zimmerman, Steiner, & Pond, 1992) (1), Sequenced Inventory of Communicative Development (Hedrick, Prather, & Tobin, 1984) (1), and Landry Parent-Child Interaction Scale (Landry et al., 2001) (1).

RQ 1: Are parent-implemented language interventions effective for improving children's receptive and expressive vocabulary? Seven studies measured receptive vocabulary outcomes and the random effects meta-analysis (see Figure 2) indicated an overall pooled effect size of 0.18 (95% CI [-0.11-0.48]). Parent-implemented language interventions did not have a significant effect on receptive vocabulary outcomes. The random effects model indicated an

overall significant pooled effect size (see Figure 3) for the 13 studies measuring expressive vocabulary *g*=0.42* (95% CI [0.19-0.65]). On average, parent-implemented interventions had a significant and moderate effect on children's expressive vocabulary[1].

RQ 2: Do the effects of parent-implemented language intervention on expressive vocabulary vary by the context of intervention? Because studies were almost evenly divided between two different types of intervention, a random effects ANOVA subgroup analysis was conducted to separately examine the effect of shared book reading interventions vs. play/routine-based interventions (see Figure 3). The overall pooled effect size for shared book reading was 0.37*; this effect was statistically significant (95% CI [0.15-0.59]). The overall pooled effect size for play/routine based interventions was 0.50 (95% CI [0.05-0.95]), and also was significant. Thus, on average, parent-implemented interventions conducted in both shared book reading and play/routine based contexts interventions had a significant and moderate effect on children's expressive vocabulary.

RQ 3: Are parent-implemented language interventions effective for improving children's global expressive and receptive language skills? The random effects meta-analysis for global expressive language (see Figure 4) indicated a statistically significant pooled effect size of 0.27*, (95% CI [0.10-0.44]) for the 13 studies measuring expressive language, indicating that intervention had a significant and small to moderate effect on expressive language. The pooled effect size for receptive language was 0.07 and was not significant, (95% CI [-0.15-0.29]) (see Figure 5). For the eight studies in this analysis, parent-implemented language interventions did not significantly improve receptive language outcomes.

[1] *Significant at p<.05

RQ4: Do parent-implemented language interventions increase parent use of language-facilitating behaviors? Parent training had a significant and large effect on parents' contingent responding to their children in the five studies measuring this parent outcome (see Figure 6). The random effects meta-analysis for parent responsivity yielded a pooled effect size of 1.20* (95% CI [0.49-2.06]), which was statistically significant.

Analysis of heterogeneity. Follow up tests for heterogeneity were completed for the two significant outcomes (expressive vocabulary, expressive language). The heterogeneity chi-squared test for child expressive vocabulary indicated a significant amount of heterogeneity due to between-study variance for studies conducted in play and routines (Q=20.32, p=.002), but not for studies of shared book reading (Q=2.25, p=.814). The I^2 statistic indicated that over half the variance in the effect size estimate for studies examining play/routine based interventions was attributable to between study variance (I^2=70.5%).

The heterogeneity chi-squared test indicated that there was not a significant amount of heterogeneity due to between-study variance for expressive language outcomes (Q=15.403, p=.222). There was a significant amount of between-study variance for parent contingent responsivity (Q=35.75, p=.000); the I^2 statistic indicated a large proportion of variability due to between-study variance (I^2=65.8%).

Moderator Analysis

RQ5: Do the effects of parent-implemented language interventions vary by the etiology of children's LI? A random effects ANOVA subgroup analysis was conducted to analyze the differences in effect sizes for expressive vocabulary, expressive language, and parent contingent responsivity among studies including populations of children who were classified as with or at-risk for ASD and studies in which children were classified as with identified LI or at-risk for LI due to low SES. Effect sizes for each outcome are provided in Table 6.

When the effect size for expressive vocabulary was examined in the subgroup analysis, the effect size for expressive vocabulary was large and significant for children with or at-risk for LI (g=0.78*, 95% CI [0.27-1.30]), however, the effect size was no longer significant for studies including children with or at-risk for ASD (g=0.48, ns) for interventions conducted in play/routines. The between study variability in the effect size appeared to be accounted for by the sample of studies conducted with children with or at-risk for ASD ($I^{2=}$80.7%).

A similar pattern of results was observed for expressive language. The effect size for expressive language was moderate and significant for studies including children with or at-risk for LI (g=0.42*, 95% CI [0.05-0.33]), but in the studies including children with or at-risk for ASD, the effect size was not significant (g=0.12, ns).

Results from the subgroup analysis of effects on parent responsivity indicated that results remained significant for studies including children with or at-risk for LI (g=1.19*, 95% CI [0.19-2.19]) and for studies including children with or at-risk for ASD (g=1.28*, 95% CI [0.04-3.60]). Given the small number of studies that reported measures of adult contingent responsivity for each population, these findings should be interpreted conservatively.

Overall results from the subgroup analyses for child expressive vocabulary and expressive global language indicated that parent-implemented interventions may be more effective for children with identified LI or at-risk for LI due to low SES than for children with or at-risk for ASD. Additionally, the variability within effect sizes appeared to be accounted for by the studies enrolling children with or at-risk for ASD.

Publication bias. In a meta-analysis, publication bias is the potential that studies that would have met criteria for inclusion in the review were not published due to non-significant or negative results. To assess the impact of potential publication bias on the pooled effect size estimates, visual examination of the funnel plots depicting the relationship between the effect

size and the standard error of included studies was conducted (funnel plots are provided in Appendix A). For expressive vocabulary (Appendix A, Figure 8), the funnel plot indicated mostly symmetric results; however, there was an absence of studies with small sample sizes and small or negative effect sizes. The funnel plot for expressive language (Appendix A, Figure 9) was also asymmetrical, indicating an absence of small sample studies with small and negative effect sizes. The funnel plot for parent responsivity (Appendix A, Figure 10), indicated an absence of moderate and large sample studies with positive effect sizes. The asymmetry in the forest plots was supported by the Egger's regression tests, which provided statistical confirmation of asymmetry in the funnel plot for expressive vocabulary ($p=0.02$) and expressive language ($p=0.01$). The Egger's test for parent contingent responsivity was not significant ($p=0.246$); however, because of the asymmetry in the funnel plots for both child outcome measures and the funnel plot for adult contingent responsivity, additional sensitivity analyses were conducted to determine the impact of small sample studies with large outcomes on the pooled effect sizes for child expressive vocabulary, child expressive language, and parent contingent responsivity.

Trim and fill analysis for publication bias. Results from the trim and fill analysis for expressive vocabulary indicated that this analysis filled six studies to adjust for the asymmetrical funnel plot (Appendix B, Figure 11). Although the effect size for child expressive vocabulary remained significant (95% CI [0.013-0.29]) after this adjustment, the magnitude of the effect size was reduced from $g=0.42$ to $g=0.15$. A similar result emerged for child expressive language (Appendix B, Figure 12). The trim and fill analysis added five estimated studies; the adjusted effect size approached significance and reduced the original ES magnitude from $g=0.31$ to $g=0.14$ (95% CI [-0.04-0.33]). For parent contingent responsivity (Appendix B, Figure 13), the trim and fill analysis filled one study. This fill resulted in a reduced effect size estimate, which

still approached significance (*g*=0.49, 95% CI [-0.003-1.00]) compared to the original larger, significant effect size (*g*=1.28*, 95% CI [0.49-2.06]).

Type of outcome measure. Given the variability in the type of measure of expressive vocabulary reported across studies (parent report, observational, standardized), an ANOVA subgroup analysis was conducted to examine the differential impact of measurement type on expressive vocabulary outcomes (see Figure 6). When analyzed separately, the effect size estimate was no longer significant for the five studies that provided parent report measures (*g*=0.52, ns) and the three studies that provided standardized measures (*g*=0.25, ns). Results from observational measures of expressive vocabulary were moderate and significant (*g*=0.46*, 95% CI [0.19-0.74]) for the five studies that reported this type of measure.

RQ6: What were the sources of risk of bias in the reported studies? Risk of bias variables are reported in Table 4. The two major sources of bias were unblinded assessment and reporting of fidelity. Five of 13 studies reporting child expressive vocabulary outcomes used an unblinded parent report outcome and five did not report the blinding of the assessor for an observational or standardized measure of expressive vocabulary. Of the 13 studies that measured expressive language, only five reported using a blind assessor.

In parent-implemented models of intervention, there are two independent levels of fidelity: (a) the fidelity of training parents to implement the intervention with their child (parent training fidelity), and (b) the fidelity with which parents implement or deliver the intervention to their child (parent implementation fidelity). Nine studies (36%) reported parent training fidelity. Studies varied in how they described the effects of training on parents' delivery of the intervention to their children. Studies either reported measuring parent implementation fidelity within the intervention session or provided a measure of one or more specific parent language-facilitating behaviors from a parent-child interaction measure post intervention. Seven studies

(28%) reported measuring parent implementation fidelity within the intervention session. Of these studies, five reported a number or percentage to index the overall fidelity with which parents provided the intervention. Fourteen studies (56%) provided at least one measure of parents using one or more trained language-facilitating behavior/s with their children during a post-intervention parent-child interaction sample (see Table 5). The effect of parent contingent responsivity was measured in five studies; no other single construct was measured consistently across more than two studies. Three studies (12%) reported measuring fidelity both within the intervention session and during interactions following intervention, a more distal measurement context.

Discussion

The purpose of this meta-analysis was to examine the impact of parent-implemented language interventions on expressive and receptive vocabulary and global receptive and expressive language for young children with or at-risk for primary and secondary LI.

Main Effects

Results from this meta-analysis indicate that, on average, parent-implemented language interventions have positive and significant effects on child expressive vocabulary. Effects of parent-implemented interventions may vary based on the type or context of language intervention. The pooled effect size estimate for play/routine-based interventions (g=0.50, 95% CI [0.05-0.95]) was larger than the pooled effect size for shared book reading interventions (g=0.37*, 95% CI [0.15-0.59]); however, there was greater variability in the range of effect sizes for intervention conducted in play and routines (g=-0.21-1.58) compared to effect sizes for shared book reading interventions (g=0.20-0.72). All of the heterogeneity in the pooled effect size estimate was accounted for by the studies conducted in play/routines. Thus, while play/routine based interventions are likely to positively impact vocabulary, the range and

variance in effect sizes suggests that outcomes may differ based on population or intervention procedures. Generally, these results should be interpreted with caution.

Parent-implemented interventions did not significantly improve receptive vocabulary (*g*=0.18, ns). Parent-implemented interventions significantly improved expressive language (*g*=0.27*, 95% CI [0.10-0.04]), but not receptive language (*g*=0.07, ns). It appears that parent implemented interventions conducted in both shared book reading and play/routine based contexts may improve the global expressive language of children with identified LI or at-risk for LI due to low SES. The non-significant receptive language outcomes may be related to population in the sample of studies measuring this construct. Five of the eight studies measuring receptive language were conducted with children with or at-risk for ASD.

It appears that parent training was effective in increasing parents' contingent responsivity, a key language-facilitating behavior (*g*=1.28*, 95% CI [0.49-2.06]). These findings should be considered preliminary because only five studies measured this construct and no other measure of parent language-facilitating strategies was reported in more than two studies; thus effects on other parent behaviors could not be analyzed.

Cautions in interpreting results. Results for both expressive vocabulary and expressive language should be interpreted with caution. First, across measures, sensitivity analyses indicated that the true effect size estimates may actually be smaller in magnitude than the original estimates. After conducting the trim and fill analysis, the effect size estimate for expressive vocabulary was reduced from *g*=0.42 to *g*=0.15*, and the effect size for the expressive language estimate was reduced from *g*=0.27 to *g*=0.14, and was no longer significant when the potential impact of missing studies was considered. For parent contingent responsivity, the effect size estimate was reduced from *g*=1.20 to *g*=0.49, and was no longer significant (95% CI [-0.003-1.00]). Second, although 25 studies met criteria for inclusion, effect sizes are based on a smaller

sample of studies. Only 13 studies measured expressive vocabulary, seven studies measured receptive vocabulary, 13 studies measured expressive language, eight studies measured receptive language, and five studies measured parent contingent responsivity.

Because of variability in the type of expressive vocabulary measure reported in this sample of studies (five studies provided parent report measures of expressive vocabulary, five studies reported observational measures, and three studies reported standardized measures), additional sensitivity analysis was conducted to examine differences in the pooled effect size estimate by type of measure. When the pooled effect size estimate was analyzed separately by measure type, the effect size for observational measures was large and remained significant (g=0.46, 95% CI [0.19-0.74]), and the effect sizes for parent report measures (g=0.52, ns) and standardized measures (g=0.25, ns) were no longer significant. One potential explanation for this finding is that observational measures provided an estimate of effect that is more proximal to the intervention context than standardized and parent report measures. Proximal measures are more likely to produce a larger effect size estimate than measures that are more distal to the focus of intervention (Yoder, Bottema-Beutel, Woynaroski, Chandrasekhar, & Sandbank, 2013).

Strategies Used to Train Parents

While studies generally described the strategies used to train parents, little detailed information about frequency or duration of the teaching strategies was provided across studies. More precise reporting of key training strategies is needed, including how frequently the strategy was implemented and how the strategy was presented (e.g., length of modeling instances, length and number of video examples, the number of strategies used in each session, and if support was faded over time). To advance both research and practice, it is important to measure and describe the active ingredients of the intervention used to train parents and to describe the dosage and adherence to the parent training procedures.

Risk of Bias in Included Studies

In general, risk of bias was moderate because all of the studies selected for the review were RCTs. The primary risks were associated with measures of fidelity and unblinded assessment of child outcomes. Fewer than half of studies (28%) assessed the fidelity of parents' implementation of the language intervention and only five quantified parents' fidelity. Nine of 25 studies (36%) assessed the fidelity with which parents were trained; eight of these nine quantified trainers' fidelity. Fewer than half of studies conducted blind assessment of child expressive vocabulary (23.1%) and expressive language (38.5%). For parent report measures, which are always unblinded, there is an increased risk that parents who expect their children to make gains as a result of intervention may provide an inflated estimate of their children's language, while parents whose children did not receive intervention may not expect their children to improve. Assessors who are not blind to the assigned condition of the participant may have expectations related to the child's performance based on his/her group assignment (Wood et al., 2008).

Extension of Previous Meta-Analyses

The current analysis included 19 studies that were not in the previous meta-analysis (Roberts & Kaiser, 2011); only 6 studies overlapped between the two meta-analyses. Similar to the findings from Roberts and Kaiser (2011), the overall effects for parent-implemented interventions were positive for expressive vocabulary (g=0.42*) and expressive language (g=0.27*). Although both meta-analyses report positive and significant results moderated by etiology of LI, the magnitude of effects for expressive vocabulary (g=0.48*) and expressive language (g=0.61*) was larger in the previous meta-analysis. Roberts and Kaiser (2011) also found significant and moderate effects for receptive vocabulary (*g*=0.38*) and receptive language (*g*=0.35*), while the effect sizes for these outcomes were smaller (0.18, 0.07

respectively) and non-significant in the current analysis. These smaller effects might have been the result of using a sample of more rigorously designed studies or as a result of including more studies enrolling children with or at-risk for ASD. Roberts and Kaiser (2011) included three quasi-experimental studies in their meta-analysis of 18 studies. Only three of 18 studies in Roberts & Kaiser's report included children with ASD compared to nine of 25 studies in the current meta-analysis. The current meta-analysis extends previous findings by examining the differential impact of intervention in two different contexts for parent-implemented interventions. These findings indicate that language interventions conducted in both shared book reading and in play/routines based contexts can be effective for increasing expressive vocabulary and expressive language in children with or at-risk for LI. Taken together, positive outcomes for expressive vocabulary and expressive language appear to be robust across studies over time and intervention contexts.

The effect size estimate for parent contingent responsivity was significant in the current meta-analysis (g=1.20*) and larger in magnitude than the effect size estimate in Roberts and Kaiser (2011; g=0.70*). Five studies in the current review and seven studies in the previous review measured parent responsiveness. Although results from both meta-analyses indicate that parents can learn to be more responsive to their child's initiations, the small sample of studies measuring responsiveness in both reviews makes it difficult to interpret differences in the magnitude of effect. Finally, this review extends the previous meta-analysis by reporting the percentage of studies that measured the fidelity of parent training (29%). Roberts & Kaiser (2011) reported that 28% of studies measure parent implementation fidelity; 36% of studies in the current review measured parent implementation fidelity. Results from both reviews indicate the ongoing need for fidelity measures at both points in the cascading model in order to examine the impact of intervention on both parents and children.

Limitations

There are several limitations that affect interpretations of the results. This meta-analysis was limited to interventions that provided explicit training to parents to increase use of specific language-facilitating strategies with their children. Interventions targeting general increases in child-directed talk or providing books without systematic parent training to address language risks associated with low SES were not included. Although efforts were made to identify all studies meeting inclusion criteria for research design and explicit parent training, it is possible that publication bias excluded some eligible studies. Results from the sensitivity analysis indicate the possibility that the sample of studies is incomplete and may have over-estimated the effect size.

Reporting. As with all meta-analyses, the results are limited by the information available in individual studies. Limited description of the parent training procedures and parent implementation was a major limitation. Potentially, an important source of variability across studies was in the dosage of parent-training. Although most studies provided some information about dosage (e.g., weeks in intervention), most did not provide sufficient information to calculate the exact dosage of the parent training intervention. Further, parent use of intervention strategies outside of intervention sessions is unknown. Thus, it was not possible to analyze precisely the effects of dosage on child outcomes. There was a wide range of time spent in intervention (reported as total minutes, weeks, and sessions) in both shared book reading and play/routine-based studies. More precise and comparable reporting is needed to determine the necessary and optimal dosages of intervention associated with child and parent outcomes by context of intervention and child etiology.

Variability in outcomes across studies. In any study, there are multiple variables that impact the effect size estimate, including: population, focus of intervention, and type of outcome

measure (proximal, distal). These variables interact in complex ways and it is likely that the variability in outcomes across studies was attributable to some combination of population, intervention context, linguistic construct, and measurement interaction. However, given the limited sample of studies and variability in measures of intervention and outcomes, the relationship among these factors could not be statistically analyzed by examining multiple concurrent moderators.

One clear example of this interaction was that children with ASD were not included in the studies of shared book reading, but were included in studies of interventions conducted in play/routines. The effects on expressive vocabulary and expressive language in the studies including children with or at-risk for ASD were highly variable. Given the wide range in ages of children and the inclusion of both children at-risk for ASD and children with identified ASD, variability in language outcomes is not surprising.

Finally, only one study included children with or at-risk for developmental disabilities and one study included children with hearing impairment. Given that children with secondary language impairments are likely to need support for language learning during early intervention and concurrent with other language intervention during the preschool years, the absence of rigorous studies with this population is concerning.

Recommendations

One goal of this meta-analysis was to make recommendations about the effectiveness of parent-implemented intervention for improving language outcomes in children at-risk for LI due to poverty. Overall, the findings from this meta-analysis support parent-implemented interventions as evidence-based practice but there is limited evidence specifically related to children and families from low resource backgrounds. Six studies specifically targeted low-

income children, twelve studies did not report SES, and no studies analyzed outcomes within their samples based on SES.

Which types of intervention are effective? Both parent-implemented interventions based in shared book reading and in play/routine based contexts may be effective. Results suggested a larger magnitude of effect on expressive vocabulary for parent-implemented shared play/routine-based interventions than for shared book reading interventions, however, there was more variability in the range of effect sizes for studies conducted in play/routines. Additionally, all of the heterogeneity in the pooled effect size estimate was accounted for by the studies conducted in play/routines. The relatively more consistent effects observed for shared book reading interventions may be the result of the specific language-facilitating behaviors taught to parents in these interventions (e.g., asking "wh" questions) and the highly structured context in which parents were trained and implemented strategies. Teaching parents a small set of pivotal skills such as question asking may be an efficient and effective way to improve productive vocabulary in children with LI. Interventions targeted in play/routines typically taught parents to implement general language-facilitating strategies (e.g., responding to child initiations, modeling language in context, prompting in response to requests). These interventions may be more challenging for parents to learn and require that parents are able to adapt their use of strategies in interactions with their children across different routines and activities. Although interventions that teach language support skills to use across settings are potentially more effective for teaching a range of language skills and effective across populations, systematic and longer-term parent training to use the strategies may be essential for ensuring consistent child outcomes.

Another potential explanation for the more variable effect sizes for expressive vocabulary in interventions implemented in play/routines versus shared book reading is that the populations of children in differed by the setting of the intervention. Children in the seven studies conducted

in play and routines were primarily children with or at-risk ASD (57.1%) or secondary LI (14.3%). In contrast, most studies (83.3%) of shared book reading interventions were conducted with children with or at-risk for LI and no studies included children with or at-risk for ASD.

Studies of shared book reading intervention frequently measured a single outcome, expressive vocabulary, while studies of play/routine based intervention were more likely to include global expressive and receptive language as well as vocabulary. Parent-implemented shared book reading may improve productive vocabulary for children; however, parent-implemented intervention in play and routines may be necessary for children who have significant delays in productive vocabulary and global expressive language.

The current sample of studies did not include longitudinal follow-up data. Thus, this review does not provide evidence indicating parent-implemented interventions minimized the impact of persistent language delays or improved social and academic outcomes. Follow-up studies including measures of the long-term impact of parent-implemented interventions on language development are needed to justify assumptions about malleability of language outcomes and reduction in long-term risk through this type of intervention. Longitudinal follow up studies also are needed to determine if changes in parent behavior are sustained over time and are related to child language outcomes.

For whom are existing interventions effective? Parent-implemented interventions may be effective at impacting expressive vocabulary and language for children with primary LI and somewhat less effective for children with secondary LI, particularly children with or at-risk for ASD. Although only five studies measured the same parent language support variable (contingent responding), these studies spanned populations, suggesting that parents of children with different etiologies can increase their use of this core strategy. While there is no indication that parent training was less effective for parents from low SES backgrounds, the small sample

of studies enrolling families from low SES backgrounds must be considered in this recommendation.

What do we know about intervention for children at-risk for LI due to low SES? Results from this meta-analysis indicate that parent-implemented interventions may be effective for increasing expressive vocabulary in young children with LI; however, only six studies specifically targeted children at-risk for LI due to low SES. Four of these studies were conducted in shared book reading contexts and two were conducted in play/routines, suggesting that interventions in either context may be potentially effective. Given current interest in closing the word gap between children from low SES and middle-income backgrounds and the frequent recommendations for improving parent talk and interactions with children as a means of closing this gap (Hoff, 2013), additional, methodologically rigorous studies of parent-implemented interventions with children and parents from low SES backgrounds are critically needed to inform policy and practice.

What are the clinical implications of these results? A conservative interpretation of the effect sizes for expressive vocabulary for children with primary LI indicates that parent-implemented shared book reading interventions may result in an average increase of 4.48 points on a standardized measure of expressive vocabulary (EOWPVT). In play/routine based interventions, children with LI may gain an average of 7.32 different words based on an observational language sample measure. Play and routine based interventions resulted in an average of 2.68 points on a standardized measure of expressive language (PLS).

Only two studies conducted in shared book reading contexts measured expressive language; neither reported sufficient data to interpret the clinical impact. In the studies reviewed here, there were non-significant effects for receptive vocabulary for children with primary and secondary LI and parent-implemented interventions did not significantly increase the expressive

vocabulary or global expressive language of children with ASD. These results should be interpreted with caution given the wide range in ages of children and focus of these particular interventions. For example, some studies (e.g., Baranek et al., 2015; Schertz et al., 2013) enrolled children who were young and may have not yet been talking. Studies that focused on increasing joint attention and social communicative behaviors to facilitate language learning in this population may have had limited short-term language effects.

What are the implications of results for future research? There is a continuing need for high quality studies examining the effects of parent-implemented language intervention. Very few studies have investigated the effects of parent-implemented interventions for children with secondary language impairment due to primary developmental disabilities excluding ASD. Additional research is needed with children at-risk for LI from low SES backgrounds to determine if parent-implemented intervention can improve long-term language development, reading, and school readiness. It is important that future studies describe and measure procedures for teaching parents and directly measure parent implementation of the language intervention. More research is needed to determine the extent to which parent training fidelity and parent implementation fidelity are associated with positive parent and child outcomes respectively. Future studies should include standardized direct assessment measures administered by blinded assessors to reduce the risk of bias. Studies should include measures of an appropriate range of language outcomes in order to evaluate impact of intervention across receptive and expressive vocabulary and receptive and expressive global language outcomes. Given the relatively poor effects of parent-implemented intervention on receptive vocabulary and receptive language, it is important to understand how parent-implemented interventions can be strengthened to improve these important aspects of language development.

Conclusions

Across populations and types of outcome measures, the pooled effect size estimates indicate a positive relationship between parent-implemented intervention and child expressive language outcomes. Additionally, the pooled effect size estimates indicate a positive relationship between parent-implemented intervention and expressive vocabulary for both interventions that taught specific strategies in a shared book reading context and interventions that taught parents more general language-facilitating strategies in the context of play/routines. Overall, these results support the use of both types of parent-implemented language interventions for improving expressive language outcomes for children with primary LI and at-risk for LI due to low SES. The effects for children with or at-risk for ASD were relatively smaller than outcomes for other populations, suggesting that parent-implemented intervention may have more limited effects on expressive language outcomes for this population. No identified studies examined the long-term effects of early language and communication intervention including parents. Although there is a substantive body of research on parent-implemented language interventions, relatively little is known about the extent of generalized and maintained effects of these interventions on parent and child behavior.

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Table 1. *Final search terms*

Inclusion Criteria	Corresponding Search Terms
Participants	(child* OR infant OR toddler) AND (parent or mother or caregiver)
Intervention	(facilitation or interaction or input or strategy or "communicative behavior" or "parent behavior" or "caregiver behavior" or "mother behavior")
Comparison	--
Outcome	(language or communicat* or vocabulary or "joint attention" or "joint engagement" or "verbal behavior"
Study Design	--

Table 2. Descriptive Statistics of Included Studies

Study	N 1434	Intervention Name	Intervention Context	Format of Training	Dosage			Mean Age	Age Range (Range) [SD]	% Minority	% Male	Population	Comparison Group	Average Parent Education	SES
					Weeks	Session minutes	Total Sessions								
Aldred et al., (2004)	28	Social Communication Intervention	Play/Routines	I	52	--	--	49.5	(24-71)	8.3	89.3	ASD	BAU	More than HS	MC
Baranek et al., (2015)	15	Adaptive Responsive Teaching	Play/Routines	B	24	--	36	15.4	(13-17) [1.4]	18.8	87.5	At risk ASD	BAU	More than HS	--
Boyce et al., (2010)	75	Storytelling for the Home Enrichment of Language and Literacy Skills	Shared Book Reading	I	--	--	--	41.4	[10.78]	--	56.0	At risk LI	BAU	HS or less	LC
Buschmann et al., (2008)	47	Heidelberg Parent Based Language Intervention	Shared Book Reading	G	12	--	8	24.7	[.9]	--	51.1	LI	W	HS or less	--
Casenhiser et al., (2013)	51	Social Communication Based Intervention	Play/Routines	I	52	120	52	44.5	(24-59) [8.75]	--	--	ASD	W	More than HS	MC
Chao et al., (2006)	41	Family Centered Intervention	Play/Routines	I	124	--	--	49.8	(36-60) [.69]	17.1	56.1	LI	W	--	--
Colmar (2011)	23	Book Reading Intervention	Shared Book Reading	I	16	60	1	59.5	(51-67)	--	73.9	At risk LI	W	--	LC
Crain-Thoreson & Dale (1999)	19	Dialogic Reading	Shared Book Reading	G	8	90	2	50.5	[8.71]	--	68.8	LI	BAU	HS or less	LC
Drew et al., (2002)	24	Social-Pragmatic Joint Attention Intervention	Play/Routines	I	52	180	8	22.5	[3.47]	--	79.2	ASD	BAU	--	--
Fey et al., (1993)	19	Focused Stimulation	Play/Routines	B	20	120	15	56.1	[6.8]	--	78.9	LI	W	More than HS	--
Fung et al., (2005)	19	Dialogic Reading	Shared Book Reading	I	8	20	1	86.7	[12.28]	--	63.2	HI	BAU	--	--
Garcia et al., (2014)	46	Parent Child Interaction Therapy	Play/Routines	--	52	--	--	45.1	[14.4] (20-70)	18	76.1	At risk LI	W	--	--

Girolametto et al., (1996)	25	Hanen More Than Words	Play/Routines	B	11	150	11	28.7	[3] (23-35)	--	--	LI	W	More than HS	MC
Guttentag et al., (2014)	225	My Baby & Me	Play/Routines	I	130	90	55	--	--	88.1	--	At risk LI	BAU	HS or less	LC
Hardan et al., (2014)	48	Pivotal Response Treatment	Play/Routines	B	12	75	12	49.2		NR	77.3	ASD	PE	More than HS	--
Huebner (2000)	115	Dialogic Reading	Shared Book Reading	G	6	60	2	28.7	[3.32]	19	61.2	TD	BAU	More than HS	MC
Kasari et al., (2014)	66	Parental Responsiveness Intervention	Play/Routines	I	12	90	12	22.4	[3.8]	53.1	78.8	At risk ASD	PE	More than HS	MC
Lonigan & Whitehurst (1998)	43	Dialogic Reading	Shared Book Reading	G	6	30	2	44.7	[6.12]	91.2	46.2	At risk LI	W	--	LC
Pile et al., (2010)	36	Shared Book Reading	Shared Book Reading	B	9	75	8	53.2	[3.95] (46-61)	NR	61.1	LI	W	More than HS	--
Roberts et al., (2012)	34	Enhanced Milieu Teaching	Play/Routines	I	12	60	28	30.9	[4.75]	20.6	79.4	LI	BAU	More than HS	MC
Schertz et al., (2013)	23	Joint Attention Mediated Learning	Play/Routines	I	7	--	16	26.1	[3.57]	NR	NR	ASD	BAU	More than HS	--
Sheridan et al., (2011)	217	Getting Reading Intervention	Play/Routines	I	104	60	-	43.1	(35.9-52.6) [3.57]	68.4	51.2	At risk LI	BAU	More than HS	LC
Siller et al., (2013)	64	Focused Playtime Intervention	Play/Routines	I	12	90	12	57.1	(32-82) [12.38]	72.2	94.4	At risk ASD	PE	More than HS	LC/MC
Solomon et al., (2014)	99	Play and Language for Autistic Youngsters	Play/Routines	I	52	180	12	50.2	(32-72) [10.26]	31	81.9	ASD	BAU	More than HS	--
Tannock et al., (1992)	32	Hanen More Than Words	Play/Routines	B	12	--	12	35.0	--	NR	53.1	DD	W	More than HS	--

Note. --=not reported. Intervention: Format of Training: I=Individual, G=Group, B=Both. Average Parent Education: More than HS=majority of sample had more than a high school education. HS or less=majority of sample had a high school education or less. Population: LI=language impairment, ASD=autism spectrum disorder, DD=developmental delay, TD=typical delay, HI=hearing impairment. SES: LC=primarily lower-class sample, MC=primarily middle class sample, LC/MC=mixed lower and middle-class sample. Comparison Group: BAU=business as usual, W=waitlist control group, PE=minimal parent education provided.

Table 3. *Summary level statistics of included studies*

Participant Characteristics	N	%
Population		
Identified Language Impairment	7	28%
At-risk Language Impairment	6	24%
Autism Spectrum Disorder	6	24%
At-risk Autism Spectrum Disorder	3	12%
Developmental Delay	1	4%
Hearing Impairment	1	4 %
Typically Developing	1	4%
Average Parent Education		
More than HS	15	60%
HS or less	4	16%
Not Reported	6	24%
Mean Child Age (years)		
0-3	9	36%
3-5	14	56%
5-8	1	4%
Not Reported	1	4%

Table 4. *Risk of Bias Factors in Included Studies*

Study	Type of Measure (Child Expressive Vocabulary)	Type of Measure (Child Expressive Language)	Blinding of Assessor	Was Fidelity of Training Reported?	Was Fidelity of Training Quantified?	Was Fidelity of Parent Implementation Reported?	Was Fidelity of Parent Implementation Quantified?
Aldred et al., (2004)	Parent Report	--	No	No	No	No	No
Baranek et al., (2015)	--	Standard	Yes	Yes	Yes	Yes	Yes
Boyce et al., (2010)	Observational	--	Yes	Yes	No	Yes	No
Buschmann et al., (2008)	Parent Report	Standard	Yes	No	No	No	No
Casenhiser et al., (2013)	--	Standard	Yes	No	No	No	No
Chao et al., (2006)	--	Standard	No	No	No	No	No
Colmar, (2011)	--	Standard	No	No	No	No	No
Crain-Thoreson & Dale, (1999)	Standard	--	No	No	No	No	No
Drew et al., (2002)	Parent Report	--	No	No	No	No	No
Fey et al., (1993)	--	Observational	No	No	No	No	No
Fung et al., (2005)	--	--	No	No	No	No	No
Garcia et al., (2014)	--	--	No	No	No	No	No
Girolametto et al., (1996)	Observational	--	No	No	No	Yes	Yes
Guttentag et al., (2014)	--	--	Yes	No	No	No	No
Hardan et al., (2014)	Parent Report	Standard	No	No	No	Yes	No
Huebner, (2000)	Standard	--	No	No	No	No	No
Kasari et al., (2014)	--	Standard	No	Yes	Yes	No	No
Lonigan & Whitehurst, (1998)	Standard	--	No	No	No	No	No
Pile et al., (2010)	Observational	--	Yes	Yes	Yes	Yes	Yes
Roberts & Kaiser, (2012)	Observational	Standard	No	Yes	Yes	Yes	Yes
Schertz et al., (2013)	--	Standard	No	Yes	Yes	Yes	Yes
Sheridan et al., (2011)	--	Standard	No	Yes	Yes	No	No
Siller et al., (2013)	--	Standard	Yes	Yes	Yes	No	No
Solomon et al., (2014)	Parent Report	Standard	Yes	Yes	Yes	No	No
Tannock et al., (1992)	Observational	--	Yes	No	No	No	No

Table 5. *Parent Outcome Measures*

Study	Variable name	Type of Measure	Measurement Context (Measure)
Aldred et al., (2004)	Parent synchrony* Parent asynchrony Parent communication acts Parent shared attention	Observational	Parent-child interaction
Boyce et al., (2010)	Maternal Elicitation Language and literacy in the home environment	Observational	Parent-child interaction (HOME: Language and Literacy subscale)
Casenhiser et al., (2013)	Co-regulation, expression of enjoyment, sensory motor support, joining, use of affect, support of reciprocity, and support of independent thinking	Observational	Parent-child interaction
Crain-Thoreson & Dale, (1999)	Verbatim book reading Statements Questions Expansions Praise or encouragement Providing sufficient time for child response	Observational	Parent-child interaction
Garcia et al., (2014)	"Do skills": behavior descriptions, reflections, and praises	Observational	Parent-child interaction
Guttentag et al., (2014)	Positive affect Warmth Contingent responsiveness* Physical intrusiveness Negativity Demonstrating/physical teaching Quality of verbal stimulation Verbal scaffolding	Observational	Parent-child interaction (Landry Parent-Child Interaction Scales)
Huebner, (2000)	Dialogic reading Behaviors to minimize	Observational	Parent-child interaction
Kasari et al., (2014)	Percent responsivity* % play acts parent ignored % play acts parents directed	Observational	Parent-child interaction

Pile et al., (2010)	# parent print concepts ratio of parent to child utterance # parent book reading strategies	Observational	Parent-child interaction
Roberts & Kaiser (2012)	Matched turns Responsiveness* Target talk Expansions Time Delays Prompting	Observational	Parent-child interaction
Schertz et al., (2013)	Focusing on faces Turn-taking Responding to JA Initiating JA	Observational	Parent-child interaction (Precursors of Joint Attention Measure)
Siller et al., (2013)	Maternal Synchronization	Observational	Parent-child interaction
Solomon et al., (2014)	Responsive/child oriented Affect/animation Achievement orientation Directive	Observational	Parent Child Interaction (Maternal Behavior Rating Scale)
Tannock et al., (1992)	Turn-taking Responsive labels* Comment Directiveness	Observational	Parent-child interaction

Note. *Studies included in the meta-analysis for parent contingent responsivity outcome. HOME=Home observation for measurement of the environment.

Table 6. Pooled Effect Sizes for Subgroup Analysis by Etiology

Outcome	Number of studies	Overall Pooled Effect size	ASD Pooled Effect Size	LI Pooled Effect Size	I^2
Expressive Vocabulary	7	0.50*	0.48	0.78*	70.5%
Expressive Language	11	0.19*	0.12	0.66*	1.3%
Parent Responsivity	5	1.28*	1.82*	1.19*	88.8%

Note. *Significant at p<.05. ASD=Autism Spectrum Disorder. LI=Language Impairment.

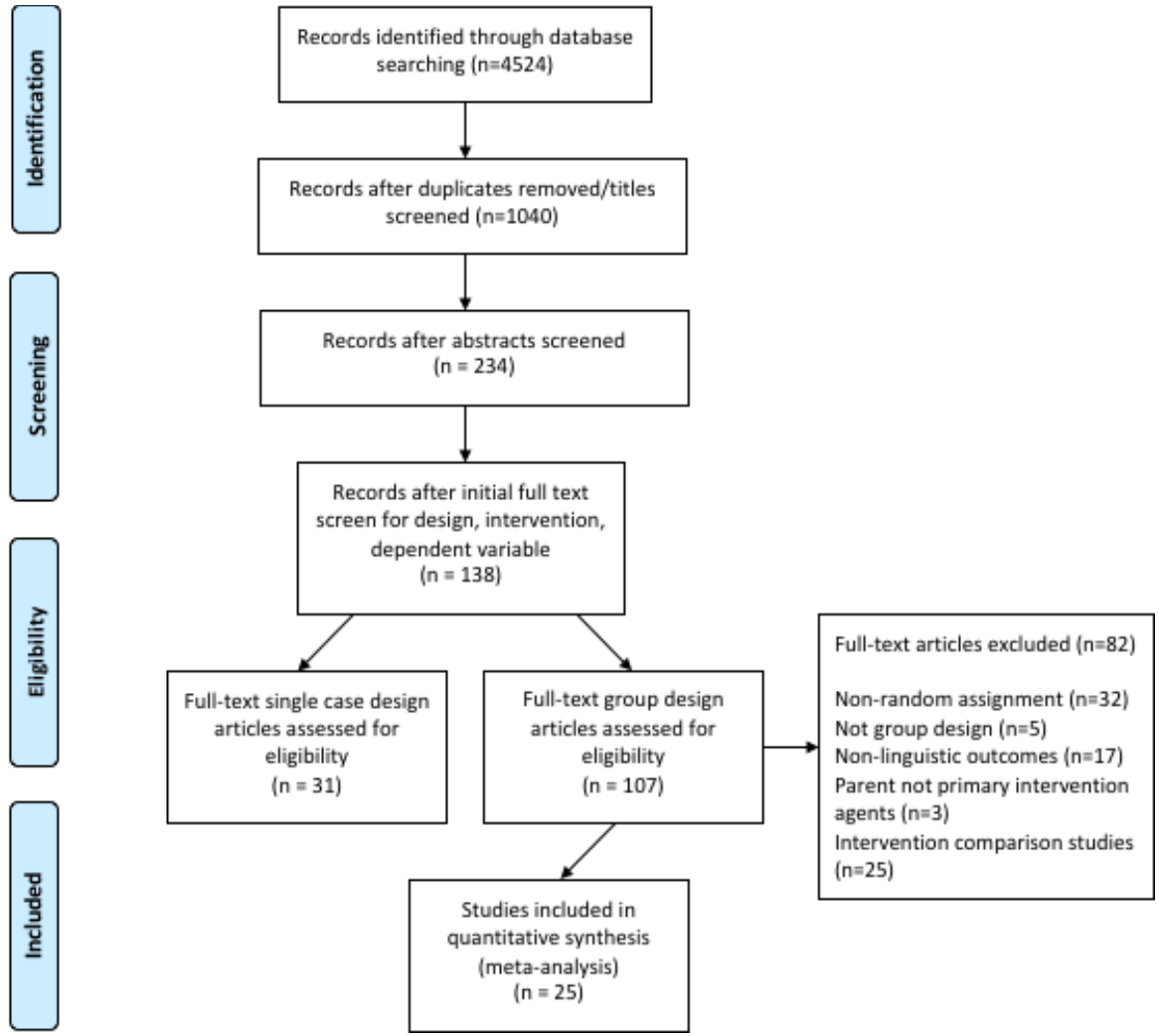

Figure 1. PRISMA Chart of Included Studies

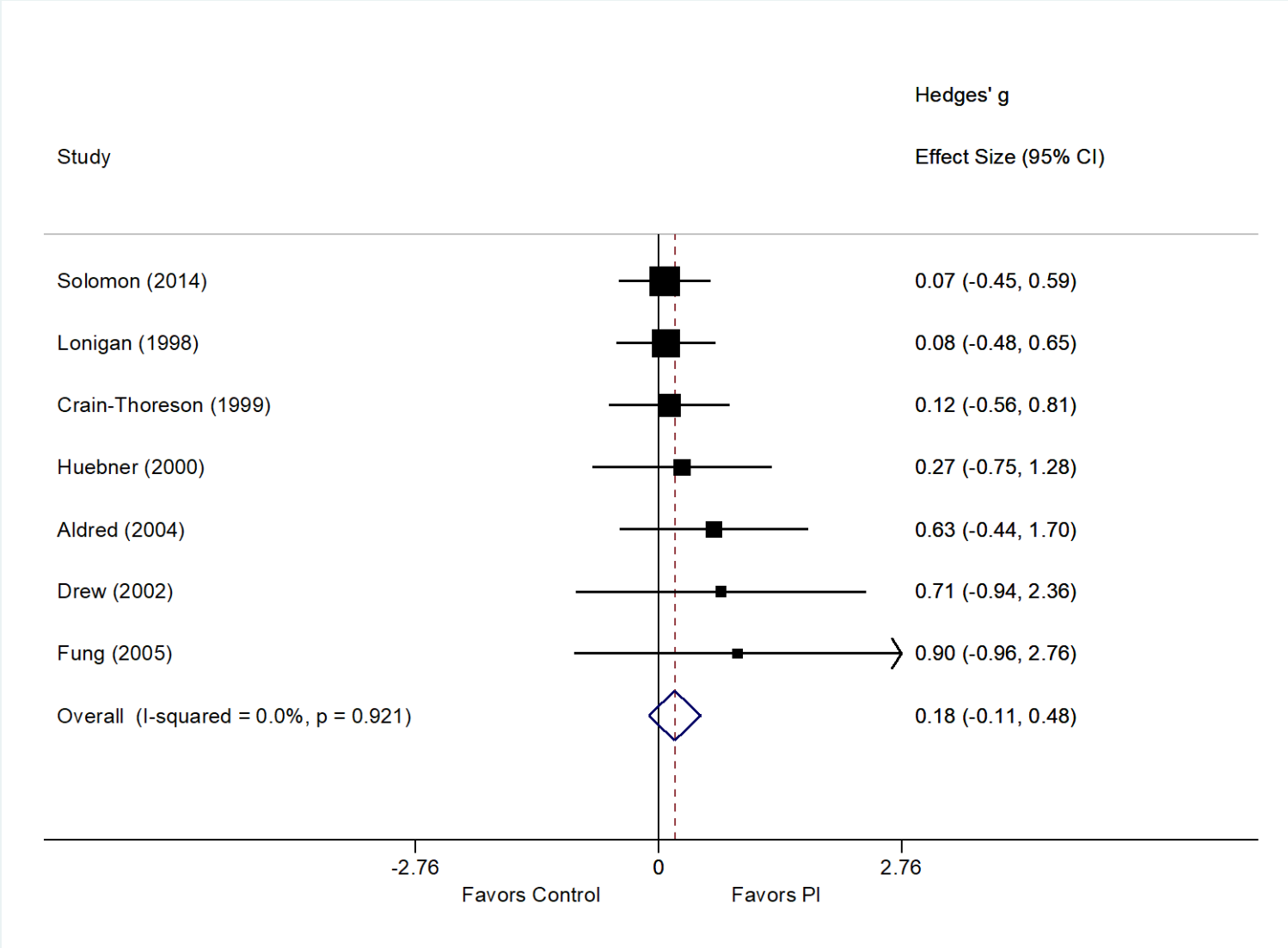

Figure 2. Forest plot of random effects meta-analysis for child receptive vocabulary

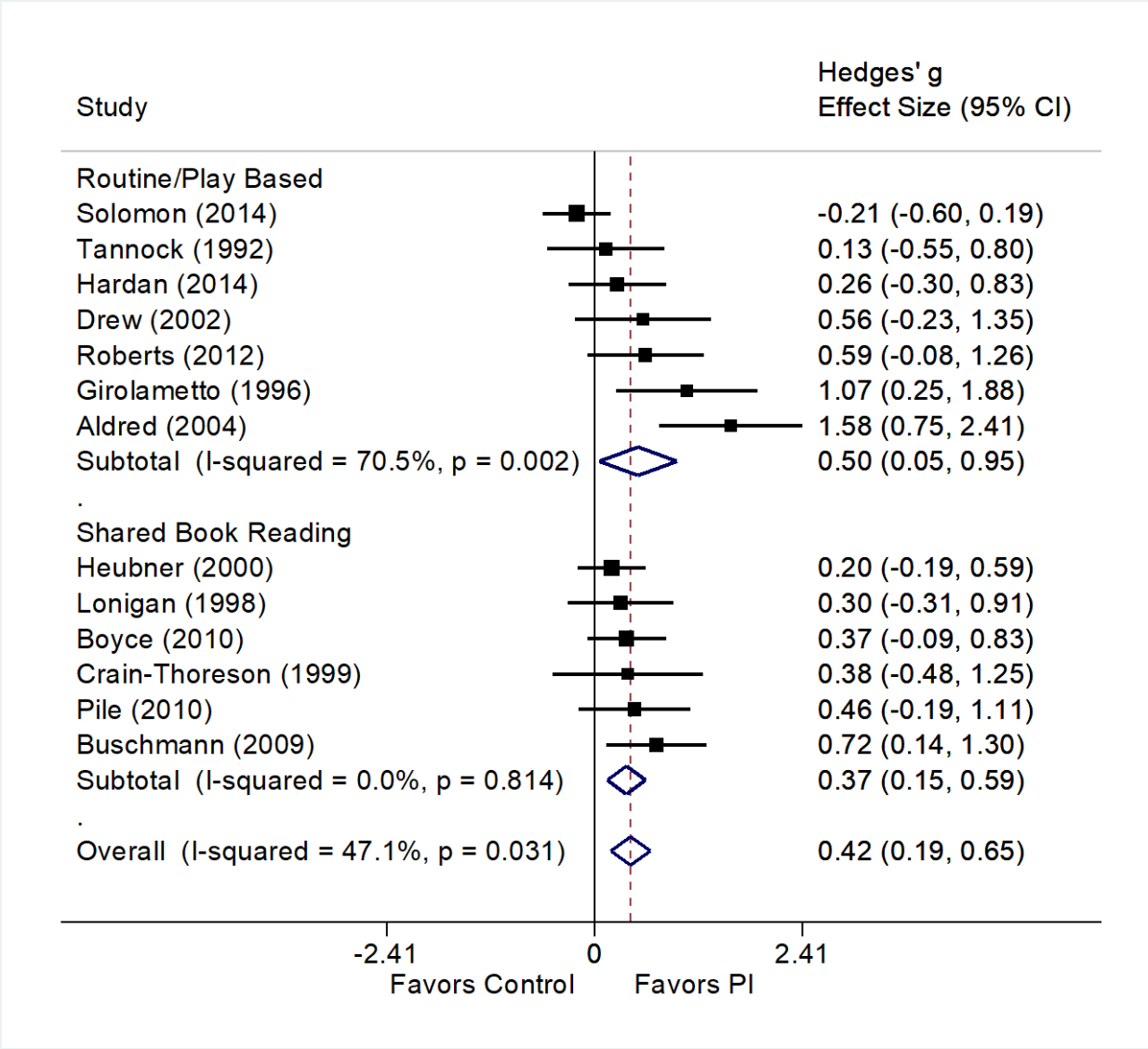

Figure 3. Forest plot of random effects meta-analysis for child expressive vocabulary

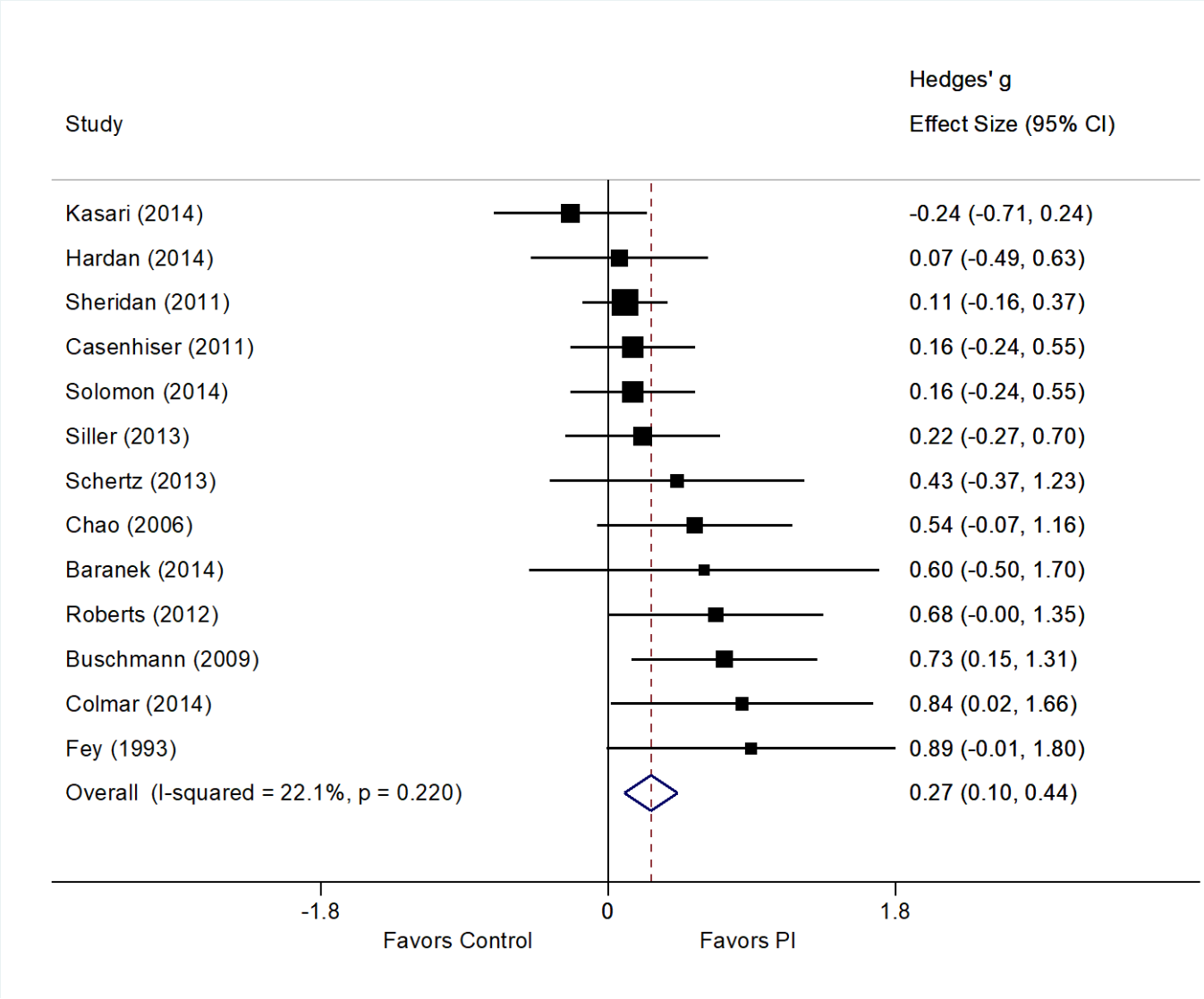

Figure 4. Forest plot of random effects meta-analysis for child expressive language

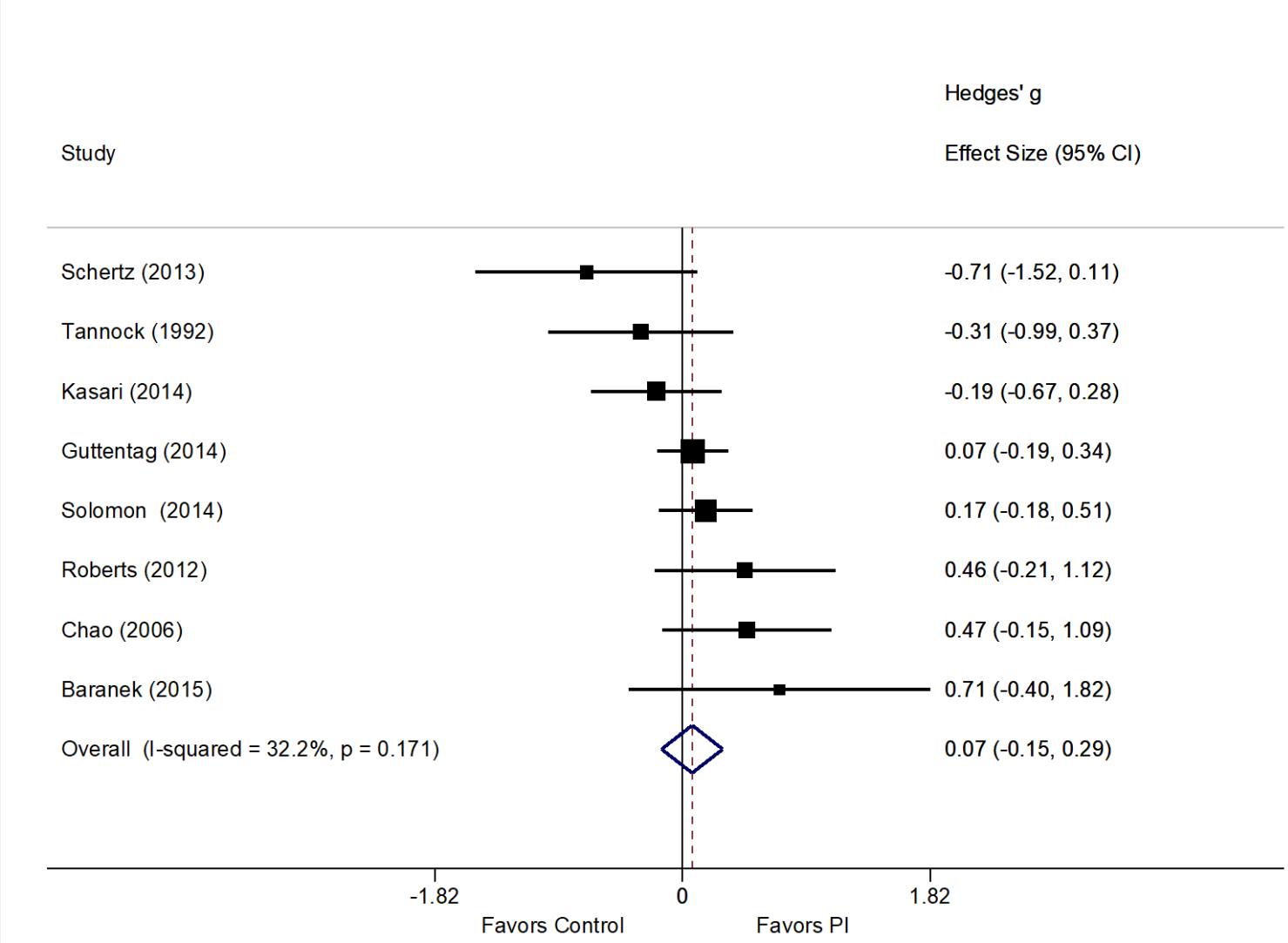

Figure 5. Forest plot of random effects meta-analysis for child receptive language

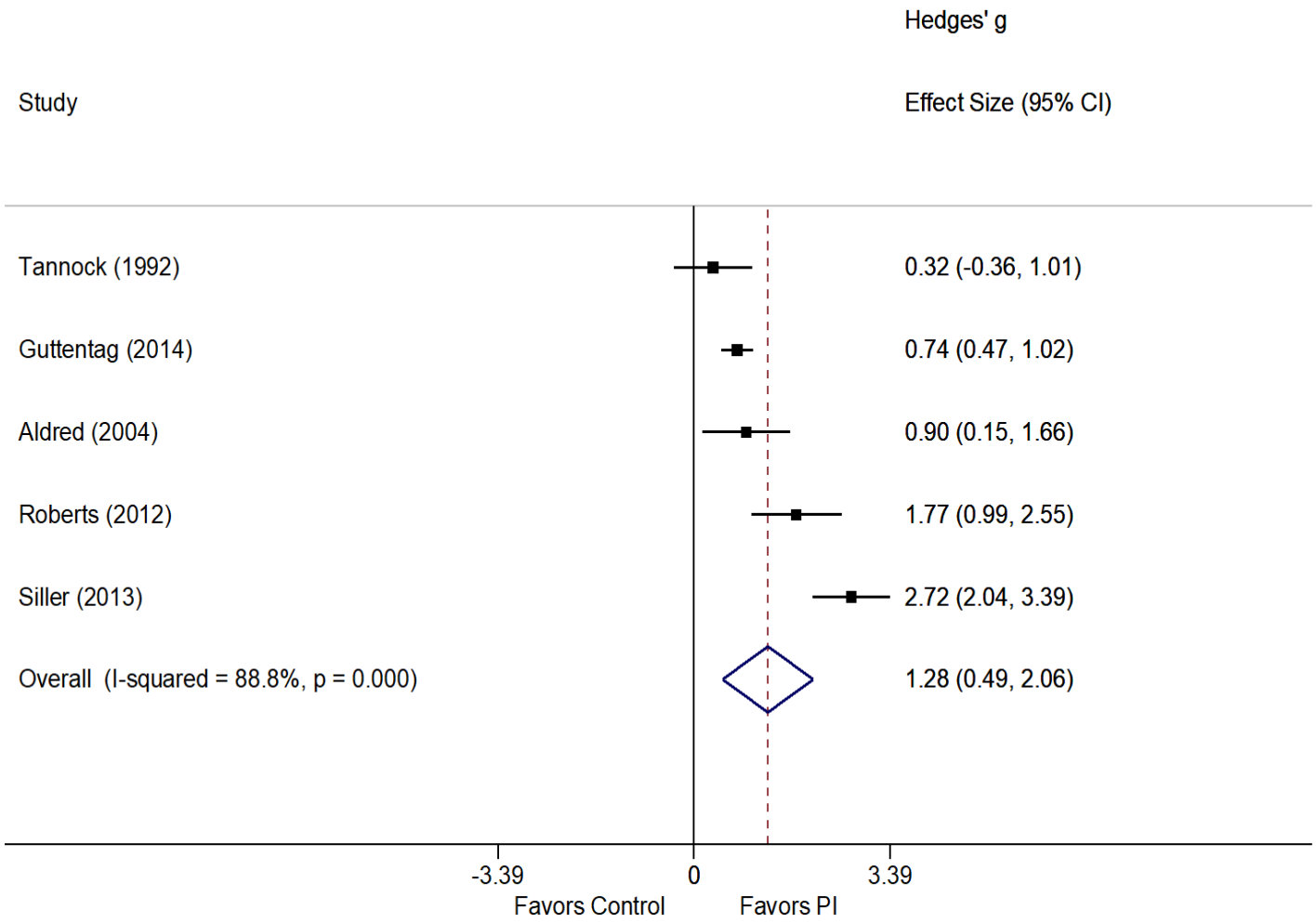

Figure 6. Forest plot of random effects meta-analysis for parent contingent responsivity

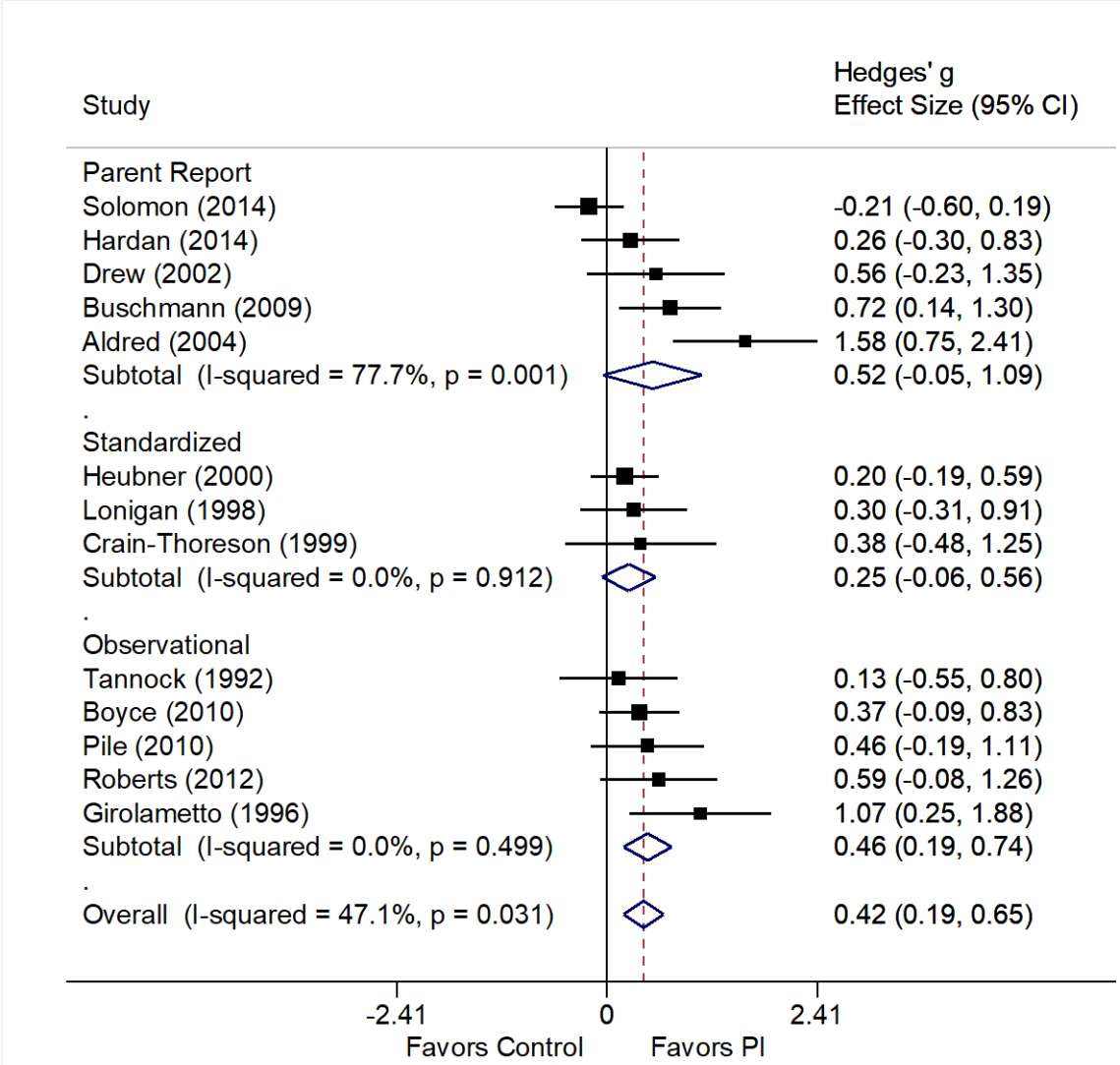

Figure 7. Forest plot of sensitivity analysis by measure type for expressive vocabulary

Appendix A
Funnel Plots Examining Potential Publication Bias

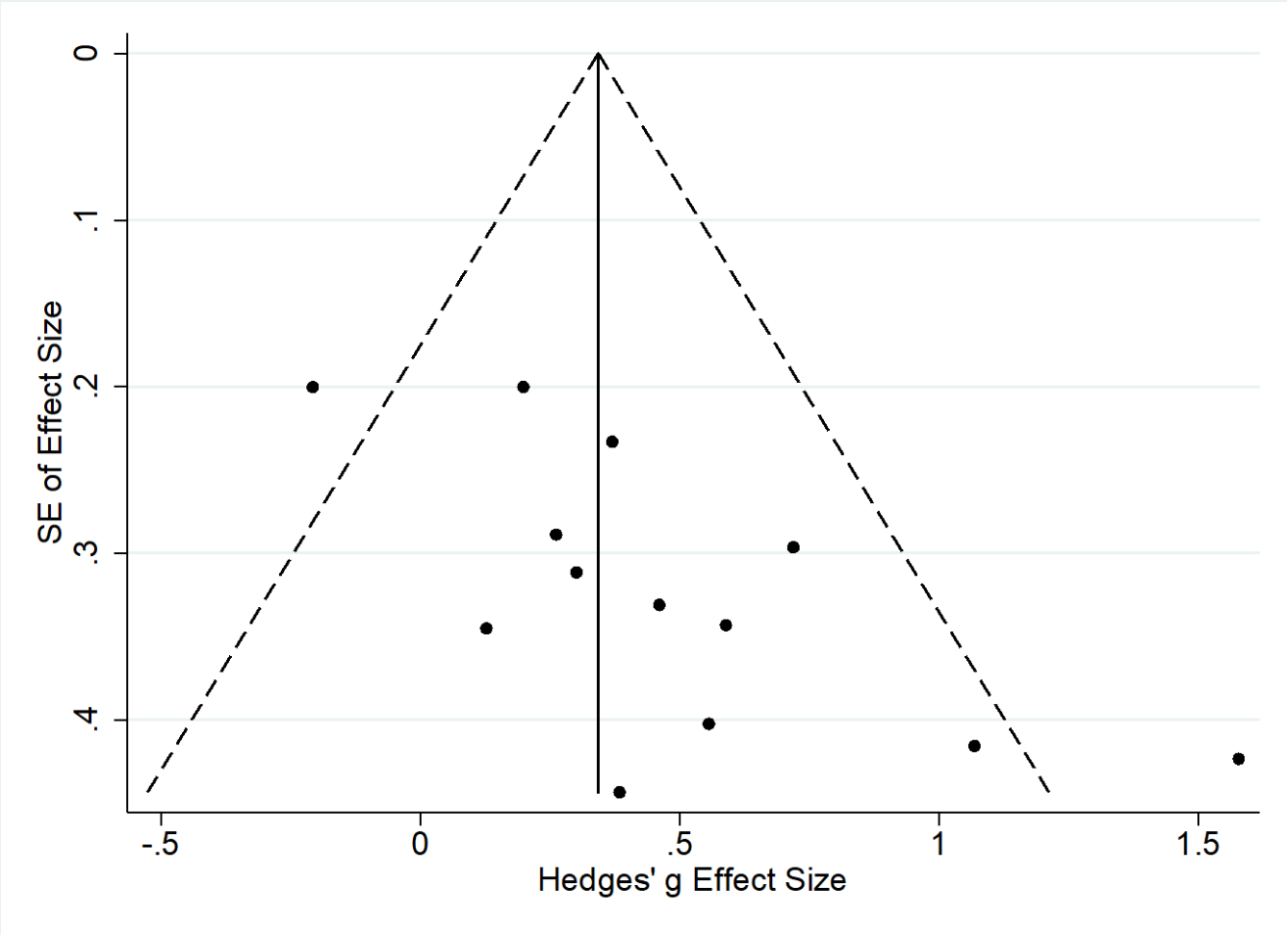

Figure 8. Funnel plot used to examine potential bias for child expressive vocabulary effect sizes

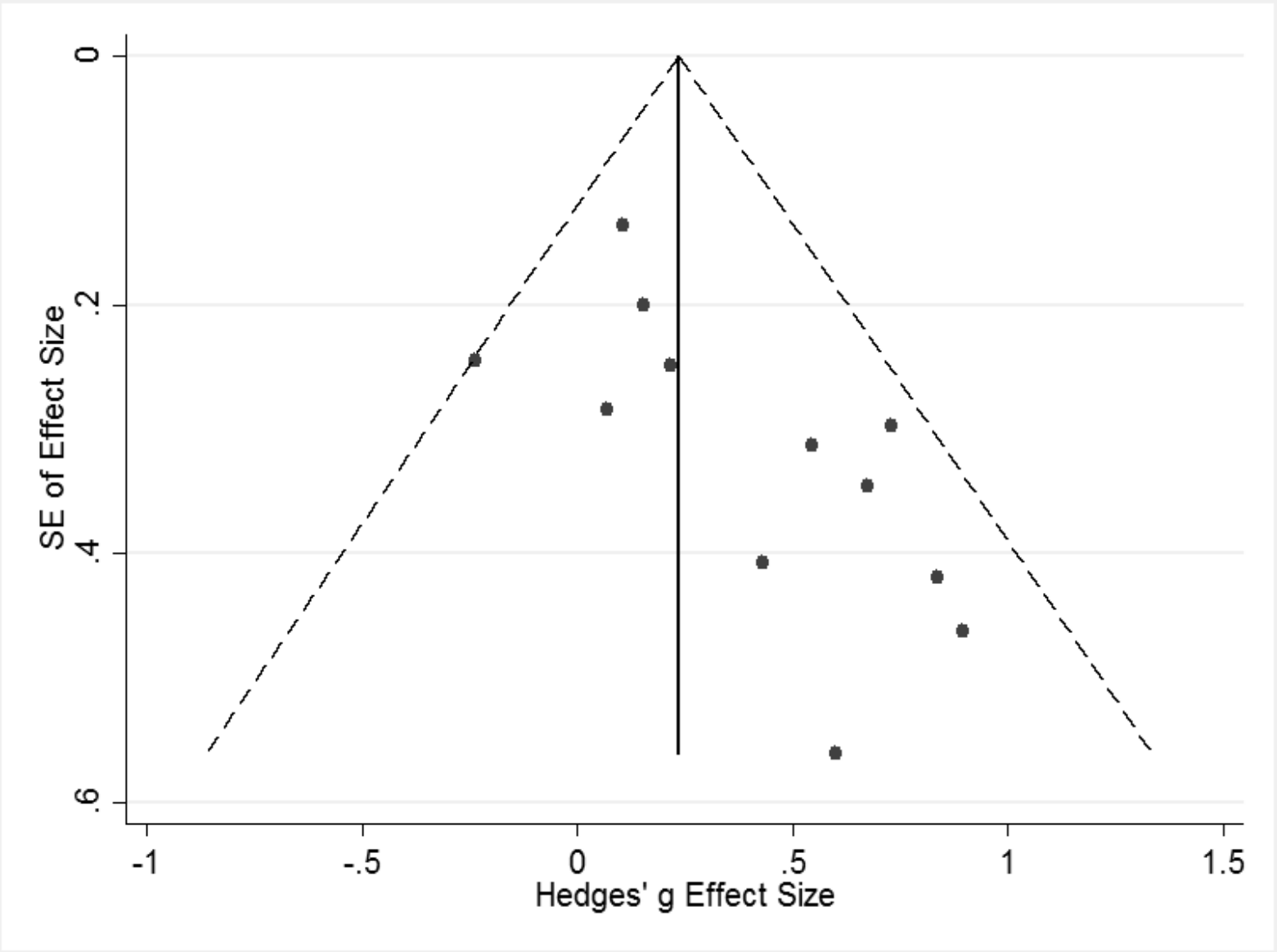

Figure 9. Funnel plot used to example potential bias for child expressive language effect sizes

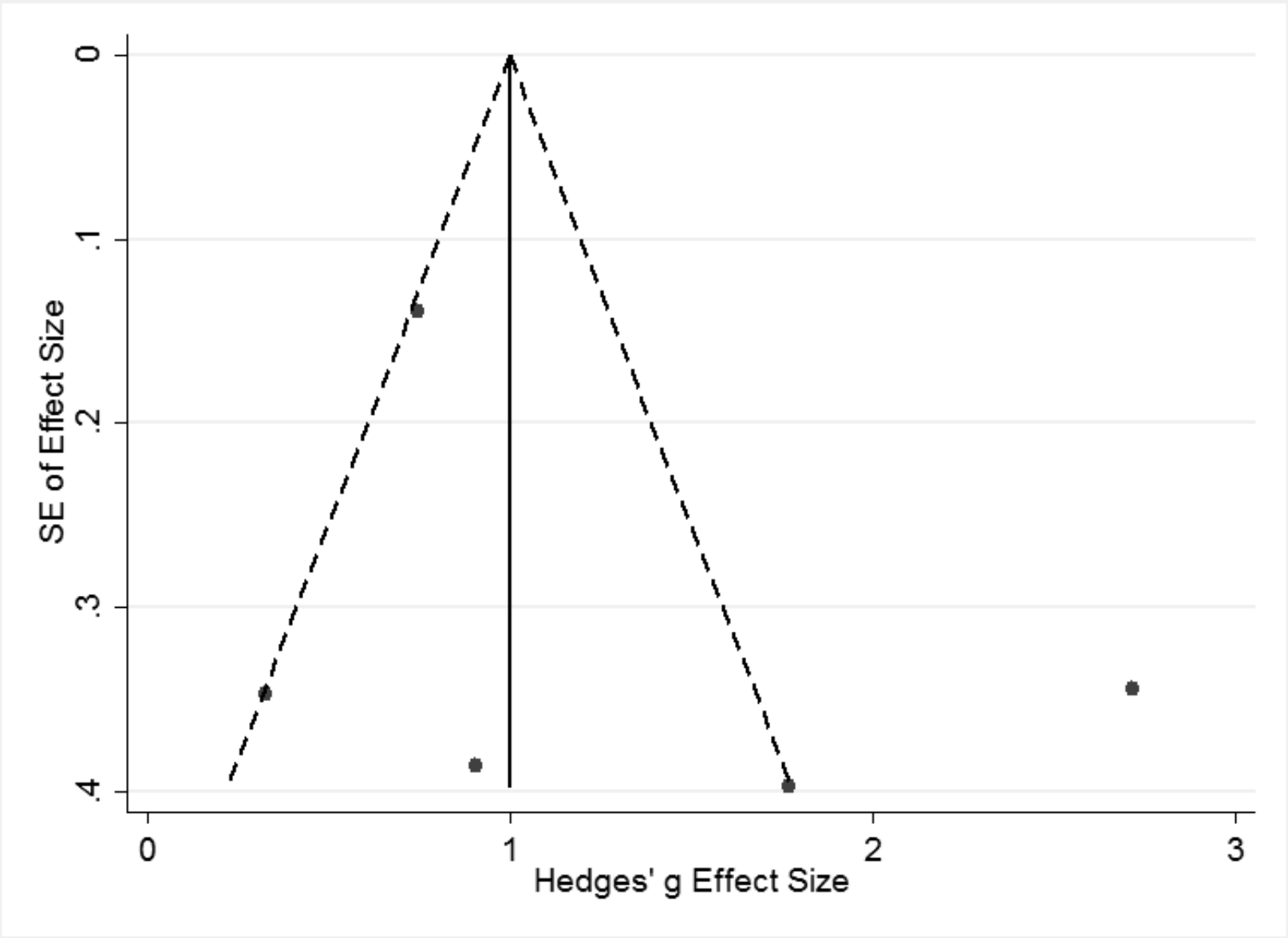

Figure 10. Funnel plot used to examine potential bias for parent contingent responsivity effect sizes

Appendix B
Trim and Fill Funnel Plots Examining Potential Publication Bias

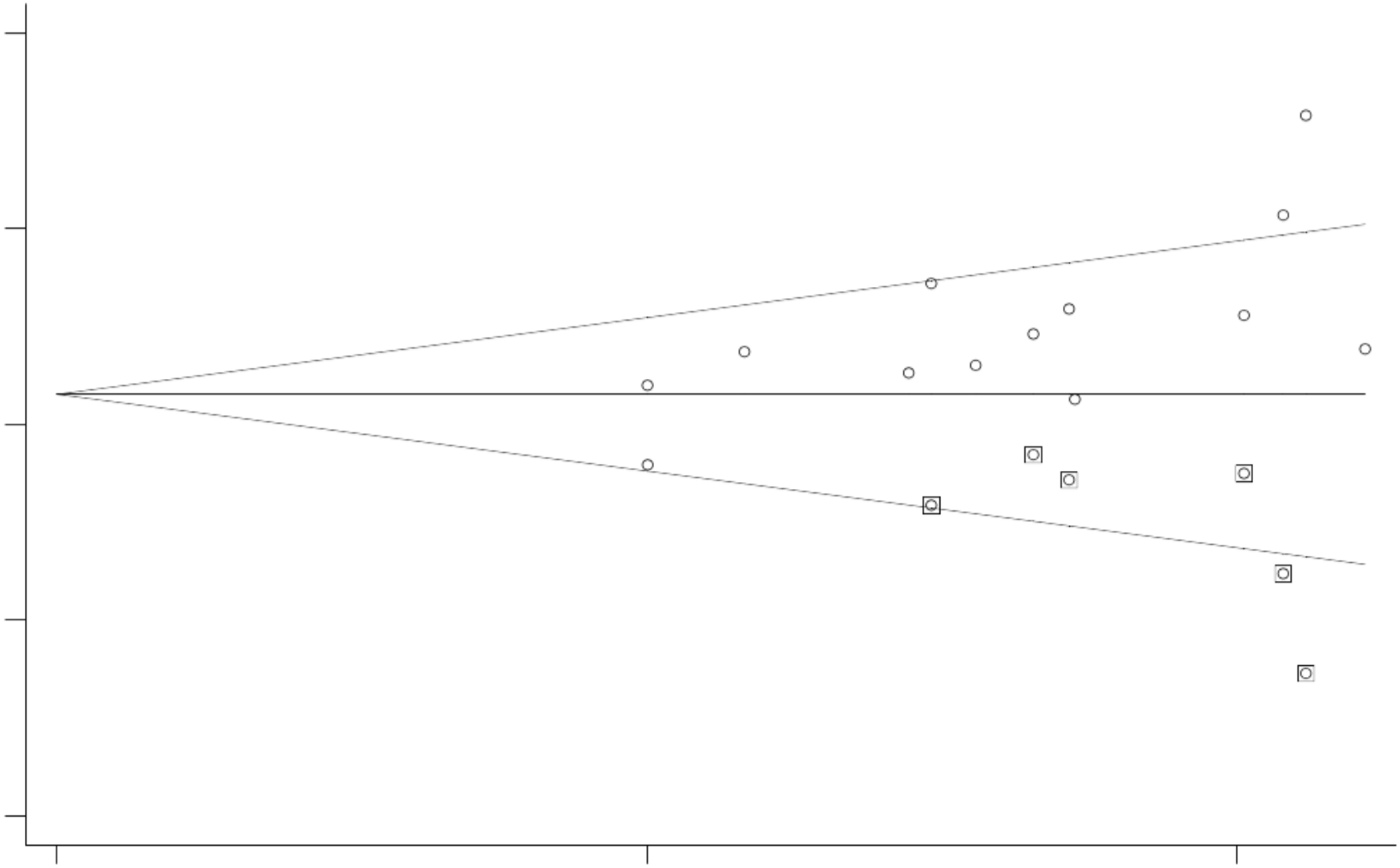

Figure 11. Trim and filled funnel plot for child expressive vocabulary

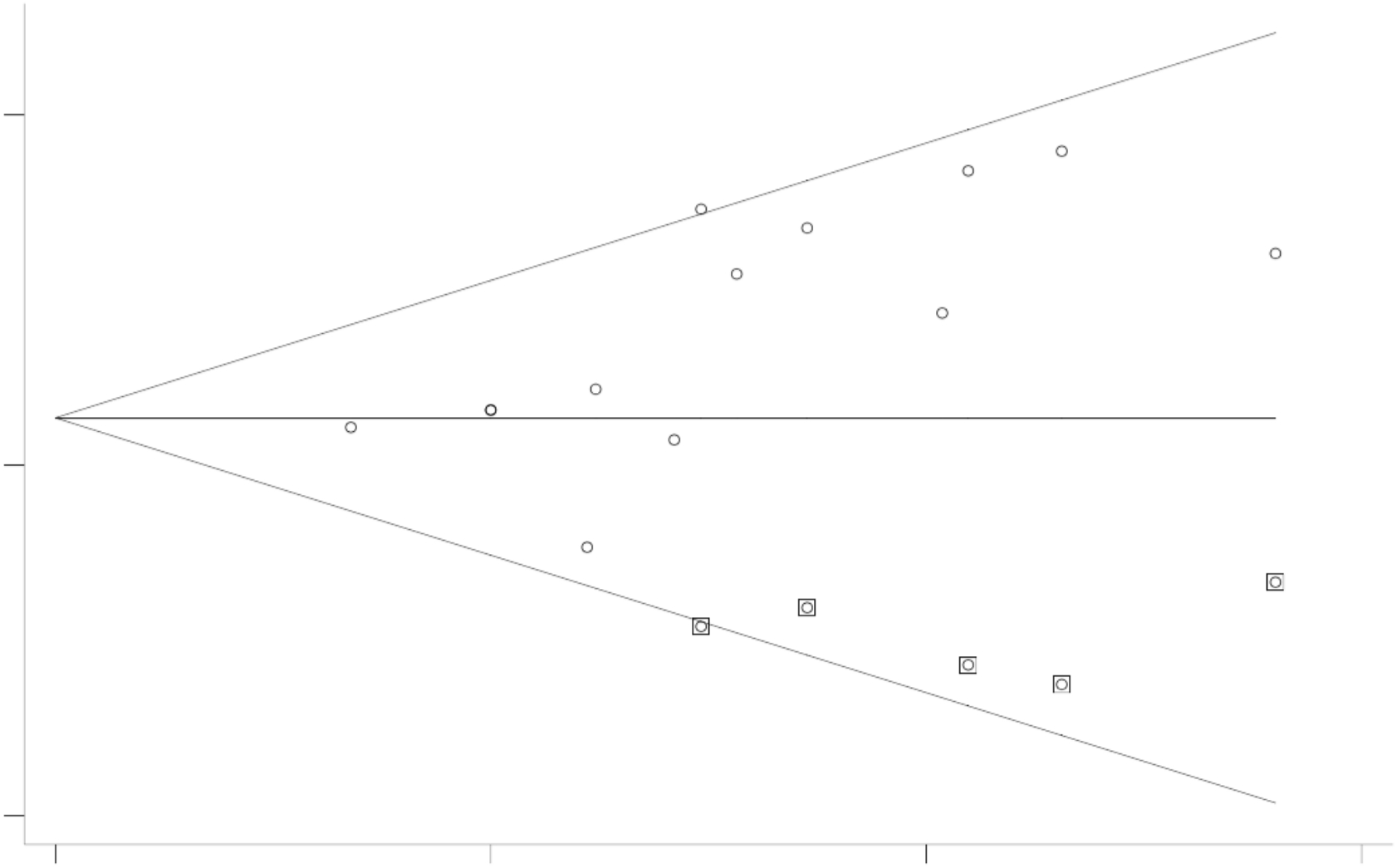

Figure 12. Trim and filled funnel plot for child expressive language

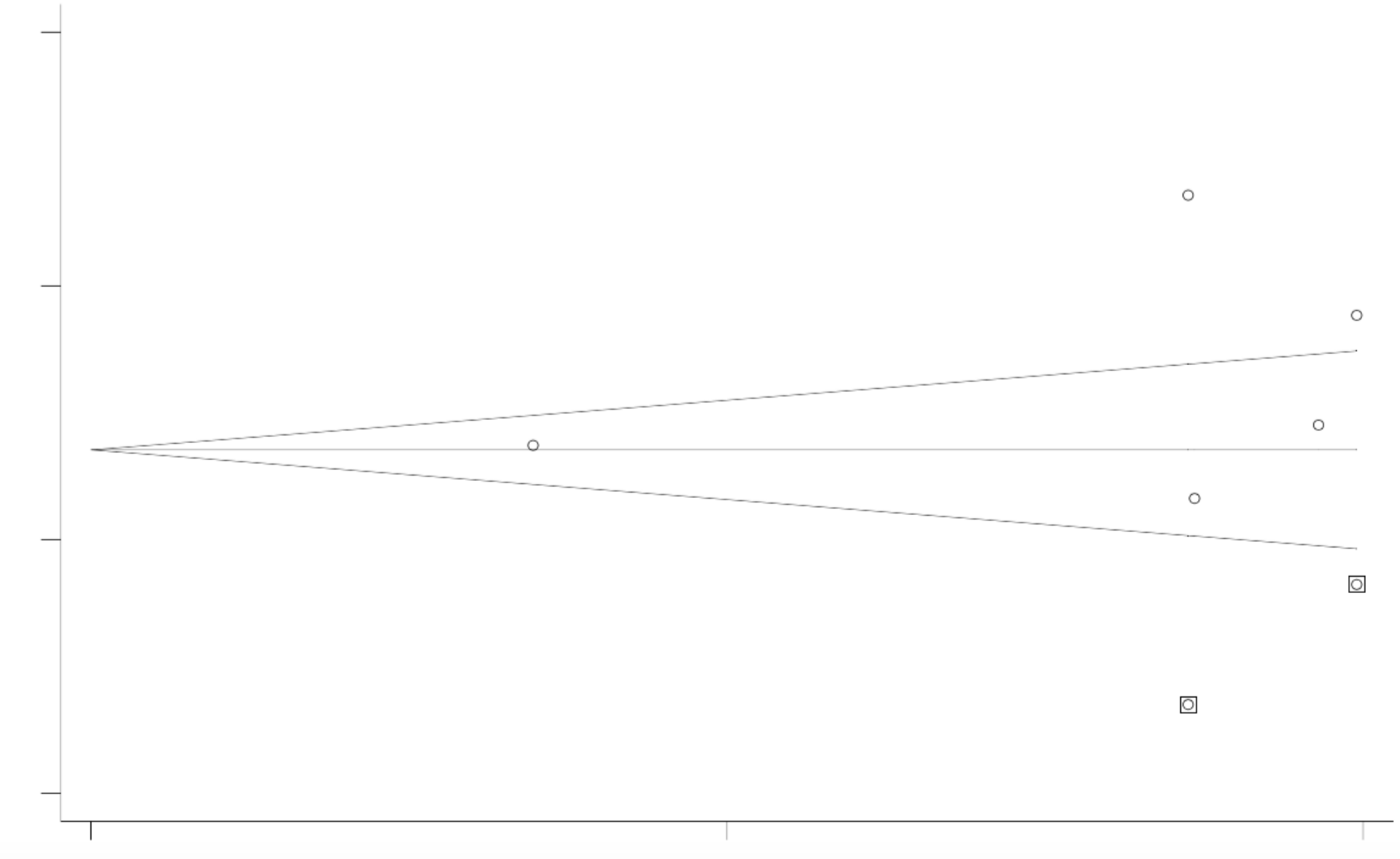

Figure 13. Trim and filled funnel plot for parent contingent responsivity