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Effects of Parent-Implemented Interventions on Outcomes for Children With Autism: A Meta-Analysis

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ABSTRACT

Effects of Parent-Implemented Interventions on Outcomes for Children With Autism: A Meta-Analysis

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Parent-implemented interventions (PIIs) can be useful in promoting parents' knowledge of autism spectrum disorder (ASD) and in transferring necessary skills to children with ASD. Individuals with ASD can directly and indirectly benefit from PIIs in terms of academics, ASD symptom severity, behavior improvement, cognition, communication, and social skills. Many studies have explored the efficacy of PIIs; however, they have tended to report mixed effects. Previous meta-analyses and systematic reviews have been characterized by limited search terms and literature search procedures, emphases on published manuscripts, dependency on parent reports, dated findings, and comparisons across of different types of control groups. This study attempts to improve on the methodology of prior meta-analyses and to update findings of the effectiveness of PIIs for children and youth with ASD. We located 1925 studies at initial manuscript search in 9 databases. After additional search from other sources, 43 studies met the inclusion criteria. Studies with same participants were merged that yield 40 records for final data coding. Eligible studies coded in Dyches et al.'s meta-analysis (2018) combined with current data resulted in 53 randomized controlled trials for data analysis. The random effects model meta-analysis found a moderate and statistically significant effect ($g = 0.55$, 95% CI 0.35 to 0.65, $p < 0.00001$) on overall weighted effect size across 53 studies included. PIIs can improve child outcomes in positive behavior/social skill ($g = 0.603$), maladaptive behavior ($g = 0.519$), adaptive behavior/life skills ($g = 0.239$), and language/communication ($g = 0.545$). These findings are inconclusive and should be interpreted with caution, especially adaptive behavior/life skill because only six studies reported outcomes on that variable. No moderating variables were identified in post hoc random effects weighted analyses. Implications for future research are discussed.

Keywords: parent-implemented intervention, program implementation, autism, meta-analysis, randomized control trials

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

DESCRIPTION OF THESIS STRUCTURE AND CONTENT

This thesis, *Effects of Parent-Implemented Interventions on Outcomes for Children With Autism: A Meta-Analysis*, follows a hybrid, or "journal-ready" format. This format combines traditional thesis requirements with journal publication formats.

The preliminary pages reflect requirements for submission to Brigham Young University. The thesis report is presented as a journal article and conforms to length and style requirements for submitting research manuscripts to journals in the field of education and family studies.

The literature review is included in an appendix. This thesis format contains two reference lists. The first reference list contains references included in the journal-ready article. The second list includes all citations found in the appendix.

Introduction

Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterized by deficits in "social communication and social interaction across multiple contexts, and restricted, repetitive patterns of behavior, interests, or activities" (American Psychiatric Association, 2013, p. 50). The term *spectrum* refers to the wide range of disability levels in functioning (from low to high functioning), skills, and symptoms. Individuals with ASD may engage in a range of problem behaviors, including impulsivity, hyperactivity, aggression, noncompliance with tasks and demands, self-injury, and/or tantrums (Lecavalier, 2006). These behaviors lead to potential issues in academic performance, skills acquisition, parental mental health, and quality of life (Dabrowska & Pisula, 2010; Williams et al., 2006). Males tend to have a higher prevalence than females, approximately four times higher (Sandbank et al., 2020), and symptoms may appear in children as young as the first year of life (Tanner & Dounavi, 2020).

To facilitate optimal developmental outcomes in cognition, adaptive behaviors, and communication, researchers suggest targeting the earliest noticeable symptoms of ASD (e.g., Koegel et al., 2014; Nahmias et al., 2019; Reichow, 2011; Sandbank et al., 2020; Warren et al., 2011). These interventions tend to be intensive (e.g., 25-40 hours per week, one-to-one adult to child ratio, for over a year or longer). However, obtaining intensive intervention for children with ASD can prove challenging for many parents due to costs, limitations of time, travel distance, access to appropriate services, time on waitlists, and insurance coverage (Buescher et al., 2014; Nevill et al., 2016; Symon, 2001). Recognition of the struggles and limitations of the families with children with ASD are facing, the interests in looking for alternatives to offset these obstacles have increased among researchers (Cidav et al., 2017; Hatcher & Page, 2020; Lee et al., 2018; Meadan et al., 2016).

Numerous studies have been conducted on the effects of PIIs on the outcomes of children with various developmental disabilities (DD) in children. Prior meta-analyses have typically reported mild effects of using PIIs in promoting the development of children and youth with DD (Nevil et al., 2016). Nevertheless, the results are variable; some individual studies indicate that PIIs have positive child outcomes, while others have suggested the opposite. Scholars had supported PIIs as a ASD evidence-based practice (EBP) in recent research (Dawson-Squibb et al., 2020; Steinbrenner et al., 2020). Two manualized interventions, Project ImPACT (Ingersoll & Dvortcsak, 2019) and Stepping Stone/Triple P (Turner et al., 2010), fall into this category (Steinbrenner et al., 2020). Even though these two interventions were classified as EBP, there are not enough details to make conclusions regarding the potency of PIIs. Therefore, there is a need for additional information to understand under what circumstances PIIs are effective or less effective than professional interventions for children with ASD.

A few methodological limitations have characterized prior meta-analytic reviews of child outcomes following PIIs. First, previous results have often been based on parent-report measures, but parents' ratings may bias study findings. It is necessary to compare parent ratings with teachers' or interventionists' ratings to have a more objective conclusion on PIIs' effectiveness. Second, studies included in these meta-analyses use different types of control groups, with some using waitlist control groups and other studies using active controls or treatment equivalent control groups. These differences should be evaluated with an updated meta-analytic review. Third, some previous meta-analyses' findings have been based on limited sources due to incomplete search terms and the inclusion of only published articles. Fourth, some prior meta-analyses have included single group designs and quasi-experimental designs that may be susceptible to research bias. Hence, this study carried out an updated meta-analytic review of

randomized controlled trials (RCTs) using comprehensive search terms to obtain up-to-date research findings specific to ASD that go beyond prior meta-analyses.

Based upon the trends in the extant literature, this study aims to answer the following questions:

1. To what extent are Parent-Implemented Interventions effective in treating ASD?
2. To what extent do study characteristics (e.g., control group, source of data), intervention characteristics (e.g., number of sessions), and participant characteristics (e.g., age, gender) moderate the effectiveness of PIIs?

Method

This meta-analysis is an update of the previous meta-analysis published in 2018 (Dyches et al.). Dyches et al.'s meta-analysis focus on PIIs for children with various developmental disabilities, including ASD. Since this meta-analysis focuses on children diagnosed with ASD, autism, Asperger Disorder, or Pervasive Developmental Disorder – Not Otherwise Specified (PDD-NOS), previously coded studies were screened based on the inclusion criteria of the current meta-analysis. The effect sizes of the eligible previously coded studies were re-evaluated to ensure accuracy. Studies coded in the following previously published meta-analyses were also located: Aldred et al. (2004), Carter et al. (2011), Frankel et al. (2010), Jocelyn et al. (1998), Kasari et al. (2010), Roberts et al. (2011), Sofronoff et al. (2004), Sofronoff et al. (2007), Solomon et al. (2008), and Wong and Kwan (2010). Data from those meta-analyses and the Dyches et al. meta-analysis were merged with the current data set for a complete analysis of the PIIs of children with ASD.

Manuscript Search

We conducted substantial manuscript searches to acquire published and unpublished studies (i.e., journal articles, conference posters, presentations, book chapters, doctoral dissertations, and master's theses) of interventions involving parents as interventionists for children with ASD. We searched in nine electronic databases for studies written in English between 2012-2020: Academic Search Premier, Education Resources Information Center (ERIC), Excerpta Medica Academic Search Premier, Education Resources Information Center (ERIC), Excerpta Medica database (EMBASE), Medline, American Psychological Association PsychINFO, Social Sciences Abstracts, and Cumulative Index to Nursing and Allied Health Literature (CINAHL). Additional searches were conducted by examining the reference lists by the authors of the identified studies. The final search was completed on June 3, 2020. For each search, we sought manuscripts that include all three primary concepts of interest.

The three primary concepts of interest to this review apprised the inclusion criteria: (a) interventions provided by parents or caregivers of (b) children diagnosed with ASD, autism, Asperger Disorder, or PDD-NOS who were under 18-years-old, which resulted in (c) functional and measurable outcomes, regardless of the location of delivery (e.g., home, clinic, school), or other aspects of the intervention (e.g., extent of training, duration, and intensity of intervention). These criteria align with the criteria established in Dyches et al.'s meta-analysis (2018). Our search strings comprise synonym lists that are separated by the Boolean "or" operator and all word alternatives were identified by the word stems. To further narrow the hits to studies using RCTs, we included relevant search strings to limit the scope of the search. We also developed search strings that tailored to fit the searching mechanism of each database and pilot tested them to revamp the accuracy of our search. Some corresponding search strings examples used in

locating studies for this meta-analysis are shown in Table 1. To ensure we captured as many studies as possible, we searched the electronic databases twice. All located studies were uploaded to Covidence Systematic Review software, a web-based tool, for screening (SaaS Enterprise, 2014).

Inclusion Criteria and Screening

The screening procedure included three stages: (a) Covidence removed duplicate studies, (b) title and abstract screening, team members excluded duplicate studies that did not catch by Covidence, and (c) full-text review and merged studies with the same participants. All studies located were screened twice during the initial screening and full-text review on Covidence. The first and second authors made final decisions for any discrepancies in the screening stage. We sought studies involving experimental designs (RCTs). Therefore, we excluded case studies, qualitative research studies, quasi-experimental designs, and single-subject designs. Furthermore, we excluded studies with interventions that used medication as the only form of treatment, children who were at-risk with ASD who had not been clinically diagnosed, unknown parent participation in the intervention, parents who did not demonstrate actual implementation of the training received, studies that compared the same intervention program which was delivered in different modes, studies which only reported an ASD screener or diagnostic composite score as the only codable effect size without subscale scores provided, and studies in which no actual parent-child interactions.

Coding Data

Teams of two members each were trained for data coding. A codebook with all study variables definition was used to ensure consistency across coders. Each article was coded twice by separate teams, with the second coding team assessing the first team's data for purposes of

verification and correction of inaccuracies on Covidence Systematic Review software. If discrepancies occurred, coding teams met to resolve the disagreement by further investigating the manuscript to reach a consensus. Coders extracted independent and identifiable characteristics from each study, including (a) number of child participants and their mean age, gender; (b) caregiver evaluated for the effect size and who provided the intervention; (c) type, and dosage of the intervention provided; (d) comparison group type and measurement type; (e) baseline difference and intervention effectiveness; (f) participants' allocation, allocation concealment; and (g) effect size calculated using statistics provided within the manuscript.

Computation of Effect Size Estimates

All effect size data were coded in the metric of Cohen's *d*. Since several different statistics (analyses of variance [ANOVAs], *t*-tests, *f*-tests, Mann–Whitney *U* test, standardized correlation coefficient, means and standard deviations, and *p*-values) may be found among the studies included in this meta-analysis, the statistics reported were initially converted into the metric of Cohen's *d* using the Meta-Analysis Calculator software (Wilson, 2021). Given the low number of participants in several studies, we subsequently converted all effect sizes to Hedge's *g* values to reduce possible small-study bias when comparing data across studies. Where analyses were reported as statistically significant with no statistic provided; the corresponding alpha level determines the *d* value (assuming two-tailed alpha = .05 unless noted otherwise). Effect size *d* = 0 was set for analyses that report non-significant results with no additional information. These procedures yield conservative effect size estimates. The direction of all effect sizes was coded uniformly. Positive values indicate a comparatively more significant benefit to child outcomes as a function of the intervention provided. Negative values indicate a relatively deleterious effect upon the child due to the parenting intervention relative to the control group.

Risk of Bias and Publication Bias

The coding sheet includes variables for evaluating the risk of bias of each article in the following areas: (a) awareness of participant allocation, and (b) allocation concealment, and (c) outcome evaluation by individuals blind to the treatment group. Since blinding parents or caregivers to intervention status is impossible in parent training (PT), studies were evaluated as low risk of bias if they included these three methods.

The direction and statistical significance of the results impact the publication of studies that may introduce publication bias (Van Aert et al., 2019). Publication bias can lead to overestimation of effect sizes and underestimation of false-positive results. To evaluate possible publication bias, we conducted multiple methods, including the Egger regression test (Egger et al., 1997), trim and fill analysis, and funnel plot analysis to detect possible asymmetry within the studies.

Statistical Analyses

We used IBM® SPSS® Statistics (Version 27.0) and STATA (Version 16.0) to analyze the data. The pooled effect size was examined by using a random effects model meta-analysis. To assess the heterogeneity of the pooled effect size, we obtained the tau-squared (τ^2) statistic, I-squared (I^2) statistic, and Cochran's Q (Q). τ^2 indicates the variance of the effects between studies; I^2 is a percentage that indicates the proportion of variances that due to heterogeneity; Q indicates the amount of variance caused by the effect size differences across studies. We determined a priori that if the effect size is heterogenous, moderator analyses, including subgroup analyses for categorical variables and meta-regression for continuous variables, would be performed.

Results

Study Selection

We located 1925 studies through manuscript search after the removal of duplicate studies. A total of 195 records remained for full-text review after initial screening. Of these records, 38 were excluded due to no or uncertain parent involvement, 40 were excluded due to non-randomized placement, 14 were excluded due to children without ASD or PDD-NOS, 10 were excluded because of duplicate data, 4 were excluded because of no ASD child outcome data, 7 were excluded due to parent outcomes only, 9 were excluded due to no data at all, 1 was excluded due to children older than 18-years-old, and 31 were excluded because of unusable data. After additional searches from other sources, a total of 43 studies met the eligibility requirements and were included in this review. Three of them were merged with studies reporting the same sample. After merging studies on Covidence, we had a total of 40 records for final coding. Including those previously coded studies, 54 studies were involved in this meta-analysis that yields 51 records. Studies included consist of 3 (5.6%) grey literature and 51 published studies. The summary of the screening process is reported in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) chart (Figure 1).

Descriptive Characteristics of Participants and Interventions

Across the 54 studies using the randomized controlled trial, 2895 child participants were recruited. These 54 studies were published between 1998 and 2020, a majority of the studies were published in 2019. The children's mean age is 5.49 years, with an average of 16.84% female child participants. The following descriptive characteristics are based on the total number of records reporting such characteristics (51 records). A total of 43 records (84.31%) involved both mother and father, 6 (11.76%) involved only the mother, and 2 (3.92%) involved other or

mixed caregivers. For the types of intervention, 12 aimed at promoting positive behavior or social skills, 8 at correcting problem behaviors, 6 at improving language or communication, and 25 are mixed. The combination of positive and negative behaviors and language/communication is the most common concern in the mixed intervention type.

Regarding the dosage of the intervention programs, parents or caregivers received an average of 89.6 minutes and 13.3 sessions of training; child participants received an average of 83 minutes and 12.6 sessions of interventions. Interventions for child participants were generally delivered weekly (54.9%), 11.8% happened bi-weekly, 7.8% occurred on a daily basis, 3.9% provided monthly or less, and 2% were delivered every other day. Training for parents mostly happened weekly (72.5%), 9.8% bi-weekly, and 3.9% monthly or less frequent, 2% each for not reported, only one session ever, daily, every other day, and twice weekly. The intervention sessions were conducted 47.06% by caregivers, 29.41% by caregivers and professionals together, 13.73% by caregivers at home and professionals in the clinic separately, and 9.8% by caregivers and professionals both together and individually. Child outcomes were measured in the following ways: 20 studies used direct observations, 15 had parents complete standardized instruments, 1 asked the children to complete standardized instruments, 14 reported using a mix of observations and standardized or unstandardized instruments, and 1 did not provide enough information.

Baseline differences did not suggest problems between intervention groups with the randomization process in 74.5% of the studies, 5.9% suggested significant group differences favor the intervention group, 11.8% suggested significant group differences favor the control group, and 7.8% did not report. Only 2 records had all interventionists, observers, and data analysts who were “blind” or unaware of participant allocation, 23 made the observers oblivious,

17 records did not provide enough information or stated that researchers were not blind, 7 reported interventionists and observers were blind, 1 had only the interventionists unaware, and 1 had observer and data analysts unaware. No information was provided for allocation concealment in 17 records; 29 indicated that researchers had no direct involvement in the randomization process, and 5 declared that researchers conducted the randomization and were aware.

Intervention effectiveness measured whether the program improved parents' abilities to intervene with the children. Twenty-two records did not report improvement parents gained from the program, 21 found that parents in the intervention group scored statistically significantly better than those in the control group, and 8 said that parents in the intervention group did not get significantly better, or they performed worse compared to the control group. Treatment fidelity was not measured or reported in most of the records (39.2%), 35.3% evaluated and reported intervention was implemented as intended, 23.5% assessed but did not report if the intervention was implemented as intended, and 2% were evaluated and there were problems. The average overall attrition is 2.89 participants in the experimental group and 2.34 participants in the control group.

For comparison group type, only one study used specified intervention program conducted by professionals, 17 used unspecified "treatment as usual" conducted by professionals, 7 used enrollments in a specific intervention program with some parent interventions, and 26 used a control group with no intervention. There are 35 records based on the effect size on completers and 16 based on intent-to-treat. A summary of the characteristics of the included studies is in Table 2.

Omnibus Analysis

To address potential issues that result from the small sample sizes of some studies, the overall average effect sizes were converted from *d* to Hedges' *g*. The random effects weighted average effect size was $g = 0.55$ (95% confidence interval $g = 0.45$ to 0.65; see Figure 2). Effect sizes ranged from $g = -0.03$ to 2.44, with statistically significant heterogeneity index ($\tau^2 = 0.05$; $I^2 = 37.64\%$; $Q = 86.39$, $p < 0.001$). The observed outcomes varied across 54 studies; however, the results tended to cluster around the overall mean, such that the magnitude of between-study variance was small. We evaluated possible moderating variables that may have accounted for differences in findings across studies.

Subgroup Analyses by Child Outcome

Within studies, authors evaluated different types of child outcomes. We categorized those outcomes into the following four groups: expected behaviors/social skills, maladaptive behaviors, adaptive behavior/life skills, and language/communication. We analyzed these data separately to ascertain the degree to which different kinds of outcomes were impacted by PII. Across 30 studies evaluating child outcomes in terms of expected behavior/social skills, the random effects weighted average was $g = 0.603$ (95% CI = 0.45 to 0.75, $p < 0.001$). These results were characterized by moderate and statistically significant heterogeneity ($I^2 = 46.6$, 95% CI = 18 to 65; $Q = 54.3$, $p = 0.003$).

Across 20 studies evaluating child outcomes in terms of maladaptive behavior, the random effects weighted average was $g = 0.519$ (95% CI = 0.37 to 0.67, $p < 0.001$). These results were characterized by small but statistically significant heterogeneity ($I^2 = 37.1$, 95% CI = 0 to 63; $Q = 30.2$, $p = 0.049$).

Across six studies evaluating child outcomes in terms of adaptive behavior/life skills, the random effects weighted average was $g = 0.239$, with that value not reaching statistical significance (95% CI = -0.11 to 0.59, $p > 0.05$). These results were characterized by small and statistically non-significant heterogeneity ($I^2 = 31.5$, 95% CI = 0 to 72; $Q = 7.3$, $p = 0.20$).

Across 19 studies evaluating child outcomes in terms of language/communication skills, the random effects weighted average was $g = 0.545$ (95% CI = 0.34 to 0.75, $p < 0.001$). These results were characterized by moderate, statistically significant heterogeneity ($I^2 = 61.2$, 95% CI = 36 to 76; $Q = 46.4$, $p < .001$).

Tests for Publication Bias

We administered several tests to detect plausible publication bias. Both Egger's regression test ($p = 0.0607$) and Begg's test ($p = 0.1482$) did not reach statical significance, suggesting the effect sizes were distributed normally. Subsequent trim-and-fill analyses did not identify any missing studies in the distribution either. We also generated a contour-enhanced funnel plot to examine publication bias (see Figure 3). In the plot, the data were only slightly asymmetrical. Even though asymmetry exists, the majority of the data were evenly distributed around the mean. Therefore, publication bias did not appear to be a potential threat to the results of this meta-analysis.

Moderation Effects of Participant and Intervention Characteristics

To inspect the influence of participant, intervention, and study characteristics on the interventions' effectiveness, we performed analyses comprising all relevant variables. Participant characteristics include the mean age of child participants and the percentage of females in each study. Intervention characteristics include who provided the intervention; caregiver evaluated for the effect size, types of intervention, intervention effectiveness, treatment fidelity, dosage

(sessions, frequency, and duration) for parents and children, types of measurement used, and baseline difference. Study characteristics include allocation concealment, masking of individuals involved in the interventions, comparison group type, attrition, and effect size based on completers or intent-to-treat. However, none of the variables reached statistical significance in the inverse variance weighted regressions and inverse variance weighted one-way ANOVA. They do not carry any moderating effects for the overall effect size. We further examined the impact of these variables on each dependent variable (i.e., positive behavior/social skills, maladaptive behavior, adaptive behavior/life skills, and language/communication). Adaptive behavior/life skills was omitted because only six cases were found. Nonetheless, there was no moderating effect of these variables on each of the dependent variable.

Discussion

Effectiveness in Treating Austism Spectrum Disorder

In general, the findings of this meta-analysis exhibited favorable effects of parent-implemented intervention for children with ASD. The random effects weighted average effect size (g = 0.55) showed a statistically significant effect and moderate in strength. This is consistent with some prior meta-analyses and systematic reviews (Deb et al., 2020; Liu et al., 2020; Ratliff-Black & Therrien, 2020). Children with ASD can improve in positive behaviors/social skills (Kent et al., 2019; Ona et al., 2019; Soares et al., 2020), maladaptive behaviors (Black & Therrien, 2017; Gerow et al., 2017; Postorino et al., 2017), adaptive behaviors/life skills (Rodgers et al., 2021), and language/communication (Fuller et al., 2020; Sandbank et al., 2020; Wang et al., 2021; Yu et al., 2020) through PIIs. There was noticeable diversified effectiveness on the dependent variables. Moderate effect sizes were found in positive behavior/social skills, maladaptive behavior, language/communication (g = 0.603, 0.519, and

0.545 respectively). A small effect size was found for child improvement in adaptive behavior/life skills (g = 0.239). However, the outcome of adaptive behavior/life skills is still provisional due to only six studies targeted in this area. All the results should be interpreted with caution due to the potential risk of bias contributed by participants' variabilities, intervention, and study characteristics.

Moderators of Treatment Effectiveness

In our attempts to explore the moderating effects of participants, intervention, and study characteristics on the effectiveness of PIIs on children with ASD, we did not identify any variables that reached statistical significance. Similarly, there were no moderators identified for the data specific to the four dependent variables when analyzed separately. These results may be due to the small number of studies included in the analyses, with corresponding low statistical power.

Regarding the treatment dosage, studies often did not report information about the amount of services received by child participants. Therefore, we did not have sufficient information to analyze the influence of dosage on the effectiveness of PIIs for children with ASD. Besides, the reports of dosage were not standardized. Some studies reported the dosage in detail, while some only reported the total hours per week. Another issue is that not all studies required parents to log their time spent on homework assignments or using the interventions. Three studies reported this information, but those data were too limited to analyze. Limited information such as this not only prevented some moderator analyses from being conducted but also increased the possibility of risk of bias remaining undetected. Future research will be needed to analyze the impact of dosage on the effectiveness of PIIs, with a strong recommendation for future research to report essential information.

The range of sample sizes across the 54 studies was 13 to 180. Among these studies, 13 (25.5%) of them with sample sizes less than 30 participants had low power, and the chances of detecting the actual effect of studies with low statistical power are low. Future research must conduct RCTs with sample sizes large enough to detect the true effect of PIIs for children with ASD. Nonetheless, oversized RCTs may be costly and may usher into unethical trials and waste resources.

Data in the following areas were missing in many studies: masking personnel involved in the interventions, allocation concealment, intervention effectiveness, and treatment fidelity. Hence, we did not have sufficient information to study their impacts on the potency of PIIs. All these components are pivotal for study and intervention qualities. It is significant for future research to track these components and include them when designing study procedures. Future research may also consider developing standardized manuals and fidelity checklists to fortify the adherence of intervention protocols and measure parents' abilities to intervene.

Comparison With Dyches et al.'s Meta-Analysis

This meta-analysis yielded overall results that were very similar to the findings of the meta-analysis by Dyches et al. (2018). This meta-analysis also showed that age and gender did not cause differences in the weighted average effect size's overall magnitude, consistent with Dyches et al.'s meta-analysis. We did not code for socioeconomic status, so we could not compare this independent variable with Dyches et al.'s analysis. Unlike Dyches et al.'s findings, the amount of time spent training parents did not affect the intervention effectiveness in this meta-analysis. We found that interventions targeting positive behavior/social skills had relatively greatest gains and relatively smallest gains when targeting adaptive behavior/life skills. Interventions targeting positive behavior/social skills, maladaptive behavior, and

language/communication had moderate gains. These results were different from Dyches et al.'s findings for children with DD.

Comparison With Previous Meta-Analyses and Systematic Reviews

As prior reviews mentioned, it is difficult to make conclusions regarding intervention effectiveness and generalize the effects since there are considerable variabilities in intervention characteristics across studies (Beaudoin et al., 2014; Deb et al., 2020; Liu et al., 2020; Nevill et al., 2016; Parsons et al., 2017; Postorino et al., 2017; Ratliff-Black & Therrien, 2020; Tachibana et al., 2017; Tarver et al., 2019). Even within the scope of meta-analyses and systematic reviews, scholars use divergent inclusion criteria. For example, some include only RCTs, while others may consist of studies with varied designs. Besides study selection criteria, many variables may sway the results of meta-analyses and systematic reviews: numbers of studies included, scales of the reviews, variables chosen, targeted dependent variables, manuscript search methods, and sample sizes of individual research. Although the number of meta-analyses and systematic reviews on PIIs for children with ASD has increased in recent years, it is still strenuous to conclude the intervention effectiveness. Past reviews had demonstrated inconsistency, but our study yield relatively small inconsistency in findings. We think it is a positive step forward, showing that professionals can have reasonable confidence that PIIs will yield consistently moderately positive results. Moreover, we haven’t located any reviews that showed adverse effects of these PIIs.

The child outcomes mainly relied on direct observations and parent-reported measures. Even though we found that parents yield similar results as professionally trained interventionists, we are still skeptical about potential bias brought by parent-reported measures. Nevill et al. (2016) and Oono et al. (2013) mentioned that the inability to blind parents might affect the

outcomes. Wolstencroft et al. (2018) also indicated self-report or parent-report measures are susceptible to expectancy bias. Traver et al. (2019) mentioned that these types of measurements might introduce reporter bias as well. We are still inconclusive on the effects of measurement types, and we need to interpret these findings with caution. To address these biases, researchers may consider using teacher-report measurements for child outcomes. We found that teacher-report measurements are uncommon across 54 studies included in this analysis. Future research should take an in-depth look at how types of measurement moderate the potency of PIIs.

Research of PII programs conducted in countries rather than the United States, Europe, Canada, and Australia are unrepresented. We located studies from Japan, Korea, Thailand, Hong Kong, Taiwan, China, India, Pakistan, Iran, and Saudi Arabia during the initial manuscript search. However, many of them were excluded due to missing essential information (e.g., parent participation), written in other languages, flaws in research designs (e.g., non-RCTs), and data for child participants at risk with ASD were not reported separately from children with ASD diagnosis, and unusable data (e.g., did not provide the subscales score of screening or diagnostic tools when they are the only codable effect size). Only nine studies from non-English speaking countries were included for the final analysis. We also found difficulty in converting the effect sizes reported in some of these studies into *d* because the authors only mentioned "effect size" without specifying the types or names of those effect sizes. Crucial information (e.g., frequency, duration, sessions, treatment fidelity) was missing in some of these studies, consistent with Liu et al.'s findings (2020). The incomplete information hindered our abilities to investigate how PIIs may work for non-western populations with ASD. As Liu et al. (2020) mentioned, there is a need to increase research quality in low-resource countries.

Gender was not a variable addressed in most of the former reviews. Across the studies were reviewed, females comprised an average of 16.8% of participants. When looking at individual studies' descriptive statistics, Kuravackel et al. (2018) was the only study with a high proportion of female participants with ASD (78.8%). Males with ASD were over-represented compared to females with ASD in the research we located, but consistent with the ratio of males to females with ASD. We could not find any interactions of the percentage of females with ASD with the effectiveness of PIIs, but this is still indeterminate. We cannot make conclusions regarding effectiveness of PIIs on females with ASD; future research should investigate this subject matter. Similarly, for effects of PII on older children with ASD are not sufficiently investigated. The mean age of child participants in this analysis was 5.49 years. There is a need to conduct more research targeting older children with ASD and compare differences across age groups.

Even though some factors hinder our abilities to conclude the effectiveness of PIIs, this type of intervention is still valuable in two ways. First. PIIs promote generalization by helping parents apply skills in real-life situations across many contexts. Second, PIIs enhance maintenance by strengthening existing skills over time, which is more time than intensive treatment of 40 hours per week. Furthermore, PIIs may be particularly effective among families unable to afford intensive ASD treatments, lack insurance coverage, or have limited access to ASD treatments close by their residing areas.

Limitations

Results of this study should be interpreted with consideration of its limitations. Studies in this meta-analysis included only three (5.6%) grey literature. This analysis mainly relied on published studies prone to reporting bias because published studies may inflate PIIs' true effect.

Thoroughly combining both published and unpublished data in this meta-analysis was intricate. Like former meta-analyses and systematic reviews, the present study revealed immense variabilities across studies in intervention and study characteristics. It is also crucial to use standardized measurement tools for parents' and child's outcomes. Using standardized measurements will eliminate the variabilities. These measurements also allow future meta-analyses or systematic reviews to combine data across studies and generalize the effects. Since not all studies include follow-up data, it is nonviable to investigate the long-term impact of PIIs for children with ASD, which provides an avenue for future research. Even though we tried to include studies outside of North America, research related to PIIs conducted in low-resource countries is still under-represented. Future research should focus on studying ASD in other cultures and the efficacies existing interventions on these cultures. We also did not code for some potential moderators, for example, socioeconomic status, intervention settings, parents' education level, parenting style, and marital status. Future research should code for these variables and take a closer look at the interactions between them and the efficacy of PIIs. Consistent with the prevalence of ASD, most of the RCTs are predominantly male samples. The effectiveness of PIIs on females with ASD is inconclusive that opens an avenue for researchers. We do not know why dosage was not necessarily predictive of outcome in this meta-analysis. Larger sample sizes may be needed for future studies to examine the association of dosage and PIIs effectiveness. In addition to the effect of dosage, future studies need to find a systemic way to report dosage. The impact of PIIs on parents is another critical area. However, this meta-analysis did not focus on this. Future studies may investigate more thoroughly how PIIs affect parental stress.

Conclusion

PIIs can promote positive outcomes for children with ASD across the four dependent variables. Medium effect sizes were found in overall effect size as well as for the specific child outcomes of positive behavior/social skills, maladaptive behaviors, and language/communication skills. A small effect size was found in adaptive behavior/life skills. Other than this one difference across outcomes, no other moderating variable was identified in the analyses.

The potential risk of bias is still a threat to this meta-analysis; therefore, all findings should be interpreted with caution. Although PIIs provide positive outcomes for children with ASD, this approach should not be considered as a replacement for services provided by professionally trained therapists or professionals. Rather, researchers should focus more on how parent-implemented interventions may help to reinforce family functioning and child development (Stahmer & Pellecchia, 2015).

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Tables

Table 1

Search String Examples Used in Final Manuscript Search

Primary concept/inclusion criteria	Corresponding search string examples
Parent	(parenting or "parent* of" or "carer of" or "mother* of" or "father*) and
Parent-implemented interventions	("parent program*" or "parent mediated" or "parent delivered" or “family delivered” or "parent-delivered") and
Children	(child* or adolescen* or teen* or youth or “under 18”) and
ASD	(Autis* or Asperger* or ASD) and
RCTs	(random* or "controlled trial" or "clinical trial" or experiment*)

Table 2 (Part 1)

Overview of 54 Studies Included

Author(s)	Country	N	Mean Age (Years)	Effect Size (*d*)
Aldred et al., 2004	United Kingdom	28	3.83	0.2613
Alquraini et al., 2018	Saudi Arabia	28	3.70	2.5100
Alvarado, 2017*	United States	30	3.73	1.3487
Amrollahi far 2017	Iran	30	7.23	0.5240
Bearss et al., 2015, 2016	United States	180	4.75	0.3620
Beaudoin et al., 2019	Canada	19	2.13	0.0000
Brian et al., 2017	Canada	62	2.10	1.0030
Byford et al., 2015	United Kingdom	146	4.00	0.4100
Carter et al., 2011	United States	50	1.67	0.0000
Casenhiser et al., 2013 & Casenhiser et al., 2015	Canada	51	3.71	0.7311
Cook et al., 2019	Australia	31	5.50	0.0000
Dekker et al., 2019	Netherlands	69	11.00	0.4300
Frankel et al., 2010	United States	68	8.53	0.2205
Ginn et al., 2017 & Clionsky 2012*	United States	30	4.72	0.6183
Green et al., 2010	United Kingdom	152	3.75	0.1694
Handen et al., 2013	United States	124	7.43	0.1975
Handen et al., 2015	United States	64	7.95	0.5216
Hardan et al., 2015	United States	47	4.10	0.4200
Ho & Lin, 2020	Taiwan	24	4.04	0.5119
Iadarola et al., 2018	United States	180	4.75	0.7770
Jocelyn et al., 1998	Canada	35	3.60	-0.0356
Kasari et al., 2010	United States	38	2.57	0.6291
Kuravackel et al., 2018	United States	33	8.08	0.7100
Lehtonen et al., 2020**	Finland	20	4.13	0.3223
Lindgren et al., 2020	United States	38	4.35	1.5700
Matthews et al., 2018a, b	United States	22	15.27	1.8700
McDaniel et al., 2020	United States	40	4.03	0.5000
Nowell et al., 2019	United States	17	6.82	0.8529
Pajareya & Nopmaneejumruslers, 2011	Thailand	32	4.50	1.0724
Pashazadeh Azari et al., 2019	Iran	33	6.82	0.3970
Rahman et al., 2016	India & Pakistan	59	5.43	0.6123
Reitzel et al., 2013	Canada	13	4.88	-0.0300
Roberts et al., 2011	Australia	57	3.55	0.6144
Schertz et al., 2013	United States	23	2.18	0.4967
Schertz et al., 2018	United States	131	2.06	0.4825
Scudder et al., 2019	United States	19	5.62	0.5057
Shire et al., 2016	United States	83	2.58	0.8403
Shum et al., 2019	Hong Kong	66	13.51	0.5620
Siller et al., 2013	United States	70	4.76	0.1740
Sofronoff et al., 2004	Australia	100	9.33	1.0912
Sofronoff et al., 2007	Australia	45	10.78	1.1332
Solomon et al., 2008	United States	19	8.15	0.5581
Solomon et al., 2014 & Mahoney & Solomon, 2016	United States	128	4.18	0.3661
Tellegen & Sanders, 2014	Australia	64	5.67	0.4800
Tonge et al., 2014	Australia	70	4.00	0.7601
Turner-Brown et al., 2019	United States	49	2.47	0.4800
Valeri et al., 2019	Italy	34	4.30	0.5800
Whittingham et al., 2009	Australia	59	5.91	0.2100
Wong & Kwan, 2010	Hong Kong	17	2.21	0.0000
Yoo et al., 2014	Korea	47	13.78	1.1648
Zand et al., 2018	United States	21	5.84	1.0220

* Thesis or dissertation; ** Conference poster

Table 2 (Part 2)

Overview of 54 Studies Included

Author(s)	Exp. *n*	Con. *n*	% female	Intervention Name
Aldred et al., 2004	14	14	10.7	Social Communication Intervention
Alquraini et al., 2018	13	15	21.4	Responsive Teaching
Alvarado 2017*	14	16	23.3	Sensoriaffective Interactional Attunement Scale-Guided Intervention
Amrollahi far 2017	15	15	43.3	Play Therapy Training
Bearss et al., 2015, 2016	89	91	12.2	Behavioral Interventions
Beaudoin et al., 2019	9	10	21.1	Parent Implemented Early Start Denver Model (P-ESDM)
Brian et al., 2017	30	32	24.2	Social ABCs Parent-Mediated Intervention
Byford et al., 2015	74	72	9.1	Pre-School Autism Communication Trial (PACT)
Carter et al., 2011	27	23	17.7	Hanen's 'More Than Words'
Casenhiser et al., 2013 & Casenhiser et al., 2015	25	26	No data	Milton & Ethel Harris Research Initiative (MEHRI)
Cook et al., 2019	14	17	12.9	Cognitive Behavioral Therapy (CBT)
Dekker et al., 2019	47	22	17.5	Social Skills Group Training
Frankel et al., 2010	33	35	14.7	Children's Friendship Training
Ginn et al., 2017 & Clionsky 2012*	15	15	20	Child-Directed Interaction Training
Green et al., 2010	77	75	9.2	PACT
Handen et al., 2013	75	49	18.1	Research Units on Pediatric Psychopharmacology – Autism Network (RUPP)
Handen et al., 2015	32	32	18.8	RUPP
Hardan et al., 2015	25	22	25	Pivotal Response Treatment (PRT)
Ho & Lin, 2020	12	12	0	Developmental Individual-Difference Relationship-Based Model
Iadarola et al., 2018	89	91	12.2	RUPP
Jocelyn et al., 1998	16	19	2.9	Autism Preschool Program
Kasari et al., 2010	19	19	23.7	Joint Attention Intervention
Kuravackel et al., 2018	23	10	78.8	Collaborative Model for Promoting Competence and Success for Hope
Lehtonen et al., 2020**	10	10	10	Parent-Led Eye Contact-Specific Training
Lindgren et al., 2020	21	17	15.8	Functional Communication Training
Matthews et al., 2018a, b	10	12	18.2	Peers-Mediated Model of Program for the Education and Enrichment of Relational Skills (PEERS®)
McDaniel et al., 2020	20	20	12	PRT
Nowell et al., 2019	8	9	23.5	Growing, Learning, and Living with Autism (GoriLLA)
Pajareya & Nopmaneejumruslers, 2011	16	16	12.5	Developmental, Individual-Difference, Relationship-Based (DIR)/Floortime™
Pashazadeh Azari et al., 2019	16	17	21	Contextual Interventions for ASD
Rahman et al., 2016	29	30	18.5	PACT
Reitzel et al., 2013	7	6	No data	Functional Behavior Skills Training
Roberts et al., 2011	57	28	9.5	Building Blocks Program
Schertz et al., 2013	11	12	No data	Joint Attention Mediated Learning (JAML)
Schertz et al., 2018	64	67	20.6	JAML
Scudder et al., 2019	10	9	10.5	Parent-Child Interaction Therapy (PCIT)
Shire et al., 2016	42	41	17.7	Joint Attention, Symbolic Play, Engagement, and Regulation (JASPER)
Shum et al., 2019	33	33	21.2	PEERS®
Siller et al., 2013	36	34	8.6	Focused Playtime Intervention
Sofronoff et al., 2004	50	50	No data	Comic Strip Conversations and Social Stories
Sofronoff et al., 2007	24	21	4.4	CBT
Solomon et al., 2008	10	9	0	PCIT
Solomon et al., 2014 & Mahoney & Solomon, 2016	64	64	18	Play and Language for Autistic Youngsters (PLAY) Project Home Consultation model
Tellegen & Sanders, 2014	35	29	14.1	Stepping Stones Triple P (SSTP)

Author(s)	Exp. *n*	Con. *n*	% female	Intervention Name
Tonge et al., 2014	35	35	17.1	Parent Education and Counselling (PEAC), Parent Education and Behavioral Management (PEBM)
Turner-Brown et al., 2019	32	17	14.3	Family Implemented TEACCH for Toddlers (FITT)
Valeri et al., 2019	17	17	20.6	Cooperative Parent-Mediated Therapy (CPMT)
Whittingham et al., 2009	29	30	20.3	SSTP
Wong & Kwan, 2010	9	8	5.9	Autism-1-2-3
Yoo et al., 2014	23	24	6.4	PEERS®
Zand et al., 2018	12	9	14.3	Positive Parenting Program

* Thesis or dissertation; ** Conference poster

Table 2 (Part 3)

Overview of 54 Studies Included

Author(s)	Intervention Providers [a]	Training for Parents [b] (weeks/sessions/minutes)	Interventions for Children [b] (weeks/sessions/minutes)	Relevant Dependent Variables [c]
Aldred et al., 2004	Mixed	32 wks/9 sess.	32 wks/9 sess./30 mins.	PB, AB, L
Alquraini et al., 2018	Together	16 wks/16 sess./60 mins	16 wks/16 sess./60 mins	PB, L
Alvarado 2017*	Parents	4 wks/4 sess./60 mins	4 wks/3 sess./60 mins	PB
Amrollahi far 2017	Parents	8 wks/17 sess.	8 wks/17 sess.	L
Bearss et al., 2015, 2016	Parents	24 wks/12 sess./75 mins	24 wks	MB
Beaudoin et al., 2019	Together	12 wks/12 sess./67.5 mins	12 wks/12 sess./67.5 mins	PB
Brian et al., 2017	Parents	12 wks/12 sess./90 mins	12 wks/12 sess./90 mins	PB, L
Byford et al., 2015	Together	52 wks/16 sess./150 mins	52 wks/16 sess./150 mins	L
Carter et al., 2011	Together	42 wks/11 sess.	42 wks/3 sess.	PB, L
Casenhiser et al., 2013 & Casenhiser et al., 2015	Mixed	48 wks/58 sess./120 mins	48 wks/50 sess./120 mins	PB, L
Cook et al., 2019	Parents	10 wks/10 sess./90 mins	10 wks/0 sess.	MB
Dekker et al., 2019	Mixed	24 wks/17 sess./90 mins	24 wks/17 sess./90 mins	PB
Frankel et al., 2010	Separate	12 wks/12 sess./60 mins	12 wks/12 sess./60 mins	PB, MB
Ginn et al., 2017 & Clionsky 2012*	Mixed	10 wks/8 sess./60 - 75 mins	10 wks/8 sess./ 60 - 75 mins	PB, MB
Green et al., 2010	Parents	52 wks/18 sess./120 mins	52 wks/18 sess./120 mins	PB, L
Handen et al., 2013	Parents	24 wks/12 sess./60 - 90 mins	No data	MB
Handen et al., 2015	Parents	10 wks/10 sess./60 - 90 mins	10 wks/10 sess./60 - 90 mins	MB
Hardan et al., 2015	Together	12 wks/12 sess./60 - 90 mins	12 wks/4 sess./60 mins	L
Ho & Lin, 2020	Parents	14 wks/5 sess./360 mins	14 wks/11 sess.	PB, AB, L
Iadarola et al., 2018	Parents	24 wks/13 sess./60 - 90 mins	No data	MB
Jocelyn et al., 1998	Separate	12 wks/5 sess./180 mins	12 wks/10 sess./180 mins	PB, AB, L
Kasari et al., 2010	Together	8 wks/24 sess./45 mins	8 wks/24 sess./45 mins	PB
Kuravackel et al., 2018	Parents	8 wks/8 sess./60 - 120 mins	No data	MB
Lehtonen et al., 2020**	Parents	No data	No data	PB, L
Lindgren et al., 2020	Parents	12 wks/9 sess./60 mins	12 wks/9 sess./60 mins	MB
Matthews et al., 2018a, b	Separate	14 wks/14 sess./90 mins	14 wks/14 sess./90 mins	PB
McDaniel et al., 2020	Together	24 wks/15 sess./300 - 600 mins per wk	24 wks/15 sess./300 - 600 mins per wk	L
Nowell et al., 2019	Together	12 wks/12 sess./90 mins	12 wks/12 sess./60 mins	PB
Pajareya & Nopmaneejumruslers, 2011	Parents	12 wks/1 sess./912 mins per wk	No data	PB
Pashazadeh Azari et al., 2019	Parents	12 sess./45 mins	No data	AB
Rahman et al., 2016	Parents	24 wks/12 sess./60 mins	24 wks/12 sess./60 mins	L
Reitzel et al., 2013	Together	16 wks/16 sess./120 mins	16 wks/16 sess./90 mins	MB, AB
Roberts et al., 2011	Mixed	40 wks/40 sess./120 mins	40 wks/40 sess./120 mins	PB, MB, L
Schertz et al., 2013	Parents	No data	15 sess.	L
Schertz et al., 2018	Parents	32 wks/32 sess./60 mins	32 wks/32 sess./60 mins	PB
Scudder et al., 2019	Parents	18 wks/16 sess./60 mins	18 wks/16 sess./60 mins	PB, MB
Shire et al., 2016	Together	10 wks/10 sess./60 mins	10 wks/10 sess./60 mins	PB
Shum et al., 2019	Separate	14 wks/14 sess./90 mins	14 wks/14 sess./90 mins	PB, MB
Siller et al., 2013	Together	12 wks/12 sess./90 mins	12 wks/12 sess./90 mins	L
Sofronoff et al., 2004	Parents	4 wks/7 sess./60 mins – 1 day	No data	PB, MB
Sofronoff et al., 2007	Separate	6 wks/6 sess./120 mins	6 wks/6 sess./120 mins	MB
Solomon et al., 2008	Parents	12.7 sess.	12.7 sess.	PB, MB
Solomon et al., 2014 & Mahoney & Solomon, 2016	Together	48 wks/10.5 sess./180 mins	48 wks/10.5 sess./180 mins	PB, L
Tellegen & Sanders, 2014	Parents	8 wks/4 sess./15 - 105 mins	No data	MB
Tonge et al., 2014	Together	20 wks/20 sess./60 - 90 mins	20 wks/10 sess./60 mins	All
Turner-Brown et al., 2019	Together	24 wks/24 sess./90 mins	24 wks/20 sess./90 mins	PB, L
Valeri et al., 2019	Together	24 wks/15 sess./60 mins	24 wks/15 sess./60 mins	PB

Author(s)	Intervention Providers [a]	Training for Parents [b] (weeks/sessions/minutes)	Interventions for Children [b] (weeks/sessions/minutes)	Relevant Dependent Variables [c]
Whittingham et al., 2009	Parents	9 wks/9 sess.	9 wks/4 sess.	MB
Wong & Kwan, 2010	Separate	2 wks/10 sess./30 mins	2 wks/10 sess./30 mins	PB, L
Yoo et al., 2014	Separate	14 wks/14 sess./90 mins	14 wks/14 sess./90 mins	PB
Zand et al., 2018	Parents	4 wks/4 sess./30 - 60 mins	No data	MB

* Thesis or dissertation; ** Conference poster. a Separate – parents and professionals separate; together – parents and professionals together. b Booster sessions were included; however, optional sessions were not. Follow-up data and self-reported intervention duration for children were not included. c PB – positive behavior/social skill; MB – maladaptive behavior; AB – adaptive behavior/life skills; and L – language/communication skills.

Figures

Figure 1

PRISMA Chart of Included Studies

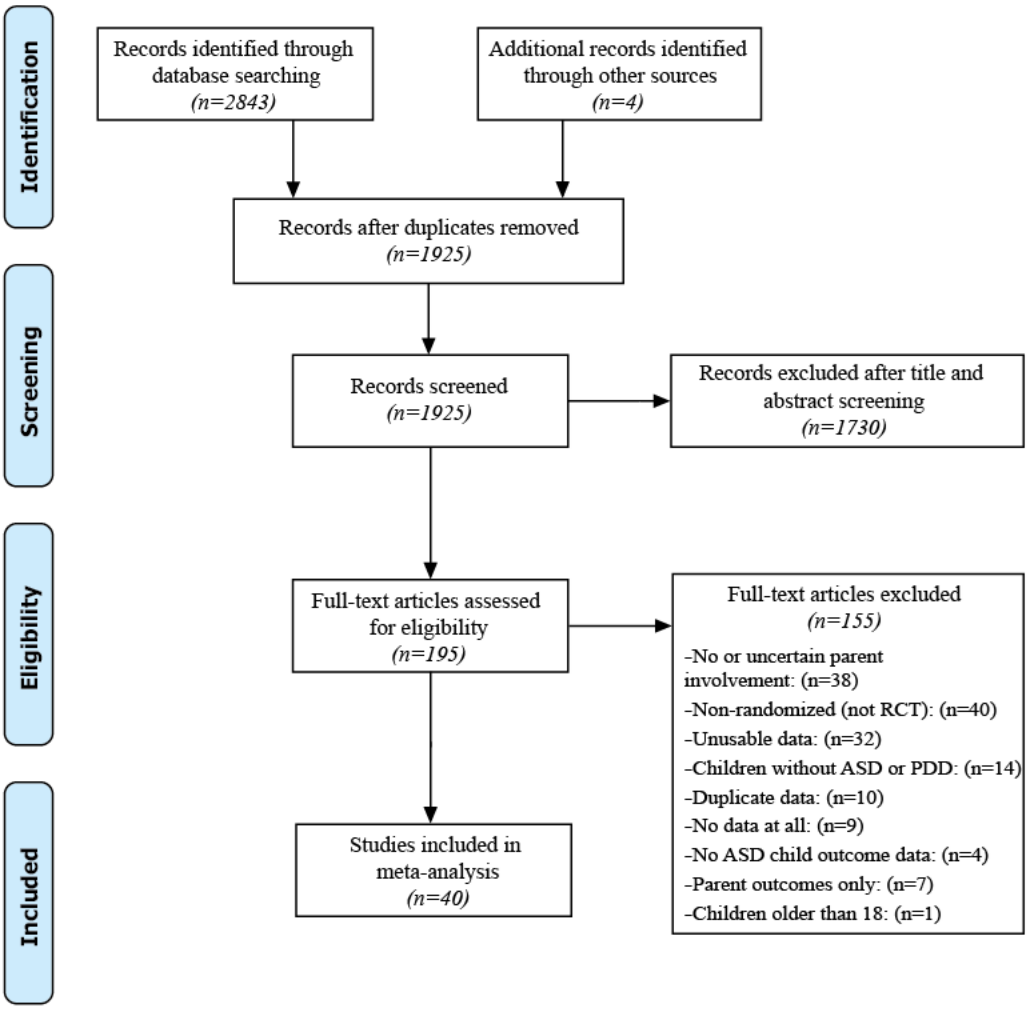


Figure 2

Forest Plot of Effect Size and 95% Confidence Interval of 54 Studies

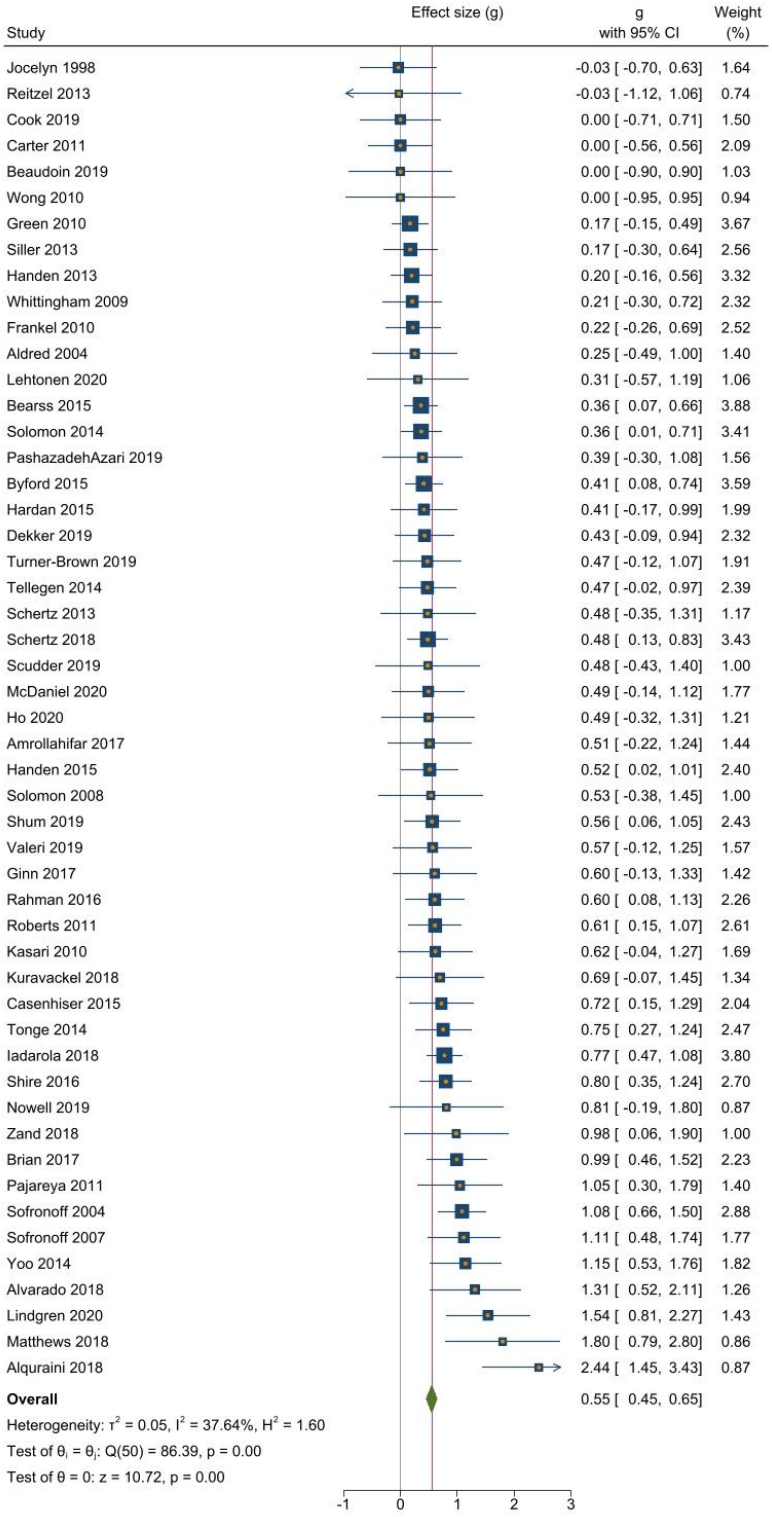
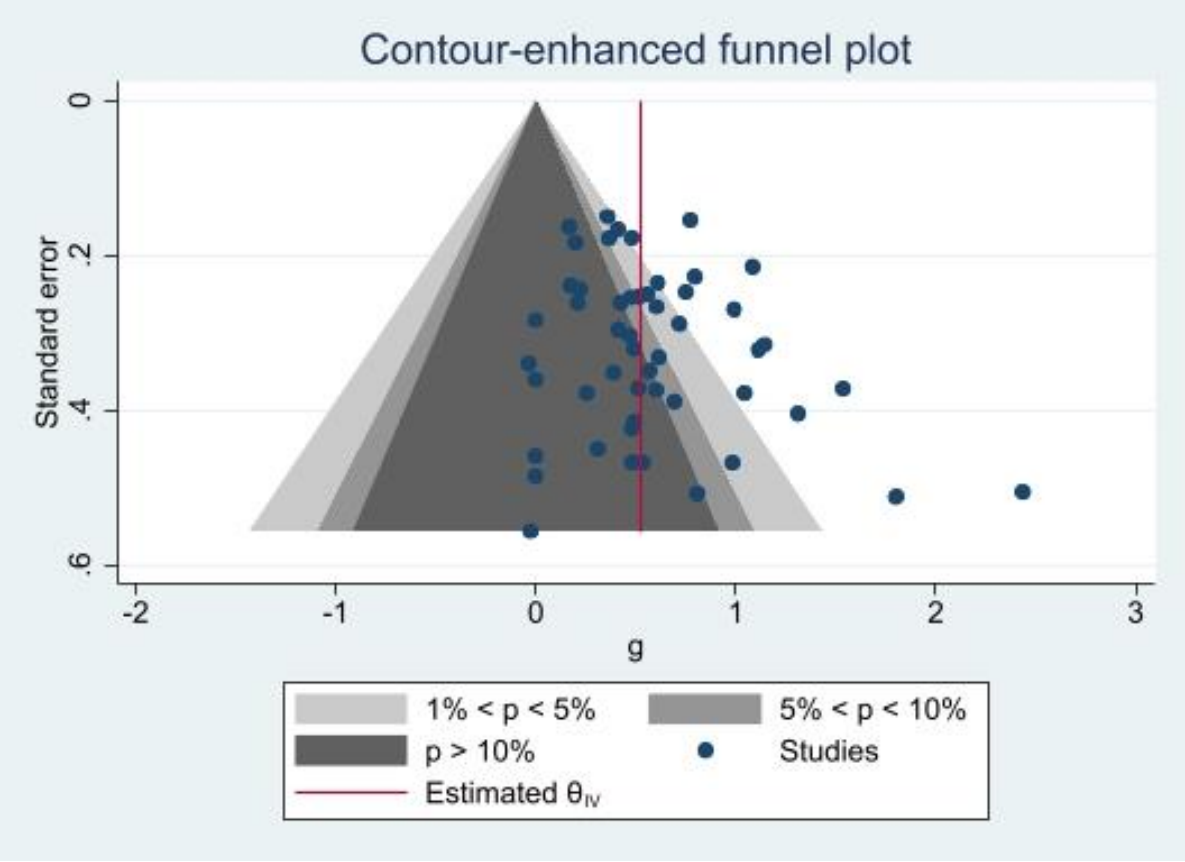


Figure 3

Contour-Enhanced Funnel Plot of 54 Studies Included



APPENDIX

Review of the Literature

According to the Centers for Disease Control and Prevention (CDC, 2019), there are different types of interventions to address the core symptoms of ASD which can be roughly grouped into the following categories: behavior and communication, medication, complementary and alternative medicine, and dietary approaches. Among these categories, the behavior and communication category is commonly addressed with parent-implemented interventions (PIIs). For the purpose of this thesis, only some of the subcategories within behavior and communication that had been used as PIIs will be addressed. This section will briefly review the following topics: interventions for individuals with ASD, the taxonomy of parent training (PT) for children with ASD, types of behaviors being addressed, and previous systematic reviews or meta-analyses related to PIIs.

Interventions for Individuals With Autism Spectrum Disorder

Scholars have organized common interventions for individuals with ASD in various ways. For example, some have organized interventions into early intervention types, and others organized interventions based on what is available in the market. There is no one way of categorizing interventions for ASD. We opted to focus on four dependent variables for child outcomes: positive behavior/social skills, maladaptive behavior, adaptive behavior/life skills, and language/communication. The following paragraphs will only address interventions targeting these dependent variables based on the characteristics of effective interventions published in *Educating Children with Autism* (National Research Council, 2001).

Positive Behavior or Social Skills

Individuals with ASD experience different degrees of social deficits. According to the DSM-V diagnostic criteria of ASD related to social communication and social interaction, people with ASD may have deficits in social-emotional reciprocity; nonverbal communicative behaviors used for social interaction; and developing, maintaining, and understanding relationships (American Psychiatric Association, 2013). For example, some individuals lack eye contact and joint attention and cannot understand play rules (Brodhead et al., 2017). No matter how divergent the social deficits are, some commonalities are found. In general, individuals with ASD have lower rates of initiations and responses in peer and social interactions, exhibit relatively fewer nonverbal gestures and facial expressions, are less observant of others' emotional displays, and demonstrate little imitations of others.

Interventions targeting social skills address the interaction between child and parents, child and adults, and child and child. These interventions have been categorized into five approaches: behaviorally-based programs, neo-behavioral approaches, interactive approaches, the Denver model, and Treatment and Education of Autistic and Related Communication Handicapped Children (TEACCH; Watson, 1991). The behaviorally-based programs (e.g., Princeton program; McClannahan & Krantz, 1997) teach social skills directly to children with ASD through utilizing the three-part contingency (antecedent-response-consequence). Neo-behavioral approaches (e.g., Learning Experiences, Alternative Program; Kohler et al., 1997; Strain et al., 1996) introduce naturalistic social interactions to children with ASD to promote peer interactions. The interactive approaches (e.g., Greenspan and Wieder's Developmental Intervention model; Greenspan et al., 1997) are child-oriented programs customized to the child's communicative and developmental competency. These approaches augment the quality

and quantity of social interactions between children with ASD and adults over time. The Denver model (Rogers et al., 2000) employs children-centered sensory, social exchanges to teach skills necessary to initiate social interactions in naturalistic social activities. Adults learn how to socially respond to the children through adult-directed interactions. Children learn imitation skills through direct teaching and social exchanges. TEACCH provides communication training in the context of group activities. Individuals with ASD learn how to follow the rules or instructions and to take turns while interacting with their peers.

Maladaptive Behaviors

Maladaptive behaviors in ASD include aggression, property destruction, uncooperative behaviors, self-injury, and withdrawal (Shattuck et al., 2006), among other behaviors. For example, some individuals engage in head-banging, throwing chairs across a classroom, screaming when working on math problems, and having tantrums. These maladaptive behaviors interfere with the life of people with ASD and others around them. They may promote social isolation from peers, prevent inclusion in school settings, and increase parental stress (Hall & Graff, 2012).

Applied behavior analysis (ABA) was previously called behavioral modification (Fishbein et al., 2017). ABA aims to improve child behaviors by identifying the contingencies that reinforce behavior change for individuals with ASD. ABA focuses on measuring observable behaviors and is tailored to meet individuals' needs in behavioral plan design. It is based on operant conditioning principles that focus on stimulus-response interactions (Sandbank et al., 2020). Preferred reinforcements of that individual are used to increase the target behavior's frequency based on reinforcement preference assessment. Skills selection is based on conclusive results from functional behavior assessment (FBA) or a combination of other assessments. ABA

can be implemented in both highly controlled experimental conditions and natural settings. This approach provides rich empirical data to monitor an individual's progress, and generalization of skills taught in therapy sessions. Examples of ABA techniques are task analysis, positive reinforcement, prompting, and self-management. With the promotion of early intensive behavioral intervention (EIBI) for positive outcomes, many studies have indicated that the use of ABA supervised by board-certified behavioral analysts (BCBA) can be beneficial for children with ASD (Dunlap et al., 2008; Makrygianni et al., 2018; Mesibov & Howley, 2018; Peters-Scheffer et al., 2011; Reichow & Wolery, 2008; Virués-Ortega, 2010).

Adaptive Behaviors or Life Skills

Life skills and adaptive behaviors are crucial for day-to-day living and ways to fulfill individuals' social responsibilities. These skills are things that individuals do for life maintenance, addressing personal needs, and utilizing their living area (Turygin & Matson, 2014). Hygiene, community skills, housekeeping skills, safety-related behaviors, and school-related skills fall under this category. For example, individuals engage in life skills when they take a bath, use an ATM, purchase items at a store, cross a busy street, or lock the door when leaving a house.

There is scant research explicitly on interventions that target adaptive behaviors or life skills. Reinforcer assessments were administered to the potency of potential reinforcers to foster skills instructions and acquisition in behavioral-based interventions. Operant conditioning procedures, aversive consequences, manuals for specific life skills (e.g., toilet training), peer tutoring, modeling, checklists, visual schedule, delayed contingency management, self-management techniques, environmental arrangement, interaction with typically developing

peers, pivotal response training, and task analysis have been used to address deficits in various aspects of adaptive behaviors or life skills.

Language or Communication

Communication impairments or language deficits exist in a range of severities in the context of ASD. Idiosyncratic patterns or characteristics of these impairments can be found in verbal and non-verbal communications. Examples of these difficulties include the perplexity of grasping non-verbal communication skills (e.g., body language, eye contact), scant conventional gestural use, unusual intonation, talking with loud volume, repetitive talk on a specific topic, difficulties in joint attention, echolalia, reversal of pronouns, intricacies in symbol use (e.g., inability to understand implicit meanings and nonliteral language, confusion over words with multiple meanings), limited written and verbal narratives, difficulty in comprehending the meaning of a context, and impairments in use of pragmatic language (Leekam, 2007). In short, most aspects, both receptive and expressive, can be impaired with children with ASD.

Interventions targeting communication and language include naturalistic teaching methods, developmental approaches, functional communication training, augmentative and alternative communication (AAC), assistive technology (AT), and facilitated communication (FC), among others. Naturalistic teaching methods promote language or communication outcomes of children with ASD through implementing child-oriented and systematic teaching trials. This approach focuses on the child's interests, which allows the child to initiate teaching episodes in a naturalistic environment. Natural reinforcers are used to enhancing the child's motivation to communicate. Developmental approaches organize the environment to provide occasions for communication. The communicative partner follows the lead of the child and is responsive while the child directs the interactions. Functional communication training is used as

a replacement for maladaptive behaviors (Koegel et al., 1992). However, it also proliferates the core communication skills and communication initiation (both verbal and non-verbal). AAC incorporates a nonspeech symbol systems to assist children with ASD who have severe language or communication deficits. Examples of AAC include visual symbol systems (e.g., words and symbols), sign language, and voice output communication aids. AT involves a wide range of devices or services to assist children with ASD. AAC and computer-based instruction programs are some of the examples of AT. FC is used to support those who have intense communication impairments. The supports involve continued aid within the AAC model consisting of physical, emotional, and communicative components to elicit communicative initiations and responses. Although the literature reports using these interventions in treating language or communication impairment, not all the approaches have the same level of evidence to prove their efficacy in promoting outcomes in language or communication of children with ASD.

The Taxonomy of Parent Training (PT) for Autism Spectrum Disorder

Parent training may also be called parent education: PT is a broader concept than PIIs according to the classification of Bearss et al. (2015). Following this brief description of PT programs, the more specific concept of PIIs will be detailed in a subsequent section.

PT had been implemented since the 1960s to ameliorate disorder-specific skills deficiency, reduce problem behaviors, and boost parent involvement (Brookman-Frazee et al., 2009). PTs have been used to treat children with attention deficit hyperactivity disorder (ADHD), anxiety, ASD, developmental disabilities, and disruptive behavior disorder (DBD). Through decades of research on PTs, many well-established structured programs were found (e.g., Barkley's Defiant Children; Barkley, 1987, The Incredible Years Parent Training Model; Borden et al., 2010, Triple P Positive Parenting Program; Sanders, 2003).

PT emphasizes the involvement of parents or caregivers in the intervention process to yield direct and/or indirect benefits to children with ASD. In PT, the roles of parents or caregivers in the intervention process are critical. Typically, children in Northern America start formal schooling at around 5 or 6 years old. Before that, children spend most of their time with parents or caregivers. For children with ASD, early diagnosis and interventions are provided to help these children to catch up to the development of their typical peers.

Dawson et al. (2012) studied the efficacy of the Early Start Denver Model (ESDM; a developmental-behavioral intervention targets on toddlers) on 48 toddlers (18 – 30 months) who had been diagnosed with ASD. These toddlers were randomly assigned to receive ESDM or referral to community intervention (CI). Faces or objects were presented to these toddlers and their brain activity was measured. When compared to age-matched typical children, Dawson et al. (2012) found that normalization of brain activity is associated with early behavioral intervention. Toddlers who received the ESDM treatment had significant improvements in adaptive behavior, autism diagnosis, cortical activation, intelligence quotient (IQ), language, and social behavior than the CI group. They had comparable brain activity when comparing to age-matched typical peers. Faster neural response was noted when viewing faces than objects for the ESDM group, while the CI group had the opposite outcomes.

Other evidence suggests that the type and amount of parent interactions the children with ASD experience will impact their development of social and language skills (Patterson et al., 2012; Siller & Sigman, 2002). Patterson et al. (2012) reported that an “increase in child communication and social outcomes as parents demonstrate an increase in their abilities, emphasizing the reflexive role that parents and children can play in each other’s development”

(p. 516). Thus, parent involvement in the early stage of intervention for children with ASD can make a difference for these individuals.

According to Bearss et al. (2015), PT can be categorized into parent support and parent implementation. The classification of PT can be based on the format, duration, intensity, location, and target group.

Parent Support

PT with the focus of parent support is knowledge oriented. Parents receive support and increase their knowledge of ASD from this type of PT. The child obtains benefits indirectly from a parent support program. Parent support can be further broken down into care coordination and psychoeducation.

Care Coordination. The complexities of the system of care often intimidate parents with children with ASD. When looking for appropriate services and resources, these parents need to consider funding availability or eligibility, the collaboration of service providers, cost, time, travel, etc. These barriers may sometimes impede the continuity of services for individuals with ASD because it seems there is no single-entry point into the multiple service systems. Therefore, care coordination is central to guiding these parents on the lifelong care pathway for their children.

McDonald et al. (2007) defined care coordination as

> the deliberate organization of patient care activities between two or more participants (including the patient) involved in a patient's care to facilitate the appropriate delivery of health care services. Organization care involves the marshalling of personnel and other resources needed to carry out all required patient care activities, and is often managed by

the exchange of information among participants responsible for different aspects of care. (p. 41)

The core elements of care coordination include involvement of multiple participants, interdependence among participants and activities, aid for appropriate healthcare delivery, exchange of information, and knowledge of resources statute and roles of others (Schultz & McDonald, 2014). Some examples of service types involved are medical, academic, and behavioral support. Social workers or case managers usually deliver this type of program in a brief consultative style. This type of service may also be provided by local or state agencies. An example of care coordination programs is Comprehensive Medical Care for Autism Spectrum Disorders (Parellada et al., 2013). Care coordination can enhance the health condition of children with ASD (Homer et al., 2008) and may minimize medical care expenditures (Kogan et al., 2008).

Psychoeducation. The lack of quality information about ASD is one of the obstacles for parents who want to take better care of their children with ASD. Psychoeducation is "a systematic and didactic approach to informing patients, and their relatives, about their illness and its treatment, thereby promoting understanding and personal management of the illness" (Dahl et al., 2020, p. 258). It provides up-to-date ASD information to parents which have these benefits: enabling parents to be able to advocate for their children, altering their expectations of their children's future, providing intervention guidance, preparing for children's transition to new stages throughout the lifetime, lessening parental stress, and alleviating the sense of isolation (Bearss et al., 2015).

Psychoeducation is usually a short-term program that can be found in individual or group sessions. Structured psychoeducation programs are delivered by professionals such as social

workers, psychologists, case managers, or psychiatric nurse practitioners. Self-guided psychoeducational materials are available in multiple sources Examples include Autism Speaks Early Childcare Provider's Guide to Managing Challenging Behaviors (https://www.autismspeaks.org/tool-kit/early-childcare-providers-guide-managing-challenging-behaviors), and *A Practical Guide to Autism: What Every Parent, Family Member, and Teacher Needs to Know* (Volkmar & Weisner, 2009).

Parent-Implemented Interventions (PIIs)

PIIs mean using parents as the intervention mediator which can be primary, complementary, or hybrid (combination of primary & complementary) programs (Bearss et al., 2015). Indeed, Dawson-Squibb reported that many PIIs are using the hybrid model (2020). Children with ASD directly benefit from PIIs because PIIs are techniques-oriented training that permits parents to be the agent of change. Parents actively engage from the beginning of the intervention to promote their children's skills acquisition (Kasari et al., 2014) and tapering off the problem behaviors (Bearss et al., 2013). Therapists partially or primarily participate in the treatment process in complementary programs. Therapists coach parents to apply skills learned in settings outside of clinical settings or for skills retention (Bearss et al., 2015). Some examples are the Early Start Denver Model (ESDM; Dawson et al., 2010; Rogers et al., 2012), and Marcus Autism Center Feeding Program (Sharp et al., 2011). PIIs can be further categorized into PIIs for core symptoms and PIIs for maladaptive behaviors.

Parent-Implemented Interventions for Core Symptoms. Core ASD symptoms encompass deficits in areas related to behaviors and communication. Interventions can be conducted at home and in various community settings that enable skills acquisition in naturalistic environments (Bearss et al., 2015). Numbers of the session, frequency, formats (primary or

complementary) and duration of this type of PIIs vary. Both structured PIIs and self-guided materials are available. Examples include Teaching Social Communication to Children with Autism: A Manual for Parents (Ingersoll & Dvortcsak, 2009), Joint Attention Symbolic Play Engagement and Regulation (JASPER; Kasari et al., 2014), and ESDM (Dawson et al., 2010).

Parent-Implemented Interventions for Maladaptive Behaviors. Maladaptive behaviors of ASD include disruptive behaviors (e.g., property destruction, noncompliance, tantrums, self-injury, aggression, and hyperactivity), sleep disturbance, elopement, toileting problems, and focal concerns like the refusal of food (Bearss et al., 2015). Some side effects of these maladaptive behaviors are intensifying parental stress and isolation from peers (Bearss et al., 2015).

Since this type of PT focuses on behavioral modification of maladaptive behaviors, ABA principles are heavily involved. Some features of ABA-guided PT are observation, data collection, antecedent or consequence manipulation. Trained behavioral therapists will mostly deliver interventions. The therapists will coach in either therapist-child or parent-dyad styles. Both structured PIIs and self-guided materials are available. The design of programs is highly individualized to tackle a specific problem. PIIs for maladaptive behaviors varies in duration, intensity, and degree of parent involvement (primary or complementary). Examples include The Research Units in Pediatric Psychopharmacology (RUPP) Autism Network parent training program (Aman et al., 2009; Scahill et al., 2012), Marcus Autism Center Feeding Program (Sharp et al., 2011), and *Toilet Training in Children with Severe Handicaps* (Dunlap et al., 1984).

Previous Systematic Reviews or Meta-Analyses Related to Parent-Implemented Interventions

Several previous meta-analyses have been conducted on the effectiveness of PIIs. These have tended to find the beneficial effects of PIIs; however, they all have varied inclusion and exclusion criteria. Each of them is described in the following paragraphs. Since this meta-analysis is an update of the Dyches et al. review published in 2018, with a focus on ASD, this review is addressed first.

Dyches et al. (2018)

Dyches et al. (2018) included 30 studies with a total of 1356 participants who have developmental disabilities–including ASD–in their meta-analysis. This review focused on the interconnection of PIIs and outcomes that are intended to be improved through PIIs (adaptive behaviors, communication skills, and social behaviors). The authors screened both published and unpublished manuscripts from 1990 to 2011 in 6 databases. Overall, the child outcomes of the parent-implemented intervention group were relatively higher than the control group. PIIs that targeted communication skills resulted in the amplest gain than PIIs targeting adaptive behaviors and social behaviors. A significant mixed effect of PIIs on outcomes for children with developmental disabilities was identified.

Black & Therrien (2018)

Black and Therrien (2018) identified 15 studies published between 1987 to 2016 from the search of two databases. This systematic review included a total of 622 children from 6 to 17 years of age who were all diagnosed with ASD. There are two intervention types: cognitive behavioral therapy and social skills training programs. Due to the relatively small sample size and the effects of the intervention confounded by other variables, Black and Therrien could not

estimate the effects of these two types of PIIs, respectively. However, the overall effects of PIIs were positive and moderate in strength.

Nevill et al. (2016)

Nevill et al. (2016) conducted a meta-analysis of 19 articles published between 2000 and 2015 of PT for children with ASD between 1 to 6 years of age. Evidence indicated that there were moderate effects for ASD symptom severity, cognition, and communication, and a very low effect for socialization. There was no significant difference based on the dose of treatment and type of control group. Treatment effects were significant when only based on parent report for communication and not for socialization. However, clinicians reported the opposite results than parents. Overall, the effects of PIIs were found to be small.

Postorino et al. (2017)

This is a systematic review and meta-analysis of 8 studies published between 1980 to 2016 for PIIs of disruptive behavior in 653 children with ASD ages from 2 to 14. Postorino et al. (2017) searched articles in three databases, and only peer-reviewed articles with randomized controlled trials (RCT) were chosen. A medium effect of PIIs on reducing disruptive behavior in individuals with ASD was found. The authors concluded that effective PIIs should last for at least 16 to 24 weeks with 10 to 12 sessions. These duration and treatment doses ensure parents have enough time to practice learned skills and receive profitable feedback from therapists.

Tarver et al. (2019)

A systematic review and meta-analysis were conducted to evaluate the parent and child outcomes of PT for children with ASD with behavioral and emotional problems. A total of 521 participants from 2- to 14-years-old with ASD were included from nine studies published between 2009 to 2015. Tarver et al. (2019) searched journals in three databases and only

included RCTs published in peer-reviewed journals. Positive effects were found in child disruptive behavior, hyperactivity, and parent stress based on parent reports. Effects on parent efficacy, internalizing behavior in ASD, parenting behaviors, observational and teacher outcomes were undetermined due to insufficient data.

Prior meta-analyses have been characterized by heterogeneous findings, often attributable to multiple studies having small sample sizes. In addition, most of the prior meta-analyses did not use comprehensive search terms, such that they obtained limited numbers of studies. Others included only published articles, which may have biased findings toward the direction of statistical significance. Furthermore, many reports did not compare results from other sources other than parents, another potential source of bias. And several had not compared findings across the type of control groups used in studies. Therefore, this thesis proposes an updated meta-analytic review of RCTs of PIIs with comprehensive search terms and an extensive manuscript search to obtain up-to-date research findings that go beyond prior meta-analyses. Published and unpublished studies were considered to obtain the most representative sample of data possible. Lastly, this thesis examines possible differences in the source of data and across the type of control group used in studies. Thus, it is necessary to conduct an up-to-date meta-analytic review that goes beyond previous meta-analyses and systematic reviews.

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