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Research

The Effect of Enhanced Milieu Teaching on Language Deficiency Among Children Who Have Autism Spectrum Disorder or Other Developmental Disabilities. A Meta-analysis and systematic review

L'effet de l'enseignement en milieu amélioré sur le déficit de langage chez les enfants atteints de troubles du spectre autistique ou d'autres troubles du développement. Une méta-analyse et revue systématique

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Abstract

We conducted a meta-analysis and systematic review to assess the effectiveness of Enhanced Milieu Teaching (EMT) procedures on language learning skills among toddlers and children who have language and communication impairments co-occurring with ASD and other developmental disabilities. Fifteen published studies were included in the present analysis with an overall of 67 parent-child dyad participants. The included studies were limited to published articles that used single subject designs and that reported AB design graphs. Studies that used group designs or did not display single subject design graphs were excluded. Using Nonoverlap of all pairs (NAP), we calculated overall and specific Effect Sizes (ES) to determine the impact of EMT on the language improvement and communication skills of child participants. We then compared the effects of EMT among ASD, and other developmental disabilities. Finally, a forest plot of Nonoverlap of all pairs (NAP) effect sizes was provided for visual interpretation. The findings suggested strong overall (ES = 0.89 with a 95% CI [0.85, 0.92]). Regarding the effectiveness of EMT, no statistically significant differences were found between child participants who have ASD (M= 0.88, SD = 0.07) and child participants who have other disabilities (M = 0.89, SD = 0.07); $T(13) = -0.12, P = 0.90$. EMT can be an effective technological package to incorporate in parent training for direct interactions with their child to develop their language and communication skills. We furthermore analyzed maintenance, generalization, social validity of the included studies, and highlighted some limitations.

Keywords: Autism spectrum disorder. Developmental disabilities. Enhanced Milieu Teaching. Meta-analysis

Resume

Nous avons mené une méta-analyse et une revue systématique pour évaluer l'efficacité des procédures d'enseignement amélioré en milieu (EMT) sur les compétences d'apprentissage du langage chez les

tout-petits et les enfants présentant des troubles du langage et de la communication concomitants avec des TSA et d'autres troubles du développement. Quinze études publiées ont été incluses dans la présente analyse, portant au total sur 67 participants à une dyade parent-enfant. Les études incluses se limitaient aux articles publiés utilisant des conceptions à sujet unique et rapportant des graphiques de conception AB. Les études qui utilisaient des conceptions de groupe ou n'affichaient pas de graphiques de conception pour un seul sujet ont été exclues. En utilisant le non-chevauchement de toutes les paires (NAP), nous avons calculé les tailles d'effet (ES) globales et spécifiques pour déterminer l'impact de l'EMT sur l'amélioration du langage et les compétences de communication des enfants participants. Nous avons ensuite comparé les effets de l'EMT sur les TSA et d'autres troubles du développement. Enfin, un tracé forestier des tailles d'effet de non-chevauchement de toutes les paires (NAP) a été fourni pour l'interprétation visuelle. Les résultats suggèrent une valeur globalement forte (ES = 0,89 avec un IC à 95 % [0,85, 0,92]). Concernant l'efficacité de l'EMT, aucune différence statistiquement significative n'a été trouvée entre les enfants participants atteints de TSA (M = 0,88, SD = 0,07) et les enfants participants ayant d'autres handicaps (M = 0,89, SD = 0,07) ; $T(13) = -0,12$, $P = 0,90$. L'EMT peut être un package technologique efficace à intégrer dans la formation des parents pour des interactions directes avec leur enfant afin de développer leurs compétences linguistiques et de communication. Nous avons en outre analysé la maintenance, la généralisation, la validité sociale des études incluses et mis en évidence certaines limites.

Mots-clés : Troubles du spectre autistique. Troubles du développement. Enseignement intermédiaire amélioré. Méta-analyse

1. Introduction

Currently known as a critical neurodevelopmental disorder, ASD has caused sufferings that affect not only the individual diagnosed with the disorder but also their family members and their communities on a larger scale (Christensen et al. 2018). The surge in the sum of individuals diagnosed with ASD is similarly alarming although a comparison on a geographic level indicates that the increase is not homogeneous (Fombonne, 2018; Xu et al., 2018). The Diagnostic and Statistical Manual (DSM-5) of the American Psychiatric Association (APA) (2013) redefined ASD by including conditions such as Asperger disorder, Pervasive developmental disorder-NOS (PDD-NOS), and autism alongside attentional or anxiety-related difficulties. Symptoms of ASD include impairments in social relationship and talk, as well as repetitive, ritualistic actions also portrayed as excessive activities. Other symptoms encompass difficult and associated losses in areas such as mental capabilities, unacceptable behaviors, and communication abilities.

ASD and Language Impairments

Much has been reported about the importance of language and communicative deficits among children who have ASD. Wetherby, Prizant, and Hutchinson (1998) asserted that the consequences of communication issues can be widespread in the early childhood and can be characterized by a deficit in the scope of communication aptitude, restricted aptitude to use other means of communication, deficiency of imaginary play, inadequate practice of collective encouraging affect, and defect in eye gaze. It is in this light that many parents whose children have ASD refer the latter for assessment when they worry about their deferred language achievements (De Giacomo & Fombonne, 1998). It was argued that children's language achievements by the age of five is strongly associated with prolonged prediction (Stone & Yoder, 2001; Szatmari et al., 2003). It is therefore understood that children who have language impairment alongside ASD are more likely to be at high risk for further diminished social growth when they are compared to their counterparts who do not have comorbid communication issues.

To help children who face language and communication impairments associated with ASD cope with their deficiencies, diverse treatments that encompass techniques such as video modeling, self-management, social games, peer mediated and peer tutoring approaches, visual cuing, pivotal response trainings, social-skills groups, direct instructions, and circle of friends have been successfully utilized. Various researchers conducted literature reviews and arranged the existing intervention literature in categories. For example, Weiss and Harris (2001) utilized classroom interventions, categories of scripts, self-management training, and social-skills training. Peer mediated articles were reviewed by DiSalvo and Oswald (2002), and Reynhout and Carter (2006) conducted a complete review on the effectiveness of social stories.

In the same vein, Wong et al. (2013) asserted that the best intervention strategies that are used in the context of ASD, that are applicable and successful, are the techniques that abide by the standard of Applied Behavior Analysis (ABA) because they require treatment proofs and are based on experimentations. The techniques used in ABA are labeled as procedures in which the individual, namely the child who has a disability is presented a specific behavior of interest. The presenter can be a peer, a parent, a teacher, a caregiver, or an interventionist. The child is then prompted to mimic the target behavior. When the behavior is successfully modelled the child's action is reinforced (Odom et al., 2010).

Although ABA is more concerned with single-subject design, a review of the literature revealed that both group designs and single subject designs have been used to gauge the effectiveness of EMT on language development among children who have ASD. The studies concerned both experimental studies and systematic review of the literature (Roberts & Kaiser, 2011).

Enhanced Milieu Teaching

EMT has been defined as an evidence-based language intervention that uses spontaneously occurring interactions to facilitate early childhood language abilities. Girolametto and Weitzman (2002) portrayed EMT as a fusion of intervention standard that associates approaches from the interactive model. EMT combines characteristics of both behavioral and social interactionist methodologies to verbal intervention. The three components of EMT are as it follows: First, there is an environmental arrangement that is utilized to stimulate the individual participant's commitment with the suggested activities (Ostrosky & Kaiser, 1991). Second, come responsive interaction approaches utilized to build up social, informal communication, and to shape new language structures (Weiss, 1981). Thirdly, milieu teaching techniques are used to motivate, imitate, and conclude the use of innovative communication types in their practical environments. A substantial body of research has proven that EMT can be used to enhance language aptitude in young children with language impairments (McCathren, 2000) who have ASD or who have other disabilities than ASD (Hancock, Kaiser, & Delaney, 2002).

Many studies investigating the effect of EMT enrolled children who had language impairment but did not have any ASD diagnosis (Kaiser, Hemmeter, Ostrosky, Fischer, Yoder, & Keefer, 1996; Kaiser, 1994; McLeod, Hardy, & Kaiser, 2017). Results suggested that EMT can be an effective technology that helps children improve their language and communication abilities. In many of the studies, participants acquired target word sets upon completion of several sessions of interventions. Despite the effectiveness of EMT as revealed in past studies, EMT-related meta-analytic studies have not been conducted to this date with children as target participants.

Previous EMT meta-analytic studies conducted over the past 10 years were limited to children whose ages ranged from 18 and 60 months. The target participants in those meta-analyses, however, were parents who received EMT training. Major research questions concerned the effect of EMT on parents,

not children. Furthermore, existing meta-analyses also included group design studies (Roberts & Kaiser, 2011). Most recently another meta-analysis was conducted that emphasized language impairment among children from low economic status alone (Heidlage et al. 2020). To our knowledge, very few meta-analytic studies if at all emphasized language impairment that co-occurs with a list of disabilities including ASD and low social economic status. This is the first meta-analytic and systematic review that utilizes multi-methods to corroborate findings about the effect of EMT on ASD and other developmental disabilities.

Aim

The purpose of the present study was to investigate the effectiveness of EMT on language problems among children who have ASD or other disabilities. Also, more specifically, the present study aims at emphasizing single-subject design meta-analysis, in an attempt to abide by Wong et al. (2013)'s suggestion to use ABA designs as excellent intervention approaches to implement and to gauge target participants' achievement. This study intends to answer the following questions:

1. What is the effectiveness of EMT on language impairment that co-occurs with ASD or other disabilities?
2. Is EMT more effective for language impairment that co-occur with ASD than with other disabilities?
3. Is EMT a socially valid intervention?
4. What are some methodological and strengths of the included studies?

2. Matériaux et Méthodes

The investigators followed Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines for systematic reviews., which comprises a search approach, selection criteria, data extraction, and procedures for data analysis (Liberati et al. 2009).

Eligibility Criteria

Studies that included the following characteristics were qualified for this systematic review:

1. Researchers taught parents, caregivers, or teachers how to use EMT. The parents, caregivers or teachers then utilized the training with their children to improve their communication skills.
2. Children were directly trained by interventionists.
3. Single-subject design with graphs were used.
4. Rigor of the studies could be assessed
5. Fidelity of implementation was detectable
6. Visual analyses were possible
7. Child participants were diagnosed with either ASD, autism, Asperger, or other disabilities such as Down syndrome, Developmental disabilities or were referred as pertaining to low social economic status.
8. Studies addressed communication deficits.
9. Studies were published in a peer-reviewed journal.
10. English versions of the studies were available.

Information Sources and Search

The researchers conducted systematic search to select experimental studies on Enhanced Milieu Teaching. The initial search encompassed studies that were published between 1994 (based on the availability of oldest articles) and 2022. They searched EBSCOhost which includes Social Sciences, SAGE, Psychological Abstracts, Elsevier, Index, and ERIC PsycInfo, Routledge, Springer, psycINFO,

and Google scholar. For Google scholar for example, where most included articles were retrieved, the following key words were utilized: Enhanced Milieu Teaching, OR the effect of enhanced milieu teaching on children, OR enhanced milieu teaching and autism, ASD, PDD-NOS, OR Enhanced milieu teaching and language impairments, teaching parents enhanced milieu, teaching parents to promote language and EMT, AND the effect of Enhanced milieu teaching on developmental disabilities. Initially, 3,341 articles were found. The investigators furthermore undertook an ancestral exploration for extra articles under the reference section of each the included studies and conducted a hand search. The investigators included gray literature in the search, that is theses and dissertations and they found 18 additional articles. Based on the eligibility criteria, the researchers selected 23 studies. No additional studies were found. Overall, eight studies were later excluded from this meta-analysis because they did not present AB graphs, because the graphs presented did not concern child participants, and because the articles contained group designs. See figure 1. The researchers identified and examined the abstracts of articles that were chosen for further comparison with the inclusion criteria. Final decision was made on each article after reading the whole article. The researchers selected 15 single-subject design studies.

Data Selection

See Figure 1 for the selection process based on PRISMA. The same data studies were included in both the systematic review.

Study selection and Data Extraction

Using a coding sheet, the author independently extracted data from all the included studies. Another volunteer faculty member was provided with the same coding sheet and was required to go over the same procedure independently, that is, to extract the data. Wherever agreement was not reached, the two researchers extracted the data together until 100% agreement was reached.

a. Coding Procedures for Study Characteristics

i. Coding Participants' Characteristics

All the included articles were coded for all participants, including child participants, their parents or caregivers, their genders and their diagnosis or social condition. We furthermore coded parent's or caregivers' role: Parents or caregivers must receive training from an expert using EMT. Then the parents or caregiver must interact with their child as they teach, reinforce, prompt, model, or mediate. Adult interventionists could also directly work with child participants to improve their language and communication deficits. We code "1" all the above criteria in each article when they were met.

b. Coding Design

We recorded for every study the design that was utilized to prove the experimental control. The latter involved ABAB design with withdrawal treatment, multiple-baseline, and reversal designs. We coded them "1" when they met the inclusion criteria.

c. Coding Procedures for Data Collection

It is possible to use AB design graphs to visually scrutinize the majority of single-case experimental designs. The investigators only included studies that provided multiple single-subject design graphs. However, graphs that represented the performance of child participants were prioritized. Published articles that reported graphs were valued 1. Articles that did not possess any graphs for participating children were simply rated 0 and were excluded from the present systematic review. Results from both investigators were finally compared, discussed, and agreed upon.

Data Items

The included articles were then analyzed for variables such as participant demographics such as ages, health condition, targeted skills, intervention, study settings, research designs, and results of the studies, and some quantitative data such as non-overlap of all pairs (NAP) (Parker & Vannest, 2009). Table 1 provides reference, design, methodology rigor.

Assessing Risk of Bias

The researchers used ROBINS-I (Sterne et al., 2016) to assess Risk of Bias. ROBINS-I was found to be suitable to researchers who conduct systematic reviews that involve non-randomized studies. Bias

areas included in ROBINS-I encompasses the following: pre-intervention (in which bias could be due to either [1] confounding and [2] in selection of participants into the study), at intervention (in which bias could be due to [3] classification of interventions), and Post-intervention (in which bias could be due to [4] the deviations from intended interventions, [5] missing data, [6] measurement of outcomes, and [7] the selection of the reported result). An interpretation table was provided that facilitates clarification of domain-level and general risk of bias (Sterne et al., 2016). The author independently rated all 15 studies and compared his results with those of the volunteer faculty member, with 100% agreement. All studies were included in the judgement “low or Moderate risk of bias” in that all studies were “sound for a non-randomized study with regard to this domain but cannot be considered comparable to a well performed randomized trial”. The study provides sound evidence for a nonrandomized study but cannot be considered comparable to a well performed randomized trial. The study is judged to be at low or moderate risk of bias for all domains” (Sterne et al., 2016).

Synthesis of Results

Effect sizes were not provided in the included studies. The researchers extracted them from the AB graphs provided in the articles.

Planned methods of analysis

Though the focus of the present study was to review, tentative meta-analysis was computed based on NAP (Parker & Vannest, 2009).

Risk of publication bias across studies

Since Effect sizes were extracted from the AB design graphs, the researchers did not estimate risk of publication bias. Effect sizes were not provided in the studies.

Additional analyses

The researchers also conducted meta-analysis on subgroups of studies that include children who have ASD and children who have other disabilities and used *t* test to compare the subgroups.

Rigor of Intervention

Rigor of design was based on the guidelines for evaluation of the rigor of interventions on ASD by Reichow et al. (2008) who utilized indicators to decide whether the intervention rigor was either strong, adequate, or weak. Multiple indicators labelled primary and secondary were utilized by Reichow and his colleagues to identify levels of rigor in the interventions. The levels were either strong, adequate, or weak. The primary indicators assessed satisfactory demographic information such as participants' age and gender diagnosis, independent variable, exact description of the dependent variable, satisfactory results of visual analysis, and successful demonstration of the experimentation. The secondary indicators assessed elements that prove rigor such as the documentation of inter-observer agreement or treatment fidelity alongside the documentation data collection blind raters, generalization, maintenance, social validity. All included studies passed the rigor test when assessed by the principal investigator and by the volunteer faculty member individually with 100% agreement. See table 1.

Data Analysis

Using the NAP method (Parker & Vannest, 2009), ES was computed for each child participant who had a diagnosis of ASD, Down syndrome, or other developmental disabilities that hinder communication, or who was identified as of low social economic status. Effect sizes for all child participants were calculated for each study. Finally, the researchers calculated the overall effect size. The NAP hand-computation approach was preferred and used to compare each baseline phase A data point with each intervention phase B data point. First and foremost, the total possible pairs (total N) were calculated. The total possible pair is defined as the number of data points at baseline A times intervention phase B ($NA \times NB$). Secondly, all overlapping pairs were counted by assigning one point to each overlap and half a point to each tie. Thirdly, overlapping pairs were subtracted from the total possible pairs to obtain the non-overlap count. And finally, the non-overlap count was divided by the total possible pairs to attain the NAP effect size.

Table 1. Table of Reference, design, methodology rigor

Authors	Methodology Design	Participant Rigor	Intervention N	Results Age/ Types	Outcome Measure	Treatment Effectiveness	Effect size (NAP)
Brown and Woods (2015)	Multiple-baseline design	Strong	9	12-28/ Training in communication	Higher rates of targeted communication needed.	8 children increased behaviors across the intervention phases.	0.82
Hancock and Kaiser (2002)	Modified single subject design across children and across families	Strong	4 (3 boys; 1 girl)	35 to 54/ Play with age-appropriate Toys.	Needs of changes in child language targets and social communication, maintenance, and generalization	Positive changes in social communication	0.94
Hancock et al. (2002)	AB single-subject designed replicated across five participants	Strong	5 (3 boys; 2 girls)	20-48/ Training in use of approaches during interaction	Expected changes in children's language and behaviors.	Children demonstrated increases in language during exchanges.	0.81
Hampton et al. (2019)	Multiple-baseline design	Strong	3	5-7/ Engagement with children in EMT-based play.	increase the diversity of language and the frequency of spontaneous social communication were needed.	Increases in number of different words and spontaneous utterances.	0.92

Table 1 (Continued)

Authors	Methodology Design	Participant Rigor	Intervention N	Results Age/ Types	Outcome Measure	Treatment Effectiveness	Effect size (NAP)
Harjusola-Webb et al. (2012)	Multiple-baseline design	Adequate	3	37- 44/ Promotion of approaches and child language use	Improvement of child expressive communication was needed	Children increased the frequency of expressive comm.	0.93
Kaiser (1994)	Multiple-baseline design	Adequate	4	57- 71/ Responsiveness to adult requests for communication	Improvement of the functional communication was needed.	Production of systematic changes in children's communication	0.84
Kaiser et al. (2000)	Modified single subject design across children and across families	Adequate	6	32-54/ Parent use specific strategies to work on during the practice session with	Improvement and generalization in language targets and social communication	All children showed improved communication targets and productive language.	0.86

Kaiser et al. (1996)	Multiple-baseline design	Adequate	12	28-56/ Parents used responsive interaction and nonverbal strategies with their child.	n were needed. Generalization of use of new language needed.	Positive effects were observed for all children.	0.85
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Table 1 (Continued)

Authors	Methodology Design	Participant Rigor	Intervention N	Results Age/ Types	Outcome Measure	Treatment Effectiveness	Effect size (NAP)
Kaiser and Hester (1994)	Multiple-baseline design	Strong	6 (5 boys; 1 girl)	37-80/ Play-based interaction sessions	Need of increases in use of target language, in frequency, complexity, and diversity	All six participants indicated increases in the treatment.	0.95
McLeod et al. (2017)	Multiple probe design across behaviors replicated across participants	Adequate	2	40-42/ Book reading in & play-based interventions.	Vocabulary diversity, increased social communication, and complexity of language were needed	Children acquired target word sets.	0.97
Nunes and Hanline (2007)	Multiple-baseline design	Adequate	1	4.6 years/ Mother used learned naturalistic teaching techniques in her home with her child.	Improvement in vocalization, verbalization, gestures, signs, and frequency were needed	Intervention was paired with higher occurrences of child's talk.	0.76
Ogletree et al. (2012)	Multiple-baseline design	Adequate	1	84 months/ Routine plays with objects. Photograph exchange as a method of requesting.	Need for the Promotion of photograph exchange as a means of symbolic requesting	Demonstration effectiveness in promoting voluntary photograph exchange	0.86

Table 1 (Continued)

Authors	Methodology Design	Participant Rigor	Intervention N	Results Age/ Types	Outcome Measure	Treatment Effectiveness	Effect size (NAP)
Olive et al. (2007)	Multiple-baseline design	Strong	3	45 to 66/ Toy-based intervention	Independent use of gestures and vocalization during play were needed	Successful learning of the VOCA to request items increased their total requesting during play	0.94
Roberts et al. (2014)	Multiple-baseline design	Adequate	4	25-38/ Play-based intervention	Generalization of language skills to new activities at home.	All children exhibited communication targets and in performances.	0.94
Wright et al. (2013)	Multiple-baseline design	Strong	4	23-29/ Play-based treatment sessions.	Increase in signing was needed.	Participants demonstrated an increase in signing.	0.97

3.Results

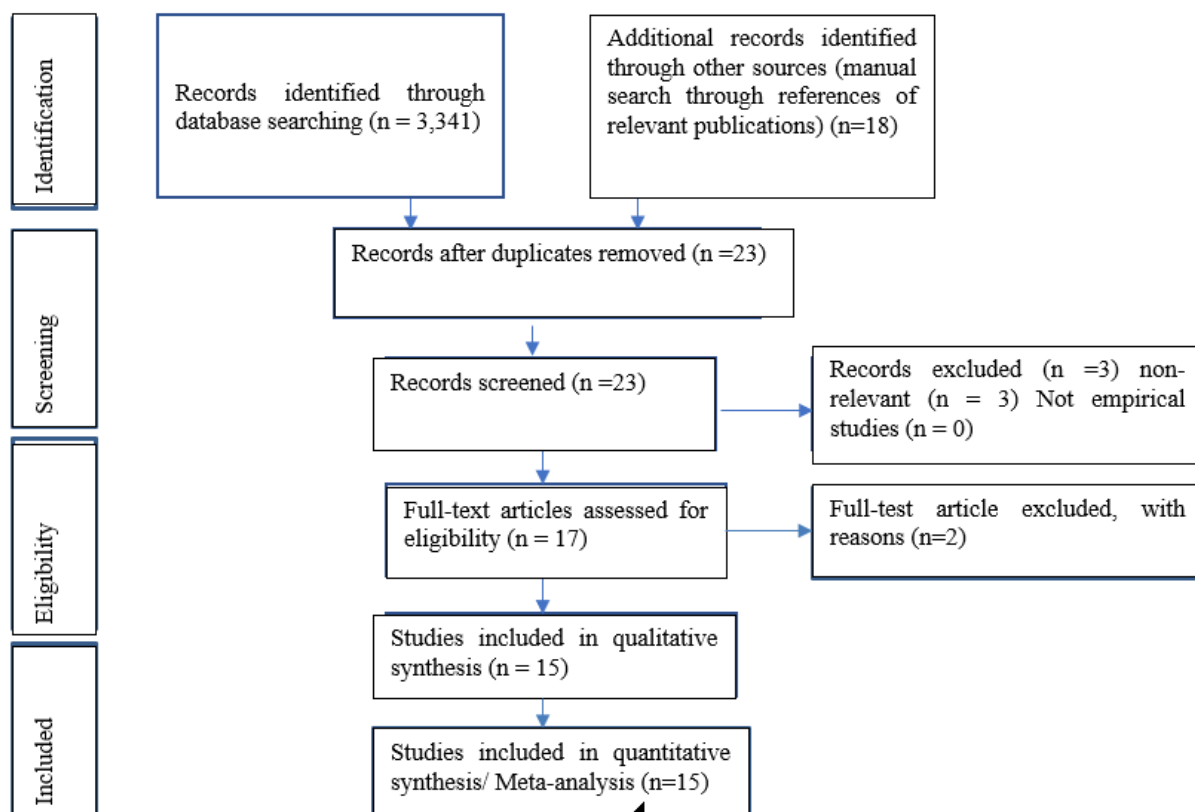


Figure 1. Flow chart of the selection process based on PRISMA

3.1. Participants

Fifteen studies were included with an overall of 67 parent-child dyad participants. Children were diagnosed with either ASD, autism, PDD-NOS, or Asperger, Down syndrome, Language Delays, low-income households with delayed language skills, Articulation disorder, General developmental delay Behavior problem, and Cerebral palsy. Language delay was their shared characteristic. This sample size included 63 male and four female participants whose ages ranged from 12 to 84 months with an average of 38.90 months (SD = 19.02). Most children were accompanied by their mothers, one by his father, and another one was participating with his grandmother. Table 1 provides additional information about adult participants.

3.2. Settings

The studies included in this meta-analysis were conducted in multiple settings such as classrooms or school settings (Harjusola-Webb & Robbins, 2012; Olive, De la Cruz, Davis, Chan, Lang, O'Reilly & Dickson, 2007; Hancock et al., 2002; Kaiser & Hester, 1994), in small playrooms (Hampton, Harty, Fuller, & Kaiser, 2019; Kaiser, 1994), in therapy clinics or laboratories (Hardy, & Kaiser 2017; Roberts, Kaiser, Wolfe, Bryant, & Spidalieri, 2014; Wright, Kaiser, Reikowsky, & Roberts, 2013; Ogletree, Davis, Hambrecht, & Phillips, 2012; Toğr Hancock & Kaiser, 2002 ; McLeod, Kaiser, Hancock, & Nietfeld, 2000, Kaiser et al., 1996), in family homes (Brown & Woods, 2015; Nunes, & Hanline, 2007).

3.3. Target Behaviors

All child participants shared communication problems or language deficiencies at different levels of needs. However, many children needed improvement in their communication patterns or additional language support (Hampton et al., 2019; Brown & Woods, 2015; Roberts et al., 2014; Harjusola-Webb, & Robbins, 2012; Hancock et al. 2002; Hancock & Kaiser, 2002; Kaiser et al., 2000; Kaiser et al., 1996; Kaiser & Hester, 1994; Kaiser, 1994) whereas other children needed to improve the frequencies or rate of their speech production (Nunes, & Hanline, 2007). Two studies emphasized children's abilities to make request (Ogletree et al., 2012; Olive et al., 2007). Two other studies emphasized children's need for words, vocabularies or manual signs (McLeod et al., 2017; Wright et al., 2013).

3.4. Research Designs

Many included studies utilized a multiple- baseline design to conduct their experimentations (Hampton et al., 2019; Brown & Woods, 2015; Roberts et al., 2014; Wright et al., 2013; Harjusola-Webb, & Robbins, 2012; Ogletree et al., 2012; Nunes, & Hanline, 2007; Olive et al., 2007; Kaiser et al., 1996; Kaiser, 1994; Kaiser & Hester, 1994). One study used an AB single-subject designed replicated across five participants (Hancock et al., 2002). Two studies used a modified single subject design across children and across families (Hancock & Kaiser, 2002; Kaiser et al., 2000). In one study, the experimentation was conducted using a multiple probe design across behaviors replicated across participants (McLeod et al., 2017).

3.5. Interventions

The purposes of most studies were to train parents or caregivers on how to use EMT with their children who have communication deficits. In the latter studies, parents, caregivers or teachers attended several sessions and were taught to be responsive to their child participants (Brown & Woods,

2015; Kaiser et al., 2014; Harjusola-Webb & Robbins, 2012; Nunes & Hanline, 2007; Hancock et al., 2002; Kaiser et al., 2000; Kaiser et al., 1996; Kaiser & Hester, 1994). In Brown and Woods (2015), interventionists instructed parents to apply communication approaches in their daily routines in their families. In terms of results, eight children increased their target behaviors across the intervention phases.

In other studies therapists directly implemented EMT on the child's target behavior. For example, the interventionist demonstrated spoken and prompted words and manual signs to children (Wright et al., 2013) whereas in Hampton et al. (2019), the therapist executed EMT on the frequency of oral language of several child participants. Many other studies conducted similar interventions (McLeod et al., 2017; Ogletree et al., 2012; Olive et al., 2007; Hancock & Kaiser, 2002). In one study, the investigators enrolled a trainer, a teacher, and a child's peer for each child participant. The aim was to examine the impacts of EMT on preschoolers who have developmental disabilities. The EMT technique was combined with environmental arrangement, responsive communication approaches, and specific elements of EMT to enable participants' commitment to the intervention. The EMT technique additionally encompassed context specific modeling of oral speech and limited incidental teaching to teach participants particular language skills. Results suggested that EMT can generate effective modifications in children's language (Kaiser, 1994). In most of the included studies, participating parents argued that EMT approaches were effective and can be used to enhance children's spoken language. Results were similar across studies. Child participants successfully developed target word within a few sessions in a study (McLeod et al., 2017).

3.6 Nonoverlap of all pairs

We calculated an overall ES for all 15 studies utilizing NAP methodologies and found 0.89 with a 95% CI [0.85, 0.92]. Regarding additional analysis, we compared participants who have ASD diagnoses with those who have other developmental disabilities. Other disabilities included Language Delays, emergent behavior, Down syndrome, Articulation Disorder, General Developmental Delay, behavior problem, Cerebral palsy, language impairment, and being at risk due to low socio-economic status. We conducted an independent t test and found no statistically significant difference between child participants who have ASD ($M = 0.88$, $SD = 0.07$) and child participants who have other disabilities ($M = 0.89$, $SD = 0.07$); $T(13) = -0.12$, $P = 0.90$. A forest plot of NAP effect sizes was provided for visual interpretation. See figure 2. Additional information was provided regarding effect sizes and standard deviations. See Table 2.

General guidelines have been utilized for the interpretation of NAP outcomes. NAP values ranging from 0 to 0.65 were considered as having weak effects, those ranging from 0.66 to 0.92 as having medium effects, and those ranging from 0.93 to 1.01 as having large or strong effects. Furthermore, transforming NAP to a zero-chance level yields the following equivalent ranges: Values ranging from 0 to 0.31 are considered weak, values ranging from 0.32 to 0.84 are considered medium, and values ranging from 0.85 to 1.0 are considered large or strong (Parker and Vannest, 2009). Considering the guidelines, we interpreted the overall NAP equaling 0.89 as being a strong ES for EMT.

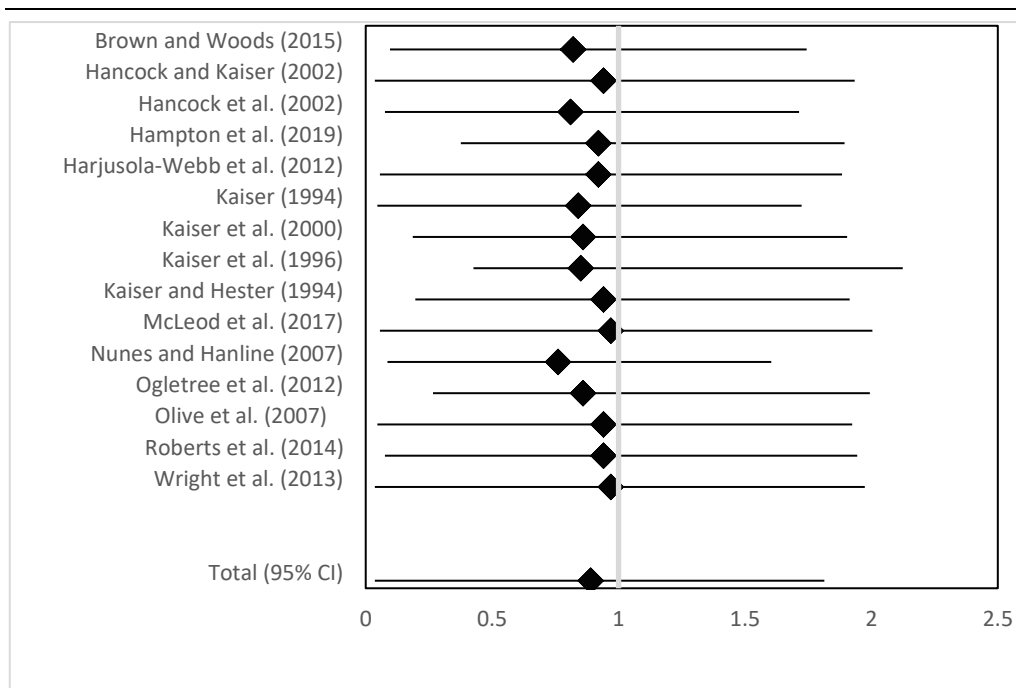


Figure 2. Forest plot of the NAP analysis for all included studies with 95% confidence interval.

3.7. Social Validity

Reports of social validity in single-subject design are deemed important. In this light, in several of the included studies the authors gave it specific attention by conducting some survey regarding the perception of parents, caregivers or teachers on the effectiveness of EMT. Parents were required to complete satisfaction survey (Hancock & Kaiser, 2002; Hancock et al., 2002; Kaiser et al., 1996). In Brown and Woods (2015), parents or caregivers were requested to complete written questionnaires upon completion of the intervention stages. The goal was to

Table 2: Summary of effect size, minimum, maximum standard deviation, and number of participants

Authors	ES	Min	Max	SD	Total
Brown and Woods (2015)	0.82	0.72	0.92	0.2	9
Hancock and Kaiser (2002)	0.94	0.9	0.99	0.07	4
Hancock et al. (2002)	0.81	0.73	0.9	0.06	5
Hampton et al. (2019)	0.92	0.54	0.97	0.07	3
Harjusola-Webb et al. (2012)	0.92	0.86	0.96	0.08	3
Kaiser (1994)	0.84	0.79	0.88	0.03	4
Kaiser et al. (2000)	0.86	0.67	1.04	0.11	6
Kaiser et al. (1996)	0.85	0.42	1.27	0.03	12
Kaiser and Hester (1994)	0.94	0.74	0.97	0.03	6
McLeod et al. (2017)	0.97	0.91	1.03	0.05	2
Nunes and Hanline (2007)	0.76	0.67	0.84	0.17	1
Ogletree et al. (2012)	0.86	0.59	1.13	0.17	1
Olive et al. (2007)	0.94	0.89	0.98	0.08	3
Roberts et al. (2014)	0.94	0.86	1	0.05	4
Wright et al. (2013)	0.97	0.93	1	0.04	4

describe the intervention's value, appropriateness, and practicability. To accomplish this, parents responded to a Likert-like survey questionnaire and answered a few open-ended questions in relation with the intervention procedure. In one study, though social validity was assessed, the researcher

reported that the measurement was not formal. In other words, anecdotal report was suggested as a social validity report (Olive et al., 2007).

Despite the positive feedbacks, more than half of the included studies did not provide any social validity reports (Hampton et al., 2019; McLeod et al., 2017; Roberts et al., 2014; Wright et al., 2013; Harjusola-Webb, & Robbins, 2012; Ogletree et al., 2012; Nunes & Hanline, 2007; Kaiser et al., 2000; Kaiser, 1994; Kaiser & Hester, 1994). See table 3 for reports on individual studies.

3.8. Maintenance and Generalization

In several studies, the authors measured and reported both maintenance and generalization. In Hancock et al. (2002) for example, parents or caregivers studied the intervention techniques and further generalized them as they interacted at home with their children. It was argued that parents or caregivers also maintained constructive variations over half a year after the intervention sessions. Child participants in turn, exhibited positive changes in language acquisitions and target behaviors throughout the intervention although maintenance and generalization of their improvement varied.

In Roberts et al. (2014) generalization of strategy was implemented at home, and it was based on caregiver and by strategy. It was argued that the participating caregivers used multiple strategies that included home play, book reading and during snack times. Regarding maintenance, it was argued that caregivers could successfully maintain the strategies that they learned previously alongside a new approach that they learned at the time of the intervention sessions at a clinic. Other studies reported similar maintenance and generalization (Nunes & Hanline, 2007; Kaiser et al., 2000; Hancock & Kaiser, 2002; Kaiser & Hester, 1994).

Analysis of the included articles suggested that several studies, however, reported on maintenance alone. The latter studies did not mention any information regarding generalization (Brown & Woods, 2015). Ogletree et al. (2012) reported on a milieu teaching system that they utilized to train a seven-year-old boy photograph exchange as a way of requesting. It was concluded that EMT was relatively effective in promoting spontaneous photograph exchange. Other studies also reported similar practices with varying durations and approaches. (Kaiser et al., 1996).

Generalization alone was also reported in a few studies. Wright et al. (2013) reported that all child participants generalized their utilization of learned signs to their caregivers at home. The authors acknowledged the absence of maintenance data in their study. Whereas Kaiser (1994) reported generalization in their study, Hampton et al. (2019) asserted that there was little evidence of generalization to different individuals and settings in their study. Three studies were included in the present meta-analytic study that reported neither maintenance nor generalization (McLeod et al., 2017; Harjusola-Webb, & Robbins, 2012; Olive et al., 2007).

Table 2 Summary of generalization, maintenance, and social validity

	Generalization	Maintenance	Social Validity
Brown and Woods (2015)		X	X
Hancock and Kaiser (2002)	X	X	X
Hancock et al. (2002)	X	X	X
Hampton et al. (2019)	X		
Harjusola-Webb et al. (2012)	X		
Kaiser (1994)	X		
Kaiser et al. (2000)	X	X	
Kaiser et al. (1996)		X	X
Kaiser and Hester (1994)	X	X	
McLeod et al. (2017)	X		
Nunes and Hanline (2007)	X	X	
Ogletree et al. (2012)		X	
Olive et al. (2007)	X		X
Roberts et al. (2014)	X	X	
Wright et al. (2013)	X		

4. Discussion

The present study aimed at investigating the effect of EMT on language impairment among child participants who have ASD and other developmental disabilities that impair language acquisition and development. The study attempted to answer questions related to the effectiveness of EMT on language impairment related to ASD and other disabilities, the social validity of interventions, and the assessment of methodological and strengths of the included studies. Findings suggested that EMT can be very helpful as a treatment that improves children's language and communication.

Regarding the effectiveness of EMT, no statistically significant differences were found between children who have ASD and those who have other disabilities. EMT was found to be equally effective for participants who have language impairment alongside ASD and those who have language impairment alongside other developmental disabilities. EMT was also found to be a socially valid intervention with limitations. Very few concerns were raised regarding methodological and strengths of the included studies.

The findings of the present meta-analysis support previous studies. For example, in a study conducted by Toğram and Erbaş (2010), findings showed that the utilization of EMT during an intervention to help child participants resulted in significant improvement. Each participating child learned his language targets and all three children exhibited an improvement in the proportion of overall utilization of target words upon completion of the training.

The present finding is also in support of previous studies using EMT whose participants have other disabilities than ASD and who were toddlers. Most recently, Philp et al (2021) conducted a study whose participants received the diagnosis of a cleft lip/alveolus or cleft lip and palate. Participants' ages ranged from 21 and 27 months of age. Although participant parents received training through telepractice to successfully use EMT, their children improved their communication. The intervention resulted in increased language and communication outcomes for their children who have cleft lip and palate. Similar studies were undertaken whose participants have other disabilities than ASD. In Quinn, Kaiser, and Ledford (2021), four toddlers who had language delays and whose ages ranged from 18 to 27 months participated and showed moderate and variable increase in communication during their interaction with their parents. Wright and Kaiser (2017) conducted a study whose four child participants were diagnosed with Down syndrome. Results suggested a practical association between the completion of the parent coaching and their utilization of the particular EMT mediation approaches. Also, two children displayed a regular increase in their overall language acquisition during the intervention sessions whereas the other children did not show sign of improvement over time.

In Hatcher and Page (2020), parents were instructed on how to use EMT strategies at home with their children. The strategies included specifically, milieu teaching prompts, matched turns, time delays, and expansions. Not only the parents successfully learned and applied the verbal communication support approach to set standard points, but all four child participants also improved their speaking abilities. Hatcher and Page aimed at examining the effectiveness of teaching four parents from low-socioeconomic status how to use EMT with their children who have language delay. The results suggested positive changes in child participants' language. It can be argued that the effectiveness of EMT is not limited by child participants' age, gender, type of disability, type of EMT delivery to parents, or intervention setting, as interventions took place in multiple settings including homes, schools, and clinics.

4.1. Limitations and Future Directions

Some limitations, however, were listed that include the assessment of generalization and maintenance in several studies. The report of generalization and maintenance is deemed very important and desirable in single-subject designs as they help further appreciate published studies and more importantly assess rigor of intervention. It is in this light that it was argued that generalization and maintenance are infrequently assessed in studies in which parents implement language intervention (Kaiser et al., 1996). Regarding the included studies in the present investigation, three studies, however reported neither maintenance nor generalization. Several studies reported on maintenance alone and similarly, generalization alone was also reported in a few studies. Given the importance of reporting on maintenance and generalization, future researchers should include such reports as part of the evaluation of their studies alongside social validity.

Further limitations were also found in the included studies regarding social validity. Although most studies provided significant results and positive feedbacks, more than half of the included studies did not provide any social validity reports and in one study, it was asserted that the conducted social validity report was informal. Social validity reports should also be considered as an essential part of all single subject designs as well as data graphs for both child and parent participants. Another limitation in this study was the inability to compare qualitatively subgroups of participants on the effectiveness of EMT. Using NAP to compute effect size was also perceived as another limitation in circumstances in which the method could face difficulties in extracting the data from a very multifaceted graph. Finally, caution is required regarding the interpretation of the above reported results insofar as this study included many child participants who were diagnosed with dissimilar disabilities and could have presented different degrees of control of their language usage.

4. Conclusion

This present study contributes an understanding of how EMT affect children's improvement of their communication skills, through the lens of single subject designs and their bar graphs. In fact, the limited number of included articles was due to the fact that many published articles did not provide any such data graphs for child participants. The articles only provided graphs on the achievement of parents or caregivers. Given that the present study aimed at emphasizing the achievement of child participants, more child participants' accomplishment graph reports would have added more value to the present study. Graphs for both parents and children would have been appreciative. A general remark made throughout the current study concerns some parents' partial ability to successfully learn and implement EMT with their children, suggesting that the learning and application of EMT by parents can have some negative effect on the improvement of child participants' improvement of their language and communication skills.

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