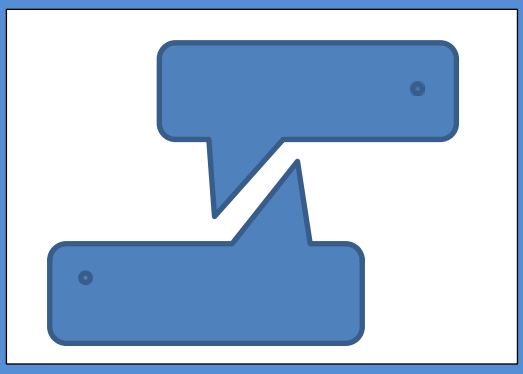
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Associations between social emotional and language domains in toddlerhood – The Steps Study

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Abstract

This research has highlighted a risk for social-emotional and behavioural (SEB) problems in children with developmental language disorder. Associations with delays in social-emotional competencies and language development have been found in both children with language delays and children with language disorders, but findings on the association between SEB problems and language delay in very young children are mixed. The purpose of this study was to explore whether there is an association between social-emotional competencies and SEB problems measured at 18 months and language skills measured at 2 years of age. In addition, background factors often related to language development were controlled statistically. The data were gathered from parents of 591 children with questionnaires in a Finnish cohort study (the STEPS study). Social-emotional competencies and SEB problems were assessed with Brief Infant-Toddler Social and Emotional Assessment (BITSEA) and language skills with MacArthur Communicative Development Inventories (CDI-T). The data were analysed with forced entry multiple linear regression analyses with three language variables (expressive vocabulary, grammar and M3L) as outcome variables and SEB problems, social-emotional competencies and background variables as independent variables.

Children with delay in social-emotional competencies in early toddlerhood according to the BITSEA cut-off scores had significantly smaller expressive vocabularies measured half a year later at 24 months of age than children with no delay in social-emotional competencies. SEB problems were not associated with weaker language skills. Child's sex was the most important background factor contributing to all of the language variables in favour of girls.

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Findings indicate that a delay in social-emotional competencies in early toddlerhood can be associated with a delay in development of expressive vocabulary in later toddlerhood. Language development of young toddlers with a delay or deficit in social-emotional competencies should be examined as early as possible to support language development when needed.

Keywords BITSEA, CDI, early language development, social-emotional competence, social-emotional problems

1. Introduction

Language and social-emotional development are interconnected in the early stages of a child's development. Social interaction with other people and sufficient exposure to language are prerequisites for language development (Tomasello, 2009). In interaction with adults, children are also socialized with respect to how to behave and how to read what others are conveying, which supports social-emotional development (Eisenberg et al., 2014).
For some children, language development does not progress in a typical way and many of them can have social-emotional and behavioural problems (SEB problems hereafter). The associations between these difficulties have been studied but results in young children are slightly contradictory.

1.1. Social-emotional competencies and problems

Social-emotional competencies refer to factors in social relationships with others such as attention skills, compliance, imitation and play behaviour, emerging empathy, and prosocial peer behaviours, which create a foundation for other social-emotional skills in children (Carter et al., 2003). The main elements of social-emotional competencies are emotional self-regulation, social problem solving and prosocial behaviour, which are important contributors to the child's effective and successful interaction with other people (Rose-Krasnor & Denham, 2009, 163–172). Social-emotional competencies develop in interaction with other people (Rose-Krasnor & Denham, 2009, 164). To be able to interact with others requires communication skills. In fact, good communication skills in toddlerhood have been associated with good social-emotional competencies (Haapsamo et al., 2012; Horwitz et al., 2003), and late talkers have been found to have more problems in these competencies than children with typical language development (Thurm et al., 2018).
Good social-emotional competencies are also important in preventing early-emerging SEB problems, because they help the developing child face the challenges met in interaction with others (Briggs-Gowan et al., 2001; Carter et al., 2003). On the other hand, children lacking age-appropriate social-emotional competencies may have a risk of developing SEB problems.
In previous research it has been observed that even young toddlers can have SEB problems, for example in a study conducted by Möricke et al. (2013) with young children at 14–15 months of age. The prevalence of SEB problems in toddlers was 12–16% in a study by Briggs-Gowan and colleagues (2001) and 16–18% in a study by Skovgaard and colleagues (2007). In a literature review by Brauner and Stephens (2006), the estimated

prevalence of these problems in children aged between 0 and 5 years ranged from 9.5% to 14.2%.

SEB problems are usually divided into three domains: externalising, internalising and dysregulation (Carter et al., 2003). Some externalising problems are expressed as difficulties with impulsivity, high activity and aggression or defiance. Almost every child shows some of these behaviours, but when these types of behaviours are too frequent and persistent it can cause problems (Carter et al., 2003). Internalising problems include e.g. depression, social withdrawal, fearfulness, worry, nervousness, and distress when separated. These behaviours belong to typical development but are considered problematic if they become too frequent and/or over-intense, and if the child has many co-occurring internalising problems (Briggs-Gowan & Carter, 2006; Carter et al., 2003).

Children start regulating their emotions as young as 6 months old by looking away or self-soothing, which lowers the child's negativity in frustrating situations (Eisenberg et al., 2014). Self-regulation has an important role in social development and is used to regulate negative emotionality and also behaviour. Poor self-regulation skills have been shown to predict weaker social skills later in life, especially for those who have a risk for developmental language disorder (Aro et al., 2012). Dysregulation problems have been defined as problems with negative emotionality, sleeping, eating, and sensory sensitivities (Briggs-Gowan & Carter, 2006; Carter et al., 2003).

1.2. Associations between difficulties in language development and social-emotional competencies and problems

Approximately 7% of children in kindergarten have a developmental language disorder (DLD) according to Tomblin et al. (1997). Typically, children with DLD have receptive problems in language comprehension (Montgomery et al., 2016) and tend to have delays in vocabulary growth (Fisher, 2017; Rice et al., 2010; Rice & Hoffman, 2015) and grammatical development (Rice et al., 2010). In addition, they tend to have lower levels of Mean Length of Utterance (MLU) measured in words and morphemes than children with typical language development (Rice et al., 2010). Language dimensions affected later in development are particularly syntax and morphosyntax (Rice et al., 2008).

Elevated risk for SEB problems in preschool and school-age children with DLD is well documented (see the meta-analysis by Yew & O´Kearney, 2013). Toddlers cannot be diagnosed with DLD, but they can be considered to have a delayed language development and are then called late talkers (Rescorla, 2002; Weismer, 2007, p. 86). Studies of SEB problems in younger children with language delay provide slightly contradictory results. Some have found elevated risk for SEB problems and poorer social-emotional competencies in these children compared with their typically developing peers (Henrichs et al., 2013; Irwin et al., 2002; Thurm et al., 2018). Other studies have found significant associations between delays in social-emotional competencies and delays in language development, but not with SEB problems (Horwitz et al., 2003; Rescorla et al., 2007).

Different hypotheses on the relationship of these associations exist. It has been suggested that language difficulties at an early age may have a negative influence on social interaction, which can lead to emotional and self-regulation problems (St Clair et al., 2019). According to the results of a longitudinal study by Roben, Cole and Armstrong (2013), children with weaker language skills and slower growth of them in toddlerhood had weaker skills in regulating anger than children with better language skills. Evidence in support of this theorised causal pathway is the observed association between language difficulties and increases in social problems with age (Clegg et al., 2015; St Clair et al., 2011). On the other hand, problems with adaptability and withdrawal have been found as early as at 9 months of age in children who have shown language difficulties later in preschool, indicating that SEB problems may possibly precede language problems (St Clair et al., 2019). Another hypothesis is that the association is bidirectional (Thurm et al., 2018). In addition, apart from a few studies that also included comprehension as a measurement (Clegg et al., 2015; Irwin et al., 2002; Thurm et al., 2018), usually the only language variable used in studies on this association is the size of expressive vocabulary. It is important also to measure other language variables in the studies to get a more comprehensive picture of the language skills of children when this association is studied.

1.3. Factors influencing language development

Several biological and environmental factors can influence early language development in children. The effect of biological sex on language development has been widely studied. There is evidence of toddler girls having a significantly larger expressive vocabulary and a faster expressive vocabulary growth than toddler boys (Eriksson et al., 2012; Fenson et al., 1994; Stolt et al., 2008). Toddler girls also combine words more than toddler boys in several language communities (Eriksson et al., 2012). However, in a meta-analysis by Fisher (2017), no significant associations between late talkers and child's sex were found. Additionally, children born preterm have a higher occurrence of language delay than full-term children (Barre et al., 2011; Gayraud & Kern, 2007; Schults et al., 2013; Stolt, 2009).

One area of interest for researchers has been the association between early language development and the socioeconomic status (SES) of the parents. In a meta-analysis by Fisher (2017), a small significant association was found between lower SES and a smaller expressive vocabulary. In previous studies, SES has been defined variously based on parent´s educational level, occupational status or income, but the results are nonetheless quite similar. Pungello et al. (2009) found that toddlers living in a family with a lower SES had slower development of expressive vocabulary than children of families with a higher SES. Fernald and colleagues (2012) reported a similar pattern in children as young as 18 and 24 months old. However, the effect sizes were small. Another demographic factor that has been shown to have a positive impact on the language development of infants and toddlers is young age of the mother (McNally & Quigley, 2014; Westerlund & Lagerberg, 2008). However, the results of some studies favour older mothers over younger ones (Keown et al., 2001; Sutcliffe et al., 2012). The differences in the results may

depend on the age range of mothers included and which background factors have been controlled for. For example, in the latter studies, more positive parenting behaviour of older mothers interrelated with language development.
Furthermore, studies exploring familial aggregation of language difficulties have found that children with language delay have a higher risk of having a family member who has experienced language difficulties in childhood (Keegstra et al., 2007; Zambrana et al., 2014).

1.4. The current study

The research described above has highlighted the risk for SEB problems in older children with a DLD diagnosis, but slightly contradictory results concerning this association can be seen in young children with delayed language development. In addition, the language measure used in previous studies has mostly been expressive vocabulary, with some exceptions including receptive vocabulary. Thus, it is important to add more language variables describing language skills when studying this relationship.
The purpose of the present study was to explore whether there is an association between social-emotional competencies and SEB problems measured at 18 months of age and the subsequent speech and language development measured at 24 months of age. The hypothesis was that children with SEB problems and/or delay in social-emotional competencies have weaker language skills than children with developmentally adequate social-emotional functioning. The second aim was to examine whether different background factors, often related to language development, have an effect on language skills in addition to SEB problems and social-emotional competencies. This study extends earlier research on the relationship between social-emotional competencies and SEB problems and language development in toddlerhood. An additional extension is the use of grammatical language variables along with expressive vocabulary when assessing language skills. If there is an association between SEB problems and lacking social-emotional competencies measured at 18 months of age and language skills measured at 24 months of age, it indicates that it would be beneficial to start supporting language development as soon as unfavourable socio-emotional difficulties can be detected.

2. Methodology

The study is part of a Finnish cohort study, Steps to the Healthy Development and Well-being of Children (the STEPS Study), which is a longitudinal, population-based multidisciplinary study of children born to mothers in an area of Southwest Finland during 1.1.2008–31.03.2010 (for more detail see Lagström et al., 2013). The cohort includes 9811 mothers and their 9936 children. The Ministry of Social Affairs and Health and the Ethics Committee of the Hospital District of Southwest Finland have approved the STEPS Study (27 February 2007).

2.1. Participants and sample selection

A subset of mothers in the cohort were recruited to participate in an intensive follow-up, either during the first trimester of pregnancy when visiting the maternity clinic or after delivery on the hospital ward. Altogether 1797 Finnish- and Swedish-speaking mothers with 1827 children accepted the invitation. The majority of them (76.8%) were recruited from a maternity clinic and about a quarter (23.2%) from the delivery hospital. Written informed consent was obtained from the parents.

In this study, Swedish-speaking and bilingual children were excluded and only Finnish-speaking children (N = 1370) were included, due to differences in the language structure between Finnish and Swedish. Families were asked to fill out two questionnaires, the Brief Infant-Toddler Social and Emotional Assessment (BITSEA; Briggs-Gowan & Carter, 2006) and MacArthur Communicative Development Inventories (CDI; Fenson et al., 1994). Altogether 704 families had filled out both questionnaires. The families had been instructed to fill out the BITSEA when the child was 18 months of age and the CDI when the child was 24 months of age. However, the ages of the children varied from 10 to 48 months upon completion of the BITSEA and 20 to 29 months for the CDI. To narrow the age range of the BITSEA assessment, children younger than 16 months and older than 20 months were excluded, as well as children whose age upon completion of the BITSEA questionnaire was missing.

Some children can experience a lexical growth spurt after 2 years of age (Clark, 2003), which is why only children aged 23–25 months upon CDI completion were included. Children younger or older than this age range upon CDI completion or whose age was missing were excluded. Children born prematurely (< 37 gestational weeks; Parikka & Lehtonen, 2017, p. 9) and children with missing information on gestational weeks were also excluded. Additionally, two outliers were excluded as they had a higher Competence score than was possible in the BITSEA questionnaire. The final sample included a total of 591 children. A flowchart of the inclusion and exclusion process is presented in Figure 1.

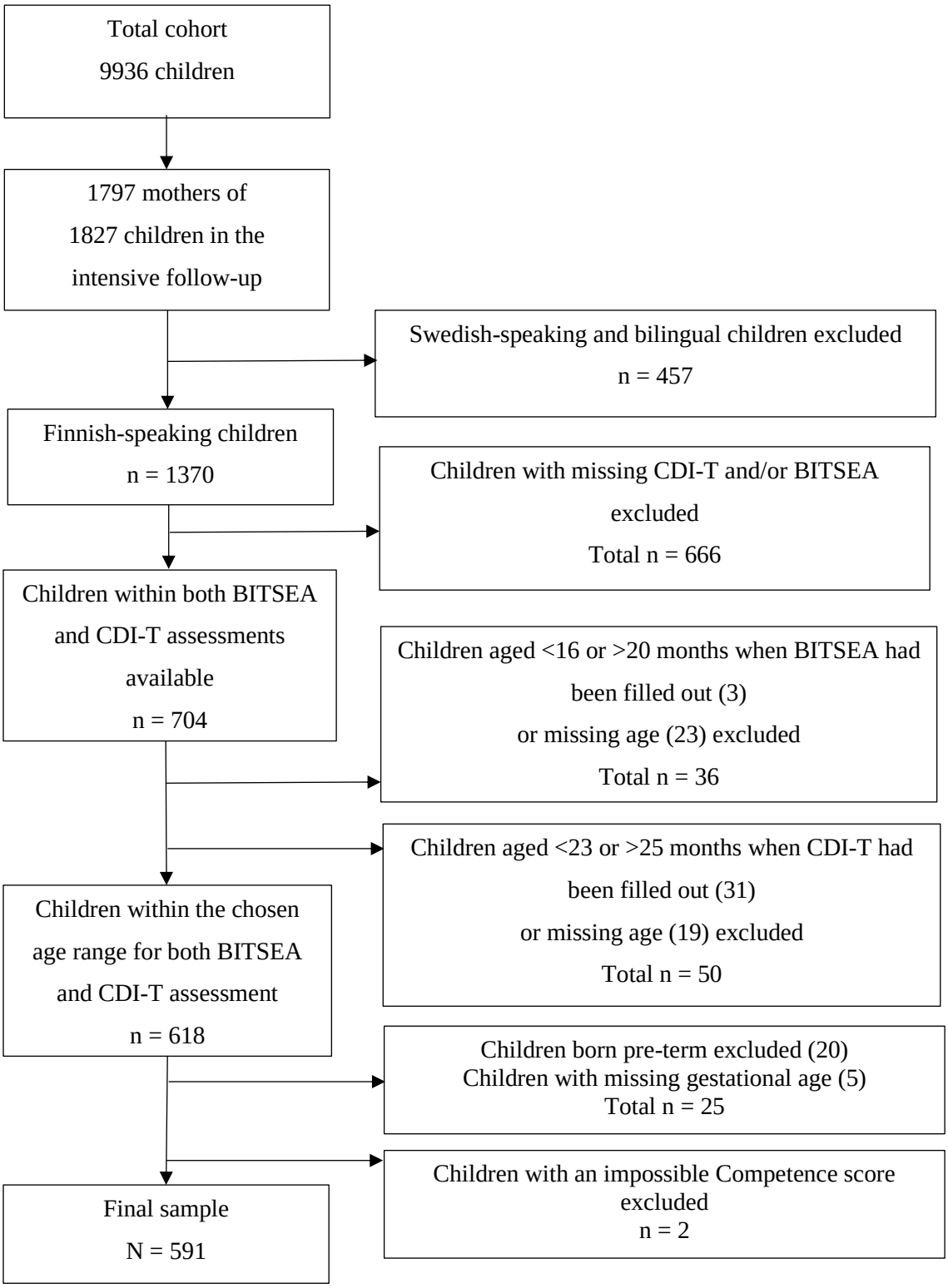


Figure 1. Flowchart of inclusion and exclusion criteria for the sample

There were 303 boys (51.3%) and 288 girls (48.7%) in the sample. Over half of the children had no siblings (55.0%), nearly a third had one sibling (29.9%), a tenth had two siblings (11.7%), and the remainder had between three and eight siblings (3.4%). Almost all parents were married (63.3%) or cohabiting (35.2%), with 1.5% reporting another status and five families this information was missing. The SES of the parents was defined in two categories based upon occupational status as at least professional or other. Those in high or intermediate positions were classified as professionals and those working in the service and industry sectors as other. Of the mothers 63.6% and of the fathers 58.0% were considered professionals. The family monthly net income was at least 3000 euro for 48.4% of the families and under 3000 euro for 51.4%; this information was missing for 11 families. The average net family earnings in Finland during the data gathering years was 3120 euro (2008) and 3173 euro (2009) (Statistics Finland's PX-Web databases). Out of the sample, 1.2% of the mothers and 2% of the fathers reported having had late onset of speech as a child. Other descriptive statistics are given in Table 1.

Table 1
Descriptive characteristics from data collected shortly after birth (N = 591)

Characteristic	***M***	***Mdn***	***SD***	***Min***	***Max***
Age of mother at birth	31.18	31.12	4.19	18.25	42.76
Age of father at birth[a]	33.02	32.41	5.17	18.35	55.78
Gestational days	280.57	281.00	8.54	259	299
Agpar (5 min)	9.05	9.00	0.81	5	10

[a]*Age missing for four fathers.*

2.2. Attrition

Due to dropouts from the cohort study and numerous exclusion criteria, the present study experienced high rates of attrition. To avoid attrition bias, we checked for any systematic difference in the background and outcome variables between participants and those who had been excluded. From the previous studies in this cohort, we know that mothers participating in the STEPS study were on average 7 months older when giving birth than mothers in the whole cohort population, and that the child participating was most likely their first. In addition, the couples were more likely married, and their occupational status was somewhat higher than in the cohort population (see Lagström et al., 2013). The participating families of the present study differed from non-participants with regards to two background variables (Table 2). The participating mothers were slightly older than non-participating mothers (31.18 vs 30.57 years) and were more likely to be married (63.3% vs 55.6%). The difference in gestational age was calculated without the premature children in excluded families because they were also excluded from the study sample.

Table 2
Comparison of characteristics of excluded and included study participants based on the chi-square test for categorical variables and t-test for numerical variables

	Variables	**Excluded participants[a]**	**Included participants[b]**	***p***
	Outcome variables			
	CDI-T, Expressive, mean (SD)	290.43(167.74)	300.14(164.14)	.510
	CDI-T, Grammar, mean (SD)	8.94(5.31)	9.34(5.23)	.400
	CDI-T, Morphosyntax, mean(SD)	6.09(2.70)	6.40(2.57)	.231
	Sociodemographics	(n=1236)	(n=591)	
Child	Gender; boys, %	52.4	51.3	.647
	Gestational days, mean (SD)	280.06(8.69)[c]	280.57(8.54)	.247
Mother	Age in years, mean (SD)	30.57(4.77)	31.18(4.19)	**.005**
	Marital status married, %	55.6	63.3	**< .001**
	First child, %	52.1	55.0	.164
	Late onset of speech, %	1.1	1.2	.799
	SES, occupational class; at least professional, %[d]	59.5	63.6	.119
Father	Age in years, mean (SD)	32.74(5.59)	33.02(5.17)	.289
	Late onset of speech, %	1.1	2.0	.130
	SES, occupational class; at least professional, %[d]	56.0	58.0	.474
Family	Family income; at least 3000e/month, %	44.3	48.6	.088

CDI-T = McArthur Communicative Development Inventories, Toddler-form
[a] (n=129–159); including only Finnish-speaking children aged between 23 and 25 months
[b] (n=498–591)
[c] (n=1101, premature children excluded)
[d] Classification: Professionals (in high positions, e.g. managerial, but also intermediate positions such as nurses) vs others [blue-collar workers (e.g. service and industry)]

2.3. Data collection and processing

Data were gathered from parents using questionnaires sent by post or electronically. One questionnaire was used to assess the child's social, emotional and behavioural problems and competencies at 18 months of age (BITSEA; Briggs-Gowan & Carter, 2006), and another to assess their language development at 24 months of age (CDI-T; Fenson et al., 1994). Further questionnaires assessed family demographics.

2.3.1. Questionnaires on demographic information

Demographic and other family-related information was collected from mothers during pregnancy weeks 10 to 15 with questionnaires sent out to the families. In addition, both mothers and fathers completed separate forms

at the 20th and 30th gestation weeks. Mothers recruited from the delivery ward completed the forms there. Additional information concerning the family and the child was gathered from one or both of the parents when the child was 13, 18 and 24 months of age. Questions concerned physical, psychological and social development of the child and demographic information of the parents. Background variables used as covariates in the present study were child's sex, gestational days, age of mother at childbirth, SES of the parents, and parent's self-reported history of late onset of speech.

2.3.2. Brief Infant-Toddler Social and Emotional Assessment (BITSEA)

The Brief Infant-Toddler Social and Emotional Assessment (BITSEA; Briggs-Gowan & Carter, 2006) used in this study is a parent-report screening tool to identify delays in social and emotional competencies, as well as potential social, emotional and behavioural problems in children between the ages of 12 months and 35 months and 30 days. It includes 42 items, of which 11 concern potential delays or deficits in social-emotional competencies and 31 cover externalising, internalising and dysregulation problems.

BITSEA has been shown to be a valid parental-report tool in measuring infants' and toddlers' social-emotional development (Bagner et al., 2012; Briggs-Gowan et al., 2001; Haapsamo et al., 2009; Pontoppidan et al., 2017). The Finnish translation of the BITSEA has been applied in a number of previous studies (Alakortes et al., 2017; Haapsamo et al., 2009; Paavola-Ruotsalainen et al., 2018). The results of the BITSEA give a Total Problem score and a Total Competence score. The maximum Total Problem score is 62 and the maximum Total Competence score is 22. Possible social-emotional and behavioural problems (SEB problems) and delays in social-emotional competencies is defined with certain clinical cut-off points in these scores depending on the age and sex of the child. A Total Problem score above the cut-off value indicates possible socio-emotional and behavioural problems and a Total Competence score below the cut-off value indicates a possible delay or deficit in social-emotional competencies. For children aged 12–17 months the Total Problem cut-off score is 13 for both sexes, and for children aged 18–23 months it is 13 for girls and 15 for boys. The Total Competence cut-off score for children aged 12–17 months is 12 for both sexes, and for children aged 18–23 months it is 14 for both sexes.

2.3.3. MacArthur Communicative Development Inventories (CDI)

The Finnish version of the McArthur Communicative Development Inventories, Toddler-form (CDI-T; Fenson et al., 1994) was applied in the present study (Lyytinen, 1999). It is a parent-report questionnaire aimed to assess the child's communicative and language development. CDI-T is intended for children aged 16–30 months and includes sections measuring expressive vocabulary and covering grammatical and morphological development. The expressive vocabulary section includes 595 words in 20 different categories and parents are asked to mark the words the child both understands and produces. The grammar section includes questions about the child's use of plural, case suffix, verb conjugation and word combinations, with maximum points of 16. Morphosyntax is measured as a mean number of morphemes in the child's three longest utterances (M3L)

(Fenson et al., 2007). MacArthur Communicative Development Inventories have been shown to be a valid parent-report instrument for measuring early communication and language development in children (Fenson et al., 1994, 2007; Lyytinen, 1999). When the Finnish CDI-T was validated, the expressive vocabulary of children aged 18 months correlated statistically significantly with the Reynell Developmental Language Scales (RDLS; Edwards et al., 1997) expressive scale (r = .85, p < .001) and receptive scale (r = .35, p < .001). At 24 months of age the expressive vocabulary in CDI-T correlated with Baileys Mental Developmental Index (r = .70, p < .001) and Baileys Scales of Infant Development (naming tasks) (r = .59, p < .001) (Lyytinen, 1999).

2.4. Data analysis

Parametric tests were applied when analysing the data, and we used the Statistical Package for the Social Sciences (SPSS) version 25.0 for Windows (IBM Corporation, Armonk, NY, USA). P-values < 0.05 were considered statistically significant. Independent samples t-tests were conducted to examine group differences between boys and girls in total scores from the BITSEA and CDI-T. Additionally, t-tests demonstrated the difference in mean scores between the two age groups. The association between SEB problems and social-emotional competencies at 18 months of age and language skills at 24 months of age was analysed with multiple linear regression analyses. Three separate forced entry multiple linear regression analyses were performed with (1) expressive vocabulary, (2) use of grammar and (3) M3L as the outcome variables. The background variables included in the analysis were sex of the child, maternal age, gestation days, mother's SES, father's SES, mother's history of late onset of speech and father's late onset of speech.

The children included in the present study were between 16 and 20 months of age when the parents filled out the BITSEA form. According to the manual, there are different cut-off points for total scores of children aged 12–17 months and children aged 18–23 months. Therefore, the Total Problem scores and Total Competence scores were reported for two different age groups in the descriptive statistics. Because after this conducted cut-off procedure takes into account the age and sex of the child, the children could be divided into two groups with and without SEB problems, as well as into two groups with and without delay in social-emotional competencies. These variables were entered as independent variables in the regression analysis along with background variables that could potentially influence the language outcome variables. The correlations between the independent variables and all three language outcomes were examined before the regression analysis was conducted, to check for any correlations that could have an effect on the regression model. Child's age at the time of filling out the BITSEA and CDI-T questionnaires varied and therefore these ages were added as covariates into the regression model.

3. Findings

3.1. Descriptive statistics

Descriptive statistics of Total scores in the BITSEA are presented in Table 3. There was no statistically significant difference in the problem scores of children aged 16–17 months (M = 8.29, SD = 5.00) and those aged 18–20 months (M = 7.95, SD = 4.79) and no sex differences in Total Problem scores. For the Total Competence score, girls had a significantly higher Total Competence score (M = 17.80, SD = 2.43) than boys (M = 16.91, SD = 2.56) in the group of children aged 16–17 months ($t(413) = 3.71$, $p < .001$, d = 0.357) but not in the group of 18–20 month-olds.

Table 3
Total scores of the BITSEA questionnaire for each of the age groups and sexes (N = 588[a])

	16–17 months			**18–20 months**		
SEB statistic	Total (n = 414)	Girls (n = 197)	Boys (n = 217)	Total (n = 174)	Girls (n = 90)	Boys (n = 84)
Total Problem score[b]						
M	8.29	8.47	8.12	7.95	7.64	8.27
Mdn	8.00	8.00	7.00	7.00	7.00	7.00
SD	5.00	5.04	4.97	4.79	4.81	4.77
Range	0–34	0–34	0–26	0–29	1–29	0–25
Total Competence score[c]						
M	17.34	17.80	16.91	17.39	17.64	17.11
Mdn	18.00	18.00	17.00	18.00	18.00	17.50
SD	2.54	2.43	2.56	2.55	2.34	2.75
Range	10–22	11–22	10–22	7–22	12–22	7–22

[a] Three participants were missing a Total Problem Score
[b] Max 62, [c] Max 22

According to the BITSEA cut-off scores, 16.6% (n = 98) of the children were considered to have SEB problems and 6.9% (n = 41) delays in social-emotional competencies.

The descriptive statistics of the CDI-T results are shown in Table 4. The results show that there was a statistically significant difference in expressive vocabulary between girls (M = 354.03, SD = 144.50) and boys (M = 283.57, SD = 155.53; $t(588.528) = 6.08$, $p < .001$, d = 0.469). Girls also had higher scores on average in the grammar section (M = 11.29, SD = 4.31) than boys (M = 8.95, SD = 5.96; $t(518.492) = 6.48$, $p < .001$, d = 0.450). The mean number of morphemes in the three longest utterances the children had produced was also slightly higher for girls (M = 6.86, SD = 2.35) when compared to boys (M = 5.73, SD = 2.52; $t(496) = 4.60$, $p < .001$, d = 0.464).

Table 4
Descriptive statistics of CDI-T including total scores and scores for each of the sexes

Language outcomes	***n***	***M***	***Mdn***	***SD***	***Range***
Expressive vocabulary[a]					
(all children)	591	300.14	329.00	164.14	4–595
Girls	288	354.03	385.50	144.50	4–595
Boys	303	284.57	297.00	155.53	9–579
Grammar (all children)[b]	526[c]	9.34	10.00	5.23	0–16
Girls	258	11.29	12.50	4.31	0–16
Boys	268	8.95	8.00	5.96	0–16
M3L (all children)	498[d]	6.40	6.42	2.57	0–15.67
Girls	255	6.86	7.00	2.34	0–13
Boys	243	5.73	5.670	2.52	0–15.67

[a] *Max 595*
[b] *Max 16*
[c] *65 participants were missing a total grammar score*
[d] *93 participants were missing data on M3L*

3.2. Results of multiple linear regression analyses

To analyse the possible associations between SEB problems and social-emotional competencies and language skills, the categorical variables of SEB problems and social-emotional competencies, created with the cut-off score procedure, were used. Separate forced entry multiple linear regression analyses were conducted with expressive vocabulary, use of grammar and M3L as outcome variables. SEB Problems and social-emotional competence variables were included in the model as independent variables. Additionally, the background variables sex of the child, maternal age when giving birth, gestational days, SES of both the mother and the father, as well as late onset of speech of mother and father were included to control for variables known to influence language outcomes. Age of the child at the time of filling out the CDI-T and BITSEA questionnaires were added as covariates to control for child's age affecting the results.

An examination of correlations revealed that none of the independent variables were highly correlated with each other. The collinearity statistics between independent variables were all within accepted limits (tolerance > 0.1, Field, 2009, p. 224) and therefore the assumption of multicollinearity was met.

3.2.1. Expressive vocabulary

Table 5 shows the results of the multiple linear regression analysis with expressive vocabulary as the dependent variable. A statistically significant regression equation was found ($F(11, 432) = 5.94$, $p < .001$) and accounted for 13.1% of the variance in the outcome variable ($R^2_{adj} = 0.109$). There was a significant association between social-emotional competence and expressive vocabulary ($\beta = -.131$, $p = .005$), indicating that children with a delay in social-emotional competencies had a mean expressive vocabulary of 83 words fewer than children with developmentally appropriate social-emotional competencies. SEB problems did not significantly contribute to the variance in expressive vocabulary.

In addition, one of the background variables that significantly contributed to the model was sex of the child ($\beta = .232$, $p < .001$), meaning girls had on average 76 words more in their expressive vocabulary than boys. Another significant variable was father's SES ($\beta = .124$, $p = .010$), which suggests that children with a father with a higher SES produced on average 41 words more than children with a father with a lower SES. Father's late onset of speech ($\beta = -.111$, $p = .016$) also had a significant association with the expressive vocabulary, suggesting that children with a father who had a history of late onset of speech as a child on average had an expressive vocabulary of 117 words fewer than children with a father without a history of delay in speech development.

A multiple regression analysis was conducted to examine whether an interaction effect was present between the sex of the child and social-emotional problems and competencies on expressive vocabulary. The results revealed no evidence of a statistically significant interaction effect between the sex of the child and social-emotional problems on expressive vocabulary. However, a statistically significant interaction effect was observed between sex and social-emotional competencies on expressive vocabulary, F (1, 588) = 4.446, p = .035, and accounted for 8.7 % of the variance.

Table 5
Coefficients for the forced entry multiple regression with expressive vocabulary as the dependent variable

	Dependent variable: Express. vocabulary			
Predictors	***B***	***SE B***	***B***	***Sig.***
Sex	76.132	14.803	.232	.000
Mother's age	-3.489	1.833	-.087	.058
Gestational days	-.418	.901	-.021	.642
Mother's SES	27.956	16.300	.082	.087
Father's SES	41.307	15.936	.124	.010
Mother's late onset of speech	41.836	64.234	.029	.515
Father's late onset of speech	-117.081	48.350	-.111	.016
Age when CDI-T completed	9.046	12.297	.033	.462
Age when BITSEA completed	9.991	9.063	.051	.271
SEB Problems	-16.254	20.127	-.037	.420
Social-emotional competence	-83.165	29.320	-.131	.005

3.2.2. Grammar and morphosyntax

A forced entry multiple linear regression analysis was conducted with grammar as the dependent variable. Independent variables included the social-emotional competence and SEB problems, as well as control variables as in the previously mentioned regression analysis. A statistically significant regression equation was found in the regression model, (F(11, 381) = 4.20, p < .001) and accounted for 10.8% of the variance (R^2_{adj} = 0.082). Neither SEB problems nor social-emotional competence proved to be predictors for grammar (Appendix A). The only variable that significantly predicted grammar was sex (β = .256, p < .001), suggesting that girls on average scored 2.7 points higher than boys.

Another forced entry multiple linear regression was conducted with morphosyntax as the dependent variable and the same independent variables as in the previously mentioned multiple regression analysis. A statistically significant regression model was found (F(11, 364) = 4.18, p < .001) and accounted for 11.2% of the variance in the dependent variable (R^2_{adj} = 0.085). Neither SEB problems nor social-emotional competence predicted morphosyntax but several sociodemographic variables did (Appendix B). These were sex of the child (β = .218, p < .001), maternal age (β = -.115, p = .024), mother's SES (β = .104, p = .049), father's SES (β = .148, p = .005), and father's late onset of speech (β = -.107, p = .032).

4. Discussion and conclusions

The aim of this study was to explore whether there is an association between social-emotional competencies and behavioural problems measured at 18 months of age and the early speech- and language development measured at 24 months of age. The hypothesis was that children with SEB problems or delay in social-emotional competencies have weaker language skills than children with developmentally adequate social-emotional functioning. In addition, the effect of different background variables was controlled for.

Language outcomes of CDI-T seemed to coincide with the normative data of the standardization study of the Finnish adaptation of the CDI by Lyytinen (1999), apart from the expressive vocabulary, which was slightly larger for the children in the present study. However, it was well in accordance with a more recent Finnish study by Stolt et al. (2008). Number of morphemes was in accordance with Finnish normative data (Lyytinen, 1999) and another Finnish study by Stolt (2009).

Mean scores of the BITSEA were very close to those in other Finnish studies with children aged 18 months (Alakortes et al., 2015; Haapsamo et al., 2009; Paavola-Ruotsalainen et al., 2018). However, the percentage of children with SEB problems (16.6%) according to the cut-off points was slightly higher and the percentage of children with delays in social-emotional competencies (6.9%) clearly lower than in other Finnish studies. The reason for this could be the wider age range when the BITSEA form was filled out in this study. Another reason could be that premature children, who often have some delays in development, were excluded from the sample. However, in spite of the lower percentage of children with delays in social-emotional

competencies in the present study, an association between having low scores in this domain and expressive vocabulary at 24 months of age was observed.

4.1. Associations between social-emotional competencies and problems and language skills in toddlerhood

According to the results, there was a statistically significant association between social-emotional competencies in early toddlerhood and expressive vocabulary measured half a year later, which partly supports the hypothesis. Children with a delay in social-emotional competencies had smaller expressive vocabulary than children without a delay in these competencies. However, this association was not present for the two other language variables, grammar and mean length of utterance. There were no associations between SEB problems and the three language variables measured. Thus, the hypothesis that SEB problems would also have associations with weaker language skills, was not supported.

The results of the present study are in accordance with those of Horwitz et al., (2003) and Rescorla et al., (2007), with no associations between language delay and SEB problems in toddlers but rather an association between language delay and delay in social-emotional competencies. Many other studies have also found significant associations between delays in social-emotional competencies and difficulties in language development, but also associations with SEB problems occurring simultaneously (Henrichs et al., 2013; Irwin et al., 2002; Longobardi et al., 2016; Thurm et al., 2018).

It is possible that social-emotional competencies have a close relationship with language development, and this is why toddlers with a delay or deficit in social-emotional competencies have a risk of delayed vocabulary development. Language is acquired in social interaction with others (Tomasello, 2009). Delayed social-emotional competencies can hinder interaction and reduce opportunities to learn language from communication partners. Social-emotional competencies include skills such as attention skills, following instructions, play behaviour and prosocial interactions with peers (Carter et al., 2003), all needed for social interaction where speech and language are used and learned. On the other hand, it is possible that delays in both domains are present already at an early age. It is difficult to draw conclusions on how these factors influence each other if the measuring points are not several and concordant, which was missing from the present study.

The result concerning the lack of an association between SEB problems and weaker language skills is in conflict with many previous studies, which have demonstrated this association in toddlers (Henrichs et al., 2013; Irwin et al., 2002; Paavola-Ruotsalainen et al., 2018; Thurm et al., 2018; Tervo, 2007). The difference may be due to grouping of the children into two groups with delayed language development and typical language development in almost all of the previous studies, which was not done in the present study. Another reason could be that because of the large variation in language development in children at 24 months of age, some of the children with weaker language skills might have belonged to the lower end of the normal variation without manifesting any SEB problems. The results and knowledge from previous research indicate that social-emotional competencies are important skills

needed in language development, and if there is a delay in these skills it can be a risk factor for development of language disorder, and for progression to SEB problems (Carter et al., 2003).

Grammatical and morphosyntactical development did not show any statistically significant associations with social-emotional competencies or SEB problems. Finnish-speaking children begin using a few grammatical expressions, such as the plural and the genitive, at about 18 months of age, increasing towards 2 years of age, and use them even more between 2 and 3 years of age (Stolt, 2009). Language abilities of the participating children were measured when they were between 23 and 25 months of age. The range of scores in these language skills varied from 0 to maximum regarding grammar and from 0 to quite a high number of M3L, which is a mean number of morphemes in children's three longest utterances. The wide variation in language development, even in children with typical development at this age, may mean that even though some of the children with weaker results in these language variables had a slower language development, they still had good social-emotional competencies and no SEB problems. This could possibly explain why weaker skills in grammar and morphosyntax did not have a significant association with either SEB problems or delays in social-emotional competencies. It is also possible that these types of language measures are not effective to differentiate children with language delay at this age, because these skills do not develop further until after 2 years of age.

4.2. Associations between demographic factors and language development

Several demographic and environmental factors contributed to language variables in addition to social-emotional competencies, but in somewhat different ways depending on the language variable. Child´s sex contributed to all language variables studied, in favour of girls. This result is in accordance with the findings of Fenson et al. (1994; 2007) and of a study by Eriksson et al. (2012) conducted in 10 non-English language communities, as well as studies by Lyytinen (1999) and Stolt et al. (2008) with Finnish children.

In addition to child's sex, father's SES and late onset of speech contributed to the size of the expressive vocabulary. Children of fathers with higher SES had a larger vocabulary than children of fathers belonging to the lower SES category. Korpilahti et al., (2016) also found that father's as well as mother's SES had significant links to the toddler's language development. Çakır (2016) found that fathers with high SES provide more language input and more open-ended questions when playing with toddlers, which subsequently increases the child's conversational participation, hence supporting language development positively. A significant effect of paternal language input on toddler's vocabulary has also been observed in a study by Reynolds et al. (2019). It is possible that these fathers interact with their children in a way that stimulates their language development.

Similar results as in the present study on the effects of parent's own history of language disorders have been observed in previous studies on familial

aggregation. Results have shown that children with language delay are significantly more likely to have a family member with a history of language difficulties than children with typical development (Keegstra et al., 2007; Zambrana et al., 2014; Zubrick et al., 2007). A potential explanation for why the mother's history of language delay did not have a significant association with language development in children in the present study could be the small number of mothers reporting such a delay in their own language development.

Child's sex was the only background factor contributing to the use of grammatical expressions, but there were several background factors which contributed to skills in morphosyntax. These factors were child's sex, father's late onset of speech, both father's and mother's SES, and mother's age. Just as fathers in the higher SES group may have a more stimulating way of interacting with their children (Reynolds et al., 2019), so may mothers with higher SES also have a different way of talking with their children, which has a positive effect on language development. Pan et al. (2005) found that mothers with higher SES used more varied word types in their child-directed speech than mothers with lower SES. Mother's age was one of the contributing factors to morphosyntactic development. Children of younger mothers produced on average slightly longer utterances. Over half the participating children were firstborns in their families. It is possible that mothers of firstborns were younger than those who already had several children, and that this caused some bias in the data. In addition, mothers of firstborns have, for example, been found to participate more in shared reading than mothers with several children (Westerlund & Lagerberg, 2008), which could indicate that they also spend more time fostering other types of interactions with their children that stimulate their language development. Families with older mothers may already have more than one child, and the mother needs to share her time with all of them. It is possible that time spent interacting with the youngest child has been less than for younger mothers who possibly had only one child.

4.3. Limitations of the study and recommendations for future research

One of the strengths of this study is the large sample size and the amount of data collected. However, the study also has some limitations to be considered when interpreting the results. Because this was a cross-sectional study measuring social-emotional competencies and problems and language skills at different time points half a year apart, we cannot interpret the results as showing a causal relation between delays in social-emotional competencies and later-observed weaker vocabulary in some of the children. It can only be concluded that there is an association between social-emotional competencies and expressive vocabulary development in toddlerhood. Further research is needed to see whether the association persists and to find the possible developmental trajectory between delays in social-emotional competencies and language development. In the future, it would be important to study these associations longitudinally, measuring all these factors concurrently and several times during the developmental stage.

One limitation of the study was the wide variation in age of the children upon completion of the BITSEA questionnaire. Although parents had been

asked to complete the parental report when the child was 18 months old, many of them did so earlier or later; thus children aged 16–20 months had to be included to maximise sample size. This was, however, considered by using age- and sex-matched cut-off points when defining groups with and without a delay in social-emotional competencies and SEB problems, and including child's age upon completion of the BITSEA questionnaire as a covariate in the regression model.

Relying solely on parent reports to measure both social emotional problems and competencies and language development was also a limitation of this study, but because of the large sample size it was not possible to meet all of the children to conduct objective tests. On the other hand, both the methods we used have been shown to be valid measures of parent reporting.

When it comes to the background variables studied, the number of parents with a history of late onset of speech was considerably lower than expected, possibly because they may not be aware of having had difficulties in language development as a child.

4.4. Conclusion

There is an association between social-emotional competencies and early language skills in toddlerhood, but there are other contributing factors, primarily the child's sex. The findings of this study indicate that a delay in social-emotional competencies during the second year of life can be associated with a smaller expressive vocabulary at 24 months of age. Regarding clinical work, the results set a foundation for a recommendation to examine language development of young toddlers with a delay or deficit in social-emotional competencies, to be able to support their language development as early as possible when needed. This is especially important for children who also have other risk factors potentially influencing their language development.

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Appendices

Appendix A

Coefficients for the forced entry multiple regression with grammar as the dependent variable

	Dependent variable: Grammar			
Predictors	***B***	***SE B***	***β***	***Sig.***
Sex	2.671	.509	.256	.000
Mother's age	-.110	.062	-.088	.077
Gestational days	-.006	.031	-.010	.837
Mother's SES	1.044	.559	.097	.062
Father's SES	1.001	.547	.095	.068
Mother's late onset of speech	1.691	2.078	.040	.416
Father's late onset of speech	-2.479	1.647	-.075	.133
Age when CDI-T completed	.001	.419	.000	.997
Age when BITSEA completed	.336	.306	.054	.274
SEB Problems	-.259	.689	-.019	.707
Social-emotional competence	-.801	.987	-.041	.417

Appendix B

Coefficients for the forced entry multiple regression with M3L as the dependent variable

	Dependent variable: Morphosyntax			
Predictors	***B***	***SE B***	***β***	***Sig.***
Sex	1.085	.249	.218	.000
Mother's age	-.070	.031	-.115	.024
Gestational days	.003	.015	.011	.832
Mother's SES	.544	.275	.104	.049
Father's SES	.749	.266	.148	.005
Mother's late onset of speech	-.340	.993	-.017	.732
Father's late onset of speech	-1.748	.813	-.107	.032
Age when CDI-T completed	.183	.204	.045	.369
Age when BITSEA completed	.239	.156	.078	.125
SEB Problems	-.171	.333	-.026	.608
Social-emotional competence	-.462	.514	-.045	.369

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Integrated approach on the acquisition of phonological targets in 4-to-6-year-old children

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Abstract

The purpose of this study was to examine the effects of an integrated approach on the acquisition of phonological targets in 4-to-6-year-old children enrolled in maximum oppositional therapy (MOT). MOT is an alternative approach to traditional phonological intervention designed to promote systemic changes to untreated phonemes from the same or different manner class.

Two groups of children 4 to 6 years of age underwent MOT treatment, with one of the groups also receiving concurrent training in the use of self-cueing strategies (using tactile gestures phonemic cues) to promote self-generated feedback. MOT targeted phonemes with maximal contrasts in placement, manner and voicing in two groups of children. One group also received instruction in the use of two tactile cues to self-monitor production of phonological targets. A comparison of therapy duration required to meet target acquisition criteria was made between the two groups.

MOT and tactile self-cues demonstrated larger gains in phonological target acquisition over a 10-week period. The tactile self-cueing MOT group achieved target accuracy in less time across three phonemic contexts. The integrated approach using MOT resulted in an increase in phonological accuracy, including untreated phonemes across manner of classes.

This study offers preliminary support and extends prior research of a novel integrated phonological intervention approach in clinical practice. The results suggest potential increases in phonological self-awareness and accuracy, reduced duration of intervention, and an increase in phonological target acquisition. Further research in this area is merited.

Key words: *cues, self-cueing, integrated intervention, maximal opposition treatment approach, phonological processes*

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1. Introduction

Service delivery considerations widely impact clinical decisions for intervention practices (Tyler, 2006). As clinicians design phonological treatment programs, use of methods and strategies that are both efficacious and efficient in promoting behavior change is essential to an impactful treatment program (Amato-Zech et al., 2006; Gierut, 2001; Kamhi, 2006; G. Rogers, 2013). At present, we have limited empirical evidence regarding which phonological intervention approach is most efficient for children with phonological errors in comparison to others due in part, to individual, environmental or "within-in" child factors (Kamhi & Pollock, 2005; Preston et al., 2013). Considering the body of research, less is known on those intervention programs that may potentially shorten the duration of treatment. However, researchers suggest that a complexity approach is potentially among the most efficient; though less frequently the treatment program of choice by clinicians (Byun & Hitchcock, 2012a; Gierut, 2001; Gierut & Morrisette, 2005; Kamhi, 2006). Until recently, traditional approaches used in the treatment of speech sound disorders have been primarily clinician-directed instruction targeting phonological accuracy with less emphasis on child-driven strategies (Baker & McLeod, 2011b; Ertmer & Ertmer, 1998; King et al., 2013; Xi et al., 2020).

Across allied health professions (i.e., Occupational therapy, Speech-Language Pathology, Physical therapy, ABA therapy), self-monitoring has been synonymous with self-cueing. Different therapeutic professions have incorporated the use of an integrated, multimodal approach as an effective behavior changing strategy (Bialas & Boon, 2010; Levendoski & Cartledge, 2000; McDougall et al., 2012; Menzies et al., 2009; Nelson et al., 2009; Rafferty, 2010). For example, some clinicians integrate self-monitoring strategies to teach children to "talk" themselves through daily routines such as packing a bag for school (Bialas & Boon, 2010). Other professions may use self-monitoring to increase compliance in the classroom or use it to encourage on- task behaviors (Amato-Zech et al., 2006; Bialas & Boon, 2010; Levendoski & Cartledge, 2000; McDougall et al., 2012; Rafferty, 2010). In speech speech-language pathology, self-monitoring, also known as self-cueing, has been used as part of an integrated approach to potentially lead to less therapist driven instruction. Given the support for integrated approaches in other fields, it seems appropriate to examine the benefits of this approach in speech sound disorders research. Within the past decade, investigators have proposed the use of an integrated multimodal approach for acquiring phonological targets (Tyler, 2016; Xi et al., 2020).

Available literature exists in speech pathology on integrated, multimodal approaches that use external feedback such as speech tools (i.e., Speech Buddy, tongue depressors, etc.), charts, visual picture stimuli, gestures and augmentative and alternative communication (AAC) systems designed for children to acquire phonological targets (Amato-Zech et al., 2006; Byun & Hitchcock, 2012b; McDougall et al., 2012; Preston et al., 2014; Rogers, 2012; Ruscello, 1995; Rusiewicz & Rivera, 2017; Xi et al., 2020). However, less is known on the effects of using self-generated cueing strategies that may promote phonological target accuracy. Based on limited available research in phonological studies (King et al., 2013), this study provides support for

phonological intervention approaches that are both integrated and multimodal. The integrated techniques may enhance a phonological treatment approach to be used and multimodal by incorporating self-generated strategies throughout intervention activities so that children may independently manage meaningful productions of phonological targets in words.

A method used by speech pathologists has been to incorporate student-driven activities into therapy that teach the client to independently, self-monitor their own target behaviors and use that feedback to self-correct phonological errors (Byun & Hitchcock, 2012b; Byun et al., 2016; Koegel et al., 1986; Landin, 1994; Rogers, 2012). In addition, Gierut (1989) posited that children often creatively find unique solutions to acquire the consistent use of phonological targets on their own; thus, teaching methods that facilitate target acquisition are critically important. Dr. Van Riper believed it was important for SLP's to focus on functional skills with prioritization of those skills that are most critical (Ertmer & Ertmer, 1998; Koegel, 1990; Koegel et al., 1986). The use of client-driven strategies with gradually less emphasis on therapist-directed support and more emphasis on client self-monitoring would potentially teach independence, promote learning, and perhaps encourage generalization of phonological intervention targets across children's phonemic inventory (Bialas & Boon, 2010; Dunlap et al., 1991; Koegel et al., 1986).

Children who are provided with self-cueing strategies they can use functionally in real world environments could potentially further develop speech and language skills outside of the therapy environment (Bialas & Boon, 2010). Researchers agree that skills can be incorporated into familiar everyday tasks that are practical since they serve to keep the child engaged in more communication opportunities (King et al., 2013). The emphasis of therapy is for children to achieve optimal performance of speech and language skills and extend these new, learned skills beyond the clinical setting into the real-world experiences (Kamhi, 2006; Kamhi & Pollock, 2005; Miccio & Powell, 2010).

Intervention strategies should be easily accessible, requiring very few steps to perform as not to create cognitive overload for the child, and practical for use with other communication partners in every-day situations (Dunlap et al., 1991; Koegel et al., 1988). Ideally, providing a system for children to use self-cueing and self-monitoring so they can take a more engaged and independent role in acquiring speech sounds would be of immense benefit to clinicians. Researchers posit though a variety of different integrated approaches may be equally effective in producing positive treatment outcomes on speech sound target accuracy, there is still need for further examination of such approaches that may support phonological target acquisition in speech pathology (Tyler, 2016). The potential benefit of the effects of integrated, multimodal phonological treatment programming is of great interest to clinical practice. Incorporating integrated activities and tasks using familiar and functional words and expressions may further allow children to potentially transfer skills across other phonological processes (i.e., different word positions or untrained phonemes and sound classes) within treatment conditions (Cole, 2013; Taps, 2007) and later may benefit from utilizing newly trained skills spontaneously

in novel settings at home and in the classroom (McDougall et al., 2012; Rivers & Lombardino, 1998)

1.1. Overview of Phonological Treatment Approaches

All phonological treatment approaches use behavior modification as the basis for remediation of phonological disorders (Shriberg & Kwiatkowski, 1987). Treatment of articulation disorders began in the early 1900's and by the 1950's generalization had begun to receive significant attention in the field. The Sensory Motor Approach developed by McDonald in the 1960's focused on teaching sounds at the syllable level and in facilitative contexts where target sounds are correctly produced (McDonald, 1964). Subsequently, the multiple phoneme and paired stimuli methods were developed, and these approaches targeted working with multiple sound contrasts that differed across sound class (Gierut, 1989; Gierut, 2001; Gierut, 2007; Gierut & Hulse, 2010). In contrast, the Distinctive Feature Approach grouped sounds within specific distinctive features and worked to achieve generalization using sounds with similar and shared characteristics (e.g., voiceless labial obstruent as in /p, /f/) (Barlow & Gierut, 2002; Williams, 2003). Later, the Phonological Approach was developed, which included the use of minimal pairs, maximal opposition pairs, multiple oppositions, cycles, and complexity approaches to phonological treatment (Gierut, 2001; Peña-Brooks & Hegde, 2007; Saben & Ingham, 1991).

Considerations in service delivery widely affect clinical decisions. Selecting targets in phonological therapy are typically based on stimulability, intelligibility, visibility of the speech movements, degree of deviance, and severity of the phonological process disorder (Powell et al., 1991; Tyler, 2006). The first steps in selecting targets involve determining which approach to use that would result in the greatest phonological change within the child's unique sound system (Gierut, 2001). Researchers agree that there are two broad classification approaches from which to choose, either a developmental target-selection approach or complexity-based approach (Kamhi & Pollock, 2005; Tyler, 2006). It remains uncertain as to the duration needed to acquire phonological targets based on which approach one chooses. However, the selection of a phonological target may lead to potential gains in either within-class generalization or across-class generalization (Gierut, 2001; Gierut & Hulse, 2010; Kamhi & Pollock, 2005; Tyler, 2006) . Within-class generalization refers to changes that occur in untreated phonemes from the same manner class or to a target's cognate pair. Across-class generalization refers to acquisition of untreated sounds from a different manner class group of sounds or class from treatment of a targeted phoneme (Gierut, 2001; Kamhi & Pollock, 2005; Tyler, 2006). Researchers suggest that selecting a developmental target approach facilitates across-class generalization, while a complex target selection approach promotes both across-class as well as within-class generalization (Gierut, 2001; Tyler, 2006). Vertical strategies require that the child achieve mastery of specific therapy targets before progressing to the next set of target goals. Horizontal strategies are broader and target multiple processes. For example, cyclical strategies incorporate portions of both vertical and horizontal strategies, with practice on targets for a specific amount of time prior to progressing to the next goals or levels, and then rotating or cycling back through the multiple targets (e.g., three different sets of phonological

targets) across therapy sessions (Hodson, 1998). Various phonemes can be targeted in one cycle and mastery of the sound is not required in order to rotate to work on sounds in the next cycle (Lancaster et al., 2010).
Traditional phonological approaches focus on selecting distinctive treatment targets that are highly stimulable (potential to be trained) and pairing the target with a phoneme that already exists within the child's phonemic inventory to encourage system-wide changes (Barlow & Gierut, 2002; Miccio & Powell, 2010; Smit et al., 2015). Such approaches consider the number and types of feature differences that are being presented for treatment (Barlow & Gierut, 2002).

1.2. Alternative to Traditional Approaches

Unlike minimal pairs or distinctive features approaches, the maximal opposition treatment approach (MOT) is an alternative to the traditional phonological approach. The MOT approach is based on principles of complexity (Baker & McLeod, 2011b; Gierut, 1989; Hodson & Paden, 1983; Saben & Ingham, 1991), which researchers argue has the potential to facilitate across-class generalization as well as within-class generalization (Gierut, 1989; Gierut, 2001; Gierut, 2007; Tyler, 2006). This approach should be considered when speech sound errors persist beyond typical age range (Gierut, 1989, 2007; King et al., 2013). MOT approach involves using broad contrasts of maximally distinct phonemes that vary in voice, place, and manner (e.g., bilabial sonorant /m/ vs. voiceless velar /k/ or voiceless affricate /ʃ/ vs. nasal sonorant /n/) (Gierut, 1989). The maximal opposition treatment approach is designed to use paired words consisting of two maximally opposing phonemic feature contrasts to encourage system-wide phonological changes within the child's phonemic inventory (Gierut, 2001). The goal of MOT approach is to increase target acquisition and provide a basis for generalization. However, MOT is less frequently chosen as the phonological approach by SLP's (Storkel, 2018).
Donicht, Pagliarin, Mota, & Keske-Soares (2011) state that MOT does not contrast the phonemic error with the target, instead it contrasts the unknown phonemic target with a phoneme that the child correctly produces. Once the maximally opposing contrast sounds are mastered by the child, it is assumed that they will independently acquire sounds with minimally opposing features, as they are easier to produce (Gierut, 1989). Using this approach appears to have a positive impact on the child's phonological system by improving overall intelligibility with evidence that complexity-based approaches can potentially lead to generalization (Tyler, 2016). This approach involves treatment of later-acquired, difficult to train or non-stimulable sounds and has the potential to lead to greater system-wide changes, with some generalization occurring to untreated sounds (Gierut, 2007; Gierut et al., 1987; Storkel, 2018).

1.3. Phonology and Attentional Control

Gray and Shelton (1992) state that attention, holding and retaining information long enough to be process it, is an important factor in therapy for increasing correct articulatory productions. The brain mechanisms underlying attentional control are also associated with self-regulation, which is vital for

effortful control; thus, attention may be potentially improved with the use of self-cueing training (Rueda et al., 2005). Ertmer and Ertmer (1998) reported that phonological treatment coupled with self-regulation training can transfer or generalize to independent, novel phonological skills. Shohamy and Wagner (2008) found that hippocampal and midbrain-dopamine region activity are highly correlated in that the two appear to work in tandem, overlapping and integrating with each other resulting in memories being encoded for retention of skills learned.

Memory involves three key processes: 1) encoding, 2) storing, and 3) recalling information (Bear et al., 2007). Additionally, consolidation is an associative part involved in the encoding and storage process. Researchers believe that consolidations re-access information from an engram (memory trace) of past experiences; therefore, it is a reconstructing of information from the past (Roozendaal, 2000). Encoding is the process of forming new memories and consolidation is the process of creating permanent representations of memories through physiological changes in the strength of connectivity between neurons (Bear et al., 2016). Storage involves holding information in the hippocampus until it is ready to be distributed to cortical areas. The cell bodies in the hippocampus store information, reinforcing learning and allowing new memories to be encoded, consolidated, formed, stored, and retrieved (Bear et al., 2016; Shohamy & Wagner, 2008). The final process involves recall of memories formed by accessing previously stored information and repeating the same pattern of neural activity formed when it was originally encoded (Shohamy & Wagner, 2008). Memory, then, is a type of perception linked to an experience-dependent event that is developed within the brain's neurophysiological system (Bear et al., 2016; Ullman, 2004). The brain possesses the ability to adapt to its environment, re-learn, re-associate, re-wire and reorganize when presented with new incoming information (Bear et al., 2016). Thus, memory and memory serving systems are important as they apply ingrained, long-term changes within the neuropsychological network (Demarin & Morović, 2014; Draganski et al., 2004; Ullman, 2004). New synaptic growth occurs that strengthens the connections between certain neural tracts making transmission easier over time, leading to neurological plasticity (Bear et al., 2016).

Researchers examined that self-generated cues are encoded, leaving behind a memory trace (engram) of the cue that is associated with a newly learned target or skill for retrieval (Roozendaal, 2000; Shohamy & Wagner, 2008; Ullman, 2004; Wheeler & Gabbert, 2017) (Fivush, 2008; Harris et al., 2014; Pansky et al., 2005). The unique relationship linking the cue to the target distinguishes it from other cues based on how each cue was originally matched to the target. This allows a person to remember to use self-generated cues across new experiences, making those experiences habitual (Wheeler & Gabbert, 2017).

1.4. Cueing Strategies

Investigators have proposed the use of different types of cueing strategies (e.g., written data collection, electronic vibrating beeper devices, tactile cues, auditory cues, visual cues, gesture cues) (Amato-Zech et al., 2006; Landin, 1994; Levendoski & Cartledge, 2000; Menzies et al., 2009) and have reported

positive effects on the accuracy and generalization of correct phonological productions (Gray & Shelton, 1992; Hedrick, 1997; Koegel et al., 1986; Landin, 1994; Preston et al., 2014; Rogers, 2013; Rogers & Chesin, 2013; Xi et al., 2020). Rafferty (2010) stated that self-monitoring is an effective behavior changing strategy initiated by external cues (therapist driven instruction) with the child being an active participant in the intervention process using their own internal cues (self-initiated behaviors).

Amato-Zech et al., (2006) examined the effectiveness of an electric tactile self-monitoring device called the MotivAider 2000. Each time the device signals through vibration, it cues the student to document their on-task attention in a special education classroom. Results indicated that tactile self-monitoring treatment increased on-task attention from a mean of fifty-five percent to greater than ninety percent in the data intervals observed, and both teachers and students found this method of self-monitoring acceptable for use. Koegel et al., (1986) examined self-monitoring to improve correct production of /s, z/ in the clinical setting and to generalize productions to the natural environment. The subjects produced correct and incorrect target sounds and were trained to self-record correct phonemic productions in conversation. The subjects were required to complete take home data sheets and only earned points for recording correct responses in reading and conversation with another individual. Trained within therapy sessions, the subjects demonstrated immediate and rapid improvements outside of the clinic setting (Koegel et al., 1988; Rhode et al., 1983). Rogers (2013) developed Speech Buddies, which are hand-held, tactile (sensory), biofeedback devices placed intra-orally in the mouth to provide a direct tactile cue for remediation of the target phonemes /r. l. s, sh, ch/.

Utilizing the R Speech Buddy device in a case study, Rogers (2013) suggested that biofeedback also promotes increased physiological awareness of speech productions, thus increasing the subject's awareness of errored phoneme productions. By utilizing the Speech Buddy device, the subject was capable of correctly shaping and strengthening the tongue through external stimulation using his commercially sold device. Three independent evaluators examined the accuracy of /r/ production to determine whether the Speech Buddy device would effectively remediate the errored phoneme. Ten weeks post-treatment, the subjects' accuracy of /r/ production increased from 23 percent to 75 percent accuracy at the word level and, at the sentence level, increased from 10 percent to 60 percent post-treatment. In a comparison study by Rogers and Chesin (2013), the Speech Buddy device was also used to remediate the targeted /s/ phoneme. The authors used a randomized, controlled, single blind research design to test two groups of subjects, those with and without the use of the Speech Buddy device, to see which group would more efficiently remediate the misarticulated phoneme /s/. The authors analyzed speech production accuracy at six data points, across and within-subject conditions. The investigators reported continual increases in speech production accuracy by the experimental group using the Speech Buddies device (e.g., 73.8%, 74.0%, and 74.0%) for the final three measurable data points while the control group experienced no significant changes in percent of accuracy across the same measured data points (e.g., 44.3%, 45.4%, and 43.7%). Within group

differences showed that measured treatment responses in seven out of eight of the experimental subjects increased to 87.5% while only three of the seven control subjects experienced increases of only 42.8% in measurable treatment responses. Results in this study reported greater increases exhibited across and within the experimental group from baseline to the final data point measured. Simply teaching correct production of a sound in the treatment environment is not consistent with best practice as generalization activities are recommended as an integral part of the intervention process (Byun & Hitchcock, 2012b; Koegel et al., 1986). Practice is important both within the treatment environment and in additional contextual environments (Baker & McLeod, 2011b; Kamhi & Pollock, 2005; Mcleod & Baker, 2014). Crafting treatment programs that promote child-driven, self-cueing techniques instead of relying heavily on SLP-directed cueing or an external feedback device should be further investigated to determine if they can be effective and efficient in remediating phonological process disorders as an integral part of treatment approaches.

1.5 Purpose of this Research

MOT is an alternative phonological treatment approach to traditional phonological intervention designed to promote systemic changes to untreated phonemes from the same or different manner class. Although highly recommended for persistent speech errors, this approach is not widely used among therapists. In addition, less is known about the effects of MOT when coupled with self-generated cueing strategies. The purpose of this study was to examine the effects of an integrated approach on the acquisition of phonological targets in 4-to-6-year-old children enrolled in maximum oppositional therapy (MOT). This study addressed the following research questions:

1) What is the effect of using MOT accompanied by the use of tactile self-cueing on overall phonological accuracy (%) as compared to the performance of a control group using MOT without the use of tactile self-cueing?
2) What is the effect of using tactile self-cues on the duration of MOT treatment required to meet criteria for acquisition of phonological targets (80% accuracy across 3 consecutive sessions in initial, medial, and final phonemic contexts)?
3) What are the parents' perceptions of the child's speech accuracy when comparing pre- and post-treatment surveys?

2. Methodology

2.1. Participants

This study was approved by the Loma Linda University Institutional Review Board and parents of participants read and signed informed consent forms explaining the benefits and limitations of participating in this study. On-site recruitment as well as letters and flyers were given to school administrators to recruit participants for this study. Of the 37 participants assessed, 32 qualified however, 20 continued to the end of the study. In addition, 15 potential participants declined from the study after they were screened. The

twenty study participants consisted of typically developing monolingual English-speaking children, ages 4 to 6 years, who were identified by their parents or teachers as exhibiting one or more speech sound errors in conversational speech. They comprised a heterogeneous sample from a center-based early childhood development program, a private clinical setting, public schools, private schools, and a virtual academy. The recruited convenience sample was age stratified (4, 5 and 6-years) and randomly divided into two groups. One group received tactile self-cueing training with MOT and the other group received MOT approach only. Inclusionary criteria were age-appropriate receptive language skills, oral motor abilities, and normal peripheral hearing sensitivity in both ears. Participants were required to have an email address and electronic device to receive and access a zoom link throughout the study. Participant exclusion criteria consisted of attention deficits (e.g., ADHD, ADD), developmental delay (ASD), chronic behavior challenges affecting ability to learn (e.g., tantrums, self-injury, biting, hitting), presence of neurological deficits, legally blind, and hearing impairment.

Throughout the study, participants were required to attend maximal opposition therapy (MOT) sessions, either with or without the use of accompanying self-cueing strategies, or prompts, twice weekly for 10 weeks. There were some expectations required of parents or caregivers. Parents who expressed an interest in the study and whose children met the criteria were scheduled for a pre-study interview. During the interview, parents who chose to participate in the study read and signed the informed consent form. The children were given a start date and parents completed an initial parent survey regarding their child's phonological development (e.g., I understand what my child says; Other people have trouble understanding what he/she says, I correct my child's speech) by giving a response of always, sometimes, or never. A parent or a caregiver was required to agree to serve as a reading partner for their child, outside of therapy sessions. They also had to consent to be videotaped engaging in story retell tasks a minimum of 3 times throughout the study. These videos were used to code for either phonological accuracy or phonological inaccuracy, and the use/non-use of accompanying tactile self-cueing strategies outside of the therapy environment. The parent/caregivers were also required to have an electronic device (e.g., Smartphone, iPad, tablet) or equivalent computer capability with a web camera to perform and record live, on-screen interactions and follow-up sessions outside of treatment setting, using the Zoom videoconferencing software. While not required to purchase the Zoom software, parental access to an internet connection via a hyperlink to join the live, zoom sessions was a requirement.

2.2. Personnel and equipment

The first author and two research assistants who provided intervention and collected data during story retell visits consisted of licensed and practicing speech-language pathologists and a speech-language pathology assistant. The first author (SLP) and research assistants used either a desktop or laptop computer with dual-core processors and access to high-speed internet consisting at a minimum of at least the ASHA recommended bandwidth of 3.0 mbs per second. Computers were equipped with either an internal or external

webcam and a built-in or external microphone. Although face-to-face intervention did not require the use of headsets while participants were seated in a private, controlled treatment room, the use of ear buds or headsets were required for all computer-based, data collection. Throughout the study, each session was recorded via Zoom video-conferencing platform. However, the pandemic surge of 2020 forced an unexpected shift in the study from clinic-based interaction to the computer-based, Zoom platform only for the health and safety of the community.

2.3. Data collection and processing

Several pre- and post-therapy assessments were given as part of this study. The Goldman-Fristoe Test of Articulation-Third Edition (GFTA-3) (Goldman & Fristoe, 2015) and the Khan-Lewis Phonological Assessment-Third Edition (KLPA-3) (Khan & Lewis, 2015) were used to diagnose the presence of phonological disorders for potential participants. The GFTA-3 is a norm-referenced and standardized assessment tool used to examine phonemic inventory in Standard American English. It provides information concerning spontaneous and imitated sound productions in single words and connected speech and provides stimulability information. It is frequently used in combination with the KLPA-3, a norm-referenced instrument which was used to determine the presence of phonological processes. GFTA-3 and KLPA-3 scores were measured using standard scores, percentile ranks, confidence intervals, by gender and age. The Oral and Written Language Scales-Second Edition (OWLS-II) (Carrow-Woolfolk 2011) is a comprehensive assessment of language comprehension that includes lexical, semantic, syntactic, supralinguistic and pragmatic language abilities. It is a standardized, norm referenced assessment tool which is measured using standard scores, confidence intervals, percentile ranks, descriptive range and test age equivalence.

A pre-and post-treatment parent survey was collected using a 3-point ordinal Likert scale (i.e., Always, Sometimes or Never). The survey consisted of 12-questions used to assess the participant's accuracy of speech productions, overall speech intelligibility, how others (i.e., family members, friends and people in the community) rate the participant's speech productions, and the child's independent, spontaneous use of tactile self-cues outside of study treatment while producing target sounds trained during the therapy sessions (See Appendix A).

Throughout the study, a data collection form and coding rubric developed by the first author (See Appendix B). Data was collected during video recorded treatment sessions and story retelling tasks to code for phonological accuracy, the presence of using tactile self-cues (C) or whether a prompt facilitated a response during intervention. The information data form was comprised of a numerical identifier, participants age, session date, and the phonemic target and finally a notes section. The purpose of the notes section was to document qualitative information such as observed, untreated sound changes during a session or parent and child subjective reporting and feedback (see Appendix B).

Similar to other investigations, we adopted/incorporated a criterion-based intervention requirement to determine the accuracy of target sounds and the

duration to target acquisition (Smit et al., 2015; Williams, 2003). Participants were to reach 80% accuracy or greater, across three consecutive sessions in any phonemic word position (initial, medial, and final). A coding rubric was used by both SLP's and the SLP-A to code for the data collection on 1) the percentage of correct phonological targets produced by each participant; 2) whether or not participants simultaneously used cueing strategies during story retell visits ; and 3) to code for the number of prompts (i.e., Did you use your strategy?, Let's try that again) that were provided in treatment to remind participants to use a trained strategy (either a finger cue on tubercle or hand cue on larynx) or to offer a second attempt to correct the phonemic production

2.3.1. Zoom Platform

The Zoom video-conferencing platform was used in this study to collect and record data and monitor participants progress, through live camera interaction, across treatment sessions and story retell visits throughout this study. This web-based video-conferencing tool is HIPAA compliant as governed by the 2003 Rules and Standards published Health Insurance Portability and Accountability Act (HIPAA) Security Rule in the Federal Register (45 CFR Parts 160, 162, and 164 Health Insurance Reform: Security Standards; Final Rule). Zoom can also be accessed through a mobile application. Through this online platform, users have the ability to meet live, with or without the use of a video camera, record sessions, share documents and annotate on shared screens with communication partners. The online video-conferencing program utilized in this study was the Zoom Pro which offers the benefit of unlimited meeting time as opposed to the cost-free version which limits meetings to 40 minutes.

2.3.2. Picture word pairs

From the maximum opposition approach to treatment, activity sheets were generated with pictured word pairs embedded with maximal feature differences (Bowen & Rippon, 2013; Gierut, 1989; Gierut, 2001; Gierut, 2007). A minimum of 10-word pairs on double-sided sheets were chosen from a combination of commercially available MOT worksheets and online pictures (See Appendix C). Participants were included in the selection process of online pictures for targeted word pairs by incorporating their unique interest in a familiar theme, character or athlete (e.g., Cookies, Koby Bryant, Om Nom, Princess Elsa).

2.3.3. Story booklets

Commercially available and printed story booklets were created with words inclusive of each participants' targeted phoneme. The booklets were short in length (10-25 words per page, 4-8 pages). Black and white or colorful picture illustrations accompanied the printed text. The purpose of the illustrations was to support early or non-readers as they describe the story, irrespective of printed words they may not recognize. Story booklets provided to subjects were at low cost, reproducible, foldable, and easy to print or color.

2.3.4. Tactile Self-Cues

Tactile hand cues were chosen to accompany the production of phonological targets as self-generated feedback for children to self-correct phonological errors and to further distinguish a target sound from other phonemes using the maximal opposition treatment approach. Participants were provided one of two tactile self-cues examined in this study; placement of a finger on the tubercle of the upper lip when producing a targeted phoneme or placement of the hand over the larynx to cue production of velar phonemes /k, g/. The development of self- generated cues is considered to be an active process which may ultimately allow children to become increasingly aware of phonemic productions (Wheeler & Gabbert, 2017).

2.3.5. Tokens and incentives

Throughout the study, participants received fun stickers, stamps, small toys, online games and movie clip choices as incentives. Upon completion of the study, a gift bag of small toys and treats were provided either in person or by mail for their valued participation.

2.3.6. Interrater Reliability Measures

Prior to identifying study participants, three pilot non-participants were recruited and videotaped while using MOT with and without the use of self-cueing strategies to establish interrater reliability among the first author (SLP), second SLP and licensed speech and language pathology assistant (SLPA). The first author (SLP) conducted a 1-hour training session with the second SLP and the SLPA. Both were given explicit instructions to identify the MOT approach and code for phonological accuracy of target phonemes. First, both SLP's independently applied codes using a coding rubric to the middle segment (20 seconds into the recorded session) of 3-prerecorded story telling sessions among 3-non-participants. The two SLP's compared and discussed findings to resolve any discrepancies in coding regarding the use of tactile self-cues or phonological accuracy. The two SLP's then re-applied the codes to the segments using the coding rubric for the three non-participants a second time and confirmed interrater reliability at greater than 80% accuracy.

The same process was used between the first author (SLP) and the licensed SLP-A. The first author and the SLP-A achieved interrater reliability of greater than 80% accuracy on phonological target identification and the use of verbal prompts when re-applying coding on a second attempt to the middle segment of 3 pre-recorded training participant videos. Next, the second SLP was trained to identify the two types of self-cueing strategies (i.e., finger cue vs. hand to larynx cue) participants may use to accompany MOT approach. Both SLPs identified self-cue strategies, applying code to the middle segment of the 3 pre-recorded sessions. Interrater reliability was achieved with no discrepancies found on observed use of tactile self-cues when reapplying the coding. The second SLP was given the two written parent-sentence prompts to monitor whether parents used them or used more than two prompts to encourage child participation during story retell for generalization data. The SLP-A used specific written instructions to administer treatment or prompts across all participants (See Appendix D).

2.3.7. Phonological Assessment

At either the participant's respective school site, or via tele-practice using Zoom software, the first author administered the GFTA-3 and the KPLA-3, pre-treatment, to assess articulation and for the presence of phonological processes (e.g., phonemic substitutions, omissions, distortions, and additions). Data from pre-treatment assessment measures were used to identify the presence of speech sound errors and to identify specific, individual phonological processes for the participants and establish target selections for therapy. The Listening Comprehension subtest of the OWLS-II was administered to participants to document that receptive language abilities are age-appropriate. To balance age groups of children (4, 5 and 6-years old), the participants were selected by consecutive sampling once they met inclusion and exclusionary criteria, and the parents and child agreed to participate in the study.

During the assessment process, the parents received a one-hour story re-telling training session and were provided the story retell materials, including two-written story retell prompts (i.e., one statement prompt and one open ended question) to use with their child during the story retell task (See Appendix E). During this training, the parents participated in mock story-retelling interaction with the first author and the SLP-A using the two-written story retell prompts. In addition, the first author also explained and demonstrated for parents how to access and open a Zoom link so one of the SLPs could then record parent-child storytelling interactions through the study.

From the phonemic inventory of the GFTA, participants targeted phonemes for intervention were chosen. Participants were randomly assigned a numerical identifier which was pulled from a list and then placed in either an experimental or control group. The first author (SLP), and a trained research assistant who is a licensed speech-language pathology assistant (SLPA), performed MOT intervention using a list of word pairs containing each child's targeted phoneme (one known phoneme in the child's phonemic inventory and one unknown phoneme with at least two distinctive features that were maximally different from each other (Gierut, 1989; Gierut, 2001; Gierut, 2007). The SLP provided MOT treatment along with training of the accompanying tactile self-cue (to the experimental group) while the SLPA provided treatment without the use of tactile cue training to the control group of participants. MOT was performed twice weekly for 30 minutes across both groups of participants over 10 weeks. The SLP and SLP-A also performed all coding during intervention. Coding was used to determine 1) correct and incorrect treatment responses and 2) if children used or did not use either of the 2-types of tactile self-cues or required prompts as reminders to use their trained strategy. The second speech-language pathologist (SLP) observed and coded phonological accuracy and participant-driven cueing to record generalization during story retell three to five times across the 10 weeks of intervention.

2.3.8. Story Retelling

To examine generalization of targeted phonological productions, subjects in both experimental and control groups received an articulation story booklet at the end of each week embedded with their targeted phoneme. Each parent or caregiver was instructed to read a story booklet with their child for at least 20 minutes a day, four times per week. After being read to by a parent or caregiver, children in both groups were instructed to practice retelling the same story to their parent or caregiver outside of the intervention environment. Every two weeks, each parent from both groups received an email from the second SLP instructing them to open the Zoom hyperlink and complete an SLP monitored story retell session online. The second SLP used Zoom to then record and collect data during story retell tasks to capture whether or not each child used self-cueing strategies to correct phonological errors outside of the treatment setting. The second SLP also collected data on the percentage of correct phonemes produced out of the total number attempted.

2.3.9. Post-Therapy Assessment

After participants continued demonstration of correct target production at 80% accuracy or greater, the first author (SLP) re-administered the GFTA-3 and applied that data to the KLPA-3. Changes in phonological target acquisition from both groups were then analyzed.

Each participant received an incentive reward that did not exceed more than a $5.00 value for participation in this study. The parents of the participants in both groups completed a post-treatment parent survey used to represent their perception of their child's independent, spontaneous use of tactile self-cues and phonological gains observed (e.g., I understand what my child says; Other people have trouble understanding what he/she says, I correct my child's speech). Parents provided feedback by giving a response using a 3-point Likert scale of Always, Sometimes, or Never (see Appendix B).

2.4. Data analysis

Differences in the overall phonological accuracy (%) on the GFTA-3 and KLPA-3 pre-treatment and posttreatment while using MOT approach and pre-test/posttest parent survey were analyzed using a non-parametric Related Samples Sign test. Analyses were stratified between the groups (tactile self-cue group vs. non-tactile self-cue group). Time-to-event analyses with Kaplan-Meier Curve and a Log Rank Test in Statistical Package for Social Sciences (SPSS) were used to analyze the duration of MOT intervention to reach phonemic target accuracy criteria of 80% accuracy or greater between the two groups of participants.

KLPA phonological processes before and after treatment were assessed using a McNemar's Test after stratification between treatment and posttreatment groups, with percent improvement reported (a participant going from not being able to produce a sound, to being able to produce a sound). Two-tailed p-values were used for all analyses, with the exception of McNemar's Test (one-tailed directional hypothesis). $P<0.05$ was used to determine statistical significance for all statistical tests in the study.

3. Findings

3.1 The impact of MOT and tactile self-cueing on phonological accuracy

Table 1 presents the median scores from GFTA-3 pre-test and post-testing raw scores (RS), standard scores (SS) and percentile scores (%). A nonparametric Related-Samles sign test was performed for male and female participants in a tactile self-cueing (tactile SC) treatment group and non-tactile self-cueing (non-SC) treatment group. Differences were found in 6 out of 9 assessment measures investigated (Table 1). As seen in Table 1, results were statistically significant in median raw scores on the GFTA-3 phonemes within words, GFTA-3 standard scores (SS), percentiles in words only, and KLPA raw scores and percentiles. No statistically significant differences were found in the GFTA-3 percentiles in sentences, GFTA-3 standard scores in sentences, or KLPA-3 Standard scores.

Table 1
Related-Samples sign test on MOT no cue – MOT self-cue group median comparisons from GFTA and KLPA-3 raw scores, standard scores and percentile measures, p values

Assessment	MOT Non-Tactile SC		MOT Tactile SC	
	Pre	***p* value**	**Pre**	***p* value**
GFTA3 Word Raw Score (RS)	9.5 (1.8,17.3)	.125	13.0 (11.0,15.0)	.001**
GFTA3 Sentences Raw Score (RS)	9.0 (3.5,27.8)	.070	7.0 (3.0,12.0)	.021*
GFTA3 Words (SS)	-6.5 (-28.3,0.0)	.219	-10.0 (-18.0,-4.0)	.001**
GFTA3 Words (%ile)	-9.0 (-22.7,0.0)	.062	-13.0 (-25.0,-2.0)	.002**
GFTA3 Sentences (SS)	-9.5 (-16.5,-1.3)	.070	-4.0 (-13.0,4.0)	.754
GFTA3 Sentences (%ile)	-12.0 (-40.8,-0.1)	.070	-2.0 (-21.0,9.0)	.754
KLPA3 Raw Score (RS)	21.5 (9.5,27.0)	.070	11.0 (10.0,19.0)	.001**
KLPA3 (SS)	-11.0 (-23.5,0.0)	.062	-11.0 (-16.0,-3.0)	.065
KLPA3 (%ile)	-11.0 (-39.8,0.0)	.062	-14.0 (-27.0,-2.0)	.004**

Values expressed as median difference and interquartile range.
Significance for Treatment *p<0.05, **p<0.01 for Related-Samples Sign Test
Goldman-Fristoe Test of Articulation- Third Edition (GFTA-3)
Khan-Lewis Phonological Analysis - Third Edition (KLPA-3)
*p <0.05, ** p <0.01

In Table 1, raw scores on the GFTA-3 represent the total number of misarticulated phonemes for each group of participants based on their phonemic inventory. Although the median raw score decreased (median difference and IQR: 9.5 (1.8,17.3)) from pretest to posttest performance for participants without tactile SC training, results were not statistically

significant (*p*=.125) (see Table 1) between the experimental and control groups. The median raw score of errored phonemes from pre-test to posttest in the treatment group while using tactile SC also decreased (30 to 11). Differences in raw scores in the treatment group from pretest to posttest after tactile self-cue training were statistically significant (median difference and IQR: 13.0 (11.0,15.0), *p* = .001, 2-tailed), however, a statistically significant difference was not found for the control group.

When examining results for raw scores of sounds in sentences, the non-TSC group median difference decreased (median difference and IQR: 9.0 (3.5,27.8)) from pretest to posttest, however results were not statistically significant (*p* = .070, 2-tailed) (see Table 1). The GFTA-3 pretest to posttest median difference in the treatment group with tactile SC decreased (median difference and IQR: 7.0 (3.0,12.0)), indicating statistical significance (*p* =.021, 2-tailed).

The non-parametric Related-Samples Sign test was also used to evaluate differences for GFTA-3 standard scores in words pre- and posttreatment. Although scores for participants without tactile SC yielded a 6.5-point median difference increase, the result was not statistically significant, *p*=0.219, 2-tailed*).* The tactile SC treatment group median standard scores from pretest to posttest yielded a 10-point median difference increase and was statistically significant (*p* =.001, 2-tailed). Additional median differences and *p* values are reported in Table 1. Statistically significant differences were found between pretest to posttest percentile scores for the treatment group receiving MOT and tactile self-cueing training (*p* =.002, 2-tailed).

Table 1 also displays KLPA median raw score differences in pre-and posttest performance for both treatment groups. A decrease in median difference and IQR (21.5 (9.5,27.0)) for the non-tactile SC group was found to be non-significant (*p* = .070, 2-tailed), however findings from the decrease in median difference of the tactile SC treatment group revealed statistical significance (median difference and IQR: 11.0 (10.0,19.0), *p* = .001).

Median percentile increases of KLPA-3 pretest to posttest to the 11th percentile for the non-tactile SC treatment group (median difference and IQR: -11.0 (-39.8,0.0)) were compared to the tactile SC treatment group median increase to the 14th percentile (median difference and IQR: -14.0 (-27.0, -2.0)). Findings from the increase in KLPA-3 median percentile scores in the non-tactile SC treatment group were non-significant (*p* = 0.062, 2-tailed) compared to the statistically significant gains seen in the tactile SC group (*p* = 0.004, 2 tailed).

The KLPA-3 pretest scores were analyzed using the percentiles to classify both groups of participants into four quartile groups to confirm that comparisons were equivalent across participants. Results indicated that all participants fell within the same comparison group (with the exception of one participant in the tactile SC treatment group) and no significant differences among participants in the study (data not shown). In further analysis of the KLPA-3 from pretest to posttest, all participants in the treatment group did not show any significant difference in improving in phonological processes in either the non-tactile SC group or tactile SC group (Table 1, Related-Samples Sign Test, p>0.05).

3.2. The effect of using tactile self-cues on the duration of MOT treatment.

The second research question in this descriptive investigation examined the impact of using a tactile self-cueing strategy on the duration of MOT treatment required to reach target accuracy across all phonemic contexts within words. Figure 1 displays a between-group analysis in the initial phonemic context of words on the duration to meet the percent accuracy criteria, across 3 consecutive sessions. The vertical axis presents the median percentage of participants in the study who met the treatment criteria. The horizontal axis represents the number of sessions across the 10-week study.

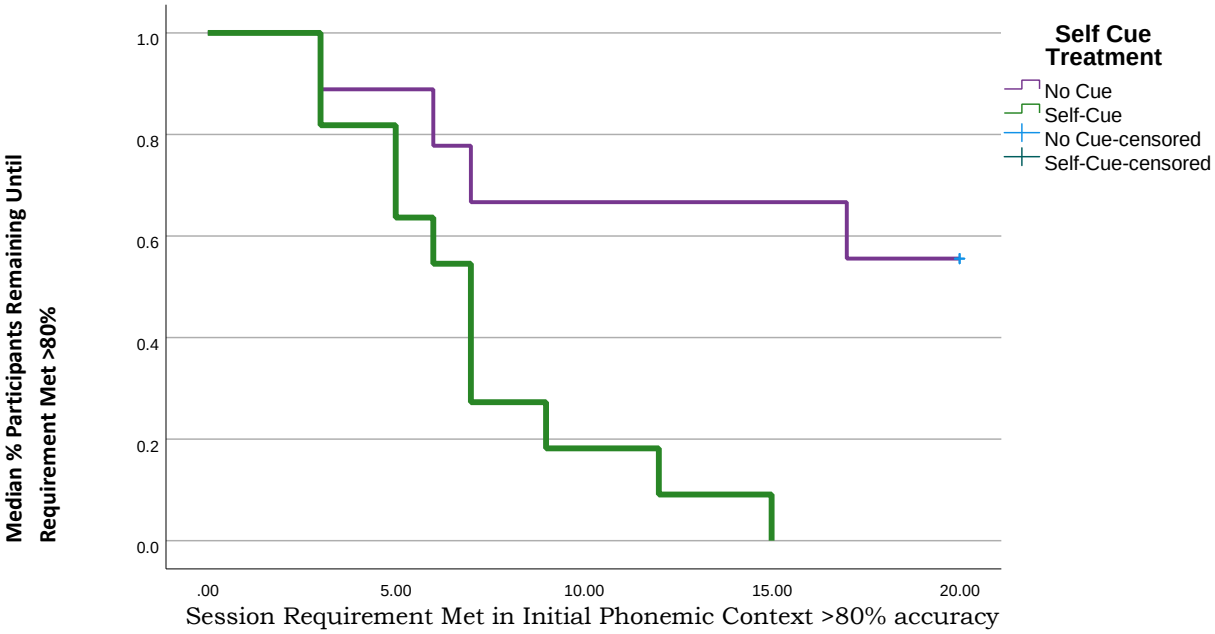


Figure 1. Duration to Meet Target Requirement % accuracy for initial phonemic context within words (goal of meeting greater than 80% accuracy, across 3 consecutive sessions). Observations were considered censored if the participant did not reach the threshold by the end of the 20th session.

In the initial phonemic context, results revealed that by the 7th session, half of the participants using tactile self-cues met the requirement of 80% accuracy or better across three consecutive sessions (see Figure 1). Results also revealed that by the 15th session, 100% of the participants taught the tactile self-cue met the requirement of 80% or better accuracy across three consecutive sessions. In comparison, participants without tactile self-cues (non-TSC) continued until session 20, with only 44.4% of the participants meeting accuracy criteria. Findings were statistically significant. Results show a positive trend on the duration of teaching young children to self-cue as they acquire phonological targets. Participants in the treatment group without

tactile SC (non-TSC) may require an extended duration beyond the number of sessions to reach 100% accuracy in the initial phonemic context (Figure 1).

To meet the second requirement in the final phonemic context, Figure 2 displays a comparison between the percentage that each group of participants reached with 80% accuracy or better by a given session. The vertical axis presents the median percentage of participants in the study who met the treatment criteria. The horizontal axis represents the number of sessions across the 10-week study. Findings here were also statistically significant. In the word final phonemic context, results revealed that by the 10th session, 50% of the tactile SC group met the requirement with 80% accuracy or greater across three consecutive sessions. By the 20th session 81.8% of the tactile SC group met the requirement. In comparison, only 33.3% of non-tactile SC participants reached the requirement of 80% accuracy or greater in three consecutive sessions by the 20th session.

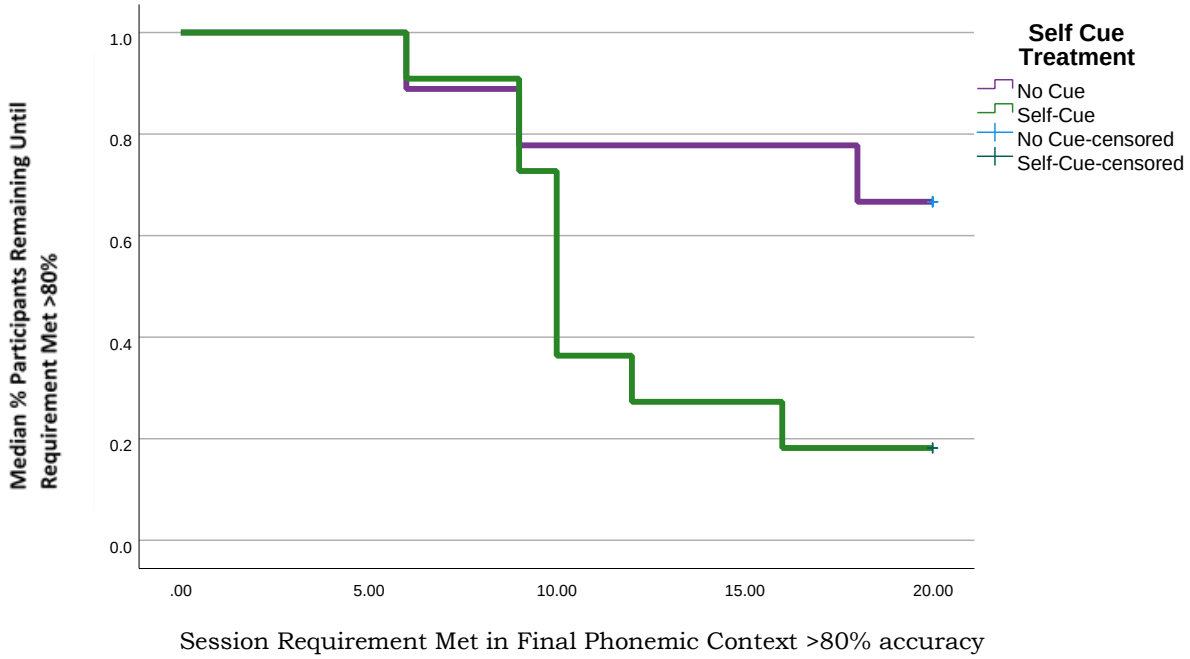


Figure 2. Duration to Meet Target Requirement % accuracy for final phonemic context in words (Goal of meeting greater than 80% accuracy, across 3 consecutive sessions). Observations were considered censored if the participant did not reach the threshold by the end of the 20th session.

In Figure 3, a Kaplan-Meier analysis was used to measure treatment group differences on duration until participants acquired targeted phonemes in medial phonemic context. As seen in the previous Figures 1 and 2, the vertical axis presents the median percentage of participants in the study who met the treatment criteria. The horizontal axis represents the number of sessions across the 10-week study. Findings were statistically significant. By the 15th session, 50% of the tactile SC group met the requirement of 80% accuracy or better across three consecutive sessions for the medial phonemic context. By the 20th session, 63.3% of the tactile SC group met the requirement while

11.1% of the non-tactile SC treatment group met the requirement by the 20th session. Of the three phonemic word positions, results displayed the largest differences between the two groups of participants in the medial phonemic context within words.

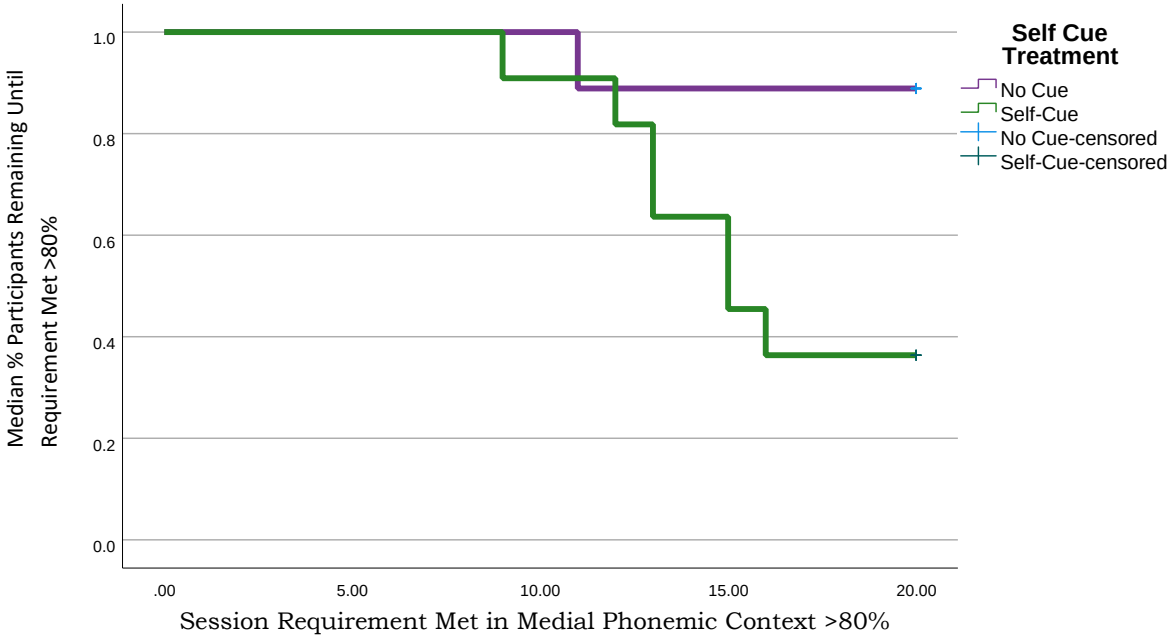


Figure 3. Duration to Meet Target Requirement % accuracy for medial phonemic context in words (Goal of meeting greater than 80% accuracy, across 3 consecutive sessions). Observations were considered censored if the participant did not reach the threshold by the end of the 20th session.

3.3. Parents' perceptions of speech sound accuracy

Table 2 represents the parent survey results obtained from both groups of participants' parents before and after 20 treatment sessions. Of 12 survey questions on parents' perceptions of speech accuracy, responses were statistically significant for the participants in the tactile self-cue group on question number 7 (see Table 2). Parents of this group reported that strategies trained were simple or easy to use (p = 0.016). Parents' survey responses to question number 7 from pre-treatment to posttreatment among the group learning the tactile cueing strategy consistently increased from sometimes to always. No other responses to the parent survey were significantly different.

Table 2
Parent survey questions and results between pre and post therapy (20 sessions twice weekly across 10 weeks) for control and treatment groups

	Control No Cue			Treatment Self Cue		
Parent Survey Items	Pre	Post	p	Pre	Post	*p*

1. Difficult for family to understand	1.00 (0.00)	1.00 (0.00)	1.000	1.00 (0.00)	1.00 (1.00)	0.688
2. Difficult to understand by strangers	1.00 (0.00)	1.00 (0.00)	1.000	1.00 (0.00)	1.00 (1.00)	0.625
3. Parent feedback/cues helps correct speech	1.00 (2.00)	1.00 (0.75)	1.000	1.00 (0.00)	1.00 (1.00)	0.500
4. Effect participation with family or friends	0.00 (1.00)	0.50 (1.00)	1.000	0.00 (1.00)	0.00 (1.00)	1.000
5. I understand my child's speech	1.00 (1.00)	2.00 (0.00)	0.125	2.00 (1.00)	2.00 (0.00)	0.500
6. Child is aware of speech errors	1.00 (1.50)	1.00 (1.75)	0.500	1.00 (0.00)	1.00 (0.00)	1.000
7. Speech cueing strategies are simple/easy to use	1.00 (1.50)	2.00 (1.75)	0.250	1.00 (0.00)	2.00 (1.00)	0.016*
8. Read to child at home at least 4x weekly	2.00 (1.00)	2.00 (1.00)	1.000	1.00 (1.00)	1.00 (1.00)	1.000
9. Child frustrated when speech is not understood	1.00 (0.00)	1.00 (0.75)	1.000	1.00 (1.00)	1.00 (0.00)	0.453
10. Parent corrects child's speech errors	1.00 (1.00)	1.00 (1.75)	1.000	2.00 (1.00)	2.00 (1.00)	1.000
11. Child self-corrects speech errors	1.00 (1.00)	1.00 (0.75)	1.000	1.00 (0.00)	1.00 (0.00)	0.500
12. Child uses cueing strategies to correct errors	0.00 (1.00)	1.00 (1.50)	0.500	1.00 (0.00)	1.00 (1.00)	0.062
Values expressed as median (IQR)						

Significance for Treatment *<0.05 for Related-Samples Sign Test

4. Discussion and Conclusions

The purpose of this study was to investigate the effects of an integrated approach to the acquisition of phonological targets in two groups of 4-to-6-year-old children who exhibited evidence of phonological processes. One group of participants were taught to use a self-cueing strategy to accompany the maximum opposition treatment approach (MOT) across 10 weeks of intervention. The second group received MOT without tactile self-cueing training. In addition, whether or not the learning effects from tactile self-cue training could influence within-class and/or across class generalization was also examined. Previous investigations regarding the efficacy of the maximum oppositions approach have found that, in comparison to other contrastive approaches, results support phonological generalization to untreated phonemes and/or sound classes. Consistent with previous research, we targeted phonemes to which participants had the least phonological knowledge and paired the targeted sound with a known phoneme within the

child's unique phonological inventory (Gierut, 1989; Gierut, 2001; Storkel, 2018; Tyler, 2006). We then integrated this approach with a tactile, self-generated modality that was not previously incorporated into prior phonological studies.

This study extends prior research that demonstrates positive effects of self-monitoring and the use of tactile cues in training young children to improve phonological accuracy (Bialas & Boon, 2010; Rogers, 2012; Rogers & Chesin, 2013). Similar to earlier studies using self-cues, the participants in this study demonstrated increased gains over the control participants when using tactile self-cues to enhance maximum opposition treatment approach as they acquired new phonological targets. Therefore, it is important to consider whether MOT alone is enough to correct speech sound errors. While a large body of research exists on phonologically based treatment methods, researchers have discovered that pairing maximally opposed sounds can generalize to untreated targets that children may not have been expected to acquire on their own (Brumbaugh & Smit, 2013; Gierut & Hulse, 2010; Hodson, 1998; Tyler, 2006). However, there is limited research using randomized control trials (RCT) examining the effects of using tactile, self-generated cues to self-monitor and self-correct phonological errors as they acquire and generalize phonological targets. Of the 134 efficacy studies examined by Baker & McLeod (2008, 2011), they found that phonological intervention studies were primarily comprised of quasi-experimental designs (e.g., single subject designs), small sample or case studies. In their review, efficacy studies with larger samples using randomized control trials comprised 14.8% while meta-analyses represented 1.5% of the phonological treatment studies.

Clinicians want to know whether incorporating elicitation techniques as an integrated, multi-modal approach (e.g., audio-visual gesture training, electrograph biofeedback and tactile biofeedback, etc.) to train young preschool-aged children could be a fundamental tool to facilitate phonological target acquisition. The combination of self-cueing strategies associated with phonological treatment approaches may perhaps lend insight into a useful and functional, multi-modal approach that has positive learning benefits for this young population. Examining new ways to approach phonological target acquisition is an area of great interest to clinicians.

4.1 Tactile self-cue effects on phonological accuracy

Training participants to use tactile self-cues to increase phonological accuracy while using a maximum opposition approach to phonological treatment resulted in significant between-group differences in pre- and post-testing scores for standardized instruments. The treatment group using tactile self-cueing strategies exhibited larger gains in the majority (6 out of 9) of the assessment measures investigated. It may be that, incorporating the integrated approach of tactile self-cueing for the treatment group and MOT may have led to increased encoding and retention of novel skills. While both groups experienced changes in phonological accuracy using the MOT approach, this was likely facilitated by the focus of a meaningful, language rich environment (Bernthal et al. 2000; (Hodson & Paden, 1983). These

findings are similar to the Speech Buddy tactile biofeedback randomized controlled studies for /R/ that found that participants in the experimental group had greater phonological accuracy when supported by the use of a tactile cue, in comparison to a control group across multiple data points (Rogers, 2012). Training young children to use self-generated tactile cues serves as an endogenous strategy to promote both target speech productions in meaningful contexts and retention of novel skills for phonological target generalization. MOT alone may not be enough to promote rapid change in the phonological system of young preschool children (Hodson & Paden, 1983; Williams, 2000a, Williams 2000b, Williams, 2009). We found it interesting that no statistically significant differences were found in GFTA-3 percentile scores or standard scores in sentences, as well as KLPA-3 standard scores between the groups. This may be related to the low number of participants in this study, characteristics of the assessment tools, and the 10 weeks of intervention used in this project. From a descriptive analysis, there were 11 participants in the MOT group receiving tactile self-cueing training that exhibited some across-class and within-class generalization and only four participants in the control group that showed this pattern (data not shown). The statistically significant results in some groups indicated a trend, where tactile SC treatment median differences were consistently and statistically greater than the median difference for the non-tactile SC treatment group. This may merit investigation for future study.

4.2 Effects of self-cues on duration

While phonological treatment programs have been reported to be successful in the remediation of speech sound disorders (Baker et al., 2018; Hodson & Paden, 1983; Kamhi, 2006; Williams, 2000; Williams, 2009; Williams et al., 2010), little research has focused on comparisons of efficiency and efficacy among different phonological intervention programs (Allen, 2013; Baker & McLeod, 2011a, 2011b). Regarding duration to phonological accuracy, both groups of participants benefited from the use of MOT. By integrating a tactile self-cueing strategy with MOT during intervention, it is possible that retention of the strategy may have contributed to differences in intervention duration between the two groups. In addition, running the study beyond 10 weeks duration may have provided closer examination to accurately determine the median time point where at least half of the control group not using tactile self-cues might have achieved 80% accuracy to make a qualitative comparison. From the findings, it seems promising that tactile self-cueing training may have potentially contributed to a reduction in treatment duration to acquire phonological targets with 80% accuracy or more for the children in the TSC group. Given the small number of participants (11 in the experimental or TSC group, 9 in the control or non-TSC group) additional data is needed on a larger scale to verify this finding beyond the scope of this study as these results represent a pilot study.

When examining the duration to reach phonological acquisition criteria in final word position, results might have been influenced by within-child factors in rate it took participants to identify regularities associated with contrastive word pairs or perhaps some targets are more sensitive than others to MOT approach. Incorporating the use of self-cues to elicit target acquisition may

offer multi-modal benefits that assist young children to better reorganize their knowledge about their own phonological sound system, potentially leading to more efficient acquisition of speech sounds.

Considering phonemic contexts, the medial position appeared to be the most challenging for all participants to acquire, particularly the participants who did not use tactile, self-cues. The tactile self-cue group overall did perform better in terms of meeting phonological acquisition criteria and did so over a shorter period of time. These pilot results suggest that the gains made by the self-cueing participants may be partially due to development of self-monitoring skills t used in conjunction with MOT. Overall, considerations should be made to address the possibility that younger children may need additional support to efficiently achieve phonological accuracy and to generalize these skills outside of the therapy environment. Perhaps the use of tactile self-cues integrated with MOT is one approach to consider in this endeavor.

4.3 Parents' perceptions of speech accuracy

From the parent survey (Table 2), we wanted to determine whether parents found value and benefit from the use of tactile self-cues in addition to MOT. It is encouraging that parents of participants who used tactile self-cues perceived them as easy to use. In review of the other 11 questions, the survey could have had robust results if there were more options in response choices for parents beyond 'Always', 'Sometimes' or 'Never'. Parent survey questions may not have been specific enough to capture parent's perception on whether their child uses tactile self-cues to correct his/her own speech productions to increase speech sound intelligibility. We were unable to ascertain whether parents focus during story retell shifted to word reading or content (e.g., child's ability to decode words, recognize letters, etc.) rather than observing their child's speech sound productions during articulation stories. In addition, parents' survey responses may have been affected by the small sample size examined as well as potential parent perceptions of the expectations on intervention outcomes as compared to SLP's perceptions. As discussed by other researchers, these differences may have resulted from parent's predictions on participation benefits (e.g., gains in socialization, gains in communication, ability to answer questions in class) and concerns related to personal factors including temperament (e.g., shyness, frustration, reluctance to participate (Baker & McLeod, 2011a, 2011b; McLeod et al., 2013).

The use of tactile, self-cueing in conjunction with MOT phonological intervention may have potential for greater gains in phonological accuracy and potentially reduce treatment duration in therapy. Our findings provide preliminary support for the MOT program paired with tactile, self-generated cues as an integrated approach to potentially remediate phonological targets in young children. Participants using tactile self-cues in addition to MOT also showed strong and positive trends of across and within-class generalization patterns as did some of the control participants. For those participants trained in the use of tactile, self-cues, the duration it took them to reach criteria was reduced substantially in comparison to the control group, once the strategy was learned. These results, though preliminary, may be of potential interest

to clinicians working with younger populations in phonology as well as those with larger caseloads.

Given the feedback received from parents, it is reassuring that these tactile self-cueing strategies also appeared to increase parent awareness of changes that occurred in their child's speech sound intelligibility. Participants also self-reported independence from having to use strategies. For emergent learners with developing phonological systems, the use of tactile self-cues could be a positive supplement to MOT or other potential phonological intervention programs.

While this study suggests positive results by supplementing the MOT phonological treatment approach in this young population, there is limited research regarding the use of tactile, self-cueing techniques to supplement phonological intervention. Given the limited number of participants in this study, further research in this area would benefit from larger samples and the use of a blind, randomized control design. Additionally, limited research exists examining the use of an integrated, cross-modal, self-generated approaches such as the one used in this study in treating phonological disorders. Of the available literature and systematic reviews on phonological intervention approaches, future clinical research would benefit from studies that compare phonological treatment approaches and cross-modal techniques or strategies used as an integrated approach to phonological target acquisition in young preschool populations (Amato-Zech et al., 2006; Baker & McLeod, 2011a, 2011b; Kamhi, 2006; Lancaster et al., 2010; McDougall et al., 2012; Rogers, 2013; Wheeler & Gabbert, 2017; Xi et al., 2020). SLP's might then apply this evidence into clinical practice as they make informed decisions in planning intervention programs.

The present study was also affected significantly by the 2020 pandemic, both in terms of participant enrollment and how pre- and post-testing and intervention was implemented. State and County Health Department policy necessitated that all methods and materials (i.e., testing and intervention) had to be implemented online. This change in study design included more digital, tele-practice interaction with the participants than was originally intended for some of the participants. In addition, the reduction in sample size was affected with 15 participants discontinuing participation in the study after screened, due to relocation, pandemic related issues, or unspecified reasons in completing the study. Future studies would benefit from considering the potential influence of socio-demographic conditions (e.g., online learning, noise distractors) as well as influence of technology use (e.g., listener perception through electronic device, headphones, internet quality, Wi-Fi disruption) and parent participation on child performance. Parents were given two written prompts to use, as children retold stories to them to examine generalization of targets trained during intervention. Some parents who provided more than the two prompts to a participant may have influenced child responses (e.g., reduced use of strategy, reluctance to participate).

Research conditions tend to require study participants to continue to use the training modality (tactile self-cues) until the condition criteria is met. This could result in user fatigue, lack of motivation, or both. Some participants in this study became disenchanted by the requirement of continuous use of a cue once the technique was self-managed/learned. Since the use of cues is

typically used to facilitate correct speech sound production during the elicitation stages of treatment, it may be beneficial for future research to examine when and how to fade and discontinue the use of cues, as there may be clinical implications for how self-cueing is managed during treatment (Riley & Heaton, 2000). The rationale behind this integrated, multimodal method is to supplement phonological treatment in young children with speech sound disorders with a method and the opportunity to become more independent learners; thus, facilitating speech sound acquisition that will generalize outside to more meaningful, natural contexts.

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Appendices

Appendix A
Parent Survey

Based on your perception of your child's speech productions, please rate each statement as to how often it occurs.

1) My child's speech is difficult to understand even by familiar listeners (For example, family and friends).
   a) Always b) Sometimes c) Never

2) My child's speech productions in conversation are difficult to understand by strangers.
   a) Always b) Sometimes c) Never

3) The feedback/cues that I give my child help correct his/her speech sound errors.
   a) Always b) Sometimes c) Never

4) My child's speech productions have an effect on participation in activities with family and friends.
   a) Always b) Sometimes c) Never

5) As the parent, I typically understand what my child is trying to say.
   a) Always b) Sometimes c) Never

6) My child is aware of his/her speech problem.
   a) Always b) Sometimes c) Never

7) The speech cueing strategies have been simple and easy to use.
   a) Always b) Sometimes c) Never

8) Parents or family members read with my child at home at least 4 times per week.
   a) Always b) Sometimes c) Never

9) My child becomes frustrated when people don't understand him/her.
   a) Always b) Sometimes c) Never

10) I correct my child's speech sound errors.
    a) Always b) Sometimes c) Never

11) My child corrects his/her own speech sound errors.
    a) Always b) Sometimes c) Never

12) My child uses cueing strategies to correct his/her speech sound errors.
    a) Always b) Sometimes c) Never

Appendix B

Subject **Number:** **Age:**				
Date:	**Activity:**	**Objective:**	**Data:**	**Notes:**
/ /				
/ /				
/ /				
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/ /				

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APPENDIX C

MOT WORD PAIR M-K	MOT WORD PAIR M-K
 MAT	 CAT
 MANE	 CANE
Who is DIZZA? ME ME	 KEY
 MAN	 CAN
 MAP	 CAP
 MAKE (A CAPE FOR ME)	 CAKE
 MISSING	 KISSING
 MOP	 COP (BATMAN MOVIE)
 MALL	 CALL
  MIGHT (Get Batman)	 KITE

APPENDIX D

Researcher instructions to train M.O.T and prompts

1. Provide the following instructions to the PARTICIPANTS.
   a. Today we are going to look at pairs of pictures!!
   b. First, I want you to practice this sound with me. Listen carefully (Clinician to model target sound)
   c. Now it's your turn (subject attempts target sound)
   d. Subject imitates sound (or not) …
   e. YOUR TURN -subject imitates (or not)
   f. Ok. Let's look at the pictures (place two pictures on the table)
   g. Using the sound XXXX (clinician models target) What is this? (subject attempts target sound on the picture card)
   h. Let's try another one, what is this? (second example)
   i. Subject attempts to produce target sound in word; clinician can model 1x if needed then subject imitates second example.
   j. Now, I am going to show you two pictures. The pictures should look different to you."
   k. Clinician models …this is Bun/sun …and this is Bun/sun… "Do they sound the same?" (subject answers YES or No).
   l. Begin data collection here: Ok, now you try it …Clinician prompts "This is… (subject says …bun) and This is …. (subject says… sun)
   m. Ok, let's try more…

2. TO END SESSION:
   a. PROVIDE STAMPS OR STICKERS.
   b. OFFER A FEW MINS OF online video game or clip from a Movie (e.g., Paw Patrol, Minecraft, etc., Bendy, Om Nom)
   c. Offer short bathroom break and snack break (as needed)

FOR RESEARCHERS USE TO TRAIN TACTILE SELF-CUEING: Participant instructions for M.O.T and with Tactile Self-Cues

   a. Use same training steps from MOT.
   b. add: *Sometimes we need strategies to help us say sounds correctly and clearly.* For example, touch your…. (Larynx) or (Mouth) like this.
   c. Now, try to say your sound…
   d. If participant does not use strategy, provide the following prompt: *Don't forget to use your strategy.*

APPENDIX E

WEEKLY READING TASK AT HOME

Please read to your child for 20 minutes, 4x per week using the following steps

Step 1. Read the story to your child.
Step 2. Read the story to your child and explain unfamiliar words.
Step 3. Have your child read the story to you and explain unfamiliar words
Step 4. Ask your child questions about the story.

Page 1 of 2

Instructions for Story Retell videoconference

Give yourself (participant) a Disney character or a superhero name to use during the study.

Every two weeks, you and your child will be asked to participate in a short, parent-child story retell task on your electronic device (e.g., computer, cell phone, iPad, etc.). You will receive a link to a video conference with a research assistant. The interaction is going to be video recorded by a speech and language pathologist through your device.

On this day, please say the following phrase(s) to your child. Do not add any other words or questions. This is for study purposes.

- "Tell me what's happening on this page."
- "Tell me more."

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Intonation patterns in children with learning disability

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Abstract

Intonation is defined as the variation in pitch superimposed on the sentences. The aim of the present study was to understand intonation patterns used by children with a learning disability to express different types of Kannada sentences (Command, Happy, Request and Sad) in comparison with typically developing children. This study also evaluated sentence duration. The recorded sentences were analyzed for intonation contours and sentence duration using Praat software. The results of the study indicated a change in the terminal F0 pattern across the different sentence types used by children with learning disability in comparison to language age matched typically developing children.

Keywords Kannada sentences, expressive intonation patterns, learning disability, typically developing children

1. Introduction

Suprasegmental aspects, or prosody, are defined as the characteristics of speech that enhance and regulate the meaning of what is said (Paul, Augustyn, Klin, & Volkmar, 2005). Acoustically, the prosodies of oral language involve variation in syllable length, loudness, pitch, and the formant frequencies of speech sounds. Intonation is one of the suprasegmental aspects of speech refer to distinctive patterns of vocal melody. The melodies of speech are related to virtually all levels of verbal communication, including emotional expression, pragmatics, and syntactic structure. Intonation is attributed with four main functions (Roach, 2000): 1) the attitudinal function (affect), 2) the accentual function (focus), 3) the grammatical function (chunking); and 4) the discourse function (interaction). Several research studies have been conducted in order to determine the role prosody plays in the organization of early language production in typically developing children (Allen & Hawkins, 1980; Gerken & McGregor, 1998). Disordered expressive prosody is widely reported to occur in the speech of children with language disorders. Weinert (1992) reported that children with Specific Language Impairment (SLI) did not use prosodic cues when learning rules of language, or in repeating sentences accurately, which suggested that prosodic deficits may be associated with language deficits. Findings on intonation in children with autism suggest that, compared with typically

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developing (TD) controls, children with autism produce pitch contours with high F0 range and high pitch variability (Diehl et al. 2009; Bonneh et al., 2011). Reilly, Klima and Bellugi (1990) reported abnormally high use of affective expressive prosody (pitch changes, vocalic lengthening and modifications in volume) by adolescents with William Syndrome. Catterall, Howard, Stojanovik, Szczerbinski and Wells (2006) evaluated prosody in children with William syndrome using the manual version of Profiling Elements of Prosodic Systems for Children (PEPS-C) battery (Wells and Peppé, 2001). They reported that children had impaired expressive and receptive prosodic abilities and had pervasive difficulties, compared to chronological age (CA) matched controls.

Variation in F0 contours can lead to changes in prosodic patterns at various levels of linguistic units (e.g., word, phrase, sentence, and discourse). Prosody play a role in language development, it serves to follow that children with deficits in language may also have difficulty with prosody. Prosodic problems are not a diagnosis per se, but symptoms that occur at different levels of language. Expressive intonation in children with learning disability is an under researched area. Hence, the present study was undertaken.

The aim of this study is to understand expressive intonation patterns, sentence duration to express different types of Kannada sentences - Command, Happy, Request and Sad, by children with Learning disability in comparison with typically developing children.

2. Methodology

1.1. Participants

Ten children with learning disability (as per the diagnosis done by speech language pathologist) with normal intelligence (as per the diagnosis done by clinical psychologist) studying in V. VI & VII grade. Ten language ages matched typically developing children studying in V. VI & VII grade participated in this study. All participants were from native Kannada speaking families studying in English medium school. Participants were evaluated for Speech and Language skills, reading / writing / mathematical skills, hearing ability, motor development and IQ assessment.

1.2. Stimuli

Four Kannada sentences depicting four emotions - Command, Happy, Request and Sad formed the stimuli.

1.3. Procedure

The participants were seated comfortably in a quiet room and were tested individually. Each sentence was spoken by the examiner and the participants were instructed to repeat back the sentences using four different emotions - Command, Happy, Request and Sad. The responses were recorded in Praat software.

1.4. Acoustic analysis

Intonation contours were analyzed using Praat software, type of F0 contour, sentence duration for each sentence was noted.

3. Findings

The findings on expressive intonation patterns and sentence duration to express different types of Kannada sentences - Command, Happy, Request and Sad, by children with Learning disability in comparison with typically developing children are as discussed below.

Table 1
Fo contours pattern of typically developing children and children with learning disability for different type of sentences

	Type of sentence	**Intonation pattern**	
		Typically developing children	**LD**
1	Command	fall-rise-fall-rise-rise	fall-fall-flat-fall-fall
2	Happy	rise-rise-rise-rise-rise	rise-rise-rise-rise-fall
3	Request	fall-fall-rise-rise-rise	rise-rise-rise-rise-fall
4	Sad	fall-flat-fall-fall-fall	rise-rise-rise-fall-fall

Table 2
Sentence duration

	Type of sentence	**Typically developing children**		**LD**		**Sig**
		Mean (ms)	**SD**	**Mean (ms)**	**SD**	
1	Command	2022	372.86	2508	312.80	.005
2	Happy	2277	323.38	2340	302.23	.657
3	Request	2307	231.36	2551	311.87	.062
4	Sad	2165	269.96	2314	360.81	.310

The intonation pattern for four different sentences are presented in Table 1. In typically developing children the terminal pitch contour for command, happy and request sentence was a rising contour. For sad sentence type it was a falling contour. Children with learning disability used falling contour for all the four type of sentences. Table 2 shows the sentence duration for four types of sentences. There was a statistically significant difference at .05 level of significance for command type of sentence. For sentences – happy, request and sad there were no differences between the two groups. The results of the present study have indicated the possibility of change in intonation pattern used by children with learning disability in comparison to language age matched typically developing children.

4. Discussion and Conclusion

The suprasegmental properties of speech play an important role in human communication. Spoken language provides information about the intention and the emotional state of a speaker. Linguistic prosody is used to mark the internal organization of sentence constituents or to convey the intonation contour of a sentence (Lieberman, 1968). It is generally assumed that pitch errors will be seen in phonetic disorders of pitch. However, one must also

look into the pitch errors in phonological disorders with no evident organic lesions or neurological issues to account for it, where the use of pitch is abnormal. This information will be very important for Speech- Language Pathologists in assessing and treating persons with speech and language disorders. Future research on intonation patterns for different type of sentences and on large group of children with learning disability is warranted.

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