Maternal Depressive Symptoms and Linguistic Input to Infants at High or Low Risk for Autism Spectrum Disorder

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Abstract

One in every 59 children in the United States is diagnosed with Autism Spectrum Disorder (ASD). ASD can be accompanied by various behavioral, medical, and financial challenges, which may lead to elevated levels of daily stress and the onset of depressive symptoms in caregivers. Parental depression, in turn, has been associated with decreased quality and quantity of speech used with children. In my thesis research, I explore associations between depressive symptoms and linguistic input in a sample consisting of mothers of infant siblings at high and low risk of developing ASD. I first analyzed levels of depressive symptoms reported by these maternal groups and found that mothers of children with ASD reported significantly higher depressive symptoms when infant siblings were 12 months old. I then analyzed concurrent and prospective relations between maternal depressive symptoms and linguistic input used with infant siblings and found that depressive symptoms were predictive of fewer words used with infants. These results demonstrate a clear need to understand the relation between maternal mental health and children's social development in all families, and especially in those where one or more children has a developmental disability.

Keywords: autism spectrum disorder, maternal depression, linguistic input, family dynamics

Maternal Depressive Symptoms and Linguistic Input to Infants at High or Low Risk for Autism Spectrum Disorder

In 2014, the prevalence of children diagnosed with autism spectrum disorder (ASD) in the United States was 1 in 59 (Baio et al., 2018). ASD is a developmental disorder characterized by deficits in social and communicative abilities, as well as restricted and repetitive interests and behaviors (American Psychiatric Association, 2013). ASD is often accompanied by various medical and behavioral challenges, which have been associated with elevated levels of daily stress for caregivers and the onset of depressive symptoms (Yang et al., 2015; Zeedyk & Blacher, 2015). Depressive symptoms have been shown to predict how parents speak and interact with their typically developing children (Rowe, Pan, & Ayoub, 2005); however, less is known about this relation in parents of children with ASD. In this thesis, I investigate (1) levels of depressive symptoms reported by mothers of children at high and low risk of developing ASD and (2) concurrent and prospective associations between mothers' depressive symptoms and their linguistic input during play interactions with their high- or low-risk children. The goal of this study is to increase our awareness of parental mental health needs in order to best support families of children with developmental disabilities.

Background

The relationship between caregiver and child is crucial towards children's early social development. For the majority of children, regular interactions with a caregiver are their first exposure to everyday social behaviors. By observing, playing with, and imitating their parents, children gradually learn important social and communicative skills such as impulse control, altruistic acts, gesturing, and speech (Hart & Risley, 1999; Hoffman, 1975; Klintfors, Gustavsson, Schwarz, Gerholm, & Marklund, 2013; Olson, Bates, & Bayles, 1990). As the child

develops, these skills develop into more advanced behaviors that shape their confidence and ability to interact with others (Cochet & Byrne, 2016; Gallagher, 1993; Hart & Risley, 1999). Despite the benefits of parent-child interactions, parents' mental health difficulties may interfere with their ability to achieve frequent, high-quality interactions with their children. This research will explore the behavioral effects associated with maternal depressive symptoms on the quality and quantity of maternal linguistic input during play interactions between mothers and children at high risk and low risk of developing ASD.

Depressive Symptoms in Parents of Typically Developing Infants and Infants with Developmental Disabilities

Prior work has demonstrated that depressive symptoms are common during the postpartum period. For instance, Paulson, Keefe, & Leiferman (2009) assessed depressive symptoms in over 9,000 new parents using the Center for Epidemiologic Studies – Depression (CESD; Radloff, 1977) scale, a self-report measure where individuals identified depressive symptoms that they had recently experienced. They found that at child age nine months, 37% of mothers and 29% of fathers reported clinically elevated symptoms of depression (Paulson et al., 2009), suggesting that approximately one-third of new caregivers experience high levels of depressive symptoms.

Parents of children with intellectual and developmental disabilities often face additional challenges. For example, the challenging behaviors that these children exhibit (i.e. temper tantrums, hyperactivity, impulsiveness), their health complications, social stigma from the community, and financial strain have been found to be potential stressors for caregivers of children with disabilities (Carter, Martinez-Pedraza, & Gray, 2009; Cheng, Palta, Poehlmann-Tynan, & Witt, 2015; Gray, 2002; Saunders et al., 2015; Zeedyk & Blacher, 2015). Navigating

these issues on a daily basis can lead to high levels of stress, feelings of low self-worth, and the onset of depressive symptoms in these parents (Farmer & Lee, 2011; Ingersoll & Hambrick, 2011). Indeed, a meta-analysis performed by Bailey, Golden, Roberts, & Ford (2007) found that compared to the general female population, mothers of children with developmental disabilities tended to experience much higher rates of depression- 6% vs. 23% of each population, respectively. This relation also applies specifically to ASD; numerous studies have found that mothers of children with ASD report significantly higher levels of depressive symptoms and stress than mothers of typically developing children (Ingersoll, Meyer, & Becker, 2010; Jeans, Milagros Santos, Laxman, McBride, & Dyer, 2013). Of note, the study by Jeans et al. (2013) analyzed maternal depressive symptoms at infant age nine months and again at four years, while Ingersoll et al. (2010) studied mothers whose children were under the age of eighteen years of age, with a mean age of nine years. This suggests that parents of children with ASD experience higher levels of depressive symptoms than typically developing parents throughout these children's lives.

Parental Depressive Symptoms, Parent-Child Social Interactions, and Socioemotional Development

Depression can severely impair an individual's desire and ability to socialize (American Psychiatric Association, 2013), and prior studies have investigated communication patterns that parents with depression use with their children. Some mothers experiencing depressive symptoms and clinically-diagnosed depressive disorders report feeling disengaged from their children (Lovejoy, Graczyk, O'Hare, & Neuman, 2000; Weinberg & Tronick, 1998). These parents tend to engage in less face-to-face playtime with their children, and during these interactions, they use less affectionate touch, speak less frequently, and use fewer total words,

also known as word tokens, and fewer unique words, also known as word types (Lovejoy et al., 2000; Pan, Rowe, Singer, & Snow, 2005; Rowe et al., 2005; Weinberg & Tronick, 1998). In addition, parents in remission from depression may struggle with emotional availability and continue to exhibit these patterns of behavior and speech (Kluczniok et al., 2016).

In one study that analyzed the relation between maternal depressive symptoms and linguistic input, Rowe et al. (2005) measured maternal depressive symptoms using the CESD and found that mothers who reported a higher number of depressive symptoms spoke fewer word tokens to their children (ages 14, 24, and 36 months) during play interactions. Meanwhile, Pan et al. (2005) found a negative correlation between maternal depressive symptoms and word types used with children the same age as those in the Rowe et al. (2005) study. Maternal tokens and types used with children are important to study because these two measures are influential towards children's own linguistic development and production (Pan et al., 2005). Moreover, Pan et al. (2005) and Rowe et al. (2005) are among the only researchers who have studied these specific linguistic characteristics. However, like the other studies mentioned above, their research focused on typically developing children and their parents. As a result, little is known about the relation between depressive symptoms in mothers of children with ASD and the word tokens and types that they use with children.

In addition to these associations between parental depression and linguistic input, parental depressive symptoms have also been negatively associated with numerous developmental outcomes in infants. Some children of parents with depression do not form a healthy attachment to their parents, perhaps due to the severity of parents' depressive symptoms and, subsequently, lower quality parent-child interactions (Coyl, Roggman, & Newland, 2002; Martins & Gaffan, 2000). Signs of cognitive delay can be observed as early as four months of

age, and developmental problems may continue to arise as the infant grows and experiences more negative social interactions with their parents (Coyl et al., 2002; Smith-Nielsen, Tharner, Krogh, & Vaever, 2016). Non-verbal communication skills such as eye contact and gesturing are slower to develop, and many of these children struggle with social engagement, self-regulation, and aspects of executive functioning (Feldman et al., 2009; Granat, Gadassi, Gilboa-Schechtman, & Feldman, 2017; Kawai et al., 2017; Park, Brain, Grunau, Diamond, & Oberlander, 2018). As these children begin to speak, they develop less advanced vocabularies than their peers (Pan et al., 2005). Moreover, children of parents with depression are at risk of developing problems with negative mood and emotional regulation themselves (Cohn, Matias, Tronick, Connell, & Lyons-Ruth, 1986; Downey & Coyne, 1990; Feldman et al., 2009; Field, 2011; Prenoveau et al., 2017). Many of these children observe and later come to emulate the symptoms of depression that parents may exhibit during social interactions, such as negative affect and irritation (Cohn et al., 1986). In sum, these studies demonstrate a significant need to understand the relation between parents' mental health and their children's emotional development, language and communication skills, and overall growth and well-being.

The Present Study: Justifications, Research Questions, and Hypotheses

As reviewed above, parental depressive symptoms have been associated with impaired social skills in both parents and children, and mothers experiencing high levels of depressive symptoms use fewer word tokens and types when speaking to their children (Pan et al., 2005; Rowe et al., 2005; Weinberg & Tronick, 1998). While this relation has been studied in typical development, research about mothers of children with ASD has focused either on these parents' depressive symptoms or the communicative patterns that they use with their children, but not both in the same study (Freeman & Kasari, 2013; Ingersoll et al., 2010; Jeans et al., 2013). Thus,

it remains less clear whether a relation between depressive symptoms and linguistic input is also found among mothers of infant siblings of children with ASD, who report higher levels of depressive symptoms than both mothers of typically developing children and the general female population (Bailey et al., 2007; Ingersoll et al., 2010). To answer this question, my research analyzes depressive symptoms in mothers of children with ASD and the word tokens and types that they use with their children, with mothers of typically developing children serving as a control.

This research is a thesis project derived from data collected as part of the Infant Sibling Project (ISP) conducted by Drs. Charles A. Nelson and Helen Tager-Flusberg at Boston Children's Hospital and Boston University, respectively. The ISP is a longitudinal study examining early development in infants at high risk and low risk for ASD during their first 36 months of life (HRA = child at high risk of ASD; LRC = low risk comparison). Children whose siblings have ASD are at heightened risk of developing ASD themselves; a longitudinal study by Ozonoff et al. (2011) found that 18.7% of infants who had an older sibling with ASD were diagnosed with the disorder as well. Conversely, children with no immediate family history of ASD are considered at low risk of developing the disorder.

For my thesis research, I studied two specific research questions:

1. *Do mothers of HRA infants, also parenting a child who has ASD, experience different levels of depressive symptoms than mothers of LRC infants, whose children are typically developing?*
2. *Is there a concurrent or predictive relation between maternal depressive symptoms and linguistic input to infants within the first two years of life? If so, does this relation exist specifically in HRA and/or LRC groups?*

Consistent with the prior literature (Farmer and Lee, 2011; Ingersoll et al., 2010; Jeans et al., 2013), I hypothesized that mothers of high-risk infants would report higher levels of depressive symptoms than mothers of low-risk infants. I also hypothesized that mothers who reported higher levels of depressive symptoms would use fewer word tokens and types with their children, as Pan et al. (2005) and Rowe et al. (2005) found. Furthermore, I speculated that maternal depressive symptoms would be negatively correlated with these linguistic input measures in both the high-risk and low-risk groups. Pan et al. (2005) and Rowe et al. (2005) have already demonstrated a relation between depressive symptoms and word tokens and types in mothers of typically developing infants. As mothers of high-risk infants report even higher levels of depressive symptoms than low-risk infants, I believed that this relation would exist in the high-risk group as well (Ingersoll et al., 2010; Jeans et al., 2013).

To address these questions, I used data from 166 mothers of infants at high or low risk of developing ASD who visited the lab at infant ages 6, 12, 18, 24, and 36 months. Mothers completed a modified version of the Center for Epidemiologic Studies Depression Scale Revised (CESD-R; Eaton, Smith, Ybarra, Muntaner, & Tien, 2004) that omitted questions related to suicidal thoughts and engaged in an unstructured, filmed play interaction with their infants for ten minutes. Infants' final diagnostic outcomes for ASD were determined at either 18, 24, or 36 months of age via the Autism Diagnostic Observation Schedule (ADOS; Lord et al., 2000) and clinical judgment by a licensed psychologist.

Methods

Participants

Participants included mothers of infants at high or low risk of ASD. For the ISP study, eligible mothers did not report any of the following: genetic disorders in the older or infant

sibling, prenatal or perinatal complications with the infant sibling, or infant sibling gestation of less than 36 weeks. Additionally, both of the children's parents had to be 18 years of age or older and could not be diagnosed with a developmental disability. For this analysis, I further excluded mothers who spoke English at home less than 80% of the time. The original number of mothers in the ISP was 274; the final number of mothers that I studied was 166.

Mothers of infants at high risk of autism (HRA) had an older child with an ASD diagnosis (n = 95). Proband older siblings' ASD diagnoses were confirmed using the Autism Diagnostic Observation Schedule (ADOS; Lord et al., 2000) and Social Communication Questionnaire (SCQ; Rutter, Bailey, & Lord, 2003) if siblings were older than four years of age; the Pervasive Developmental Disorders Screening Test-II (PDDST-II; Siegel, 2004) was used for children three years of age or younger. Of the 95 high-risk infant siblings, 28 met criteria for ASD during their last visit to the lab (HRA+) whereas 67 did not (HRA-). Mothers of infants whose older sibling (and all other first and second-degree relatives) did not have an ASD diagnosis were considered low-risk comparisons (LRC); these infants also did not meet criteria for ASD (n = 71). Demographic information of mothers and infants was obtained during their first visit to the laboratory and is reported in Table 1.

Procedure

Institutional Review Boards (IRBs) at Boston Children's Hospital and Boston University approved this study. Caregivers' written, informed consent concerning infants' participation in study activities was obtained prior to experimentation. Visits to the lab occurred at 6, 12, 18, 24, and 36 months of age; however, if an infant was older than 6 months but younger than 12 months, they were still eligible to enter the study. Participants were expected to attend sessions at all time points.

Mothers completed a modified version of the CESD-R (Eaton et al., 2004) that omitted questions related to suicidal thoughts when infants were 6, 12, 18, and 24 months of age. Additionally, at child ages 12, 18, and 24 months, mothers and infants engaged in an unstructured play interaction at the laboratory lasting for ten minutes. Interactions were filmed and subsequently transcribed and coded for verbal data. All linguistic data was automatically coded using the Child Language ANalysis (CLAN; MacWhinney, 2000) program.

The ADOS (Lord et al., 2000) was administered to infants at 18, 24, and 36 months of age by an experienced member of the research team. Psychologists used ADOS scores and the filmed ADOS administration if ADOS scores were in range of or within three points of qualifying for an ASD diagnosis in order to make a final clinical diagnosis (either ASD or no ASD) during infants' final visit to the lab (at either 18, 24, or 36 months of age).

Measures

Center for Epidemiologic Studies Depression Scale Revised (CESD-R; Eaton et al., 2004). The CESD-R is a twenty-item questionnaire that asks participants to report the symptoms of depression that they have experienced over the past week. The CESD-R covers nine categories of depressive symptoms as listed by the *Diagnostic and Statistical Manual of Mental Disorders, 5th Edition* (DSM-5): sleep disturbances, loss of interest, feelings of guilt or worthlessness, lack of energy, impaired concentration, appetite changes, psychomotor agitation, and suicidal ideations. Each question is answered on a four point scale (0, 1, 2, or 3) to indicate how frequently symptoms have occurred. Thus, scores may range from 0 (experiencing no symptoms) to 60 (experiencing all listed symptoms nearly every day for two weeks). Though the CESD-R is not a substitute for a formal diagnosis provided by a psychologist, a score of 16 or above may indicate clinically significant levels of depressive symptoms and serve as a screening

measure for individuals who may meet diagnostic criteria for a depressive disorder. For this research, CESD-R scores were analyzed from mothers at infant ages 6, 12, 18, and 24 months. Additionally, questions relating to suicidal thoughts were omitted. Finally, scores were treated as a continuous rather than a categorical measure because no formal clinical diagnoses were available for the participants.

Autism Diagnostic Observation Schedule (ADOS; Lord et al., 2000). The ADOS is a standardized, semi-structured assessment that uses a series of play-based activities to assess examinees' social skills, communication abilities, and restricted/repetitive behaviors. The ADOS was administered by an experienced member of the research team, and scores were co-verified by a reliable researcher. The ADOS was administered at the infant's last visit to the lab (18, 24, or 36 months) to determine a diagnosis of either ASD or no ASD.

Word tokens and types. To measure mothers' linguistic input, I examined word tokens and types from transcribed parent-child play interactions. Word tokens refer to the total number of words used overall. Word types, on the other hand, refer to the number of unique words used by a speaker. For example, in the sentence "The brain is the best," there are five words total (five word tokens) and four unique words (four word types). Maternal word tokens and types used in transcripts of parent-child play interactions for a subsample of participants were analyzed using the Child Language ANalysis (CLAN) program (MacWhinney, 2000) at each infant age group (12, 18, and 24 months). CLAN's built-in frequency counter was able to calculate the total number of word tokens and types in each transcript.

Data Analysis

For the first research question, due to non-normal distribution of maternal depressive scores, Kruskal-Wallis H tests (and Mann-Whitney U tests for post hoc pairwise comparisons)

were used to determine whether there was a group difference in CESD-R scores between mothers of HRA+, HRA-, and LRC infants at infant ages 6, 12, 18, and 24 months.

To address the second research question, I used both concurrent data determining the relation between CESD-R scores and maternal linguistic input at the same infant age and predictive data analyzing the relation between CESD-R scores at one time point and maternal linguistic input at a later infant age (i.e., 12 month CESD-R scores and 24 month maternal linguistic input). Bivariate correlational analyses were used for both analyses, and partial correlations were used to control for maternal education level, as there was a statistically significant difference in education level among maternal groups (Table 1), more educated mothers may have had larger vocabularies due to more exposure to formal educational resources (Rowe, 2008), and higher levels of maternal education have been associated with increased maternal speech quantity and quality used with children (Dollaghan et al., 1999; Hoff-Ginsberg, 1994; Rowe et al., 2005). Finally, because not all parent-child interactions lasted exactly ten minutes, the number of word tokens and types that would have occurred in an exactly ten-minute-long interaction was calculated (Equation 1).

Results

Research Question 1: Group Differences in Depressive Symptoms Between Mothers of HRA+, HRA-, and LRC Children

Maternal CESD-R scores at 6, 12, 18, and 24 months are reported in Table 2 and displayed in Figure 1. When examining group differences in CESD-R scores, no significant group difference in CESD-R scores at 6 months was observed, $\chi^2(2, N = 105) = 2.27, p = .13$. However, there was a significant group difference in levels of maternal CESD-R scores reported at 12 months, $\chi^2(2, N = 129) = 6.22, p = .05$. Post-hoc pairwise analyses revealed that HRA+

mothers' CESD-R scores were significantly higher than those of LRC mothers, $z = -2.24$, $p = .03$. Additionally, HRA- mothers' CESD-R scores were higher than those of LRC mothers, though marginally significant, $z = -1.19$, $p = .07$. There was no significant group difference between HRA+ and HRA- mothers' CESD-R scores, $z = -.86$, $p = .39$. There was no significant group difference in CESD-R scores at 18 months, $\chi^2(2, N = 127) = 1.46$, $p = .23$, and additionally at 24 months, $\chi^2(2, N = 104) = .90$, $p = .34$.

Research Question 2a: Concurrent Relations Between Maternal Depressive Symptoms and Linguistic Input, Controlling for Maternal Education Level

First, I examined concurrent correlations between maternal CESD-R scores and linguistic input at 12, 18, and 24 months for the entire maternal sample. Descriptive statistics for these measures are reported in Table 3. At 12 months, there was no significant relation between CESD-R scores and the number of word tokens or types that mothers used with their infants, tokens: $r(49) = -.11$, $N = 52$, $p = .44$; types: $r(49) = .09$, $N = 52$, $p = .52$. At 18 months, CESD-R scores were significantly negatively correlated with word tokens, $r(45) = -.31$, $N = 48$, $p = .04$. However, the relation between CESD-R scores and word types at 18 months was not significant, $r(45) = -.06$, $N = 48$, $p = .70$. Finally, at 24 months, there was no significant relation between CESD-R scores and word tokens or types, tokens: $r(45) = -.18$, $N = 48$, $p = .22$.; types: $r(45) = -.14$, $N = 48$, $p = .34$.

Mothers of high-risk infants only. Next, I conducted analyses in the HRA group only. Descriptive statistics for these measures are reported in Table 4. At 12 months, there was no significant relation between maternal CESD-R scores and word tokens or types, tokens: $r(27) = -.13$, $N = 30$, $p = .50$; types: $r(27) = .04$, $N = 30$, $p = .83$. At 18 months, there was no significant relation between CESD-R scores and word tokens or types, tokens: $r(23) = -.33$, $N = 26$, $p = .11$;

types: $r(23) = .-05$, $N = 26$, $p = .83$. Finally, at 24 months, there was no significant relation between CESD-R scores and word tokens or types, tokens: $r(23) = -.14$, $N = 26$, $p = .50$; types: $r(23) = .-17$, $N = 26$, $p = .41$.

Mothers of low-risk infants only. Similarly, I conducted analyses in the LRC group only. Descriptive statistics for these measures are reported in Table 5. At 12 months, there was no significant relation between maternal CESD-R scores and word tokens or types, tokens: $r(49) = -.11$, $N = 52$, $p = .44$; types: $r(49) = .04$, $N = 52$, $p = .83$. At 18 months, there was no significant relation between CESD-R scores and word tokens or types, tokens: $r(19) = -.29$, $N = 22$, $p = .21$; types: $r(19) = .-05$, $N = 22$, $p = .83$. Finally, at 24 months, there was no significant relation between CESD-R scores and word tokens or types, tokens: $r(19) = -.26$, $N = 22$, $p = .25$; types: $r(19) = .-14$, $N = 22$, $p = .55$.

Research Question 2b: Predictive Relations Between Maternal Depressive Symptoms and Linguistic Input, Controlling for Maternal Education Level

I also analyzed all mothers' CESD-R scores at one infant age and linguistic input at a later infant age in order to determine whether maternal depressive symptoms at one time point were associated with their subsequent linguistic input used with infants. Descriptive statistics for these measures are reported in Table 3. I found that CESD-R scores at 12 months were significantly negatively correlated with the number of word tokens used with infants at 24 months, $r(50) = -.31$, $N = 53$, $p = .03$. However, CESD-R scores at 12 months were not significantly negatively correlated with the number of word types used at 24 months, $r(50) = -.12$, $N = 53$, $p = .38$.

Additionally, CESD-R scores at 18 months were marginally significantly negatively correlated with the number of word tokens used at 24 months, $r(42) = -.26$, $N = 45$, $p = .09$.

However, CESD-R scores at 18 months were not significantly negatively correlated with the number of word types used at 24 months, $r(42) = -.08$, $N = 45$, $p = .60$.

Mothers of high-risk infants only. Next, I conducted analyses in the HRA group only. Descriptive statistics for these measures are reported in Table 4. There was a marginally statistically significant relation between CESD-R scores at 12 months and the number of word tokens used with infants at 24 months, $r(28) = -.31$, $N = 31$, $p = .09$. However, there was not a significant relation between CESD-R scores at 12 months and types at 24 months, $r(28) = -.12$, $N = 31$, $p = .52$. There was no significant relation between CESD-R scores at 18 months and the number of word tokens or types used with infants at 24 months, tokens: $r(20) = -.02$, $N = 23$, $p = .92$; types: $r(20) = .02$, $N = 23$, $p = .94$.

Mothers of low-risk infants only. Similarly, I conducted analyses in the LRC group only. Descriptive statistics for these measures are reported in Table 5. There was no significant relation between CESD-R scores at 12 months and the number of word tokens or types used with infants at 24 months, tokens: $r(19) = -.22$, $N = 22$, $p = .33$; types: $r(19) = -.02$, $N = 22$, $p = .93$. There was, however, a significant relation between CESD-R scores at 18 months and the number of word tokens used with infants at 24 months, $r(19) = -.53$, $N = 22$, $p = .01$. There was no significant relation between CESD-R scores at 18 months and the number of word types used with infants at 24 months, $r(19) = -.19$, $N = 22$, $p = .40$.

Discussion

This study on depressive symptoms in mothers of infants at high and at low risk of developing ASD and mothers' linguistic input to infants led to several key findings. First, mothers of high-risk infants reported significantly higher levels of depressive scores than mothers of low-risk infants at infant age 12 months. Second, after controlling for maternal

education level, maternal CESD-R scores at 18 months were significantly negatively correlated with word tokens used with infants at that same time point for the entire maternal sample. Third, after controlling for education, maternal CESD-R scores at 12 months were significantly negatively correlated with word tokens used with infants at 24 months for the entire maternal sample. Finally, after controlling for education, maternal CESD-R scores at 18 months were significantly negatively correlated with word tokens used with infants at 24 months in the LRC mothers only.

Group Differences in Reported Maternal Depressive Symptoms

With my first research question, I examined whether mothers of infants at high risk of developing ASD (HRA+ and HRA-) would report higher levels of depressive symptoms than mothers of typically developing infants (LRC), as prior studies have shown that mothers of children with developmental disabilities, including ASD, do tend to report higher rates of depression than mothers of typically developing children throughout these children's lives (Ingersoll et al., 2010; Jeans et al., 2013). Though maternal CESD-R scores were analyzed at four infant time points (6, 12, 18, and 24 months), there was a significant group difference only at infant age 12 months. At this time point, HRA+ mothers reported significantly higher CESD-R scores than LRC mothers, and HRA- mothers reported marginally significantly higher CESD-R scores than LRC mothers. Notably, there was no significant group difference in depressive symptoms between HRA+ and HRA- mothers.

There are several reasons why HRA+ and HRA- mothers may have reported higher levels of depressive symptoms than LRC mothers at infant age 12 months. ASD can be accompanied by a number of behavioral, medical, and societal challenges, which can lead to high levels of daily stress for parents and the onset of depressive symptoms (Cheng et al., 2015; Gray, 2002;

Saunders et al., 2015; Zeedyk & Blacher, 2015). Parents may also begin to notice developmental delays in infants during their second year of life. In one study by Goin-Kochel & Myers (2004), parents began to notice characteristic symptoms of ASD in their infants, such as lack of responsiveness, difficulties with caregiver-child attachment, and an unusual fixation with objects, between 12 and 23 months of age, on average. As there was only a significant group difference in CESD-R scores at child age 12 months in this maternal sample, it is possible that HRA+ and HRA- parents, already having a child with ASD, would be able to notice symptoms of ASD in their other children earlier than parents encountering ASD for the first time. Perhaps this could culminate in the feelings of distress that many parents experience when realizing that their child may have ASD (Fernández-Alcántara et al., 2016).

Moreover, HRA+ and HRA- mothers both had at least one child with ASD, so it is possible that these parents had many shared experiences with raising a child with ASD that LRC mothers did not. This may explain why there were significant and marginally significant group differences in depressive symptoms between HRA+ and HRA- mothers as compared to LRC mothers, respectively, and no group difference in depressive symptoms between HRA+ and HRA- mothers.

Overall, the difference in CESD-R scores between HRA and LRC mothers at infant age 12 months may indicate that this time period may be particularly distressing for parents of children at high risk of developing ASD. While mean CESD-R scores increased for both high-risk groups from 12 to 18 months, suggesting that the entire second year of life may be stressful for these parents, the significant difference between HRA and LRC parents at 12 months and not at 18 months may have been driven by (1) a lowering of CESD-R scores in the LRC group at 12 months, and the largest between-group variation between HRA+ and LRC mothers' mean

CESD-R scores occurring then, (2) the number of HRA+ mothers being the highest at 12 months, thus increasing statistical power, and (3) attrition of HRA+ mothers at 18 months possibly contributing to lower statistical power and, subsequently, non-significant results (Table 2). Perhaps there is a reason why infant siblings' second year of life, specifically the 12 month mark, is associated with such different levels of depressive symptoms between parents of children with ASD and parents of typically developing children.

Maternal Depressive Symptoms and Linguistic Input

With my second research question, I sought to determine whether maternal depressive symptoms were related to the word tokens and types used with infants. In one sub-question, I focused on concurrent relations between these two measures; in the other, I looked at whether maternal depressive symptoms at one infant age were predictive of speech patterns used later in the infants' lives. Additionally, I wanted to see whether these relations would be found in the individual infant risk groups.

When analyzing mothers' linguistic data, I controlled for maternal education level for three reasons: (1) there was a statistically significant difference in education level among HRA and LRC mothers, with LRC mothers having a significantly higher mean education level than HRA mothers, (2) more educated mothers may have been able to access more formal educational resources, and therefore, they may have had larger vocabularies than less educated mothers (Rowe, 2008), and (3) prior research has shown that higher levels of maternal education are associated with higher maternal talkativeness to children and complexity of speech (Dollaghan et al., 1999; Hoff-Ginsberg, 1994; Rowe et al., 2005).

The only significant relation between concurrent maternal CESD-R scores and linguistic input occurred at infant age 18 months, when CESD-R scores were significantly negatively

correlated with word tokens used with infants for the entire maternal sample. As for predictive relations, maternal CESD-R scores at 12 months were significantly negatively correlated with word tokens used with infants at 24 months for the entire maternal sample. Additionally, maternal CESD-R scores at 18 months were significantly negatively correlated with word tokens used with infants at 24 months for the LRC mothers only.

It is interesting that maternal depressive symptoms were only significantly negatively correlated with word tokens but not with word types. This result aligns with Rowe et al.'s (2005) finding that maternal depressive symptoms were significantly correlated with tokens produced, but not types. Another study by Murray, Kempton, Woolgar, & Hooper (1993) found that depressed mothers spoke less to their infants, but maternal depression was not related to complexity of speech. These findings, in conjunction with mine, suggest that the main challenge regarding maternal depressive symptoms and subsequent linguistic input is the quantity of speech that depressed mothers use with children, rather than the quality of their speech. The content of maternal speech and its impact on children's socioemotional development and well-being should still be studied in future research, however, as Frye & Garber (2005) and Murray et al. (1993) found that more depressed mothers tended to use more negative, more critical, and less child-focused speech, which were associated with negative consequences on children's mental health.

Additionally, I hypothesized that there would be a negative correlation between maternal depressive symptoms and linguistic input in both the high risk and low risk groups. However, the only time this occurred was in predictive relations between 18 month CESD-R scores and 24 month word tokens in the LRC group. As I divided the original sample of 89 mothers (and 148 total parent-child play interactions) into infant risk groups, thus reducing the sample size used in

each separate subgroup analysis, I believe this may have reduced statistical power and resulted in my findings for the subgroup analyses being non-significant. Future studies would benefit from including a large number of mothers in each risk group to increase statistical power. Perhaps this would allow me to better detect true effects, if any, in these populations.

Finally, analyzing both concurrent and predictive relations between maternal CESD-R scores and linguistic input underscores the importance of understanding both the immediate and long-term relations between parental depressive symptoms and family dynamics. Knowing that parental depression has been associated with decreased linguistic input to children, it is interesting that there was a significant negative correlation between CESD-R scores and concurrent linguistic input only at infant age 18 months (Lovejoy et al., 2000; Pan, et al., 2005; Rowe et al., 2005; Weinberg & Tronick, 1998). One reason for this could have been my relatively small sample size of 89 mothers. As noted above, this may have resulted in lower statistical power in my analysis. Seeing as CESD-R scores and concurrent linguistic input were negatively correlated at all three infant time points, perhaps a larger sample size would have allowed me to better detect true effects in this population. Additionally, it would be interesting to analyze CESD-R scores and linguistic input more frequently, such as in three-month intervals rather than six-month intervals. Perhaps there is a reason why CESD-R scores and concurrent linguistic input are significantly negatively correlated at a certain time in infants' lives, but not during others, and performing more frequent assessments with larger sample sizes might pinpoint an exact time in infants' lives at which this relation begins and ends.

As for predictive relations, it makes sense that maternal CESD-R scores at infant age 12 months were predictive of linguistic input at two later infant ages, 18 and 24 months. In a study by Ashman, Dawson, & Panagiotides (2008) that tracked mothers' depressive symptoms over the

first seven years of typically developing children's lives, only 30% of mothers who reported experiencing depressive symptoms at baseline reported a decrease in symptoms over time, whereas the remaining mothers' symptoms either worsened or remained constant. Similar results have been found in mothers of children with ASD as well. A two-year longitudinal study by Carter et al. (2009) found that the number of depressive symptoms reported by mothers of children with ASD was elevated both at the beginning and the end of the study. Thus, regardless of infant risk status, perhaps mothers who experience high levels of depressive symptoms over time might continue to use reduced linguistic input with their children as their symptoms do not improve. These findings are consistent with my findings that in the overall maternal sample and in the LRC mothers, maternal CESD-R scores were able to predict fewer word tokens used later in children's lives.

There are several takeaways from the results from RQ2: maternal CESD-R scores were significantly negatively correlated with the number of tokens produced but not types; this relation appeared more frequently in the entire maternal sample than in separate infant risk groups, but this may have been due to small maternal subgroup sample sizes; and CESD-R scores were fairly predictive of tokens used later in the infants' lives, but were only significantly correlated with concurrent linguistic input at one infant age. Thus, there does seem to be a relation between maternal depressive symptoms and some aspects of linguistic input used with infants.

Limitations & Future Directions

Many of the correlations between maternal CESD-R scores and linguistic input, concurrent relations in particular, were not statistically significant or only marginally so. Again, this may have been due to low statistical power, as there was CESD-R and linguistic data for

only 89 mothers total, and approximately 50 mothers at each infant time point (Table 3). When further broken down by infant risk status, there were 30 mothers or less in each group (Tables 4-5). Future studies would benefit from a larger sample size so that statistical power could be increased.

Additionally, in the ISP, there was not a set age difference between older and younger siblings. For example, one pair of siblings may have been one year apart in age, while another pair may have been five years apart. This lack of consistency between infant ages could have meant that mothers were experiencing vastly different life events in the older siblings' lives, while the younger siblings that the ISP studied were the same age. In a replication of this study, sibling dyads would ideally be the same number of years apart in order to control for potentially confounding causes of stress at different sibling ages, such as older siblings starting school (Giallo, Kienhuis, Treyvaud, & Matthews, 2008). However, as no two families are exactly the same, it would be impossible to control for every life event, stressful or not, that children and families experience throughout their lives.

Another study limitation was the lack of fathers who completed the CESD-R and play interactions with children in the lab. As Paulson et al. (2009) and Goin-Kochel & Myers (2004) have found, fathers of both typically developing children and children with ASD also experience symptoms of depression. However, paternal mental health has not been as widely studied as maternal mental health (Condon, Boyce, & Corkindale, 2004). Yet, fathers, especially single fathers and male couples, still spend ample time with their children (Cooksey & Fondell, 1996; Kalil & Rege, 2015; Prickett, Martin-Storey, & Crosnoe, 2015). Thus, more research on paternal depression should be conducted in order to determine whether there is also a relation between paternal depressive symptoms and the linguistic input used with their children and to develop

mental health resources that are specifically tailored towards fathers who are experiencing symptoms of depression.

Despite these limitations, this research is still valuable because it sheds light on the relation between maternal depressive symptoms and linguistic input in an autism high-risk context, which has not been heavily studied in current literature. It is important to understand how ASD affects the family dynamic as a whole—from parental mental health to the social and linguistic development of younger children in the family—in order to provide families of children with ASD with mental health resources and educational support that are tailored specifically towards their needs. These resources would be especially useful during these younger siblings' second year of life, when mothers of children with ASD report higher levels of depressive symptoms than mothers of typically developing children and parental depressive symptoms are predictive of reduced linguistic input used with children. Future research regarding parental mental health and linguistic input and infants at high and low risk of developing ASD would benefit from larger sample sizes that include more fathers and a set age gap between sibling dyads, and more frequent visits to the lab to assess patterns of parental depressive symptoms and language used with children. Hopefully, these suggestions would improve the quantity and quality of my current findings and lead to the discovery of more knowledge about this important topic.

Conclusions

Group differences in depressive symptoms between mothers of high and low risk infants around infant siblings' first birthday may indicate that this is a particularly stressful time for mothers of high-risk infants, considering that ASD-related symptoms often appear around the second year of life (Goin-Kochel & Myers, 2004). Additionally, high levels of maternal

depressive symptoms are predictive of decreased linguistic input used later in infants' lives, suggesting that depressive symptoms that do not improve over time may be associated with characteristics of the speech patterns that mothers use with their infants. It is crucial for clinicians to understand parental depression and social functioning both in families of children with ASD and in families with typically developing children. Though the specific needs of these family groups may differ, all parents and children should have access to the medical, psychological, and educational resources that will contribute towards their individual and familial success and growth.

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Table 1

Demographic Information of Mothers and Infants in the ISP

	Overall	HRA+	HRA-	LRC	p[c]
Infant sex (% male)	53.6 $N = 89$	67.9 $N = 19$	46.3 $N = 31$	54.2 $N = 39$	.159
Infant race/ethnicity (% White)	91.0 $N = 151$	85.7 $N = 24$	95.4 $N = 64$	85.5 $N = 63$	.210
Mean household income[a]	7.54 (1.33) $N = 145$	7.04 (2.06) N = 23	7.76 (0.84) $N = 62$	7.50 (1.37) $N = 60$	.224
Mean mother education level[b]	5.99 (1.61) $N = 151$	5.04 (1.76) N = 24	5.71 (1.67) $N = 63$	6.63 (1.21) $N = 64$	.000***

Note. Means, standard deviations, and sample sizes are recorded for participants who reported this information.
[a]An 8-point scale was used to measure household income: (1) less than $15,000, (2) $15,000–$25,000, (3) $25,000–$35,000, (4) $35,000–$45,000, (5) $45,000–$55,000, (6) $55,000–$65,000, (7) $65,000–$75,000, (8) more than $75,000.
[b]A 9-point scale was used to measure highest maternal education level completed: (1) some high school, (2) high school graduate, (3) some college, (4) community college/ two-year degree, (5) four-year college degree, (6) some graduate school, (7) master's degree, (8) doctoral degree, (9) professional degree.
[c]Fisher Exact tests were used to calculate p values for group differences in infant sex and race. Kruskal-Wallis non-parametric tests were used to calculate p values for group differences in family income and maternal education.
***$p < .001$

(Raw frequency of tokens or types / Actual length of parent-child interaction) * 10 = Frequency of tokens or types in 10:00 long parent-child interaction. (1)

Equation 1. Formula used to determine word tokens and types in an exactly 10 minute long interaction. Additionally, there was not a group difference in the mean length of play interactions between risk groups (HRA+: $M = 9.21$, $SD = 1.90$; HRA-: $M = 9.31$, $SD = 2.25$; LRC: $M = 9.77$, $SD = 2.04$).

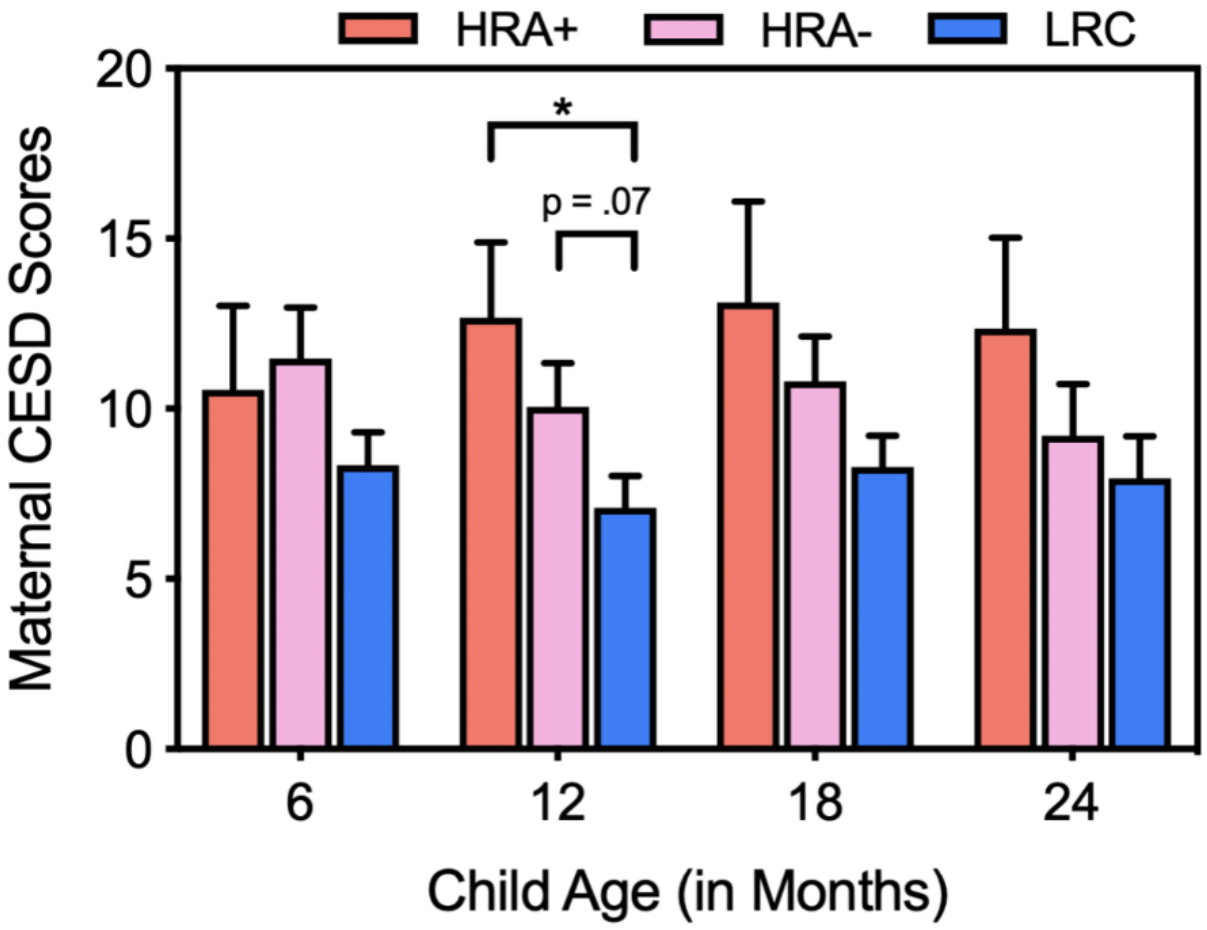

Figure 1. Group differences in mean CESD-R scores reported amongst HRA+, HRA-, and LRC mothers at infant ages 6, 12, 18, and 24 months.

Table 2

Maternal CESD-R data at child ages 6, 12, 18, and 24 months.

	Overall	HRA+	HRA-	LRC
6 months	9.81 (8.37) *N* = 105	11.12 (9.78) *N* = 16	11.47 (9.25) *N* = 38	8.33 (7.01) *N* = 51
12 months	9.26 (8.77) *N* = 129	12.67 (10.89) *N* = 24	10.06 (8.99) *N* = 49	7.09 (6.95) *N* = 56
18 months	9.97 (8.97) *N* = 127	13.12 (12.28) *N* = 17	10.81 (9.50) *N* = 52	8.29 (6.95) *N* = 58
24 months	9.07 (9.32) *N* = 104	12.36 (9.98) *N* = 14	9.21 (9.90) *N* = 43	7.96 (8.50) *N* = 47

Note. Means, standard deviations, and sample sizes are recorded. Possible CESD-R scores could range from 0-60.

Table 3

Maternal CESD-R data and recorded tokens and types at child ages 12, 18, and 24 months for all mothers.

	CESD-R	Word tokens	Word types
12 months	9.23 (9.31) $N = 52$	544.29 (232.36) $N = 52$	159.04 (60.10) $N = 52$
18 months	9.02 (9.46) $N = 48$	598.00 (176.19) $N = 48$	170.52 (43.71) $N = 48$
24 months	8.60 (9.15) $N = 48$	675.93 (185.7) $N = 48$	186.20 (36.20) $N = 48$

Note. Means, standard deviations, and sample sizes are recorded. Possible CESD-R scores could range from 0-60.

Table 4

Maternal CESD-R data and recorded tokens and types at child ages 12, 18, and 24 months for HRA mothers only.

	CESD-R	Word tokens	Word types
12 months	11.77 (10.56) *N* = 30	545.86 (233.90) *N* = 30	159.77 (67.51) *N* = 30
18 months	10.42 (10.50) *N* = 26	556.29 (144.06) *N* = 26	162.98 (40.97) *N* = 26
24 months	9.31 (9.86) *N* = 26	645.25 (185.52) *N* = 26	177.52 (26.35) *N* = 26

Note. Means, standard deviations, and sample sizes are recorded. Possible CESD-R scores could range from 0-60.

Table 5

Maternal CESD-R data and recorded tokens and types at child ages 12, 18, and 24 months for LRC mothers only.

	CESD-R	Word tokens	Word types
12 months	5.86 (5.95) $N = 22$	542.14 (235.71) $N = 22$	158.05 (49.77) $N = 22$
18 months	7.36 (7.98) $N = 22$	647.29 (200.18) $N = 22$	179.43 (46.09) $N = 22$
24 months	7.77 (8.38) $N = 22$	712.18 (183.51) $N = 22$	196.46 (36.11) $N = 22$

Note. Means, standard deviations, and sample sizes are recorded. Possible CESD-R scores could range from 0-60.