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The Relationship Between Type of Parental First Concerns and Severity of Developmental Delays in Toddlers with Autism or Developmental Delay

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The Relationship Between Type of Parental First Concerns and Severity of Developmental Delays in Toddlers with Autism or Developmental Delay

A Thesis

Submitted to the Graduate Faculty of the Louisiana State University in partial fulfillment of the requirements for the degree of Master of Arts in The Department of Psychology

by
Joshua Montrenes
B.S., University of Pittsburgh, 2013
May 2021
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Abstract

Autism spectrum disorder (ASD) is characterized by impairments in social communication and the presence of restricted, repetitive behaviors. The impairments which are commonly associated with ASD manifest during early development as delayed speech or impaired social skills, for example. These early indicators are often noticed by parents who convey concern to medical professionals. Research has found associations between these early parental concerns and a later diagnosis of autism, noting their predictive validity. Research has yet to address the relationship between types of parental concerns and developmental functioning. This study examined whether certain parent reported concerns are more predictive of impaired developmental functioning assessed by a standardized measure in toddlers with ASD or developmental delay (DD). The DD group was found to have significantly higher frequencies of parent-reported language concerns, while the ASD group had significantly higher frequencies of general developmental concerns, multiple concerns, and other concerns. Individuals with ASD had significantly greater developmental impairment than the DD group across first concern types. For the ASD group, greatest developmental impairment was found for those with general developmental concerns, followed by motor, multiple, other, sensory, communication, and language concerns. For the DD group, greatest developmental impairment was found for those with general developmental concerns, followed by multiple, motor, other, language, communication, and sensory concerns.
Introduction

Autism spectrum disorder (ASD) is a lifelong, neurodevelopmental disorder than consists of both impairments in social communicative behaviors as well as the presence of restricted, repetitive behaviors and interests (RRBs; American Psychiatric Association [APA], 2013; Volkmar & McPartland, 2014). Symptoms of ASD emerge early in life and can be recognized within a child’s first 24 months (Bryson, Rogers, & Fombonne., 2003). Further, ASD can be reliably diagnosed by 24 months of age, although the average age of diagnosis is suggested to range from 38 to 120 months (Daniels & Mandell, 2014). Research has found that children whose parents reported concerns about their development received earlier diagnoses and faster access to services, indicating the importance of early parental concerns (Zablotsky et al., 2017).

Parental first concerns about their children have been shown to be predictive of a later diagnosis of autism (Ozonoff et al., 2009). Further, relationships between parental estimates of their child’s functioning and performance on developmental and language measures have been found, suggesting that parents may be skilled at understanding their child’s functioning (McMahon, Malesa, Yoder, & Stone, 2007; Ozonoff et al., 2009; Richards, Mossey, & Robins, 2016). Certain types of concerns presented by parents are more predictive of a later ASD diagnosis, such as those related to social communication deficits (Richards et al., 2016). Whether different kinds of parental concerns are more predictive of impaired developmental functioning has not been well researched. This information may help parents and medical professionals understand which concerns are most important to identify when considering referral for an autism evaluation.

This work aims to further investigate the impact of type of parental first concern on developmental functioning measured by a standardized developmental measure.
The relationship between types of first concerns presented by parents (e.g., concerns about speech, concerns about motor skills) and developmental quotient scores in toddlers with autism and toddlers with developmental delay will be assessed.

**History of Autism**

The initial description of autism arose from Leo Kanner’s (1943) early study of 11 children which he described as infantile autism. He posited that these children had a condition that was distinct from childhood schizophrenia or intellectual disability. While schizophrenic children seemed removed from reality, these 11 children paid little attention to the outside world, displaying an “extreme autistic aloneness,” a term originating from a subset of schizophrenia (Bleuler, 1950; Kanner, 1943). Kanner’s case study noted symptoms of delayed or absent speech, echolalia, pronoun reversal, odd fears, insistence on sameness, and little interest in social interaction. These children had normal intelligence and lacked the physical deformities which were consistent with intellectual disability (Kanner, 1943).

Kanner’s (1943) early descriptions of autism symptoms included mention of social skills deficits, such that the children in the study were not interested in other people and appeared to be most content when they were left alone. He further described that these children were more concerned with objects than people and became upset when they were pressed to engage in social interactions with others. His early descriptions of restricted, repetitive behaviors and interests included documentation of insistence on sameness, such that the children placed blocks in precise order by color and size, for example. Kanner further mentioned that the children were observed to become upset when these routines were interrupted or when they observed a pattern that was unfinished.
Later work by Rutter (1978) noted several areas of uncertainty to be addressed regarding diagnostic considerations for autism. He mentioned confusion resulting from the use of the term “autism” and that it had originally been used to describe a subset of schizophrenia. Unlike autistic schizophrenia, he differentiated the current autism definition as describing individuals who were unable to develop relationships, not just those who were simply withdrawn as originally described by Kanner (1943). Further, Rutter (1978) discussed problematic diagnostic practices that used childhood schizophrenia, autism, and child psychosis being used interchangeably. Finally, he mentioned the wide variability in diagnostic criteria for autism in the research literature and the inconsistency in what symptoms were emphasized (e.g., Eisenberg & Kanner [1956] presented only 2 diagnostic criteria: extreme aloneness and insistence on sameness).

Rutter (1978) integrated Kanner’s initial work with current research to create a diagnostic framework which would be adopted by the Diagnostic and Statistical Manual of Mental Disorders, Third Edition (DSM-III; APA, 1980). Combining the multiple definitions of autism, Rutter (1978) proposed broad symptom domains that included universal symptoms that occurred in all autistic individuals and specific symptoms that differ between autistic individuals. Universal symptoms posed by Rutter (1978) consisted of difficulty or inability to produce social relationships, delays in both expressive and receptive language, and insistence on sameness (Rutter, 1978). His description of specific symptoms included restricted, repetitive behaviors, self-injurious behavior (SIB), attention difficulties, and delayed bowel control.

Rutter (1978) worked to differentiate autism from other disorders to promote its validity as a diagnosis. He examined whether IQ is lower across autistic individuals or if it is variable as proposed by Kanner (1943), finding that IQ varies within the autistic population similarly to
those who are typically developing. Further, Rutter (1978) described that the cognitive impairments characteristic of autism were specific (e.g., affecting language and social skills) while those characteristic of intellectual disability were broad. Unlike autism, schizophrenia had later onset, tended to be episodic, and was characterized by hallucinations and delusions that were not observed in autism (Rutter, 1978).

In part due to Kanner’s initial observations and through Rutter’s integration, the DSM-III was the first DSM to include autism as a diagnosis, referred to as “infantile autism” (APA, 1980). In addition to infantile autism, the diagnoses of childhood onset pervasive development disorder (PDD), residual infantile autism, residual childhood onset PDD, and atypical PDD were added (Volkmar, Bregman, Cohen, & Cicchetti, 1988). To receive a diagnosis of infantile autism, the individual had to display onset at or before 30 months, a lack of social relationships, language delays or deficits, and the absence of delusions and hallucinations (Volkmar et al., 1988). This early classification of autism was crucial as it finally acknowledged autism with a diagnostic category. Several problems arose surrounding the diagnosis, however, including the onset requirement of 30-months-old and the emphasis on autism being “infantile” (Volkmar, et al., 1988).

Transitioning from the DSM-III to the Diagnostic and Statistical Manual of Mental Disorders, Third Edition Revised (DSM-III-R) resulted in significant changes to the diagnostic criteria for autism (APA, 1987). Volkmar and colleagues (1988) stated that “Infantile” was dropped from the name and the focus shifted to be developmental and acknowledged that autism lasts into adulthood. They also noted that additionally, the criteria were shifted to have a developmental orientation so that impairments over chronological age and developmental level would be captured. Volkmar and colleagues found that a comparison of the DSM-III to the
DSM-III-R revealed that the DSM-III criteria was too strict when relating to clinicians’
diagnoses but resulted in few false negatives. In contrast, the DSM-III-R criteria was broader and
more resulted in many false positive diagnoses as well as an overall increase in diagnoses that
would not have occurred under the DSM-III criteria (Volkmar et al., 1988).

When setting out to develop the criteria for the upcoming DSM-IV, researchers aimed to
address the shortcomings of the DSM-III and DSM-III-R. During this time, the International
Classification of Disorders, Tenth Edition (ICD-10) from the World Health Organization (WHO)
contained autism diagnostic criteria that more closely aligned with clinicians’ diagnostic
decisions, so the APA set out to model their criteria after the ICD-10 criteria for the upcoming
DSM-IV (Volkmar et al., 1994; WHO, 2004). Prior to establishing the DSM-IV criteria, the
APA set out to perform field trials to assess whether the DSM-IV and ICD-10 criteria agreed
with one another, if the DSM-IV criteria resulted in false positives as the DSM-III-R criteria had
done previously, and if the range of pervasive developmental disorders (including Asperger’s
Syndrome; AS) were valid, in addition to other concerns (Volkmar et al., 1994). Findings from
the field trials concluded that the DSM-IV autism criteria had good sensitivity (0.93) and
adequate specificity (0.78) and good agreement with the ICD-10 criteria (kappa = 0.86; Volkmar
et al., 1994).

McPartland, Reichow, and Volkmar (2012) stated that after the DSM-IV, the APA
proposed changing the criteria for autism from having multiple pervasive developmental
disorders to having one umbrella term of autism spectrum disorder (ASD) on a continuum of
severity. They noted that another proposed change included combining the communication
deficits with social skills deficits into one social communication criterion and that individuals
needed to meet all 3 social communication criteria for a diagnosis. A further change described by
McPartland and colleagues was the inclusion of sensory abnormalities under the RRB domain and the requirement to meet 2 of 4 RRB criteria for diagnosis. Due to concerns that the removal of PDD-NOS would result in many individuals who do not fully meet for ASD criteria not being captured, the APA included social communication disorder (SCD) which was characterized by impairments in social communication with the absence of impairing RRBs; this diagnosis was comparable to PDD-NOS and was unable to be diagnosed in the presence of an autism diagnosis (McPartland et al., 2012). Motivating factors behind the transition from multiple PDDs to one autism spectrum included concerns about the reliability of the PDDs, a perceived lack of objectivity when making clinical decisions regarding autism, as well as creating diagnostic criteria that more closely aligned with the psychometric standards which were available at the time (McPartland et al., 2012).

The DSM-5 autism criteria was found to have reduced sensitivity that varied by each subgroup of autism (autistic disorder; AD = 0.76, AS = 0.25, PDD-NOS = 0.28) as well as by cognitive functioning (intelligence quotient; IQ < 70 = 0.70, IQ ≥ 70 = 0.46) but heightened specificity (94.9%) when compared to the DSM-IV criteria; those with AD (75.8%) were more likely to meet for DSM-5 ASD than those with AS (25%) or PDD-NOS (28.3%) (McPartland et al., 2012). Overall, the DSM-5 criteria were more strict than that of the DSM-IV, with individuals with greater cognitive functioning and those who had previously met for AS and PDD-NOS being less likely to meet for ASD (McPartland et al., 2012).

The current DSM-5 criteria for autism spectrum disorder consists of a diagnostic dyad: impairments in social communication and the presence of restricted, repetitive behaviors and interests (APA, 2013). Individuals must display 3 of 3 social communication criteria (i.e., A1. Deficits in social emotional reciprocity, A2. Deficits in nonverbal communicative behaviors used
for social interaction, A3. Deficits in developing and maintaining relationships appropriate for the individual’s developmental level), and 2 of 4 RRB criteria (i.e., B1. Stereotyped or repetitive motor movements, use of objects, or speech, B2. Insistence on sameness, inflexible adherence to routines, or ritualized patterns of verbal or nonverbal behavior, B3. Highly restricted, fixated interests that are abnormal in intensity or focus, B4. Hyper- or hyporeactivity to sensory input or unusual interest in sensory aspects of the environment) to meet for a diagnosis of ASD (APA, 2013).

The DSM-5 allows for the clinician to specify if the individual displays an accompanying intellectual impairment, an accompanying language impairment, whether the ASD is associated with a known medical or genetic disorder, whether the ASD is associated with a known neurodevelopmental, mental, or behavioral disorder, or if the individual displays catatonia (APA, 2013). Further, the DSM-5 provides severity specifiers for an ASD diagnosis including level 1: requiring support, level 2: requiring substantial support, and level 3: requiring very substantial support (APA, 2013).

Prevalence of ASD

Research of autism prevalence appears to point toward an increasing trend. Recent estimates from the Centers for Disease Control (CDC) and the Early Autism and Developmental Disability Monitoring (Early ADDM) Network describe rates of ASD as high as 1.7% in 4-year-old children which has risen from 1.34% in 2010 and 1.53% in 2012 (CDC, 2019; Christensen et al., 2018). A separate survey, the National Health Interview Survey (NHIS) found rates as high as 2.47% in children and adolescents aged 3-17 (Xu, Strathearn, Liu, & Bao, 2018). It should be noted that autism prevalence studies lack standardization and are subject to wide variability in the practices of data collection, analysis, and presentation of findings (Fombonne 2018, Iskasen,
Diseth, Schjolberg, & Skjeldal, 2013). Further, changes in the conceptualization of autism, diagnostic practices, and public awareness may influence the prevalence of the disorder and how it is studied (Isaksen et al., 2013). Despite this, reasonable evidence of increasing prevalence has been found, but the extent to which it has increased is debatable (Fombonne, 2018).

**Etiology**

Although research has identified many risk factors that are associated with an increased risk for ASD, no singular cause of ASD has been identified to date (Banerjee, Riordan, & Bhat, 2014). Additionally, the role of genetic and environmental factors in ASD risk has been debated. In a recent study it was found that heritability of ASD was approximately 80% (Bai et al., 2019). Bai and colleagues (2019) further stated that nonshared environmental factors consistently contributed to risk and no support was found for maternal effects. Overall, heritability of ASD has been found to range from 38% to 95% (Bolte, Girdler, & Marschik, 2019). Folstein and Piven (1991) described 3 types of genetic risk factors for autism. These consisted of familial aggregation of autism (e.g., prevalence of autism was found to be higher in infant siblings of autistic children than the general population; rates ranged from 2% to 8.6%; Ritvo, Freeman, Mason-Brothers, Mo, & Ritvo, 1985), familial aggregation of disorders other than autism (e.g., cognitive delays, social deficits, language abnormalities, and other psychiatric disorders in first degree family members have been associated with higher autism risk), and the association between autism and disorders for which the etiology is known (e.g., fragile x, tuberous sclerosis, etc.).

Many environmental risk factors for ASD have been explored. Advanced parental age of one or both parents and discordant parental age have been found to be associated with increased risk of autism with risk accumulating over generations of parents (Bolte et al., 2019). Fetal
exposure to sex steroids has been identified to be associated with increased risk of autism (Bolte et al., 2019). Further, fetal testosterone levels have been linked to development of eye contact, word repertoire, restricted interests, empathy, and overall autistic traits (Auyeung, Lombardo, & Baron-Cohen, 2013). Maher and colleagues (2018) described that maternal hypertensive disorders such as preeclampsia during pregnancy were also identified as risk factors for autism, with odds ratios (ORs) as high as 1.35 being identified. Autism risk has also been linked to several infections including rubella (Bolte et al., 2019). Research has further shown that maternal influenza doubles autism risk (Atladottir, Henriksen, Schendel, & Parner, 2012). Related to this, mothers who had an infection requiring inpatient treatment had a 30% increase in autism risk (Lee et al., 2015). Risk for ASD has been found to raise with infections during any trimester making unclear whether timing of infections influences risk (Atladottir et al., 2010). Multiple obstetric risk factors have been found to be associated with ASD including fetal distress, birth trauma, low birth weight, and multiple birth among others (Bolte et al., 2019). Maternal medication use has also been investigated as a potential risk factor for ASD. Valproate and other epilepsy treatments have been shown to increase risk for congenital malformations, developmental delays, and cognitive impairment (Meador, 2008). Epigenetic underpinnings of ASD may provide a path for these treatments to influence neurodevelopment (Grafodatskaya, Chung, Szatmari, & Weksberg, 2010). Selective Serotonin Reuptake Inhibitors (SSRIs) have been found to be associated with ASD risk with an OR of 1.81 or 1.52 when controlling for maternal mental illness but research is currently conflicting (Brown et al., 2017; Mezzacappa et al., 2017). The psychogenic effects of intense maternal stress as well as impoverished levels of neonatal care have been found to have long lasting, detrimental effects on a child’s development and outcomes but have not been linked to ASD risk specifically (Bolte et al., 2019).
Assessment and Treatment

Current research supports that diagnoses of autism can be made during the first 2 years of life and remain stable over time (Steiner, Goldsmith, Snow, & Chawarska, 2012). Toddlers may have a unique presentation when compared to older individuals with autism, such that clinicians will examine core symptoms of autism alongside developmental delays in communication and social skills (Steiner et al., 2012). Several best practice guidelines exist for diagnosing ASD in toddlers have been noted by Volker & Lopata (2008). They stated that children with language delays should have audiological testing prior to their assessment to investigate whether hearing impairments are influencing language development. They also note that a detailed psychological evaluation should consist of an interview to gather relevant developmental and family history from parents and caregivers, teachers, and, if applicable, the child. This should be followed by an adaptive assessment, social functioning assessment, cognitive testing, behavioral observation, and a functional behavior assessment (FBA; Volker & Lopata, 2008).

Treatment for ASD consists of several strategies. Applied behavioral analytic interventions (ABAIs) have been found to be the most effective interventions for treating core symptoms of ASD (Howard et al., 2005; Lovaas, 1987). Other interventions for individuals with less severe cognitive and language deficits include cognitive behavioral interventions and social skills training (Volker & Lopata, 2008). Pharmacological interventions are also widely used to treat the core symptoms of autism, although these treatments have little evidence of effectiveness (Ameis et al., 2018). Atypical antipsychotics have been found to be effective when addressing associated symptoms of irritability; stimulants have also been found to be effective to treat symptoms of hyperactivity and impulsivity in ASD (Volker and Lopata, 2008).

Prognosis
Studies of outcomes for individuals with ASD have yielded results suggesting that the prognosis for ASD is generally poor. Follow up studies found that in adulthood and pre-adolescence the majority of individuals who were diagnosed with ASD as children had poor to very poor social adjustment (Nordin & Gillberg, 1998). Further, 40-55% of the children in the sample were later placed in institutions (Nordin & Gillberg, 1998). A meta-analytic study found that across studies of outcomes for individuals with ASD, the majority (i.e., 47.7%) had poor outcomes, such that they had the ability to make some social progress despite being severely impaired, while 31.1% had fair outcomes (i.e., had some social deficits but were still able to make social gains) and 19.7% had good outcomes (i.e., close to normal, independent functioning; Steinhausen, Jensen, & Lauritsen, 2016). Studies have also investigated individuals who make gains until they no longer met for an autism diagnosis; so called “optimal outcomes” are rare, however (Fein et al., 2013).
Developmental Delay

Poon, LaRosa, and Pai (2010) stated that developmental delay is defined as a child, toddler, or infant who has a delay in obtaining skills or meeting milestones across one or multiple developmental domains; these include gross and fine motor skills, language and speech skills, cognitive abilities, personal and social skills, and activities of daily living (ADLs). They further noted that a delay in acquiring skills that is 1.5 to 2 standard deviations from the mean time of acquisition is considered a significant delay. In addition to delayed development, individuals may experience deviated development (e.g., skill acquisition does not follow the expected pattern), dissociated development (e.g., some skill domains may not be delayed while others are significantly delayed), and regression (i.e., loss of acquired skills; Poon et al., 2010).

Etiology

Regarding causes of developmental delay, a wide number of associated conditions have been identified. These can be divided into prenatal, perinatal, and postnatal causes. Prenatal causes are most frequently identified, and include chromosomal abnormalities (e.g., deletions, trisomies), non-chromosomal genetic conditions (e.g., Fragile X syndrome), metabolic conditions (e.g., Phenylketonuria), dysmorphic syndromes (e.g., Joubert syndrome, Angelman syndrome), fetal deprivation from placental damage or protoxemia, hydrocephalus, fetal alcohol syndrome, and fetal infections (e.g., cytomegalovirus; Aicardi, 1998). Identifiable perinatal causes are less frequent and include conditions such as perinatal asphyxia and neonatal convulsions (Aicardi, 1998). Postnatal causes of developmental delay include brain injuries and trauma, meningitis, encephalitis, and postnatal malnutrition (Aicardi, 1998).

Assessment and Treatment
The assessment process for developmental delays begins with surveillance techniques and use of screening tools. Poon and colleagues (2010) described that pediatricians and other medical professionals work with parents and document their early concerns, keep a record of the child’s developmental history, document observations of the child, investigate potential risk factors and protective factors, and organize a collection of these findings over time. They also noted that in addition to developmental surveillance, medical professionals administer brief screening tools to identify potential developmental delays. Screening tools may consist of parent report measures such as the Parents’ Evaluation of Developmental Status (PEDS) that parents complete independently, or measures such as the Ages and Stages Questionnaire that are administered by a medical or other professional. Although screening tools cannot diagnose developmental delays, meeting cutoff scores trigger a referral process that connects children at-risk for developmental delays to necessary early intervention services as well as a full, standardized, developmental evaluation (Poon et al., 2010).

Following initial screening, individuals at-risk for developmental delays are administered standardized developmental measures. The purpose of these measures is to give a thorough assessment to classify developmental deviation as well as understand the specific characteristics of the individual’s developmental functioning (Johnson & Marlow, 2006). Several full-scale measures of developmental functioning exist and serve to provide an assessment of an individual’s overall developmental functioning and may also provide levels of functioning in specific developmental domains (Johnson & Marlow, 2006). Standardized developmental assessment measures that are commonly utilized include the Mullen Scales of Early Learning (MSEL; Western Psychological Services, 1995) and the Bayley Scales of Infant Development (BSID; The Psychological Corporation, 1993).
Majnemer (1998) indicated that treatment of developmental delays most often involves treatments which are categorized as early intervention. Early intervention services include a diverse array of therapeutic and educational programs which are aimed at treating delayed infants and toddlers from birth to 3 years of age. He additionally stated that these treatments are meant to maintain current developmental functioning as well as aid the individual in making necessary developmental gains. For instance, Majnemer noted that individuals who live in a deprived environment may be given psychoeducational services that maximize social and cognitive skills acquisition to enhance interactions between children and caregivers as well as increase intellectual functioning. Further, the treatment needs of individuals with identified developmental or biological impairments may vary greatly and generally require a multidisciplinary team of professionals including occupational therapists, speech language pathologists, and physical therapists (Majnemer, 1998). Interventions that address developmental deficits in each domain may be implemented by this team.

**Prognosis**

For individuals with developmental delay, it has been found that early screening and early intervention lead to the best outcomes (Poon et al., 2010). However, findings on long-term treatment efficacy are mixed (Orton, Spittle, Doyle, Anderson, & Boyd, 2009). For example, early intervention targeting cognition in developmentally delayed toddlers had modest treatment effects at infancy and preschool age, but not school age while interventions targeting motor delays were not found to be superior to treatment as usual (Orton et al., 2009). Research has also found that the effects of developmental delays may be long-lasting, such that language-delayed children had reduced IQ scores and reduced reading scores as well as increased rates of
behavioral problems compared to non-delayed peers at ages 7-8 years (Silva, Williams, & McGee, 1987).
ASD and Early Development

Autism influences how an individual develops which has been explored in multiple studies focusing on early development. Early retrospective studies used combinations of parent report and home movies to examine early development and identified behavioral indicators of ASD such as response to name (Osterling, Dawson, & Munson, 2002). Overall, retrospective studies found that motor, social, language, sensory, and regulatory development were atypical in ASD (Baird et al., 2000; Baraneck, 1999).

Later prospective studies examined development of autistic individuals longitudinally. Prospective studies have consistently found that at autistic toddlers do not differ significantly from typically developing peers at 6 months of age on developmental measures (Landa, Gross, Stuart, & Faherty, 2013; Landa & Garrett-Mayer, 2006; Ozonoff et al., 2010; Zwaigenbaum et al., 2005). Other early developmental differences have been observed, however, such that autistic infants and toddlers have been found to display considerable delays in postural development at 6 months including delayed development of advanced postures, less initiation of posture changes, and a smaller overall postural repertoire (Nickel, Thatcher, Keller, Wozniak, & Iverson, 2013). Toddlers with ASD have been found to display slowed development that is detectable with developmental measures starting around 12 months (Landa et al., 2013). For example, Landa and colleagues (2013) found that toddlers with ASD scored lower on domains of receptive and expressive language, communication, shared positive affect, initiation of joint attention, and a consonant inventory at 14 months compared to peers without ASD. This group difference was maintained through 36 months and the ASD group was found to score lower in the domain of fine motor skills at this time as well (Landa et al., 2013). Similarly, Ozonoff and colleagues (2010) found that toddlers with ASD displayed slowed development starting after 6 months, with
significant differences between ASD and non-ASD groups in the domains of gaze to faces, shared smiles, and vocalizations to others at 12 months.

**Regression**

In addition to the aforementioned developmental disturbances characteristic of ASD, these individuals may also exhibit a period of developmental regression. Regression in this case is defined as a stagnation of skills acquisition paired with either the failure to use, or a loss of previously acquired skills (Baird et al., 2008). Further defined, regression is commonly categorized by a loss of spoken language after a child has acquired 3-5 words (Baird et al., 2008). Additional skills that are commonly lost include non-verbal communicative skills, eye contact, social interest, and play skills (Ozonoff, Williams, & Landa, 2005; Werner, Dawson, Munson, & Osterling, 2005). Motor development has not frequently been found to be affected by regression; gross motor skills have been found to remain intact and fine motor skills have been found to be lost in some cases (Davidovitch et al., 2000).

Baird and colleagues (2008) indicated that developmental regression most often occurs in the 2nd year of life. They further stated that some children may have a period of normative development followed by a period of regression, although subtle, unnoticed delays may have been present. Other children may have already shown delayed development followed by a period of marked regression (Baird et al., 2008).

Research on outcomes is variable, and has found that in some cases, children who regressed have less language capability and poorer social skills than those who did not regress (Hoshino et al., 1987; Kobayashi & Murata, 1998). A study by Baird and colleagues (2008) found that children who regressed had both more severe symptoms of autism and met for more severe diagnostic categories of autism than children who did not regress. Other outcome studies
have found no difference between children who regressed vs. non-regressed children (Davidovitch et al., 2000).

Current research has yet to identify an underlying neurobiological cause for regression (Baird et al., 2008). It has been hypothesized that synaptic growth and pruning that takes place during a child’s second year of life may be impaired in individuals with autism by a gene-based mechanism, and that this process may lead to regression (Carper & Courchesne, 2005). It is additionally unknown if regression may be catalyzed by environmental factors (Baird et al., 2008)

**Parental First Concerns**

Research by Ozonoff and colleagues (2009) has shown that parents are skilled at identifying relevant first concerns which are related to diagnostic outcomes. They found moderate, positive correlations between parent reported language abilities and their children’s scores on measures of expressive language (0.45 – 0.65) as well as high correlations between parent report of approximate developmental age and developmental quotient scores. Moreover, first concerns presented by parents about their high-risk infants were verified by formal assessments 95% of the time (Ozonoff et al., 2009). Parents’ concerns about their child’s developmental functioning have been found to be associated with high scores on measures of ASD symptomatology and low scores on measures of cognition (McMahon et al., 2007; Richards et al., 2016).

Research has shown that concerns that are most accurate in predicting a later ASD diagnosis included concerns relating to the core symptoms of ASD (Richards et al., 2016). The most common concerns presented by parents include speech and language concerns, which have also been found to be the most predictive of later ASD diagnosis (De Giacomo & Fombonne,
1998; Hess & Landa, 2012). Concerns that are reported less frequently include social impairments and behavioral abnormalities (De Giacomo & Fombonne, 1998; Hess & Landa, 2012). Concern type has been found to differ according to the child’s sex, such that parents of females who later received an ASD diagnosis reported significantly fewer concerns about social interaction than did parents of males (Little, Wallisch, Salley, & Jamison, 2017). Concern type has also been found to differ as a function of race, with concerns about RRBs and social communication being presented less often by black parents than white parents (Donohue, Childs, Richards, & Robins, 2019). In line with this, Blacher, Cohen, and Azad (2014) discovered that Latino mothers less frequently reported concerns about ASD specific behaviors such as RRBs and more frequently reported concerns about overall development compared to white mothers.

Some studies have also assessed whether parental concerns may be affected when their child has an older sibling with an existing ASD diagnosis (Herlihy et al., 2013; Hess & Landa, 2012, Ozonoff et al., 2009; Talbott, Nelson, & Tager-Flusberg, 2015). In instances where parents already have a child with ASD, they may report concerns earlier (i.e., 6-10 months of age) than parents without a child with ASD; however, these earlier concerns may not be as predictive of a later ASD diagnosis as concerns reported at 12 months of age (Herlihy et al., 2013; Talbott et al., 2015, Ozonoff et al., 2009). Moreover, one study found that concerns relating to either language or autism symptoms (i.e., social communication, restricted and repetitive behaviors) were more likely to be reported for the families with an older child with ASD than families who did not have a child with ASD (Talbott et al., 2015).
Factors Associated with the Presentation and Identification of Autism

Gender

Multiple factors affect the presentation of ASD which influences when it is identified and which symptoms are most prominent. Gender differences in presentation of ASD are well documented. ASD has repeatedly been found to be more prevalent in males than females, with a ratio of 3:1 (Beggiato et al., 2017). These differences have implications including missed or delayed diagnosis in females; they may be incorrectly diagnosed with borderline personality disorder or social phobia, for instance (Wijngaarden-Cremers et al., 2014). Females are thought to be affected by societal gender-role expectations that may play a part in the acquisition of social behaviors that mask ASD symptoms, such as imitation of conventional social behaviors and suppressing disruptive ASD symptoms (Lai, Lombardo, Auyeung, Chakrabarti, & Baron-Cohen, 2015).

Research has found that for females with autism, RRBs are less frequently exhibited and are less severe than in males (Beggiato et al., 2017; Lai et al., 2015; Wijngaarden-Cremers et al., 2014). Additionally, females display superior expressive behaviors (e.g., combining gestures and verbal communication, changing their behavior to adapt to social contexts; Lai et al., 2015). Both males and females have been found to have difficulty with peer relationships, but these problems differ by gender, such that females have difficulty maintaining relationships over time and are disregarded by peers who are seeking friendships rather than being denied like their male counterparts (Lai et al., 2015). Females have been found to show a better range of facial expressions used for social interactions, better imaginative play skills, and fewer restricted interests (Beggiato et al., 2017).

Lai and colleagues (2015) outlined characteristics which are more common in females and differentiate males and females with ASD. Socially, they described that females with ASD
need to interact with their peers, more frequently initiate social interactions, and are able to cover up their social difficulties with compensatory behaviors. Considering communication, they stated that females with ASD have greater language abilities in the context of developmental functioning. For restricted and repetitive behaviors, they indicated that females with ASD have restricted interests that appear more normative (e.g., celebrities, fashion) and are not always thought to be related to ASD symptomatology.

**Race and Ethnicity**

The presentation of autistic symptoms has been found to differ in different racial and ethnic groups. For example, results from Cuccaro and colleagues (2007) suggested that African American children with ASD had more severe language delays than Caucasian children with ASD. Further, children with ASD who were African American, Hispanic American, Central or South American, Filipino, and Vietnamese had increased risk of receiving an autism diagnosis and had an increased risk of being diagnosed with comorbid intellectual disability (ID) than Caucasian children with ASD (Becerra et al., 2014). Individuals with ASD who were African American, Hispanic American, and Central or South American were also found to have poorer emotion regulation and greater expressive language delays than Caucasian children with ASD (Becerra et al., 2014). Research has shown that certain aspects of presentation do not differ by race, however, such that symptom severity was not found to differ by race in children with autism (Mayes & Calhoun, 2011).

Studies into whether race influences age of diagnosis have yielded inconsistent findings. Mandell and colleagues (2002) found that Caucasian children entered the mental health system and received an ASD diagnosis approximately a year earlier than African American children. Conversely, Jo and colleagues (2015) found that age of diagnosis was not significantly different
across ethnic groups including Caucasian, African American, and Latino American children between 3 to 4 years of age.

**Medical Conditions**

Individuals with ASD may be prone to having co-occurring medical conditions that affect symptom presentation. For example, individuals with ASD and comorbid microcephaly were found to have impaired adaptive and cognitive functioning (Zachor & Itzchak, 2016). Sleep disorders have been found to be correlated with increased behavioral problems, neurocognitive deficits, and more severe core symptoms as identified by parents (Bauman, 2010; Zachor & Itzchak, 2016). Further, gastro-intestinal disorders such as gastroesophageal reflux disease (GERD) may increase rates of atypical behavior such as facial grimacing, chewing on non-food items, and aggression (Bauman, 2010). Metabolic disorders may also be associated with aggression, as well as irritability, hyperactivity, and self-injurious behavior (SIB; Bauman, 2010). Thusly, children with ASD and co-occurring medical conditions may present uniquely compared to those without these conditions, which may influence how and when parents have concerns about their child.
**Purpose**

To ensure the best future outcomes for individuals with ASD, the importance of early identification and early behavioral intervention cannot be understated (Koegel, Koegel, Ashbaugh, & Bradshaw, 2014; Remington et al., 2007). Parents of children who receive a later ASD diagnosis often have concerns about their child before their first birthday (Ozonoff et al., 2009). These concerns are often predictive of both performance on developmental measures and diagnostic outcomes (McMahon et al., 2007; Ozonoff et al., 2009; Richards et al., 2016). Further, certain types of concerns, such as language concerns, have been found to be more predictive of a future autism diagnosis than other types of concerns, such as social functioning (De Giacomo & Fombonne, 1998; Hess & Landa, 2012). Despite these findings, whether type of concern is related to the severity of developmental delays has yet to be addressed.

Parent-reported concerns of interest in this study include overall developmental and cognitive concerns, concerns about language and speech, concerns about communication, concerns about motor functioning and restricted, repetitive behaviors, concerns about sensory use, multiple concerns, or other concerns. Each concern was selected due to its consistency of being reported by parents as a first concern as well as the concern being indicative of a later diagnosis (e.g., autism) as noted in the literature. A more detailed discussion of the rationale behind the concerns chosen is listed in the Methods section.

The current study aims to investigate the relationship between type of first concern and developmental functioning. Specifically, whether certain types of concerns are related to increased impairments in developmental functioning as measured by developmental measures, and whether these concerns and delays differ between individuals with ASD and individuals with developmental delay (DD). Given that individuals with ASD have been found to show atypical
development across several areas of development (i.e., motor, social, language, sensory, and regulatory development; Baird et al., 2000; Baraneck, 1999), greater understanding of how parental concerns may align with these delays may provide additional insight into early markers for ASD. Additionally, the implications of this study may aid parents in specific concerns to investigate which may be more predictive of increased developmental delays as compared to other types of concerns. By including a DD comparison group, whether these concerns or level of delays differ by diagnosis may also provide additional information relating to differential diagnosis. To date, few studies have investigated the relationship between type of concern and severity of developmental delays in toddlers with ASD or DD. Due to type of concern and age of diagnosis having both been shown to be influenced by child gender (Durkin et al., 2010; Giarelli et al., 2010; Little et al., 2017), lower age of concern having been shown to be associated with more severe symptoms (Chawarska et al., 2007) and type of concern reported differing for children with a sibling with ASD (Talbott et al., 2015), group differences for variables including age, gender, and the presence of a sibling were also examined.
Hypotheses

Extending from this review of prior research, the following hypotheses are presented:

1. It is hypothesized that the ASD and DD groups will not significantly differ by age, as early developmental delays can be seen in both groups (Landa et al., 2013; Poon et al., 2010).
   a. It is also hypothesized that the ASD and DD groups will not significantly differ on the presence of a sibling; both groups exhibit increased risk factors related to having a sibling or an older sibling with ASD (de Moura et al., 2010; Ozonoff et al., 2011).
   b. Additionally, it is hypothesized that the ASD and DD groups will not significantly differ by gender, as individuals across both conditions have been found to have a higher ratio of males (Beggiato et al., 2017; Zablotsky et al., 2019).

2. It is hypothesized that individuals in the ASD and DD groups will not significantly differ on the frequency of other concerns, but will significantly differ across the remaining concern groups, such that those in the ASD group will have a greater frequency of language, communication, motor, sensory, and multiple concerns, while those in the DD group will have a greater amount of general developmental concerns. Rationale and supporting evidence for the selection of these concerns can be referenced in the Methods: First Concerns section.

3. It is hypothesized that a main effect of diagnosis will be found, such that individuals with ASD will have lower BDI-2 scores than those with DD. This is hypothesized due to prior research finding a positive association between severity
of developmental delays and autism symptom severity (Goldin, Matson, Beighley, & Jang, 2014).

a. Next, it is hypothesized that a main effect of first concern will be found across groups, such that individuals for which the concern was indicated would have lower BDI-2DQ scores than those without the indicated concern.

b. Lastly, it is hypothesized that a significant interaction between diagnosis and concern type will be found, as individuals in the ASD group will have lower BDI-2 scores across concern categories. Additionally, for individuals with ASD, those with overall developmental concerns are hypothesized to have the lowest BDI-2 scores, followed by language and speech concerns, then communication concerns, and next by motor concerns, sensory concerns, then multiple concerns, and lastly by other concerns. This ordering is based on prior research on performance of individuals with ASD on the BDI-2, that a positive association between ASD symptom severity and lower BDI-2 DQ scores has been found (Goldin et al., 2014), and on research indicating the ability these concerns to identify impairment (e.g., De Giacomo & Fombonne, 1998; Hess & Landa, 2012; Matheis et al., 2016). Individuals with DD and ASD overlap on several areas of developmental delays (e.g., motor, language, cognitive, etc.; Poon et al., 2010). As such, it is hypothesized that the DD group will follow the same pattern with respect to BDI-2 DQ scores across concern groups.
Method

Participants

Participants consisted of toddlers aged 17-37 months who were enrolled in EarlySteps, an early intervention program under the Individual with Disabilities Education Act, Part C, in Louisiana. Children qualify for EarlySteps services if they are under 3 years of age and if they have a developmental delay or are at risk for a developmental delay due to risk factors including medical conditions (e.g., Cerebral Palsy, Chronic Ear Infections, Down Syndrome, Seizures, premature birth).

Following an initial referral to EarlySteps by a parent, caregiver, medical professional, etc., these individuals are assessed via the Ages and Stages Questionnaire (ASQ, Bricker et al., 1999; B. Sharp, personal communication, January 27, 2021; Louisiana Department of Health [LDH], 2010). Individuals exhibiting impairments in developmental functioning as indicated by the ASQ (i.e., 1.5 SD below the mean in 2 areas of development) are then included in EarlySteps and receive further screening (B. Sharp, personal communication, January 27, 2021; LDH, 2010). However, individuals with an established medical condition that places them at heightened risk for developmental delays who are referred to EarlySteps are considered eligible without being administered the ASQ. Established conditions include chromosomal abnormality syndromes (e.g., Down syndrome), prenatal exposures (e.g., fetal alcohol syndrome), and pervasive developmental disorders (e.g., autism), for example (see Appendix A for a full list of established medical conditions; B. Sharp, personal communication, January 27, 2021; LDH, 2010). Once determined eligible, individuals receive regular EarlySteps evaluations, which include a measure of developmental functioning (Batelle Developmental Inventory, Second Edition [BDI-2]; Newborg, 2005) and an autism screening tool (i.e., BISCUIT Part-1; Matson, Boisjoli, & Wilkins, 2007 or the M-CHAT; Robins, Fein, Barton, & Green 2001; B. Sharp,
personal communication, January 27, 2021; LDH, 2010). Children with elevated ASQ scores or established medical conditions that warranted inclusion in EarlySteps comprised the sample of this study.

Participants were assigned to an ASD group if they met criteria for an ASD diagnosis via diagnostic algorithm used by a licensed clinical psychologist based on the Diagnostic and Statistical Manual of Mental Health Disorders, Fifth Edition (DSM-5; APA, 2013). The diagnostic algorithm used scores from the BISCUIT Part-1, which corresponded to the symptom domains of ASD as outlined in the DSM-5, as well as domain scores of the BDI-2 (e.g., personal-social domain, communication, adaptive, etc.), to determine which participants should be assigned to the ASD group. The licensed, clinical psychologist using the algorithm was blind to the BISCUIT Part-1 total score. Subjects were assigned to a developmental delay (DD) group if they did not receive an ASD diagnosis and were determined to have delays in developmental functioning as assessed by the ASQ, or had an established medical condition, that warranted their inclusion in EarlySteps.

Data utilized in this study were collected from February 2008 to March 2019. Initially, 22,055 participants comprised the dataset. Following the removal of participants who did not have an assigned diagnosis, the dataset included 11,446 individuals in the ASD group (87%), while 1,705 were in the DD group (13%). 31% of the dataset was female and the remaining 69% was male. Mean age of the sample was 25.24 months ($SD = 4.63$). Regarding ethnicity, the sample was 38% African American, 52% Caucasian, 4% Hispanic, and 6% were of another ethnicity. The mean number of siblings across participants in the sample was 1.42 ($SD = 1.40$). Lastly, the mean birth order of the sample was 2.13 ($SD = 1.31$).
Participants were removed for the following reasons: if they were missing data relevant to research analyses, if they were not able to be assigned a diagnosis due to missing data, if their parents or caregivers declined the BISCUIT screen, or if they did not fall into one of the concern categories of interest (i.e., language and speech concerns, communication concerns, general developmental/cognitive concerns, motor concerns, sensory concerns, other concerns, or multiple concerns containing one of the other concern categories). See Figure 1 for a full description of excluded participants. Following data cleaning, the final sample consisted of 2,380 participants.

Appropriate samples sizes for adequate power were determined using the G*POWER analysis program (Faul, Erdfelder, Lang, & Buchner, 2007). Power analyses are used to determine what sample size is needed for a particular statistical test to detect an effect at a predetermined effect size (Cohen, 1992; Nakagawa & Foster, 2004). Furthermore, power analyses also allow researchers to more effectively examine non-significant findings, such that they can state whether non-significant findings were due to the true absence of an effect or due to the test simply not having enough statistical power to identify the effect (Mayr, Erdfelder, Buchner, & Faul, 2007). Effect sizes reported across similar studies investigating parental first concerns utilized various methods, or, in some cases, numerical values were not reported. However, effect sizes ranging from medium to large were most frequently reported (Chawarska et al., 2007; Herlihy et al., 2015). As such, to detect a medium effect ($\eta^2 = .25$) with .95 power using a Two-way ANOVA with alpha at 0.05, a minimum of 251 participants is required, while 210 participants are needed to achieve this for a One-way ANOVA. The final sample consisted of 2,380 individuals which met the sample size requirements for analyses as calculated her
Figure 1. Flowchart of Participant Selection.

- 22,055 initial participants in dataset
- 8,904 removed due to: substantial missing data, no diagnosis, BISCUIT refusal
- 2,797 removed due to: missing variables of interest (i.e., DQ and/or Parental First Concern)
- 992 removed due to: not falling into one or more of the concern categories of interest
- 6,982 removed due to: not meeting matching requirements during matching procedures
- Final sample: N = 2,380
Measures

*Baby and Infant Screen for Children with Autism Traits (BISCUIT)*

The BISCUIT (Matson, Boisjoli, & Wilkins, 2007) is a measure with three sections designed screen for ASD symptoms in children aged 17 to 37 months. It is an informant-report measure that is usually completed by a parent or caregiver. The BISCUIT comprises of three separate subscales: Part 1 assesses ASD symptomatology, Part 2 assesses comorbidities, and Part 3 assesses challenging behaviors. Part 1 consists of 62 items which are rated on a 3-point Likert scale. Each item is rated based on a comparison to same-aged peers or a level of impairment associated with the item. A score of “0” indicates not different or no impairment, a “1” indicates somewhat different or mild impairment, and a “2” indicates very different or severe impairment. The total score is calculated by combining the scores for all 62 items; a score of 17 or higher falls in the “at risk” range or constitutes a positive screen for ASD.

Regarding psychometric properties, the BISCUIT has been shown to have good convergent validity with the Modified Checklist for Autism in Toddlers (M-CHAT) and Personal-Social scale of the BDI-2 and divergent validity with the BDI-2 Adaptive and Motor domains (Matson, Wilkins, & Fodstad, 2011). Furthermore, the BISCUIT was found to have .97 internal reliability and .89 correct classification rate (Matson et al., 2009).

The BISCUIT also includes a demographic form which gathers identifying information, demographic variables, developmental history including parental first concerns, medical conditions, and relevant family history. The current study utilized several variables from the demographic form including age, gender, ethnicity, and parental first concerns. Additionally, the BISCUIT was used to inform the diagnostic algorithm utilized in this study.

*Battelle Developmental Inventory, Second Edition (BDI-2; Newborg, 2005)*
The BDI-2 (Newborg, 2005) is a developmental functioning measure for children up to 7 years of age. The measure yields a total developmental quotient (DQ) and five domain scores (i.e., Adaptive, Personal-Social, Communication, Motor, Cognitive). Items are scored on a 3-point Likert scale (i.e., 0 equals no ability, 1 equals emerging ability, and 2 equals ability) and the measure contains 450 total items. Individual domain scores have a mean of 100 and standard deviation of 15.

Concerning psychometric properties, the BDI-2 has been demonstrated to be adequate, showing convergent validity with the Preschool Language Scales and the Bayley Scales of Infant Development, Second Edition. Test-retest reliability has been assessed to be over .80 for nearly all domains and subdomains. For the total DQ, an internal consistency of .98 to .99 has been estimated (Bliss, 2007).

The BDI-2 was used in this study to inform the diagnostic algorithm as well as provide a measure of developmental functioning. Individuals with both ASD and DD exhibit delays across several areas of developmental functioning (Baird et al., 2008; Baraneck, 1999; Poon et al., 2010). Understanding whether these delays relate to initial parental concerns may have implications for diagnosis and treatment of ASD and DD. Thusly, the primary dependent variable (DV) of this study consists of the BDI-2 total developmental quotient (DQ).

**First Concerns**

Parental first concerns used for analysis in this study consisted of overall developmental and cognitive concerns, language and speech concerns, communication concerns, motor concerns, sensory concerns, multiple concerns, and other concerns. These concerns are of interest based on their descriptions in prior research regarding first concerns of parents and caregivers with children with ASD. Relating to overall developmental and cognitive concerns,
work by Ozonoff and colleagues (2009) found high correlations between parent report of developmental age and subsequent developmental quotient scores for children with ASD, while Rogers et al (1992) found moderate correlations between overall developmental concerns and developmental functioning in toddlers at-risk for DD. Furthermore, Zwaigenbaum and colleagues (2019) found that individuals with greater cognitive abilities received later ASD diagnoses than other children. Concerns about language and speech as well as communication have been found to be reported at earlier ages than other types of concerns for toddlers with ASD (i.e., 12.94-14 months of age; Chawarska et al., 2007; Hess & Landa, 2012; Kozlowski, Matson, Horovitz, Worley, & Neal, 2011) and are also commonly reported in children with DD (Kozlowski et al., 2011; Turygin et al., 2014). Moreover, concerns related to language and communication have been found to be more reliable indicators of ASD than other types of concerns (De Giacomo & Fombonne, 1998; Hess & Landa, 2012; Matheis et al., 2016).

Regarding concerns related to motor abilities and repetitive motor movements, these concerns have been found to be predictive of an ASD (Richards et al., 2016) or global developmental delay (GDD; Notritz & Murphy, 2013) diagnosis, as well as an earlier age of diagnosis (Mandell et al., 2005). Next, sensory atypicalities have been found to be associated with earlier age of concern in ASD (Chawarska et al., 2007; Herlihy et al., 2015) and while sensory atypicalities also occur in DD (Watson et al., 2011) it is unclear the degree to which this is reported as a first concern for this group. It should also be noted that higher frequencies of parental concerns have been found to be associated with increased ASD symptomatology (Richards, et al., 2016) and that increased ASD symptom severity has been found to be positively associated with increased developmental delays (Goldin et al., 2014). As such, individuals meeting for any of the concerns listed here as well as 1 or more additional concerns were included in the sample. An additional
“other” category was included, as some parents and caregivers expressed significant concerns for their child that are of interest (e.g., regression) for their effects on development (Baird et al., 2008). The other concerns category also included conditions such as early physical trauma, abuse, and neglect, which have all been associated with poor developmental outcomes (Glaser, 2000; Greiner et al., 2012; Hildyard & Wolfe, 2002). Given the ability of the concerns mentioned here to indicate impairment, and the frequency of these concerns being expressed by parents, they will comprise the primary independent variables (IVs) of this study.

**Procedure**

Prior to data collection, the study was approved by Louisiana’s Office for Citizens with Developmental Disabilities as well as the institutional review board (IRB) of Louisiana State University. Service providers administered the BDI-2 as part of an assessment battery along with direct observation, parent interview, and autism screening via the BISCUIT Part-1. During the completion of the demographic form of the BISCUIT Part-1, parents or caregivers were asked by the service provider to indicate the age at which they first had concerns about their child. Parents or caregivers were subsequently asked what this initial concern was (e.g., “I first became concerned because my child was not saying words”). If this concern applied to an existing concern category, the service provider recorded that category as the first concern, along with the parental response (e.g., my child is overly sensitive to loud noises, sensory concern). If the parent-reported concern did not seem to fit into an existing category, the qualitative response was recorded without a designated concern category. Sessions were conducted either in-home or in a daycare setting.

Service providers consisted of individuals with a license, degree, or certification in professions which included speech-language pathology, special education, occupational therapy,
psychology, and physical therapy. Trainings which focused on the administration of the measures included in the assessment battery were attended by each service provider. Records for the current study were collected from a de-identified, archival research database. The LSU institutional review board concluded that the 45 CFR part 46 of the U.S. Department of Health and Human Services regulation doesn’t apply to this study, so informed consent wasn’t required.
Analyses

Analyses were completed using R version 3.5.2 (R Core Team, 2014). Developmental delay severity was defined by the BDI-2 total developmental quotient (DQ). Parental first concerns were defined as qualitative responses collected as a part of the demographic form of the BISCUIT Part-1 by a service provider during an EarlySteps evaluation. Providers recorded the type of first concern as reported by the parents or caregivers (see Table 1 for a coding rubric, see Table 2 for concern examples). The provider recorded the concern as applying to 1 of the existing categories when possible. Otherwise, parents’ qualitative responses were recorded verbatim and later recoded into an existing category by a research assistant or graduate student. For example, if parents reported their first concern as, “my child holds their ears when the dishwasher or vacuum is running,” it would be coded as a sensory concern. Concern categories were not mutually exclusive, and participants were coded as having 1 or more concerns where appropriate. Inter rater reliability (IRR) for coding concerns between the author and the existing codes (determined by research assistants or graduate students) was calculated via percentage agreement for each concern category. The author took a random selection of parental concern responses for each concern category and coded whether the concern applied to the specific category (i.e., yes or no) for approximately 50 random items selected per category. The author
Table 1.

First Concern Coding Rubric

<table>
<thead>
<tr>
<th>Concern Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Developmental/Cognitive</td>
<td>Global developmental concern affecting several areas of development, also includes cognitive concerns.</td>
</tr>
<tr>
<td>Communication</td>
<td>Includes expressive and receptive communicative behavior.</td>
</tr>
<tr>
<td>Language/Speech</td>
<td>Includes talking, using words, articulation, etc.</td>
</tr>
<tr>
<td>Motor</td>
<td>Gross and fine motor concerns, posture, walking, toe walking, etc.</td>
</tr>
<tr>
<td>Problem Behaviors</td>
<td>Concerns regarding tantrums, self-injury, aggression, etc.</td>
</tr>
<tr>
<td>Social</td>
<td>Includes concerns about play, eye contact, interest in peers, initiation, etc.</td>
</tr>
<tr>
<td>Feeding</td>
<td>Not eating, only eating certain foods, drinking from bottle, etc.</td>
</tr>
<tr>
<td>Sensory Issues</td>
<td>Odd reactions to loud noises, lights, textures, pain, etc.</td>
</tr>
<tr>
<td>Weight</td>
<td>Includes low birth weight, weight gain, etc.</td>
</tr>
<tr>
<td>Prematurity</td>
<td>Recoded if concerns related to prematurity were specified by parents.</td>
</tr>
<tr>
<td>Attention</td>
<td>Concerns related to attention, impulsivity, concentration, etc.</td>
</tr>
</tbody>
</table>

Table cont’d.
<table>
<thead>
<tr>
<th>Concern Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adaptive Skills</td>
<td>Related to self-help and daily living skills such as toileting.</td>
</tr>
<tr>
<td></td>
<td>Includes concerns related to conditions such as cerebral palsy, cleft palate, flat feet, etc.</td>
</tr>
<tr>
<td>Medical</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>Concerns that do not fit into the aforementioned categories.</td>
</tr>
</tbody>
</table>
Table 2.

First Concern Examples

<table>
<thead>
<tr>
<th>Concern Type</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>&quot;I have concerns relating to all aspects of my child's development.&quot; &quot;I have concerns about my child's intelligence and learning ability.&quot;</td>
</tr>
<tr>
<td>Developmental/Cognitive</td>
<td>&quot;My child has difficulty pronouncing words.&quot; &quot;My child says words repetitively.&quot;</td>
</tr>
<tr>
<td>Language/Speech</td>
<td>&quot;I am concerned about my child's ability to express their wants and needs.&quot; &quot;My child has trouble responding to what I say.&quot;</td>
</tr>
<tr>
<td>Communication</td>
<td>&quot;My child has trouble walking.&quot; &quot;My child flaps their hands repetitively.&quot;</td>
</tr>
<tr>
<td>Motor</td>
<td>&quot;My child does not seem to react to pain.&quot; &quot;My child holds their ears when they hear the vacuum or the radio.&quot;</td>
</tr>
<tr>
<td>Sensory</td>
<td>&quot;My child experienced trauma during birth.&quot; &quot;My child regressed in skills.&quot; &quot;My child experiences tics.&quot; &quot;My child has sleeping difficulties.&quot;</td>
</tr>
<tr>
<td>Other</td>
<td>*Meets for one of these concerns plus one or more additional concerns</td>
</tr>
</tbody>
</table>
was blind to the existing codes. IRR percentage agreement was calculated as 92% for language concerns, 83% for communication concerns, 98% for overall developmental concerns, 94% for motor concerns, 98% for sensory concerns, and 88% for other concerns. Percentage agreement ratings from 75% to 90% are considered acceptable (Hartmann, 1977; Stemler, 2004). The multiple concerns category was created by assigning all cases with 2 or more concerns to the category, so IRR was not calculated.

In order to adequately understand whether the ASD and DD groups significantly differed demographically, One-way ANOVAs were performed across demographic variables (i.e., age, number of siblings) as well as a Chi-Square analysis (i.e., gender). Next, Chi-Square analyses were performed to investigate whether the number of individuals with ASD vs. DD differed across first concern categories. To assess the relationship between type of parental first concern and severity of developmental delays in individuals with ASD and individuals with DD, and whether these concerns differ by diagnostic group, a Two-way ANOVA was performed. The dependent variable (DV) consisted of the total developmental quotient (DQ) as assessed by the BDI-2, while the independent variables (IVs) consisted of parent-reported first concerns about their child; these included overall developmental and cognitive concerns, concerns about language and speech, concerns about communication, concerns about motor functioning and restricted, repetitive behaviors, concerns about sensory use, whether multiple concerns were present when individuals met for at least one of the other concern categories, and a catch-all “other” concerns category.
Results

Prior to analyses, cases with multiple missing values were removed and significant outliers were addressed via mean imputation. Quantile-quantile plots indicated that the distribution exhibited a mild departure from normality (see Fig. 2). However, due to the large sample size (N = 2,380), normality can be assumed due to the central limit theorem (Ghasemi & Zahediasl, 2012) and F-tests such as ANOVA have been found to be robust to departures from non-normality when sample sizes are adequately large (Blanca, Alarcon, Arnau, Bono, & Bendayan, 2017). Visual analysis of plotted residuals did not indicate heteroskedasticity (Fig. 3).

One-way ANOVAs revealed that the ASD and DD groups significantly differed by age $F(1, 9,360) = 17.84, p < .001$ and number of siblings $F(1, 9,360) = 15.76, p < .001$. Tukey’s honestly significant difference (HSD) post hoc analyses indicated that individuals in the ASD had a significantly higher mean age ($M = 25.79$ months, $SD = 4.61$) than those in the DD group ($M = 25.17$ months, $SD = 4.60$). Those in the ASD group were found to have a significantly higher mean amount of siblings ($M = 1.57$, $SD = 1.50$) than those in the DD group ($M = 1.40$, $SD = 1.37$). A Chi-Square analysis indicated that the ASD and DD groups significantly differed by gender $X^2 (1, N = 9,360) = 27.16, p < .001$; the ASD group had a higher percentage of males (76%) than the DD group (68%). An additional, follow-up, Independent Samples T-test revealed that individuals in the DD group were significantly lower in birth order ($M = 2.11$) than those in the ASD group ($t(9360) = 2.83, M = 2.23, p = .005$).

In order to address group differences in age, gender, and number of siblings, the ASD and DD groups were matched on these variables using the MatchIt package in R (Ho, Imai, King, & Stuart, 2011). Matching was achieved by utilizing propensity score matching, or calculating the
probability that a participant would be assigned to a particular group based on specified covariate distributions (Ho et al., 2011; Sussman et al., 2015). Propensity score matching is utilized to
Figure 2. Plotted Quantiles.
Figure 3. Plotted Residuals.
reduce confounding effects of using non-randomized or observational data (Austin, 2011). Nearest neighbor propensity score matching was utilized, which designates the closest match from the control group (i.e., DD) to the treatment group (i.e., ASD) by calculating a propensity probability score with a logistic regression model run on the covariates of interest (i.e., age, gender, number of siblings; Ho et al., 2011; Vohra, Madhavan, & Sambamoorthi, 2016).

To assess matching accuracy, or whether matching procedures resulted in comparable covariate distributions between groups, balance measures may be used, including examining standardized mean differences between matched and unmatched data on covariate distributions (Austin, 2009; Ho et al., 2011). The MatchIt package provides several measures of balance, including standardized mean differences, percent balance improvement from unmatched to matched data, and mean distance between empirical quantile functions (where values greater than 0 correspond to differences between matched groups in some part of the empirical distribution based on specified covariates; Ho et al., 2011). The standardized mean difference in age between unmatched groups was 0.13, which lowered to -0.01 following matching with a 92.34% balance improvement (see Table 3, Figure 4). Regarding gender, for males, the standardized mean difference was 0.18 for unmatched data which lowered to 0.00 following matching with 98.89% balance improvement; for females, the standardized mean difference was -0.18 which changed to 0.00 after matching with 98.88% balance improvement. For number of siblings, the standardized mean difference in the unmatched data was 0.12, which changed to 0.01 following matching with an 89.68% balance improvement. With respect to the distance between empirical quantile functions, a mean distance of 0.64 and max distance of 26.00 between groups on age was found in the unmatched sample (see Table 4). Following matching, the mean distance between the ASD and DD groups on age reduced to 0.05, and the max
Table 3.

Covariate Standardized Mean Differences and Balance Improvement in Mean Difference

<table>
<thead>
<tr>
<th></th>
<th>Unmatched Data</th>
<th>Matched Data</th>
<th>Balance Improvement (Percentage)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ASD</td>
<td>DD</td>
<td>ASD</td>
</tr>
<tr>
<td>N</td>
<td>N = 8,170</td>
<td>N = 1,190</td>
<td>N = 9,360</td>
</tr>
<tr>
<td>Mean Age (in months)</td>
<td>25.77</td>
<td>25.17</td>
<td>0.13</td>
</tr>
<tr>
<td>Mean Gender Male</td>
<td>0.76</td>
<td>0.68</td>
<td>0.18</td>
</tr>
<tr>
<td>Mean Gender Female</td>
<td>0.24</td>
<td>0.32</td>
<td>-0.18</td>
</tr>
<tr>
<td>Mean Number of Siblings</td>
<td>1.57</td>
<td>1.40</td>
<td>0.12</td>
</tr>
</tbody>
</table>
Figure 4. Histograms of Propensity Score Density Before and After Matching.
Table 4.

<table>
<thead>
<tr>
<th></th>
<th>Unmatched</th>
<th></th>
<th>Matched</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean Distance Between Empirical Quantile Functions*</td>
<td>Max Distance Between Empirical Quantile Functions*</td>
<td>Mean Distance Between Empirical Quantile Functions*</td>
<td>Max Distance Between Empirical Quantile Functions*</td>
</tr>
<tr>
<td>N</td>
<td>N = 9,360</td>
<td>26.00</td>
<td>0.05</td>
<td>2.00</td>
</tr>
<tr>
<td>Age</td>
<td>0.64</td>
<td></td>
<td>0.05</td>
<td>2.00</td>
</tr>
<tr>
<td>Gender Male</td>
<td>0.08</td>
<td>1.00</td>
<td>0.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Gender Female</td>
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<td>1.00</td>
<td>0.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Number of Siblings</td>
<td>0.17</td>
<td>3.00</td>
<td>0.02</td>
<td>1.00</td>
</tr>
</tbody>
</table>

*Values greater than 0 indicate a difference between groups in some part of the empirical distribution.
distance reduced to 2.00. For both the gender/male and gender/female groups, the mean distance was 0.08 and the max distance was 1.00 for the unmatched data, and the mean distance was 0.00 and the max distance was 1.00 for the matched data. Regarding number of siblings, the mean distance was 0.17 and the max distance was 3.00 prior to matching; matched data had a mean distance of 0.02 and a max distance of 1.00. Lastly, the ASD and DD groups did not significantly differ by age $F(1, 2,380) = 0.06, p = 0.81$), gender $X^2 (1, N = 2,380) = 0.00, p = 1.00$, or number of siblings $F(1, 2,380) = 0.09, p = .769$) following matching procedures.

The final, matched sample consisted of 2,380 individuals across diagnostic groups. Regarding gender, the overall sample was 76% male. 41% of the sample was African American, 49% was Caucasian, 4% was Hispanic, and 6% was of another ethnicity. The mean age across groups was 25.80 months ($SD = 4.60$), mean number of siblings was 1.57 ($SD = 1.47$), and mean birth order was 2.21 ($SD = 1.36$).

Chi square analyses were performed to assess differences in concern type frequency across diagnostic groups. Diagnostic groups were found to significantly differ on the frequency of parent reported language concerns, $X^2 (1, N = 2,380) = 6.93, p = .008, \phi = 0.054$ (see Table 5). 52% of the DD group were not in this concern category (i.e., “no”), while 48% were in this category (i.e., “yes”) and 57% of the ASD group were “no” for this category while 43% were “yes” for this category. With respect to communication concerns, diagnostic groups were not found to significantly differ by this concern type $X^2 (1, N = 2,380) = 3.96, p = .05$ (65% “no” vs. 35% “yes” for the DD group, 61% “no” vs. 39% “yes” for the ASD group). ASD and DD groups were found to significantly differ by concern type for general concerns $X^2 (1, N = 2,380) = 7.12, p = .007, \phi = 0.055$ (89% “no” vs. 11% “yes” for the DD group, 85% “no” vs. 15% “yes” for the ASD group). The ASD and DD groups did not significantly differ by motor concerns $X^2 (1, N =$
# Table 5.

Cross Tabulated Frequencies of Concern Types

<table>
<thead>
<tr>
<th>Concern Indicated</th>
<th>General</th>
<th>Language</th>
<th>Communication</th>
<th>Motor</th>
<th>Sensory</th>
<th>Multiple</th>
<th>Other</th>
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</thead>
<tbody>
<tr>
<td>DD Group</td>
<td>1057</td>
<td>134</td>
<td>613</td>
<td>578</td>
<td>770</td>
<td>421</td>
<td>1011</td>
</tr>
<tr>
<td>ASD Group</td>
<td>1012</td>
<td>179</td>
<td>678</td>
<td>513</td>
<td>722</td>
<td>469</td>
<td>1012</td>
</tr>
</tbody>
</table>
Moreover, the diagnostic groups did not significantly differ by sensory concerns $X^2(1, N = 2,380) = 3.75, p = .05$ (99% “no” vs. 1% “yes” for the DD group, 98% “no” vs. 2% “yes” for the ASD group). Regarding multiple concerns, the ASD and DD groups significantly differed by this concern $X^2(1, N = 2,380) = 8.92, p = .003, \phi = 0.061$ (88% “no” vs. 12% “yes” for the DD group, 84% “no” vs. 16% “yes” for the ASD group). Lastly, the ASD and DD groups significantly differed by other concerns $X^2(1, N = 2,380) = 4.84, p = .03, \phi = 0.045$ (98% “no” vs. 2% “yes” for the DD group, 96% “no” vs. 4% “yes” for the ASD group).

Two-way ANOVAs were performed to investigate the relationship between parental first concerns and mean BDI-2 developmental quotient (DQ) scores across ASD and DD groups; Type-II models were used due to groups being unbalanced across concern categories (Navarro, 2019). A bar chart of mean BDI-2 DQ scores can be referenced in the appendix (see Fig. 5); see Table 6 for a full list of mean BDI-2 DQ scores across groups.

Regarding language concerns, results of the Two-way ANOVA indicated a significant main effect of diagnosis, $F(1, 2380) = 651.94, p < .001, \eta^2 = .213$, a significant main effect of first concern type $F(1, 2380) = 5.99, p = .01, \eta^2 = .002$, and a significant interaction between diagnosis and concern type $F(1, 2380) = 13.14, p < .001, \eta^2 = .004$. A Tukey’s Honestly Significant Difference (HSD) post hoc analysis indicated that individuals with ASD and language concerns ($M = 80.90, SE = 0.55$) had significantly lower BDI-2 DQ scores than those with DD and no language concerns ($M = 92.49, SE = 0.50, p < .001$) and those with DD and language concerns ($M = 91.89, SE = 0.52, p < .001$). Individuals with ASD and no language concerns ($M = 77.77, SE = 0.48$) had significantly lower BDI-2 DQ scores than those with ASD and language concerns ($M = 80.90, SE = 0.55, p < .001$), those with DD and language concerns
Table 6.

<table>
<thead>
<tr>
<th>Concern Type</th>
<th>Concern Indicated</th>
<th>N</th>
<th>Degrees of Freedom</th>
<th>Diagnosis</th>
<th>Mean BDI-2 Developmental Quotient (DQ)</th>
<th>Standard Error (SE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall/General</td>
<td>No</td>
<td>1,057</td>
<td>1</td>
<td>DD</td>
<td>92.72</td>
<td>0.38</td>
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<tr>
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<td>No</td>
<td>1,012</td>
<td>1</td>
<td>ASD</td>
<td>80.46</td>
<td>0.38</td>
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<td></td>
<td>Yes</td>
<td>134</td>
<td>1</td>
<td>DD</td>
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<td>1.06</td>
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<tr>
<td></td>
<td>Yes</td>
<td>179</td>
<td>1</td>
<td>ASD</td>
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<td>0.91</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>613</td>
<td>1</td>
<td>DD</td>
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<tr>
<td></td>
<td>No</td>
<td>678</td>
<td>1</td>
<td>ASD</td>
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<td>0.48</td>
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<tr>
<td></td>
<td>Yes</td>
<td>578</td>
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<td></td>
<td>Yes</td>
<td>513</td>
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<tr>
<td></td>
<td>No</td>
<td>770</td>
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<td>DD</td>
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<tr>
<td></td>
<td>No</td>
<td>722</td>
<td>1</td>
<td>ASD</td>
<td>78.12</td>
<td>0.46</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>421</td>
<td>1</td>
<td>DD</td>
<td>93.30</td>
<td>0.61</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>469</td>
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<tr>
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<td>1</td>
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<tr>
<td></td>
<td>No</td>
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<td>ASD</td>
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<td>0.39</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>180</td>
<td>1</td>
<td>DD</td>
<td>90.00</td>
<td>0.92</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>179</td>
<td>1</td>
<td>ASD</td>
<td>74.49</td>
<td>0.93</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>1,183</td>
<td>1</td>
<td>DD</td>
<td>92.12</td>
<td>0.36</td>
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<tr>
<td></td>
<td>No</td>
<td>1,172</td>
<td>1</td>
<td>ASD</td>
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<td>0.36</td>
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<tr>
<td></td>
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<td>8</td>
<td>1</td>
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<td>3.47</td>
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<tr>
<td></td>
<td>Yes</td>
<td>19</td>
<td>1</td>
<td>ASD</td>
<td>78.51</td>
<td>2.86</td>
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</table>

Table cont’d.
<table>
<thead>
<tr>
<th>Concern Type</th>
<th>Concern Indicated</th>
<th>Degrees of Freedom</th>
<th>Diagnosis</th>
<th>Mean BDI-2 Developmental Quotient (DQ)</th>
<th>Standard Error (SE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple</td>
<td>No</td>
<td>1</td>
<td>DD</td>
<td>92.64</td>
<td>0.38</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>1</td>
<td>ASD</td>
<td>79.58</td>
<td>0.39</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>1</td>
<td>DD</td>
<td>88.98</td>
<td>1.04</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>1</td>
<td>ASD</td>
<td>76.75</td>
<td>0.89</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>1</td>
<td>DD</td>
<td>92.24</td>
<td>0.37</td>
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<tr>
<td></td>
<td>No</td>
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<td>ASD</td>
<td>79.18</td>
<td>0.37</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>1</td>
<td>DD</td>
<td>90.59</td>
<td>2.49</td>
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<tr>
<td></td>
<td>Yes</td>
<td>1</td>
<td>ASD</td>
<td>77.43</td>
<td>1.88</td>
</tr>
</tbody>
</table>
(M = 91.89, SE = 0.52, p < .001) and those with DD and no language concerns (M = 92.49, SE = 0.50, p < .001).

For communication concerns, a significant main effect was found for diagnosis F(1, 2380) = 667.65, p < .001, η² = .219 and concern type F(1, 2380) = 16.23, p < .001, η² = .002; the interaction was not significant F(1, 2380) = 0.62, p = .43. A Tukey’s HSD analysis indicated that individuals with ASD (M = 79.40, SE = 0.37) had significantly lower mean BDI-2 DQ scores than those with DD (M = 92.50, SE = 0.38, p < .001), and that individuals across diagnostic groups with communication concerns (M = 87.00, SE = 0.42) had significantly higher BDI-2 DQ scores than those with no communication concerns (M = 84.90, SE = 0.32, p < .001).

Regarding general developmental concerns, a main effect of diagnosis F(1, 2380) = 653.14, p < .001, η² = .207 and concern type F(1, 2380) = 89.82, p < .001, η² = .028 was found, which was qualified by a significant interaction between diagnosis and concern type F(1, 2380) = 8.61, p = .003, η² = .003. A Tukey’s HSD post hoc analysis indicated that individuals with ASD and general concerns (M = 71.50, SE = 0.91) had significantly lower mean BDI-2 DQ scores than those with DD and general concerns (M = 88.14, SE = 1.06, p < .001), those with DD and no general concerns (M = 92.72, SE = 0.38, p < .001), and those with ASD and no general concerns (M = 80.46, SE = 0.36, p = .003). Participants with ASD and no general concerns had significantly lower mean BDI-2 DQ scores than individuals with DD and no general concerns (M = 92.72, SE = 0.38, p < .001) and those with DD and general concerns (M = 88.14, SE = 1.06, p < .001).

With respect to motor concerns, significant main effects were found for diagnosis F(1, 2380) = 665.80, p < .001, η² = .216 and concern type F(1, 2380) = 32.04, p < .001, η² = .01; these were qualified by a significant interaction between diagnosis and concern type F(1, 2380)
As demonstrated by a Tukey’s HSD post hoc analysis, individuals with ASD and motor concerns ($M = 74.49, SE = 0.93$) had significantly lower mean BDI-2 DQ scores than those with DD and motor concerns ($M = 90.00, SE = 0.92, p < .001$), those with DD and no motor concerns, ($M = 92.72, SE = 0.38, p < .001$), and those with ASD and no motor concerns ($M = 79.93, SE = 0.39, p < .001$). Participants with ASD and no motor concerns had significantly lower BDI-2 DQ scores than those with DD and motor concerns ($M = 90.00, SE = 0.92, p < .001$) and those with DD and no motor concerns ($M = 92.72, SE = 0.38, p < .001$).

For sensory concerns, a significant main effect of diagnosis was found $F(1, 2380) = 658.92, p < .001, \eta^2 = .217$ as well as a significant interaction between diagnosis and concern type $F(1, 2380) = 5.28, p = .02, \eta^2 = .002$. The main effect of concern type was not significant $F(1, 2380) = 1.54, p = .21$. Results of a Tukey’s HSD post hoc test indicated that individuals with ASD and sensory concerns ($M = 78.51, SE = 2.86$) had significantly lower BDI-2 DQ scores than participants with DD and sensory concerns ($M = 97.41, SE = 3.47, p < .001$) and those with DD and no sensory concerns ($M = 92.12, SE = 0.36, p < .001$). Participants with ASD and no sensory concerns ($M = 79.12, SE = 0.36$) had significantly lower scores than those with DD and sensory concerns ($M = 97.41, SE = 3.47, p < .001$) and those with DD and no sensory concerns ($M = 92.12, SE = 0.36, p < .001$).

For multiple concerns, significant main effects were found for diagnosis $F(1, 2380) = 644.35, p < .001, \eta^2 = .211$ and concern type $F(1, 2380) = 19.23, p < .001, \eta^2 = .006$. The interaction was not significant $F(1, 2380) = 0.31, p = .58$. A Tukey-adjusted post hoc analysis indicated that individuals with ASD ($M = 78.20, SE = 0.49$) had significantly lower mean BDI-2 DQ scores than those with DD ($M = 90.80, SE = 0.55, p < .001$), and that individuals across diagnostic groups with multiple concerns ($M = 82.90, SE = 0.68$) had significantly lower BDI-2
DQ scores than those without multiple concerns ($M = 86.10, SE = 0.28, p < .001$). Lastly, results of a Two-way ANOVA indicated a significant main effect of diagnosis $F(1, 2380) = 651.64, p < .001, \eta^2 = .214$ for other concerns. The main effect of concern type $F(1, 2380) = 1.26, p = .26$ and the interaction $F(1, 2380) = 0.001, p = .98$ were not significant. Following a Tukey’s HSD post hoc test, it was found that individuals with ASD ($M = 78.30, SE = 0.96$) had significantly lower mean BDI-2 DQ scores than those with DD ($M = 91.40, SE = 1.26, p < .001$).
Discussion

As indicated in the results section, individuals in the ASD and DD groups significantly differed by gender, age, and number of siblings. As such, hypotheses 1., 1a., and 1b. were not upheld. Relating to gender, though both groups had a higher number of males than females, which corresponds with prior research (Beggiato et al., 2017; Zablotsky et al., 2019), this difference was more pronounced in the ASD group (i.e., 76% male) than the DD group (68% male). Furthermore, individuals in the ASD group had a significantly higher age ($M = 25.79$ months, $SD = 4.61$) than the DD group ($M = 25.17$ months, $SD = 4.60$, $p < .001$) though these were both in the 25-month range. Given that individuals are included in EarlySteps after an initial referral (which can be made by parents, caregivers, doctors, etc.) it may be helpful to consider prior research regarding parents’ initial age of concern as a contributing factor to the age of the sample. Mean age of concern for individuals with ASD has been found to range from 12.05-30.00 months (Chakrabarti, 2009; De Giacomo & Fombonne, 1998; Jang, Matson, Cervantes, & Konst, 2014; Matheis et al., 2016; Shevell, Majnemer, Rosenbaum, & Abrahamowicz, 2001; Zablotsky et al., 2017). For individuals with DD, fewer studies have investigated the mean age of parental concern, though it has been found to range from 11.68-27.30 months (Jang et al., 2014; Kozlowski et al., 2011; Shevell et al., 2001). Moreover, it is not uncommon for individuals who receive a later ASD diagnosis to display what appears to be typical development for the first year of life, with either delays or a regression of skills being recognized after this point (Landa, Gross, Stuart, & Bauman, 2012). As such, it may be the case that individuals with DD display delays that are recognized somewhat earlier, while those who will go on to receive an ASD diagnosis display delays somewhat later. Further research into the age of entrance into Part C early intervention programs, and how this age may differ by
condition, is likely needed to better understand what may have driven these observed age differences. Lastly, those in the ASD group had significantly more siblings \((M = 1.57, SD = 1.50)\) than the DD group \((M = 1.40, SD = 1.37, p < .001)\) while individuals in the DD group had a significantly lower mean birth order \((M = 2.11)\) than those with ASD \((M = 2.23, p = .005)\). Considering this finding, it should be noted that prior research has found increased risk of ASD when one has an older sibling with ASD (Ozonoff et al., 2011). Additionally, there is research that supports an increased risk of developmental delay in individuals with an older sibling who was born less than 24 months before them, or if they have an older sibling with ASD (de Moura et al., 2010; Landa et al., 2012). As such, in an at-risk sample such as the one utilized in the present study, it may be the case that while increased sibling-risk status is observed in each group, it was more pronounced for the DD group.

As indicated by Chi-Square analyses (see Table 5), a significantly higher frequency of individuals in the DD group had parent reported language concerns \((N = 578)\) than those in the ASD group \((N = 513)\), though the effect was small \((\phi = 0.054)\) indicating a low degree of association between diagnosis and language concerns. This finding was the opposite of the pattern proposed by hypothesis 2. Individuals in the ASD group had significantly higher frequencies of general concerns \((ASD: N = 179 vs. DD: N = 134; \phi = 0.055)\), multiple concerns \((ASD: N = 196 vs. DD: N = 144; \phi = 0.061)\), and other concerns \((ASD: N = 44 vs. DD: N = 25; \phi = 0.045)\); effect sizes were small for each of these concern group differences, indicating a small degree of association between diagnosis and general, multiple, and other concerns. The findings regarding multiple concerns aligned with the pattern proposed in hypothesis 2, while the findings regarding general concerns and other concerns did not follow the hypothesized pattern. Lastly,
diagnostic groups did not significantly differ by communication, motor, or sensory concerns; each of these findings went against the hypothesized pattern.

As outlined in the introduction, language and speech concerns have been found to be the most commonly reported concerns for children with ASD as well as the most predictive of a future ASD diagnosis (De Giacomo & Fombonne, 1998; Hess & Landa, 2012). Unsurprisingly, high frequencies of language and communication concerns were reported for both ASD and DD groups in the present study. Presently, there is scant literature examining parental first concerns in a primarily developmentally delayed sample. However, two studies have compared rates of parental concerns in toddlers with ASD utilizing an atypically developing, DD comparison group (Kozlowski et al., 2011; Turygin et al., 2014). In each study, individuals in the atypically developing, DD comparison group had higher rates of parental concerns regarding communication (this category collapsed separate concerns related to communication and language) than the ASD groups (i.e., 80.69% in the DD group vs. 73.83% in the ASD group [Kozlowski et al., 2011], 79.70% in the DD group vs. 71.90% in the ASD group [Turygin et al., 2014]). The present study appears to follow the same pattern with regard to language concerns but went against this pattern with respect to communication concerns. Both language and communication impairments are common in individuals with ASD and DD (Bishop, 2010; Horovitz & Matson, 2010), and it may be the case that language concerns (specifically) are more frequently reported for individuals with DD, while for communication concerns, similar frequencies of the concern are reported across ASD and DD.

Regarding general (i.e., overall developmental and cognitive) concerns, although both diagnostic groups exhibited high frequencies of this concern, significantly greater general concerns were reported for the ASD group. Delays across several areas of development (e.g.,
social, motor, language, sensory, regulatory) are common in young children with ASD (Baird et al., 2000; Baraneck, 1999). Likewise, Ozonoff et al (2009) found that parents are competent at estimating their child’s developmental functioning. Additionally, the current study found that individuals with ASD had significantly lower BDI-2 DQ scores than those in the DD group. As such, these delays may be more pronounced in ASD, making them more salient to parents, leading to more frequent reporting of these concerns in children with ASD than those with DD.

As hypothesized, individuals with ASD had significantly higher parent reported multiple concerns than the DD group. This finding appears to be warranted, as a positive association has been found between higher frequencies of parental concerns and a subsequent ASD diagnosis (Richards et al., 2016) and that co-occurring delays in addition to the core symptoms of ASD are common (Baird et al., 2000; Baraneck, 1999).

Though it was hypothesized that diagnostic groups would not significantly differ by frequency of other concerns, individuals in the ASD group had a significantly higher frequency of other concerns. The other concerns category was a catch-all category that included concerns such as trauma, anxiety, drug exposure, etc. This category also included developmental regression, which occurs frequently in ASD (e.g., overall prevalence has been found to be 32.1% in ASD) but is rare in other neurodevelopmental disorders (e.g., prevalence ranges 1-3%; Williams, Brignell, Prior, Bartak, & Roberts, 2015). It may be the case that this concern category was more frequently endorsed in the ASD group due to higher rates of regression occurring in ASD.

ASD and DD groups were not found to differ by frequency of motor concerns, which included motor delays as well as repetitive motor movements (e.g., hand flapping) and atypical posture (e.g., toe walking), against hypothesis 2. Although repetitive motor movements are a
core feature of ASD, these can still occur in children who are developmentally delayed (Barry, Baird, Lascelles, Bunton, & Hedderly, 2011). Further, early motor delays are common in both conditions (Provost, Lopez, & Heimerl, 2006). Considering these findings, early motor delays and repetitive motor movements are likely not sufficient to distinguish between young children with ASD and DD, especially in the context of parent reported concerns, at least according to the research that is currently available (Iverson et al., 2019; Provost et al., 2006).

Diagnostic groups did not significantly differ by sensory concerns, against hypothesis 2. Although atypical sensory reactivity is a core feature of ASD, sensory atypicalities can occur in DD as well (Watson et al., 2011). Certain patterns of sensory reactivity have been found to differentiate between ASD and DD; one study found higher rates of sensory seeking, hyper-, and hyporesponsiveness to sensory stimuli in ASD vs. DD (Watson et al., 2011), while another found higher rates of hyporesponsiveness only in ASD vs. DD (Baranek, Poe, Stone, & Watson, 2006). However, these increasingly specified differences may not be apparent to caregivers, and the frequency of parent-reported concerns regarding sensory atypicalities may not differ greatly between the 2 groups.

Two-way ANOVAs indicated that individuals with ASD had significantly lower BDI-2 DQ scores than those in the DD group, regardless of concern type; this was in agreement with hypothesis 3. Effect sizes ranged from small (e.g., $\eta^2 = .002$ for communication concerns) to large (i.e., $\eta^2 = .217$ for sensory concerns, $\eta^2 = .211$ for multiple concerns, $\eta^2 = .214$ for other concerns, $\eta^2 = .207$ for general concerns, $\eta^2 = .213$ for language concerns). This finding aligns with a prior study, which found that ASD symptom severity is positively corelated with developmental delay severity (Goldin et al., 2014). Additionally, due to early developmental
delays being common in ASD across developmental areas (Baird et al., 2000; Baraneck, 1999; Landa et al., 2013) this finding appears to be warranted.

In line with hypothesis 3a, main effects for first concerns, and significantly lower scores for groups for which the concern was indicated, were found for the following groups: general ($\eta^2 = .003$), motor ($\eta^2 = .01$), and multiple ($\eta^2 = .006$). Significant main effects were found for both language ($\eta^2 = .002$) and communication ($\eta^2 = .002$), though in each case, individuals for which the concern was not indicated had significantly lower BDI-2 DQ scores, which was the opposite of the hypothesized pattern. Also against the hypothesized pattern, main effects of concern type for sensory and other concerns were not found. Due to significant interactions being found for general, language, and motor concerns, detailed interpretation will not be discussed here.

Regarding multiple concerns, due to prior research indicating higher frequencies of concerns being associated with ASD symptom severity (Richards et al., 2016), and ASD symptom severity being positively correlated with developmental delay severity (Goldin et al., 2014), the finding which indicated significantly lower DQ scores for those with multiple concerns appears to be warranted. For communication concerns, though prior research has indicated that communication concerns are reported earlier (Chawarska et al., 2007), likely indicating they are easier to recognize, and that they are more reliable predictors of a future ASD diagnosis than other types of concerns (Hess & Landa 2012), they may not be as accurate at indicating developmental delay severity. Few studies have investigated the relationship between communication concerns and developmental delay severity. However, a similar pattern was found by Turygin and colleagues (2013), such that individuals with communication as an initial parent concern who had ASD or were atypically developing had higher developmental quotient scores than those without this concern. As such, it may be the case that given the variety of
concerns reported in the present study, concerns other than communication were better indicators of developmental impairment.

In line with hypothesis 3b, lowest BDI-2 DQ scores across the ASD and DD groups were found in the ASD, general developmental concerns group (\(M = 71.50, SE = 0.91\); see Table 6, Figure 5). Relatedly, lowest scores within the DD group were found in the DD, general concerns group (\(M = 88.14, SE = 1.06\)). This finding aligns with prior research that indicated positive agreement between parental estimation of developmental functioning and subsequent, standardized scores of developmental functioning (Ozonoff et al., 2009). For the ASD group, this finding also aligns with a study indicating a positive correlation between ASD symptom severity and developmental delay severity (Goldin et al., 2014).

The next lowest BDI-2 DQ scores were in the following order: ASD, motor, (\(M = 74.49, SE = 0.93\)), ASD, multiple (\(M = 76.75, SE = 0.89\)), ASD, other (\(M = 77.43, SE = 1.88\)) which did not follow the hypothesized pattern developed from a prior research investigating the performance of individuals with ASD on the BDI-2 (Goldin et al., 2014) as well as prior research on ASD and first concerns (see the Methods: First Concerns section). The DD group followed a somewhat similar pattern, though the ordering was unique from the ASD group, against hypothesis 3b (DD, multiple [\(M = 88.98, SE = 1.04\)], DD, motor [\(M = 90.00, SE = 0.92\)], DD, other [\(M = 90.59, SE = 2.49\)]).
Figure 5. Mean BDI-2 Developmental Quotients Across Concern and Diagnostic Groups.
The finding that the ASD, motor concerns group had the next lowest DQ scores (and the 3rd lowest in the DD group) may be due to several factors. Recall that motor concerns have been found to be a good predictor of a future ASD diagnosis and are associated with a younger age of concern (Mandell et al., 2005; Richards et al., 2016). What’s more, motor delays are common, vary in severity, are associated with at-risk development, and can be a first sign of global developmental delay (GDD; Noritz & Murphy, 2013). Thusly, since the study population is at-risk, it may be the case that the intensity of motor delays within this sample are moderately severe given the association with developmental impairment which was observed following analyses.

Individuals in the ASD, multiple concerns group had the next (3rd) lowest DQ scores ($M = 76.75, SE = 0.89$) overall; those with DD and multiple concerns had the 2nd lowest DQ scores within the DD group ($M = 88.98, SE = 1.04$). Given that higher frequencies of concerns have been found to be associated with greater ASD symptom severity (Richards et al., 2016), and that ASD symptom severity has been found to be positively associated with impaired developmental functioning (Goldin et al., 2014) it may be the case that individuals with ASD and multiple concerns are also exhibiting greater developmental delays. This finding also suggests that for individuals with DD and multiple concerns, greater levels of developmental impairment may be observed.

For individuals with ASD and other concerns ($M = 77.43, SE = 1.88$), as previously discussed, this group included individuals with trauma, drug exposure, regression, and so on. Regression in ASD may be associated with a loss of skills across several areas of development; the observed impairment in developmental functioning in this study appears to be warranted in individuals experiencing regression (Baird et al., 2008). Furthermore, individuals experiencing
early trauma (e.g., head trauma) and abuse or neglect are associated with poorer developmental outcomes (Glaser, 2000; Greiner et al., 2012; Hildyard & Wolfe, 2002). Likely, a combination of these and other factors within the other concerns category contributed to lower DQ scores for this group; similar factors (other than developmental regression due to its rarity in DD; Williams et al., 2015) likely contributed to lower DQ scores in the DD group ($M = 90.59, SE = 2.49$) as well.

Sensory concerns in ASD have been found to be associated with earlier age of concern (Chawarska et al., 2007; Herlihy et al., 2015) and are common areas of delayed development in ASD (Baird et al., 2000; Baraneck, 1999), though the current study found that sensory concerns ($M = 78.51, SE = 2.86$) were associated with higher DQ scores than general, multiple, or other concerns. A possible explanation for this is the low number of participants with indicated sensory concerns across groups (ASD: $N = 19$, DD: $N = 8$) leading to analyses being underpowered. However, in a study with toddlers with either ASD or DD, abnormal sensory reactivity was not found to be related to developmental level or IQ (Rogers, Hepburn, & Wehner, 2003). This study finding aligns with what was found in the present study; highest DQ scores in the DD group were found in the DD, sensory concerns group ($M = 103.63, SE = 4.40$).

Considering the findings of the present study and the reviewed literature supporting that general, multiple, and other concerns may indicate higher levels of developmental impairment (e.g., Richards et al., 2016; Greiner et al., 2012) it may also be the case that sensory atypicalities are less associated with developmental impairment than other concern types.

The ASD, communication ($M = 80.65, SE = 0.57$) and ASD, language ($M = 80.90, SE = 0.55$) concern groups had the highest BDI-2 DQ scores among the ASD sample, which was unexpected due to prior research indicating the consistency of these concerns being reported as
well as their reliability in indicating a future ASD diagnosis (De Giacomo & Fombonne, 1998; Hess & Landa, 2012). However, as discussed previously, Turygin and colleagues (2013) found that individuals with ASD and communication as an initial parent concern had higher developmental quotient scores than those without this concern. Due to the scarcity of literature in this area, it is unclear whether this relationship differs between individuals with language concerns and communication concerns. However, one study indicated that for individuals with ASD and normal intelligence, early language delays were not predictive of later functional impairment in childhood. Consequently, as previously mentioned, developmental impairment may be better indicated by concerns such as general, motor, and multiple, rather than language or communication. This may also be the case for individuals in the DD group, as general ($M = 88.14, SE = 1.06$), multiple ($M = 88.98, SE = 1.04$), and motor ($M = 90.00, SE = 0.92$) concerns were all associated with lower DQ scores than language ($M = 91.89, SE = 0.52$) and communication ($M = 93.30, SE = 0.61$) concerns.

The findings of this study have important implications for both the diagnosis and treatment of ASD. Considering the difficulties already associated with ASD, toddlers with ASD whose parents and caregivers express overall developmental and cognitive concerns, multiple concerns, or other concerns may be at an increased risk for further delays in development. This is especially salient when considering the interrelated nature of these early delays from a cascading developmental perspective (i.e., developmental delays may lead to increased delays in the future if not addressed early; Iverson, 2018). For individuals with ASD or DD whose parents and caregivers express these overall developmental, motor, or multiple concerns, it may be prudent to maximize the amount of early intervention received across developmental areas (e.g., speech
therapy, occupational therapy) or within the specified area of concern (i.e., physical therapy for motor concerns) to maximize positive outcomes.

This study was subject to several limitations. For instance, the dataset only contained four categories for ethnicity (i.e., Caucasian, African American, Hispanic, Other). Considering the differences in parent reported concerns across ethnicities (e.g., Donahue et al., 2019), a sample with more diverse representation would be beneficial. It is recommended as a direction for future research to investigate parent and child ethnicity and its relation to first concerns and developmental functioning. Additionally, though the sample size was adequate for the purpose of this study, many participants were removed due to missing data or screening refusal. Socioeconomic status (SES) is another important factor that was not able to be addressed in this study. Due to the association between lower SES and higher risk of delays (Potjik et al., 2013), and that individuals with higher SES report a higher frequency of concerns (Glascoe, 1999), it is additionally recommended that SES be investigated for its ability to mediate or moderate the relationship between first concern type and developmental functioning in future research.

To conclude, for individuals with intellectual and developmental disabilities, early detection is crucial in order to begin the referral process, receive a diagnosis, and be enrolled in intervention services. Oftentimes, parents are the first to notice areas where their child displays impairment, which they report to health professionals as a first concern. Results from this study support that individuals with ASD or DD whose parents or caregivers report overall developmental and cognitive concerns, motor concerns, or multiple concerns, are at increased risk of lower developmental functioning. For these children, early access to intensive intervention targeting these delays is paramount to attempt to avoid further developmental delays and increase positive outcomes.
Appendix. Established Medical Conditions.

EarlySteps utilizes the following medical conditions which have a high probability of developmental delay for eligibility:

Diagnosed Conditions List and ICD-9 Codes

If documented by a physician’s signature (or that of an audiologist in the case of hearing impairment or a speech/language pathologist in the case of a child with developmental apraxia of speech) children with the following diagnoses are eligible for EarlySteps. These diagnoses have a high probability of resulting in developmental delays.

Some ICD-9 code categories may contain both pediatric and adult diagnosis; however, adult diagnosis codes are not used for EarlySteps eligibility. The 3 digit codes usually indicate a “general” diagnosis category; more specific codes may be listed under the general category or may be given later by a physician when a more specific diagnosis is made. Always use the most descriptive code available.

Genetic Disorders

A. Chromosomal Abnormality Syndromes
   Down syndrome (758.0), Trisomy 13 (758.1), Trisomy 18 (758.2)
   Autosomal deletion syndromes (758.3_) General Category
      --Cri-du-chat (758.31)
      --Velo-cardio-facial (758.32)
   Other micro-deletion syndromes include Miller-Dieker and Smith-Magenis syndromes (758.33)
   DiGeorge Syndrome (279.11)
      Fragile X (759.83)
      Prader-Willi (759.81)
      Other conditions due to autosomal anomalies (758.5)
   Other conditions due to chromosomal anomalies (758.8)
   Conditions due to sex chromosome anomalies, (758.81) not including Klinefelter’s Syndrome (XXY) or Turner’s syndrome (XO)
      Conditions due to anomaly of unspecified chromosome (758.9) (includes Williams Syndrome)

B. Pre-natal exposures
   Fetal alcohol syndrome (760.71)
   Fetal hydantoin syndrome/Other (760.79)
      Narcotics exposure (760.72)
      Hallucinogenic agent exposure (760.73)
      Cocaine exposure (760.75)
      Anticonvulsant exposure (760.77)

C. Neurocutaneous Syndromes
   Congenital pigmented anomalies of the skin (757.33)
   Neurofibromatosis (237.7)
   Sturge-Weber syndrome (759.6)
   Tuberous sclerosis (759.5)
D. Inborn Error of Metabolism
    Disorders of amino-acid transport and metabolism (270.0)
    Phenylketonuria (PKU) (270.1)
    Maple Sugar Urine Disease (270.3)
    Disorder of Urea cycle metabolism (270.6)
      Disorders of Carbohydrate metabolism (271) General Category
        --Glycogenosis (271.0)
        --Galactosemia (271.1)
      Disorders of Lipid Metabolism (272) General Category
        --Lipidoses (272.7)
        --Other disorders of lipid metabolism (272.8)
        --Hunter’s and other mucopolysaccaridoses (277.5)

E. Cerebral degenerations of the central nervous system-- (330) General Category
    Leukodystrophy (330.0)
    Cerebral lipidoses such as TaySach’s (330.1)
    Cerebral degeneration in generalized lipidoses (330.2)
    (Code first underlying disease as 272.7):
      - Fabry’s disease
      - Gaucher’s disease
      - Niemann Pick
      - sphingolipidoses
    Other specified degenerations in childhood (330.8)
    Unspecified cerebral degenerations in childhood (330.9)

F. Prenatal Infections
    “TORCH” infections (771.0--771.2), including:
      --Congenital rubella (771.0)
      --Congenital cytomegalovirus infection (CMV) (771.1)
      --Congenital herpes simplex (771.2)
      --Congenital toxoplasmosis (771.2)

F. Other Syndromes
    --Chondrodystrophies (756.4)
    --Congenital anomalies of central nervous system (742.--General Category
      --Osteodystrophies (756.5)
      --Cerebral gigantism (253.0)
    --Other specified congenital anomalies(759.8-)
      --includes Beckwith Weidnerman Syndrome (758.89)
      --Cornelia de Lange Syndrome (759.8)
      -- others (759.89)

Sensory Impairment
    Vision--Impairment can be congenital or acquired (369—general category—more specific diagnosis obtained from physician):
--Profound impairment, both eyes (369.0-)
--Moderate or severe impairment, better eye, profound impairment lesser eye (369.1-)
--Moderate or severe impairment, both eyes (369.2-)
--Legal blindness, as defined in USA (369.4)
--Retrolental fibroplasia or retinopathy of prematurity
--ROP Stage 4 (362.26)
--ROP State 5 (362.27)
--Bilateral (362.21)
--Cortical Blindness (377.75)

Hearing-- Hearing impairment (25dB loss or greater) unilateral or bilateral (389)
General Category
--Conductive hearing loss (389.0)
--Sensorineural hearing loss (389.1)
--Mixed conductive and sensorineural hearing loss (389.2)
--Hearing loss unspecified (389.9)
--Central hearing loss (389.14)

Orthopedic and Neurological Disorders
Anoxic brain damage (348.1)
Anterior horn cell disease (335.--) General Category—obtain specific diagnosis
Arthrogryposis (728.3)
Injury to the Brachial plexus—birth trauma (767.6) Brachial plexus—post perinatal origin (953.4)
Cerebral cysts (348.0)

Cerebral palsy (all types) (343.-- General Category
--Infantile cerebral palsy (343)
--Diplegia (343.0)
--Hemiplegia (343.1)
--Quadriplegia (343.2)
--Monoplegia (343.3)
--Infantile hemiplegia (343.4)
--Other specified infantile cerebral palsy (343.8)
--Infantile cerebral palsy, unspecified (343.9)

Cleft hand (755.58)

Congenital anomalies of the central nervous system (742.-- General Category
--Encephalocele (742.0)
--Microcephaly (742.1)
--Congenital hydrocephaly (742.3)

Congenital anomalies of limbs (755) General Category
--Reduction of deformities of upper limb (755.2)
--Reduction of conformities of lower limbs (755.3)
--Reduction deformities, unspecified limb (755.4)

Other congenital musculoskeletal anomalies (756) General Category
--Anomalies of skull and face bone (756.0)
--Absence of vertebra, congenital (756.13)
--Osteogenesis imperfecta (756.51)

Cerebral degenerations usually manifest in childhood (330) General Category—Use additional code to identify associated mental disabilities
    Developmental apraxia of speech (784.69)
    Encephalopathy Not Otherwise Specified (348.30)
Fracture of vertebral column with spinal cord injury (806) General Category—include additional diagnosis from physician

Hemiplegia and hemiparesis (342.--) General Category
--flaccid hemiplegia (342.0)
--spastic hemiplegia (342.1)
--other specified hemiplegia (342.8)
--hemiplegia, unspecified (342.9)

Hereditary/degenerative diseases of the central nervous system
--Communicating hydrocephalus (331.3)
--Obstructive hydrocephalus (331.4)
--Cerebral degeneration in discrete classified elsewhere (331.7)—include underlying disease code
--Werdnig-Hoffman disease (335.0)

Infantile spasms (345.6)
    Intraventricular hemorrhage (IVH) - Grade 3 (772.13) & Grade 4 (773.14)

    Spina Bifida/Neural Tube Defect (741) General Category—include additional diagnosis
    --Meningomyelocele(741.9)
    -- Myelomeningocele(741.9)
    --Spina Bifida (741.9)
    --with hydrocephalus (741.0)

    Muscular dystrophies and other myopathies (359) General Category
    --Congenital hereditary muscular dystrophy (359.0)
    --Hereditary progressive muscular dystrophy (359.1)
    --Myotonic disorders (359.2)

Paralytic syndromes (344) General Category—include additional diagnosis
--Quadriplegia and quadripareisis (344.0)
--Paraplegia (344.1)
--Diplegia of upper limbs (344.2)
--Monoplegia of lower limb (344.3)
--Monoplegia of upper limb (344.4)
-- Unspecified monoplegia (344.5)

Spinal cord injury without evidence of spinal bone injury (952.--) General Category—include code for location of injury from physician diagnosis

--Occlusion of cerebral arteries or stroke (434) General Category
--cerebral thrombosis (434.0)
--cerebral embolism (434.1)
--unspecified occlusion (434.9)

Cerebral laceration and contusion or traumatic brain injury (851) General category—include additional diagnostic information

Social Emotional Disorders
   Childhood Depressive disorders, not elsewhere classified (311)
   Reactive attachment disorder (313.89)

Pervasive Developmental Disorders (299.--) General Category including:
   Asperger syndrome / disorder (299.8)
   Autism (299.0)
   Childhood disintegrative disorder (299.1)
   Unspecified pervasive developmental disorder-NOS (299.9)
   Other specified degeneration in childhood—Rett Syndrome (330.8)

Medically Related Disorders
   Congenital or infancy-onset hypothyroidism (243)
Cleft palate (749.00)—unspecified
   --unilateral, complete (749.01)
   --unilateral, incomplete (749.02)
   --bilateral, complete (749.13)
   --bilateral, incomplete (749.14)

Cleft palate with cleft lip (749.20)—unspecified
   --unilateral, complete (749.21)
   --unilateral, incomplete (749.22)
   --bilateral, complete (749.23)
   --bilateral, incomplete (749.24)

   Premature closure of the sutures and other anomalies of skull and face bone (756.0)
Toxic effects of lead and its compounds (including fumes) (984) General category
   --unspecified lead compound effects (984.9)

Non-organic failure to thrive (783.41)
Chronic respiratory failure or ventilator dependence (518.83)

Prematurity
Bronchopulmonary Dysplasia (BPD) (770.7)
Disorders relating to short gestation and low birth weight (765) General Category—include 5 digit code
--Other preterm infant’s birth weight of 1000-2499 grams (765.10)—unspecified weight—an EarlySteps eligibility criterion is <1500 grams at birth:
  --less than 500 grams (765.11)
  --500 to 749 grams (765.12)
  --750 to 999 grams (765.13)
  --1000 to 1249 grams (765.14)
  --1250 to 1499 grams (765.15)

--Weeks of gestation (765.20)—unspecified gestation—General Category—EarlySteps eligibility criteria is 32 weeks gestation or less
  --Less than 24 weeks of gestation (765.21)
  --24 complete weeks of gestation (765.22)
  --25-26 weeks of gestation (765.23)
  --27-28 weeks of gestation (765.24)
  --29-30 weeks of gestation (765.25)
  --31-32 weeks of gestation (765.26)
References


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Vita

Joshua John Montrenes, born in Pittsburgh, Pennsylvania, spent approximately 1 year administering treatment to individuals severely affected with autism spectrum disorder (ASD) as well as individuals with other mental health challenges (e.g., oppositional defiant disorder [ODD]) after receiving his bachelor’s degree from the University of Pittsburgh. Following this, he spent 2 years as a research assistant on an inpatient unit for individuals with ASD and other intellectual and developmental disabilities (IDDs). In this position, he developed a behavioral coding system as a part of a structured research paradigm which collected physiological data. He additionally administered IQ tests to severely affected individuals with ASD at this time. He plans to receive his master’s degree in May of 2021. Following the completion of his master’s degree, he plans to pursue his doctorate.