

DISSERTATION

DEVELOPMENTAL TRAJECTORIES OF ADAPTIVE BEHAVIOR
IN AUTISM SPECTRUM DISORDER AND DOWN SYNDROME

Submitted by

Brianne Gerlach-McDonald

Department of Human Development and Family Studies

In partial fulfillment of the requirements

For the Degree of Doctor of Philosophy

Colorado State University

Fort Collins, Colorado

Summer 2017

Doctoral Committee:

Advisor: Susan Hepburn

Co-Advisor: Deborah Fidler

Lisa Daunhauer

Nathaniel Riggs

Pat Sample

Copyright by Brianne Gerlach-McDonald 2017

All Rights Reserved

ABSTRACT

DEVELOPMENTAL TRAJECTORIES OF ADAPTIVE BEHAVIOR IN AUTISM SPECTRUM DISORDER AND DOWN SYNDROME

The increasing prevalence of developmental disabilities indicates a need for research and interventions for these populations. One growing area of interest is *adaptive behavior* or the functional skills individuals perform in their everyday lives, such as communication and daily living skills. Individuals with developmental disabilities with greater adaptive behavior skills experience a better quality of life in childhood and achieve better functional outcomes in adulthood (e.g., living independently). However, more research is needed to understand how adaptive behavior develops in childhood to identify critical time points for targeted interventions. The current study examined developmental trajectories of adaptive behavior across childhood in two developmental disabilities: Autism Spectrum Disorder (ASD) and Down syndrome (DS). This study examined secondary data obtained from a longitudinal study conducted at the University of Colorado Health Sciences Center between 1997 and 2007.

The aim of this dissertation was to examine the extent to which individual differences in diagnostic status, maternal education, intellectual functioning, executive function, and autism symptoms predicted developmental trajectories of adaptive behavior. Examination of the predictors of developmental trajectories of adaptive behavior provided information regarding potential intervention targets to promote optimal adaptive behavior. This study used growth modeling techniques to compare two developmental disabilities.

Participants included 77 children with ASD and 24 children with DS who were assessed in toddlerhood (ages 1-3 years), preschool (ages 4-6), and during the school years (ages 7-10).

Parents completed a demographic questionnaire and interviews of adaptive behavior (Vineland Adaptive Behavior Scales; Sparrow, Balla, & Cicchetti, 1984), and autism symptoms (Autism Diagnostic Interview-Revised; Lord, Rutter, & LeCouteur, 1994). Child participants completed standardized developmental testing (Mullens Scales of Early Learning; Mullen, 1995), an executive function task measuring cognitive flexibility and working memory (Spatial Reversal; Kaufmann, Leckman, & Ort, 1989), and a semi-structured play-based assessment of autism symptoms (Autism Diagnostic Observation Schedule; Lord, Rutter, DiLavore, & Risi, 1999).

Growth models were specified for developmental trajectories of communication, daily living skills, and socialization as measured by the Vineland Adaptive Behavior Scales. Diagnostic status, maternal education, intellectual functioning, executive function, and autism symptoms were added as predictors. Children with ASD and DS made gains in their adaptive behavior skills from toddlerhood to middle childhood but had significantly delayed scores compared to children in the standardization sample. The best fitting models of communication and socialization indicated significant linear and quadratic growth, and the best fitting model of daily living skills indicated significant linear growth. Diagnostic status was a significant predictor of initial starting states of communication and socialization in toddlerhood, but not daily living skills. Diagnostic status was a significant predictor of linear and quadratic slopes of communication. Maternal education was a significant predictor of initial starting states of socialization in toddlerhood in both groups. Mental age in toddlerhood was a significant predictor of initial starting states in toddlerhood for communication, daily living skills, and socialization in both groups. Mental age was a significant predictor of linear slopes of communication, daily living skills, and socialization, and quadratic slopes for communication and socialization in both groups. These findings provide implications for intervention; many

existing manualized early intervention treatments do not explicitly target adaptive behavior.

Implications for available programs are discussed, followed by recommendations for targeting adaptive behavior and expanding research efforts to promote these skills in children with ASD and DS.

ACKNOWLEDGMENTS

The completion of this dissertation would not have been possible without the support and guidance from several people. First, I would like to thank my dissertation advisor, Dr. Susan Hepburn, who has provided a tremendous amount of time and advice throughout the duration of this project. Thank you for your generosity and the opportunity to be a part of this project, as well as the incredible opportunity to attend the statistics workshop. Your expertise and breadth of knowledge in this field have been an inspiration and an incredible introduction to expanding my research to include autism. Finally, thank you for your insightful feedback and careful reading of my dissertation.

I owe an incredible amount of gratitude to my committee members. To Dr. Deborah Fidler, thank you for your guidance and continued interest in the developmental trajectory of my career throughout graduate school. I have so much appreciation for my involvement in the projects for the past four years. My experience in the adult education program truly shaped my research interests. To Dr. Lisa Daunhauer, thank you for your support, belief, and mentorship throughout graduate school, including my master's thesis, teaching, and my first grant application, as well as much more. To Dr. Nathaniel Riggs, thank you so much for your time providing feedback on my competencies and drafts of my dissertation, answering questions, and your support during my time in the program. To Dr. Patricia Sample, thank you for providing helpful feedback and your thoughtful questions.

Thank you to the National Institute of Child Health and Human Development grant, The Collaborative Programs of Excellence in Autism (HD3S468), for funding this project. In addition, I would like to thank the Global Down syndrome Foundation, the National Institute on

Disability, Independent Living, and Rehabilitation Research, and the Institute of Education Sciences for supporting my involvement in additional research projects and having the opportunities to attend additional workshops and conferences.

I would also like to thank the HDFS faculty and staff that have supported me along the way. Thank you to Dr. Dave MacPhee, Dr. Doug Coatsworth, and Dr. Lise Youngblade, for listening, answering my questions, and encouraging my future career goals. To Dr. Erika Lunkenheimer and Dr. Mary Khetani, for supporting my development as an academic scientist, providing letters of recommendation, and being role models for research. To Dr. Manfred Diehl, for inspiring my passion for learning advanced statistical methods. To Dr. Ashely Harvey, for being an incredible teaching mentor and for your openness to exchange ideas, truly changing my teaching philosophy. To all my committee members and HDFS faculty, for being exceptional role models in academia.

To Foothills Gateway and Cynthia Hansford, thank you for letting me continue to work as a direct support professional with my incredibly complex and always changing schedule. My time at Foothills Gateway allowed me to complete graduate school and my dissertation. I am so thankful for my time with the children, adults, and their families. It kept me motivated and provided a sense of purpose when I needed it.

Finally, to my peers and friends in HDFS, friends in Colorado and Michigan, and my family, I owe you all so much for supporting me throughout the entirety of graduate school. Through every single milestone or setback, you listened, encouraged me, and most importantly, believed in me every step of the way. There aren't enough words to truly express my gratefulness for each one of you.

DEDICATION

For all the children, adults, and families, I have had the opportunity of supporting.

TABLE OF CONTENTS

ABSTRACT	ii
ACKNOWLEDGEMENTS.....	v
DEDICATION.....	vii
LIST OF TABLES	ix
LIST OF FIGURES	x
CHAPTER 1- INTRODUCTION AND LITERATURE REVIEW.....	1
CHAPTER 2- METHODS	24
CHAPTER 3- RESULTS	40
CHAPTER 4-DISCUSSION.....	58
REFERENCES	87
APPENDIX A- ADAPTIVE BEHAVIOR DEVELOPMENTAL EXPECTATIONS IN INFANCY AND TODDLERHOOD	121

LIST OF TABLES

TABLE 1- PARTICIPANT CHARACTERISTICS 36

TABLE 2- DESCRIPTIVE STATISTICS 48

TABLE 3- ADAPTIVE BEHAVIOR LEVEL PERCENTAGES OF INDIVIDUALS WITH
ASD AND DS ACROSS TODDLERHOOD, PRESCHOOL, AND IN THE SCHOOL-AGED
YEARS 49

TABLE 4- PARAMETER ESTIMATES FOR GROWTH MODELS OF COMMUNICATION,
DAILY LIVING SKILLS, AND SOCIALIZATION 51

TABLE 5- EVIDENCE BASED-PRACTICES RELATED TO ADAPTIVE BEHAVIOR 83

TABLE 6-OVERVIEW OF EARLY INTERVENTION PROGRAMS AND ADAPTIVE
BEHAVIOR OUTCOMES 85

LIST OF FIGURES

FIGURE 1- FLOW CHART OF INCLUSION AND MISSING DATA FOR THE SAMPLE ..	35
FIGURE 2- PATH DIAGRAM OF THE HYPOTHESIZED MULTIPLE GROUP LINEAR GROWTH MODEL OF ADAPTIVE BEHAVIOR.....	37
FIGURE 3- PATH DIAGRAM OF THE HYPOTHESIZED LINEAR GROWTH MODEL OF ADAPTIVE BEHAVIOR OVER THREE TIME POINTS WITH TIME-INVARIANT COVARIATES OF DIAGNOSTIC STATUS, EXECUTIVE FUNCTION, MENTAL AGE, MATERNAL EDUCATION, AND AUTISM SYMPTOMS.....	38
FIGURE 4- PATH DIAGRAM OF THE HYPOTHESIZED TIME-VARYING COVARIATE LINEAR GROWTH MODEL EXAMINING INTERRELATIONSHIPS OF ADAPTIVE BEHAVIOR AND AUTISM SYMPTOMS OVER THREE TIME POINTS.....	39
FIGURE 5- ADAPTIVE BEHAVIOR PROFILES IN AUTISM SPECTRUM DISORDER AND DOWN SYNDROME FROM TODDLERHOOD TO MIDDLE CHILDHOOD IN COMMUNICATION, DAILY LIVING SKILLS, AND SOCIALIZATION STANDARD SCORES AS MEASURED BY THE VINELAND ADAPTIVE BEHAVIOR SCALES	50
FIGURE 6- INDIVIDUAL DEVELOPMENTAL TRAJECTORIES OF COMMUNICATION RAW SCORES AS MEASURED BY THE VINELAND ADAPTIVE BEHAVIOR SCALES IN CHILDREN WITH AUTISM SPECTRUM DISORDER AND DOWN SYNDROME	52

FIGURE 7- COMMUNICATION QUADRATIC GROWTH MODEL WITH TIME-
INVARYING PREDICTORS OF DIAGNOSTIC STATUS, EXECUTIVE FUNCTION, AND
EXECUTIVE FUNCTION53

FIGURE 8- INDIVIDUAL DEVELOPMENTAL TRAJECTORIES OF DAILY LIVING
SKILLS RAW SCORES AS MEASURED BY THE VINELAND ADAPTIVE BEHAVIOR
SCALES IN CHILDREN WITH AUTISM SPECTRUM DISORDER AND DOWN
SYNDROME.....54

FIGURE 9- DAILY LIVING SKILLS LINEAR GROWTH MODEL WITH TIME-
INVARYING PREDICTORS OF DIAGNOSTIC STATUS, EXECUTIVE FUNCTION,
MENTAL AGE, MATERNAL EDUCATION, AND AUTISM SYMPTOMS 55

FIGURE 10- INDIVIDUAL DEVELOPMENTAL TRAJECTORIES OF SOCIALIZATION
RAW SCORES AS MEASURED BY THE VINELAND ADAPTIVE BEHAVIOR SCALES IN
CHILDREN WITH AUTISM SPECTRUM DISORDER AND DOWN SYNDROME56

FIGURE 11- SOCIALIZATION QUADRATIC GROWTH MODEL WITH TIME-
INVARYING PREDICTORS OF DIAGNOSTIC STATUS, MENTAL AGE, AND
MATERNAL EDUCATION.....57

CHAPTER 1.

Introduction and Literature Review

Development occurs through dynamic interactions among behavioral domains within an individual, including biological, psychological, and environmental factors. The interrelationships among factors influence developmental outcomes across the lifespan (Ford & Lerner, 1992; Granic, 2005; Gottlieb, 1992; Thelen & Smith, 2006). Some factors have the potential to constrain development, such as the presence of a developmental disability (Fidler, Hahn, & Lunkenheimer, 2011; Karmiloff-Smith & Thomas, 2003). According to 2006-2008 census records, approximately one out of every six children in the United States has a developmental disability. The prevalence of developmental disabilities has increased by 17.1% since the 1990s (Boyle et al., 2011). Developmental disabilities are defined by the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) as a group of conditions that include impairments in academic, social, and functional skills that begin during the developmental period, and persist throughout an individual's lifetime. (American Psychiatric Association[APA], 2013). Functional impairments are often described as delays in adaptive behavior. The term *adaptive behavior* is commonly used to describe an individual's functional skills within developmentally appropriate, everyday activities; including conceptual, social, and practical skills (American Association of Intellectual and Developmental Disabilities [AAIDD], 2013). These skills include communication (e.g., understanding and expressing language), daily living skills (e.g., hygiene and household chores), socialization (e.g., forming relationships and coping), and motor skills(e.g., going up and down the stairs or using scissors) (AAIDD, 2013; Sparrow, Balla, & Cicchetti, 1984;2005). During childhood, adaptive behavior is considered critical to performing tasks independently and is associated with quality of life (Gardiner & Iarocci, 2015; Tasse et al.,

2012). In adults with developmental disabilities, better adaptive skills are associated with greater opportunities for employment and increased independence in residential settings (Farley et al., 2009; Foley et al., 2013; Woolf, Woolf, & Oakland, 2010).

Adaptive behavior is a component of diagnosis of intellectual disability (AAIDD,2013; APA, 2013). Recent research also suggests that children who have intact general intellectual functioning and present with Autism Spectrum Disorder, Attention Deficit Hyperactivity Disorder(ADHD), and other behavioral, emotional, and/or learning disorders also tend to show impairments in adaptive behavior (Ditterline & Oakland, 2009). Therefore, adaptive behavior is a significant area for establishing goals in clinical, home, and school settings for individuals with a variety of developmental disabilities (Tasse et al., 2012).

More longitudinal research is needed to understand how adaptive behavior changes over time in children with developmental disabilities. This information is necessary in order to develop tailored interventions that will promote meaningful change. The aim of this dissertation was to examine developmental trajectories of adaptive behavior within a dynamic systems framework in two developmental disabilities: Autism Spectrum Disorder (ASD) and Down syndrome (DS). A dynamic systems framework attempts to understand the underlying mechanisms of how behaviors at one point in time are influenced by previous behaviors and how they may predict future behaviors (Karmiloff-Smith, 2011). This dissertation contributes to the growing literature on developmental trajectories of adaptive behavior from toddlerhood to middle childhood in Autism Spectrum Disorder(ASD) and adds a comparison of these trajectories to another developmental disability, Down syndrome (DS).

This chapter includes four sections: First, an overview of dynamic systems theory is presented and describes how dynamic systems theory extends longitudinal research to examine

differences within and between developmental disabilities. Then, a detailed review of the literature regarding what is known about ASD and DS is presented next, including the development and predictors of adaptive behavior. Next, the application of dynamic systems theory to studying adaptive behavior is discussed. Finally, this introductory and literature review chapter concludes with a list of research questions and hypotheses that are addressed empirically in Chapters 2 and 3.

Overview of Dynamic Systems Theory

Dynamic systems theory views development as a continuous process involving a self-organizing developmental system (Granic, 2005; Thelen & Smith, 2006). *Self-organization* refers to the “pattern and order [that] emerge from interactions of the components of a complex system without explicit instructions, either in the organism itself or from the environment” (Thelen & Smith, 2006, p. 295). The pattern and order produced within an individual over time is due to the dynamic relationship between genes, the environment, and constraints on the process of self-organization (Thelen & Smith, 2006). Many components constitute behaviors that self-organize within this complex system. For example, components of a requesting behavior (such as appealing to a caregiver for a preferred toy) include pointing to the object and making eye contact with a caregiver. Components have the potential to combine in infinite ways to form behavioral patterns underlying critical developmental skills, such as expressive or receptive language. The formation of patterns becomes increasingly complex over time with the potential for changes and reformation. (Thelen & Smith, 2006).

Patterns that emerge in individuals with specific neurogenetic syndromes have been referred to as a *behavioral phenotype*, or patterns of relative strength and challenge to a specific diagnosis or a genotype (Hodapp & Dykens, 1994; 2012). Behavioral phenotypes self-organize

over time as the result of interactions among genetic, neurodevelopmental, behavioral, and environmental factors. Behavioral phenotypes are probabilistic, in that individuals with a specific diagnosis, such as DS, are more likely to experience a specific behavioral pattern of strengths and challenges, such as difficulties with expressive language and receptive language (Fidler, Most, & Philofsky, 2009); however, there is considerable variability within diagnostic groups. Across individuals diagnosed with the same developmental disabilities, not all individuals will experience the same patterns of self-organization (Hodapp & Dykens, 1994;2012).

The initial behavior pattern preference is called a *starting state* (Thelen & Smith, 2006). Starting states can be viewed as the foundation of behavioral patterns that will lead to later developmental outcomes. Small initial differences in behavior outcomes in early childhood may lead to more pronounced differences in later childhood (Fidler et al., 2011; Karmiloff-Smith, 1998). For example, starting states of expressive language include smiling in response to caregivers in typically developing infants (See Appendix A for developmental expectations of adaptive behavior in infancy and toddlerhood). Following the starting state, development is examined as a series of patterns changing and dissolving over time (Thelen & Smith, 2006). The challenges that emerge as starting states in early development have the potential to cascade into more distinct difficulties over time (Fidler et al., 2011). For example, a toddler with ASD may have delays in his/her ability to request objects that lead to difficulties in communication and socialization during the school-age years. Therefore, identification of starting states and influences on developmental trajectories are critical to developing interventions.

Dynamic systems research focuses on identifying possible developmental trajectories of behavioral outcomes that follow starting states, with the incorporation of external and internal factors. Rather than focusing on one aspect of a system, including the relationship of gene and

behavior, dynamic systems theory considers the entire system, such as the interrelationships among individual, between-person, and environmental factors (Thelen & Smith, 2006). A genetic variation associated with developmental disabilities (e.g., a deletion or trisomy), is considered a constraint that influences developmental outcomes (Fidler et al., 2011; Thelen & Smith, 2006).

Multilevel models that incorporate an individual's genetic factors, such as a specific genetic diagnosis, behavioral factors, such as cognitive development and adaptive behavior, and environmental factors, such as maternal education, are critical to fully understand developmental processes (Fidler et al., 2011). Within an individual, developmental processes vary in strength over time depending on both internal and external factors. In people with developmental disabilities, behavioral states at specific points in time are important to recognize as dynamic and modifiable (Thelen & Smith, 2006). During early childhood, certain aspects of behavioral profiles may be less pronounced, providing the potential for targeted interventions.

Comparing behavioral development in one developmental disability to another can provide information for researchers, providers, and parents regarding patterns of strength and challenge unique to specific diagnoses. Knowledge of the differences in behavioral phenotypes over time provides information regarding critical time points for intervening (Karmiloff-Smith, 2011). For example, if young children with ASD do not gain skills as quickly during preschool than their typically developing peers, interventions may focus on targeting these skills in preschoolers with ASD. Knowledge of the differences in behavioral phenotypes over time provides information regarding critical time points for intervening (Karmiloff-Smith, 2011). In sum, dynamic systems theory involves the examination of self-organization processes by

studying behavioral profiles and starting states to inform the development of targeted interventions.

Overview of Autism Spectrum Disorder and Down syndrome

Autism Spectrum Disorder

ASD is defined by the DSM-5 as a lifelong developmental disorder characterized by “persistent deficits in social communication and social interaction across contexts” and “restricted, repetitive patterns of behaviors, interests, or activities” (APA, 2013, p. 40). Deficits in social communication and social interactions encompass difficulties in social-emotional reciprocity, nonverbal communication behaviors, and interpersonal relationships. Restricted and repetitive patterns of behavior include stereotyped or repetitive motor movements, inflexibility in routines and difficulties with transitions, restricted and repetitive interests, and sensory impairments. A diagnosis of ASD requires that symptoms: are present in early childhood, cause significant clinical impairments in functional areas, and are not better explained by intellectual disability or global developmental delays (APA, 2013). There is wide variability in diagnostic characteristics in individuals with ASD, including the specific symptoms demonstrated by an individual, when and how the symptoms emerge, the duration of symptoms, and which areas of functioning are impacted (Volkmar, Lord, Bailey, Schultz, & Klin, 2004; Wozniak, Leezenbaum, Northrup, West, & Iverson, 2016).

Prevalence. Approximately 14.6 per 1,000 children are thought to be at risk for ASD (Christensen et al., 2016). Thus, surveillance studies suggest that the estimated prevalence of ASD has increased from 1 in 150 in 2000 to 1 in 68 children in 2012 (Christensen et al., 2016). ASD is reported in all socioeconomic, racial, and ethnic groups, although prevalence is

significantly higher for non-Hispanic white individuals (15.5 per 1,000) than non-Hispanic black (13.2 per 1,000) or Hispanic individuals (10.1 per 1,000) (Christensen et al., 2016). The differences in ethnic groups are possibly reflective of problems with equitable access to care rather than an increased risk of ASD (Christensen et al., 2016; Mandell et al., 2009). The median age of diagnosis in the United States is 3 years, 4 months of age, although studies report that a valid and stable diagnosis of ASD can be achieved as early as 18 months- 2 years of age (Center for Disease Control[CDC], 2016a). Parents usually report developmental concerns and differences within the first year of life; however, it is difficult to distinguish these concerns from the variable skills demonstrated by many typically developing infants (Ozonoff et al., 2011). In a longitudinal study of infant siblings with ASD, differences in social communication and fine motor skills were evident by six months of age for a subset of children who were later diagnosed with ASD (Bolton et al., 2012).

Behavioral phenotype. Variability of autism symptoms is associated with differences in intellectual functioning, language, and adaptive behavior. Georgiades and colleagues (2013) identified three distinct subgroups in preschoolers with ASD displaying different levels of social and communication deficits and fixated interests and repetitive behavior. Only two subgroups were identified at age six in a follow-up study, suggesting that phenotypic variability changes over time (Georgiades et al., 2013; 2014). ASD is considered to be a lifelong condition; however, the specific symptoms change qualitatively across development. Factors influencing ASD symptoms across the lifespan include intellectual functioning, gender, and language abilities (Billstedt et al., 2007). Extant research examining autism symptoms from early childhood to adulthood suggest that parents reported more severe autism symptoms in early childhood than in adolescence and adulthood (Billstedt, Gillberg, & Gillberg, 2007; Taylor & Selzer, 2010).

Billstedt and colleagues (2007) reported that adults with ASD were less likely to have severe communication impairments, such as echolalia (i.e., repetition of speech), than younger individuals with the condition. Between individuals with ASD, social interaction impairments were more similar than maladaptive and stereotyped behaviors, which were more variable (Billstedt et al., 2007).

Another important source of within-group variability is intellectual functioning. Approximately 44% of children with ASD have an average to high IQ (Christensen et al., 2016; Pugliese et al., 2016). Variability in intellectual functioning appears to be present in early childhood. Munson and colleagues (2008) identified subgroups of children ages 2-5 based on their developmental quotient scores (i.e., average of age equivalents across domains tested, divided by chronological age). Four subgroups were identified that varied on their nonverbal and verbal abilities (Munson et al., 2008). Variability in intellectual functioning was associated with differences in age, autism symptoms, and adaptive behavior in younger children (Munson et al., 2008). Eagle, Romanczky, and Lenszenweger(2010) identified two subgroups of intellectual functioning in a sample of 2-12 years olds with ASD. Membership in the low vs. high intellectual functioning subgroups was not associated with age or autism symptoms but was associated with differences in receptive language and social skills (Eagle, Romanczky, & Lenszenweger, 2010). These findings suggest that variability in autism symptoms and intellectual functioning is present throughout the lifespan, phenotypic variability changes over time, and variability leads to differences in outcomes.

Co-occurring conditions. In addition to variability in autism symptoms and intellectual functioning, children with ASD often have co-occurring medical, psychiatric, and developmental conditions. In a population-based study of 8-year-olds with ASD, Levy and colleagues (2010)

reported that 83% of the sample had at least one co-occurring condition that was considered a developmental disability, (e.g., language or intellectual disability, or ADHD). In addition, 15.7 % had a diagnosis of a neurologic disorder (e.g., epilepsy, encephalopathy, or cerebral palsy); 10% had a diagnosis of a psychiatric diagnosis (e.g., oppositional defiant disorder or anxiety), and 3.7% presented with a genetic condition associated with intellectual impairment (e.g., DS, Fragile X syndrome) (Levy et al., 2010). Other studies report co-occurring chromosomal or genetic disorders ranging from 8.3% to 40% (Abdul-Rahman & Hudgins, 2006; Freitag, 2007; Levy et al., 2010). Billstedt and colleagues (2007) suggest that a co-occurring condition may complicate a diagnosis of ASD and impact future outcomes. Individuals with ASD with co-occurring medical disorders, such as epilepsy, have more difficulties with social interaction and communication during adulthood than individuals with ASD without co-occurring medical disorders (Billstedt et al., 2007).

Adaptive behavior in ASD. Children with ASD who have IQs in the average to above-average range (i.e., “high-functioning” ASD) often demonstrate unexpected difficulties in adaptive behavior (Kanne et al., 2011; Kenworthy et al., 2010; Klin et al., 2007; Pugliese et al., 2015). Much of the research examining adaptive behavior in ASD has been cross-sectional, while some longitudinal research has been conducted in individuals with high-functioning ASD (Kanne et al., 2011; Pugliese et al., 2016). In a cross-sectional study with a large sample of children ages 4-17 with high functioning ASD, the greatest delays were observed on socialization skills, while moderate delays were observed on communication and daily living skills. Age was negatively associated with standard scores on adaptive behavior measures suggesting that individuals with ASD are not acquiring skills at the same rate as their typically developing peers (Kanne et al., 2011). Klin et al. (2007) reported socialization and

communication deficits in children ages 7-18 with high functioning ASD. Age and adaptive behavior standard scores were negatively correlated (Klin et al., 2007), suggesting that the gap between developmental expectations and mastery of adaptive skills widens across development. In high functioning individuals with ASD ages 4-23, Pugliese et al. (2015) also found a negative association between age and standard scores on adaptive behavior. In individuals 12-22 with high functioning ASD, parents and caregivers reported global adaptive behavior delays, with more prominent delays in socialization skills. Age was not significantly associated with adaptive behavior in this study (Kenworthy et al., 2010). Taken together, the research provides support for adaptive behavior delays from middle childhood to early adulthood, and, in particular, a socialization delay.

Many studies report a negative association between chronological age and adaptive behavior except for the Kenworthy et al. (2010) study, which did not include any children under 12 years. Szatmari et al. (2009) examined developmental trajectories of individuals with ASD spectrum disorder from early childhood through adolescence. They found that adaptive behavior skills increased from ages 2 to 17 and then tended to plateau (Szatmari et al., 2009). These findings suggest that adaptive behavior skills are not developing at the same pace for children with ASD as compared to typically developing peers of the same chronological age; however, during adolescence, adaptive skills may reach a plateau for youth with ASD (Kenworthy et al., 2010; Szatmari et al., 2009). It is important to note that these studies are cross-sectional and longitudinal studies are needed to explore adaptive behavior growth or stability over time, particularly during the preadolescence years.

Longitudinal studies show increases in daily living skills across the lifespan (Baghdadli et al., 2011; Green & Carter, 2014; Smith, Maenner, & Seltzer, 2012). Baghdadli and colleagues

(2011) examined developmental trajectories of adaptive skills from childhood to adolescence in children with ASD with variability in intellectual functioning. Children were, on average, 5 years old at Time 1, 8 years old at Time 2, and 15 years old at Time 3. Parents reported relative strengths and increases in daily living skills across all three time points compared to communication and socialization skills, although their age equivalent scores were still below expectations for their chronological ages. The age equivalent daily living scores were higher than their communication and socialization age equivalent scores, but these scores also showed growth across the three time points. The identified trajectory of daily living skills suggested that children with ASD make gains in daily living skills as they get older. In addition, children with poorer adaptive behavior trajectories in socialization and communication were more likely to show intellectual impairment and more severe autism symptoms (Baghdadli et al., 2011).

In toddlers with ASD, Green and Carter (2014) reported that daily living skills raw scores increased over time; however, this growth in daily living skills was smaller when compared to typically developing toddlers and smaller when compared to toddlers with intellectual disabilities indicated by a decrease in standard scores over time (Green & Carter, 2014). Similarly, Pugliese et al. (2016) examined adaptive behavior over time in individuals ages 4-23 and found that daily living standard scores declined over time (Pugliese et al., 2016). In adolescents and adults with ASD, daily living skills improved during early adolescence and early adulthood but declined in the 30s. Individuals with ASD with lower IQ scores had smaller rates of change in daily living skills over time but showed similar trajectories to individuals with ASD without intellectual disability (Smith et al., 2012). Therefore, existing research suggests that although daily living skills tend to increase over time as noted by increases in raw scores, standard scores tend to

decrease, suggesting that individuals with ASD have adaptive behavior delays compared to their typically developing peers.

There are some limitations to the previous research in this area that need to be considered. Few studies included comparison groups. Participant attrition exceeded 50% in the Baghdadli et al., (2011) study, and little information was shared about participants' experience in intervention. In addition, this study was conducted in France, where the predominant conceptualization of ASD is psychodynamic. Thus these findings may not be generalizable to cultures who view the condition as neurobiological in nature. More research across cultures is warranted to examine developmental trajectories in adaptive behaviors including replication in toddlerhood, examination of toddlers with varying levels of intellectual functioning, and the inclusion of comparison groups.

Predictors of adaptive behavior in ASD. Studies report that a variety of cognitive skills predict adaptive behavior in people with ASD. General intellectual functioning (i.e, IQ) is usually an important predictor of adaptive behavior in childhood and adolescence (Bagdhali et al., 2011; Kanne et al., 2011; Flanagan et al., 2015), although this association does not appear to hold for individuals with high functioning ASD (Munson et al., 2008). It may be that intellectual functioning emerges as a significant predictor of adaptive behavior in later childhood. However, the influence of intellectual functioning in toddlerhood to later adaptive behavior outcomes in preschool and middle childhood has not been examined, as the youngest participants in longitudinal studies have been five years old (Baghdadli et al., 2011).

Another area of interest that may influence adaptive behavior is executive function. Executive function is an umbrella term for complex cognitive processes involved in goal-directed behavior (Garon, Bryson, & Smith, 2008; Pennington & Ozonoff, 1996; Zelazo &

Müller, 2011). In typically developing children, executive function is thought to be critical for the development of several important functional life skills including school readiness, academic achievement, social skills, and health outcomes (Best, Millar, & Naglieri, 2011; Blair & Razza, 2007; Fitzpatrick, McKinnon, Blair, & Willoughby, 2014; Fuhs et al., 2014; LeFevre et al., 2013; Viterbori et al., 2015). Research suggests that executive function domains develop at different rates across childhood and adolescence in the general population (for a review see Best, Millar, & Jones, 2010; Carriedo, Corral, Montoro, Herrero, & Rucián, 2016; Clark et al., 2013; Dajani & Uddin, 2015). Inhibitory control and cognitive flexibility develop rapidly during 3-4 years of age. Inhibitory control continues to mature through mid-childhood while cognitive flexibility improves more slowly through adolescence (Clark et al., 2013). Working memory improves during adolescence (Gur et al., 2012). It is hypothesized that the development of executive functions across childhood corresponds with the development of adaptive behavior. Both executive functions and adaptive behaviors mature rapidly during childhood and adolescence (Tarizi, Mahone, & Zabel, 2007).

The executive dysfunction hypothesis in ASD suggests that EF deficits underlie repetitive behaviors and cognitive inflexibility noted in persons with ASD with and without intellectual disability (Hill, 2004). Historically, evidence for the executive dysfunction hypothesis was found in older children and adults with ASD (Ozonoff, South, & Provençal, 2007). Yet, many studies have found no differences between younger children with ASD and children who are typically developing, suggesting that executive function deficits do not emerge until later childhood (Griffith, Pennington, Wehner, & Rogers, 1999; Ozonoff et al., 2007; Yerys, Hepburn, Pennington, & Rogers, 2007).

Studies have also shown that executive function is a significant predictor of adaptive behavior in children with ASD (Gilotty et al., 2002; Pugliese et al., 2015;2016). Gilotty and colleagues (2002) examined the relationship between executive function skills as measured by parent-report using the Behavior Rating Inventory of Executive Function (BRIEF; Gioia, Isquith, Guy, & Kenworthy, 2000) and adaptive skills using the Vineland Adaptive Behavior Scales (VABS; Sparrow, Balla, & Cicchetti, 1984) in children with ASD ages 6-17. The authors found that impairments in executive function strongly correlated with deficits in communication and socialization (Gilotty et al., 2002). In children with high functioning ASD ages 4-23, Pugliese and colleagues (2015) found that parent-reported executive functions were associated with adaptive behavior. Specifically, parent-reported difficulties in initiation were associated with poorer adaptive behavior scores. Parent-reported difficulties in working memory were associated with poorer communication and daily living skills scores. Pugliese et al. (2015) also reported that difficulties organizing materials significantly predicted poorer daily living scores and cognitive flexibility difficulties predicted poorer socialization scores (Pugliese et al., 2015).

In a longitudinal study, executive function difficulties were associated with poorer daily living skills and socialization, but not communication. Specifically, self-monitoring difficulties were associated with poorer adaptive behaviors. Inhibitory control difficulties were associated with poorer daily living skills and socialization skills (Puglise et al., 2016). Pugliese et al. (2016) replicated their previous cross-sectional findings and provided evidence that cognitive flexibility difficulties were associated with poorer socialization. Pugliese et al. (2016) suggest that further research is necessary to examine developmental trajectories of adaptive behavior in individuals with ASD.

Studies show mixed findings for the relationship between autism symptoms and adaptive behavior. While some studies reported non-significant findings or weak associations in individuals with high functioning ASD ages 7-18 years (Klin et al., 2007; Saulnier & Klin, 2007), other studies reported negative associations between autism symptoms and adaptive behavior skills in children with varying levels of intellectual functioning ages 2-22 years. Kim and colleagues (2016) identified four subgroups of toddlers with ASD who displayed variability across autism symptoms and adaptive behavior with three subgroups making gains in communication during toddlerhood; however, the fourth subgroup, which included children with the most significant impairments in intellectual functioning and adaptive behavior at intake, did not make adaptive behavior gains despite receiving the most amount of interventions (Kim et al., 2016). Similar findings are reported in studies of preschoolers and early elementary-aged children with ASD, where more severe autism symptoms were associated with poorer adaptive behavior skills (Perry et al., 2009). McDonald and colleagues (2015) reported that higher levels of repetitive and restricted ASD symptoms were associated with poorer adaptive behavior skills. Two studies have reported negative associations between social and communication symptoms and adaptive behavior skills (Kanne et al., 2011; Kenworthy et al., 2010). These conflicting findings may be due to the various age ranges, the inclusion of children with varying levels of intellectual functioning, and measurement differences of autism symptoms. Studies used parent-report and clinical observation methods of measuring autism symptoms. For studies using parent-report measures of autism symptoms using the ADI-R (Kanne et al., 2011; McDonald et al., 2015), an association with the parent-report measure of adaptive behavior may be expected. However, studies using clinical observation using the ADOS reported conflicting results (Kim et

al., 2016; Klin et al., 2007; Kenworthy et al., 2010). Therefore, the relationship between autism symptoms and adaptive behavior warrants further exploration of these associations over time.

In addition to individual child factors, environmental factors may influence adaptive behavior outcomes, such as maternal education. Maternal education is identified as an important predictor of child outcomes in the general child literature (Carneiro, Meghir, & Parey, 2012). Less maternal education has been associated with lower language skills from toddlerhood to middle childhood in children born prematurely (Luu et al., 2009; Potijk, Kerstjens, Bos, Reijnevald, & de Winter, 2011). In a study examining early intervention outcomes in toddlers ages 15-38 months with ASD, higher maternal education was associated with greater cognitive gains (Itzchak & Zacor, 2011). Maternal education has not been associated with differential growth in adaptive skills within many different samples of children (e.g., infants and toddlers born prematurely, school-aged typically developing children, and school-aged children with ASD) (De Battista et al., 2016; Bornstein, Hahn, & Suwalsky, 2013; Pugliese et al., 2015). Nevertheless, this relationship has not been examined from early toddlerhood to middle childhood.

Down syndrome

Prevalence and Behavioral phenotype. DS is a chromosomal disorder associated with intellectual disability in which individuals have an extra chromosome on chromosome 21, or Trisomy 21, in 95% of cases. Mosaicism occurs when not all cells have the extra chromosome and translocation occurs when parts of chromosome 21 are relocated to another chromosome, typically chromosome 14 (CDC, 2016b). DS occurs in 8 individuals per 10,000 people in the United States in 2008 (Parker et al., 2010). Since 1979, the prevalence of DS has increased by 30% (Presson et al., 2013). The behavioral phenotype of individuals with Down syndrome (DS)

includes relative mental-age appropriate strengths in visuospatial processing, receptive language, and socialization (Daunhauer & Fidler, 2011; Daunhauer & Fidler, 2013; Fidler, 2005;2006).

Individuals with Down syndrome are also likely to show relative challenges in motor skills and expressive language (Fidler, 2006; Fidler, Hepburn, & Rogers, 2006; Fidler et al., 2005ab; Fidler et al., 2006).

Co-occurring conditions. Individuals with DS are more likely to have co-morbid health conditions than the typically developing population. About 50% of infants with Down syndrome are born with a congenital heart defect, which has later impacts on cognitive and behavioral outcomes (Visootsak et al., 2011). Individuals with DS are also more likely to have sleep problems, such as sleep apnea that may influence their adaptive behavior outcomes (Esbensen, 2016; Stores & Stores, 2012). Individuals with DS are more likely to have a hearing impairment, vision problems, celiac disease, hypothyroidism, and hypotonia, or low muscle tone (Bull & Committee on Genetics, 2011). Finally, individuals with DS are at a greater risk than typically developing children to have ASD (DiGuseppi et al.,2010).

Adaptive behavior in Down syndrome. In individuals with DS, a distinctive adaptive behavior profile of relative strengths and challenges emerges beginning in early childhood that suggests socialization and mobility as relative strengths and daily living skills and communication as relative challenges (Daunhauer, 2011). In toddlers with DS, a strength is reported in socialization relative to challenges in daily living skills and communication (Dykens et al., 2006; Fidler et al., 2006). Specifically, caregivers report relative challenges in expressive communication over receptive communication (Fidler et al., 2006). In children with DS ages 5-7, studies reported challenges in daily living skills, socialization and communication domains, relative to strengths on measures of mobility (Dressler et al., 2010; Dolva, Coster, & Lilja, 2004;

Dolva, Lilja, & Hemminsson, 2007; Volman, Visser, & Lensvelt-Mulders, 2006). Only one study used a comparison group when examining adaptive behavior in children with DS (Mancini et al., 2003). In children with DS at 2-and-5 years of age, social function was a relative challenge in both age groups as compared to chronologically age-matched typically developing children. However, each group included only ten children, thereby limiting the generalizability of these results (Mancini et al., 2003). Additional studies report that school-aged children with DS have a relative strength in domestic daily living skills relative to personal daily living skills (Dressler et al., 2010).

Predictors of adaptive behavior in DS. There are few studies examining predictors of adaptive behavior in children with DS. In a longitudinal study, Marchal and colleagues (2016) found that mental age at 24 months predicted adaptive behavior at ten years old (Marchal et al., 2016). Significant correlations were also reported between intellectual functioning and adaptive behavior in children with DS ages 6-16 (Rihtman et al., 2010); however, there is emerging evidence that executive function predicts adaptive behavior in school-based settings above and beyond mental age (Daunhauer et al., 2014b). Daunhauer et al. (2014b) found executive function to be the only significant predictor of functional performance in contrast to nonverbal cognitive ability and language skills in the school context in children with DS ages 5-10. Daunhauer et al. (2014b) did not include a comparison group and did not address adaptive behavior outside of an academic context. In adolescents with DS, memory and age were significant predictors of adaptive behavior (Pennington et al., 2003), and in another study, working memory was significantly associated with adaptive behavior in school-aged children and adolescents (Daunhauer et al., in press; Edgin, Pennington, & Mervis, 2010).

Prior research using laboratory-based behavioral tasks indicates that school-age children

and adolescents with DS demonstrated a profile of relative strengths and challenges in executive function. Studies in childhood indicate pronounced significant deficits in planning (Fidler et al., 2005ab; 2006; 2015; Kasari & Freeman, 2001) and working memory (Carney, Brown, & Henry, 2013a; Costanza et al., 2013). Planning difficulties have been observed in young children with DS (Fidler, Hepburn, Mankin, & Rogers, 2005) and are also evident in older children and adolescents with DS (Fidler et al., 2015; Lanfranchi et al., 2010).

There is mixed evidence in the literature for difficulties with cognitive flexibility (i.e., shifting) and inhibitory control among children with DS. For tasks measuring cognitive flexibility, children with DS have performed better than developmentally matched peers with autism (Dawson et al., 1998), but worse when compared to typically developing children and children with Williams syndrome (Costanzo et al., 2013; Edgin, 2003). Studies using informant-reports of executive function have yielded conflicting findings. Using caregiver report of executive function, Daunhauer et al. (2014a) found that children with DS did not perform significantly differently from mental age-matched typically developing peers on items measuring children's ability to solve problems or switch attention flexibly in everyday contexts. For inhibitory control laboratory-based tasks, children and adolescents with DS performed worse when compared to mental age-matched typically developing peers (Borella, Carretti, & Lanfranchi, 2013; Costanzo et al., 2013; Lanfranchi, Jerman, Pont, Alberti, & Vianello, 2010). However, studies using informant-report suggest that parents report difficulties in inhibitory control (Daunhauer et al., 2014a; Lee et al., 2011), but not teachers (Daunhauer et al., 2014a). The current study aimed to examine the relationship between mental age, executive function, and adaptive behavior to help identify appropriate targets for phenotypic-specific and adaptive behavior interventions for children with DS.

Applying DST to Understanding Adaptive Behavior in ASD and DS

Few studies explicitly discuss a theory of change of adaptive behavior development before examining their hypotheses. Examining adaptive behavior from a theoretical perspective may help to identify the underlying mechanisms of developmental trajectories. There is evidence that cognitive skills, such as general intellectual functioning and executive function, play important roles in the developmental trajectories of adaptive behavior. Longitudinal work provides evidence for understanding how behaviors develop over time, whether skills remain stable or change, and captures the dynamic relationships of an individual within their environments. This theoretical perspective can then inform identification of critical time points within developmental trajectories to target specific behaviors.

The goal of intervention programs are designed to improve developmental outcomes for individuals with developmental disabilities. From a dynamic systems framework, behavioral phenotypes and developmental trajectories are viewed as modifiable. By understanding predictors of adaptive behavior, interventions may be developed in toddlerhood to promote adaptive behavior in preschool and middle childhood. Longitudinal research can identify patterns and predictors of optimal developmental trajectories that will inform prevention and intervention science. Also, longitudinal studies can specify how behavioral phenotypes change over time in specific developmental disabilities (Knowland & Thomas, 2011).

Growth modeling is one method for examining the initial starting states and predictors of developmental trajectories. Growth models examine patterns of change over time in behavioral constructs and allow for the inclusion of multiple factors. Growth models examine changes within an individual and between individuals over time while examining the mechanisms that influence these changes (Grimm, Ram, & Estabrook, 2015). The current study used growth

modeling to examine developmental trajectories of adaptive behavior from toddlerhood to middle childhood in children with ASD and DS. While adaptive behavior and predictors of adaptive behavior have been examined in older individuals with ASD, this research has been primarily focused on individuals with high functioning ASD. This dissertation is one of the first studies to compare adaptive behavior developmental trajectories between two syndromes in young children. Growth modeling was used in individuals with varying cognitive abilities, and a novel technique was employed to correct for missing data and estimate model fit in a lower incidence developmental disability with a small sample size (DS) when comparing to a higher incidence disability (ASD).

Research Questions

1. What are the relative strengths and challenges of communication, daily living skills, and socialization in children with ASD and DS in toddlerhood, preschool, and middle childhood?
 - a. It was hypothesized that individuals with ASD will have a relative strength in daily living skills and relative challenges in communication and socialization and that individuals with DS will have a relative strength in socialization and relative challenges in daily living skills and communication from toddlerhood to middle childhood.
2. What are the developmental trajectories of adaptive behavior in individuals with ASD and DS from early to middle childhood and do they differ between groups?
 - a. It was hypothesized that developmental trajectories of raw scores of adaptive behaviors as measured by the VABS will increase over time in both groups,

indicating that individuals with ASD or DS make gains in adaptive behavior over time.

- b. Based on the behavioral phenotype literature in ASD and DS and reports of different strengths and challenges within these syndromes, it was hypothesized that there will be differences in starting states of adaptive behavior, and rates of change from toddlerhood to middle childhood. Specifically, it was hypothesized that individuals with DS will have significantly higher socialization scores and gain socialization skills more rapidly than individuals with ASD.
3. How do maternal education, mental age, performance on a cognitive flexibility and working memory executive function task, and autism symptoms in toddlerhood predict developmental trajectories of adaptive behavior in ASD and DS?
 - a. It was hypothesized that maternal education, mental age, performance on a cognitive flexibility and working memory executive function task, and autism symptoms will be associated with the initial starting states of adaptive behavior scores in toddlerhood. Specifically, higher levels of maternal education, mental age, performance on a cognitive flexibility and working memory executive function task, and lower levels of autism symptoms will be associated with higher adaptive behavior scores in toddlers with ASD and DS.
 - b. It was hypothesized that higher levels of maternal education, mental age, performance on a cognitive flexibility and working memory executive function task, and autism symptoms and lower levels of autism symptoms will be associated with greater rates of change of adaptive behavior from toddlerhood to middle childhood in ASD and DS.

4. How are the developmental trajectories of autism symptoms and adaptive behavior interrelated in individuals with ASD?
 - a. It was hypothesized that higher levels of autism symptoms in toddlerhood will be associated with poorer levels of adaptive behavior in toddlers with ASD. Also, it was hypothesized that higher levels of ASD symptoms would be related to a slower rate of change in adaptive behavior from toddlerhood to middle childhood in individuals with ASD.

CHAPTER 2.

Methods

Participants

Participants were part of a larger longitudinal study conducted at the University of Colorado Health Sciences Center. The longitudinal study included approximately 220 children with a diagnosis of ASD, another developmental disability (e.g., DS or Fragile X syndrome), or a history of typical development enrolled between 1997 and 2007. The present study focused only on two diagnostic groups, ASD and DS¹. Participants included 77 individuals with ASD and 24 individuals with DS and their families (see Figure 1 for a flowchart of inclusion in the current study). Groups did not differ by age, race, or maternal education. There were significantly more males in the ASD group than the DS group, which was expected given that males are more likely to have a diagnosis of ASD (Christensen et al., 2016; see Table 1 for participant characteristics).

Participants were invited to complete a comprehensive assessment battery at up to three time points: Toddlerhood (i.e., 1-3 years old, $M = 2.79$ years, $SD = .517$), Preschool (i.e., 4-6 years old, $M = 4.89$ years, $SD = .408$), and Middle Childhood (i.e., 7-11 years old, $M = 8.92$ years, $SD = 1.27$). All participants had at least one time point of data collection (see Figure 1 for missing data at each time point). In the ASD group, 20.8% of participants were seen at all three time points, 24.7% of participants were seen at two time points, and 54.5% participants were seen at one time point. In the DS group, 25% of participants were seen at all three time points, 29.2% of participants were seen at two time points, and 45.8% of participants were seen at one time point. Participants were recruited from community-based referral sources, including health

¹Some of the current sample had some data previously reported on (i.e., adaptive behavior; Fidler, Hepburn, & Rogers, 2006). The research questions and analytic strategy are unique to the current study.

and early education agencies and parent/support advocacy groups, such as the Autism Society of America and the Mile High Down Syndrome Society located in Denver, Colorado.

Inclusion in the ASD group of the study was based on the child meeting four out of five criteria including: (1) previous clinical diagnosis of ASD, (2) current scores above the “Autism Spectrum” cutoff on the Autism Diagnostic Observation Schedule (ADOS; Lord, Rutter, DiLavore, & Risi, 1999), (3) current scores above the “Autism” cutoff on the Autism Diagnostic Interview- Revised (ADI-R; Lord et al., 1994); (4) endorsements of specific symptoms on a DSM-IV checklist by a licensed clinical psychologist with experience in autism identification; and (5) a current clinical diagnosis of ASD. Exclusion criteria included: major medical illness or history of head injury/significant trauma. Inclusion in the DS group was based on confirmation of the DS diagnosis via chromosomal testing, as evident in the child’s medical records. Exclusion criteria included extreme prematurity (i.e., less than 28 weeks), major medical illness or history of head injury/significant trauma.

Procedures

Parent interviews and developmental testing occurred at either the research suite or in the child's home for both groups. Additional lab measures (such as measures of intellectual functioning, executive function, and autism diagnostic measures) were performed in the research suite. All measures were administered by experienced clinicians, including speech-language pathologists, clinical psychologists, occupational therapists or advanced graduate students under the direct supervision of a licensed professional. Inter-observer reliability was assessed on all measures at all time points by randomly selecting 20% of observations for coding by a second, independent rater.

Measures

This study focused on a subset of the longitudinal battery from the larger study. Constructs of interest for this study included: demographic information, adaptive behavior, overall intellectual functioning, executive function, and autism symptoms. Measures of each construct are described briefly below.

Demographic and health information. *Child Information Sheet.* Parents completed a questionnaire providing demographic information regarding their child's date of birth, gender, ethnicity, and diagnosis; as well as information regarding maternal and paternal employment, their level of education, marital status of the parents, and gross family income. Parents provided information at all three time points about the child's health history; including significant head injuries, illnesses, diagnosis of any other medical conditions, and current medication or vitamin usage. Parents also completed information regarding social symptoms, language development, and the amount of child therapies and care the child receives, such as speech and language therapy or occupational therapy.

Medical Records. With the consent of the parents, medical records were obtained for each child. A medical records checklist form was completed to include any relevant health information, such as seizure disorders, traumatic brain injury, meningitis, or other neurological or genetic conditions.

Parent Interview of Adaptive Behaviors. *Vineland Adaptive Behavior Scales, Interview Edition.* The Vineland Adaptive Behavior Scales (VABS; Sparrow et al., 1984) is a standardized parent interview assessment of adaptive behavior. The interview was administered by a graduate student to the primary caregiver of the child. The VABS assesses adaptive

behavior across four domains (i.e., communication, daily living skills, socialization, and motor skills). The VABS yields standard scores for each domain as well as an overall adaptive behavior composite. The VABS was administered at the all three time points for 91 participants. For 10 participants, the Vineland Adaptive Behavior Scales-II (VABS-II; Sparrow, Cicchetti, & Balla, 2004) was administered at the third time point. Their VABS-II raw scores were recoded into VABS raw scores using the items that were matched for both assessments. For items that did not match, a scoring rule was created. If the item was below the individual's basal, a 2-point credit was given to the item. If the item was above the individual's ceiling, a 0-point credit was given to that item. If the item was in-between the basal or the ceiling, a 1-point credit was given to that item.

Developmental testing and Mental Age *Mullen Scales of Early Learning*. The Mullen Scales of Early Learning (MSEL; Mullen, 1995) is a standardized assessment of development for children ages 3 to 68 months of age. The MSEL has five domains including Gross Motor, Fine Motor, Visual Reception, Expressive Language, and Receptive Language. The MSEL demonstrates concurrent validity with other developmental assessments of cognitive, motor, and language development (Mullen, 1995). Overall mental age was used in this study. Overall mental age was calculated by adding the age equivalency scores from the Fine Motor, Visual Reception, Expressive Language, and Receptive Language domains and dividing by four. The use of overall mental age is considered ecologically valid. The use of overall mental age as compared to standard scores assists with floor effects (Munson et al., 2008).

Leiter International Performance Scale-Revised. The Leiter International Performance Scale-Revised (Leiter-R; Roid & Miller, 1997) is a standardized assessment of nonverbal intellectual functioning for individuals ages 2 to 22 years of age. The Brief IQ assesses intellectual functioning across four domains: Figure Ground, Form Completion, Sequential Order, and Repeated Patterns. The Leiter-R demonstrates high test-retest reliability ($r_s = .80-.90$) and concurrent validity with cognitive assessments, such as the Wechsler Intelligence Scale for Children- Third Edition (Roid & Miller, 1997).

Executive Function. *Spatial Reversal.* The Spatial Reversal Task (Kaufmann, Leckman, & Ort, 1989) was used to assess both cognitive flexibility and working memory. This task required the child to (1) maintain the previous location of a reward in working memory, and (2) flexibly shift reward association between two locations (Yerys et al., 2007). During the practice trial, an examiner places two cups on the table and places a screen between the child and the cup. The examiner hides a reward under both cups and tells the child, "I am hiding a _____." The examiner removes the shield and allows the child to find the reward. When the child finds the reward, the shield is replaced, and the examiner continues to hide that reward in that location. During the experimental trials, the screen is put in place, and the reward is hidden. The child is allowed to search for the reward underneath one cup. If the child is correct, the procedure is repeated for four consecutive searches, and the side of hiding is reversed following every four consecutive trials for 23 trials. If the child is incorrect, the screen is quickly replaced, and the child is allowed to try again. Scoring includes the number of correct searches across 23 trials, the number of sets achieved, the number of perseverative responses after the side of hiding is changed, and the number of failures to maintain a set (i.e., three correct searches followed by an incorrect search). A perseverative response is defined as when a child is incorrect and

immediately searches in the incorrect position again. Raw scores of correct searches were used in this analysis (Yerys et al., 2007).

Autism Symptoms. *Autism Diagnosis Observational Schedule.* The Autism Diagnostic Observational Schedule (ADOS; Lord, Rutter, DiLavore, & Risi, 1999) is a standardized assessment that provides opportunities to observe symptoms of autism within a play-based context. Observations are coded within four domains, including social interaction, communication, play, and repetitive behavior. The examiner observes these symptoms during a 30-40-minute session using developmentally appropriate toy-based and social interactions. There are four different modules of the ADOS, each designed for children of different communicative competencies. Module 1 is for children who are currently producing few words; Module 2 is for children who communicate primarily in multi-word phrases and Module 3 is for verbally fluent children and Module 4 for verbally fluent adults. Modules 1, 2, and 3, were used across the different time points in the present study. Autism severity scores are derived from specific algorithms that have been developed and tested within each module. Autism severity scores range from 1-10 (Gotham, Pickles, & Lord, 2009), with values of 3 or less indicating low risk of ASD, 4-6 indicating moderate risk and scores at 7 or above indicating a significant risk of ASD. The ADOS provides a “risk classification” that informs a clinical diagnosis, but does not – by itself- provide a diagnosis. Clinical judgment and parent report of symptoms in other settings are essential parts of the diagnostic process (Risi et al., 2006).

Autistic Diagnostic Interview-Revised. The Autism Diagnostic Interview-Revised (ADI-R; Lord et al., 1994) is a standardized semi-structured parent interview that assesses ASD symptom presence and severity across three areas: (1) social relatedness, (2) communication, and (3) repetitive or restricted behaviors. The ADI-R is considered a gold standard in the assessment

of ASD. The ADI-R produces an algorithm score and cutoff scores for a diagnosis of ASD. The algorithm score distinguishes ASD from other diagnoses of developmental disabilities with high sensitivity and specificity ($> .90$) for individuals with mental ages of 18 months or older.

Interobserver reliability was high ($r_s > .80$) (Rogers, & Hepburn, & Wehner, 2003).

Data Analysis Plan. To address the first research question, preliminary analysis of variances (ANOVAs) was performed to examine group differences in maternal education, intellectual functioning, executive function, and autism symptoms. Repeated-measures ANOVAs were performed to characterize profiles of adaptive behavior in ASD and DS and to examine change over time in adaptive behavior scores.

Growth modeling was utilized to examine adaptive behavior over an 8-year period across the three time points (i.e., ages 2-10). As shown in Table 1, there was a significant proportion of missing data across the three time points. Data was assumed to be missing completely at random or missing at random. Missing completely at random assumes that the probability of the incomplete data is completely unrelated to observed or unobserved variables, while missing at random assumes that the probability may be related to other observed variables in the dataset, but unrelated to the potential values of the unobserved data. For example, the likelihood of a participant's missing adaptive behavior value at Time 3 may be related to maternal education at Time 1 (Grimm et al., 2015). For data that is missing completely at random or missing at random, full information maximum likelihood (FIML) estimation can be used. FIML is recommended for use with longitudinal data due to the larger amount of missing data (Grimm et al., 2015). FIML estimation allows for each participant to contribute to the estimation of models based on their available data. Probabilities are used for each observation and integrated over the

missing data values (Allison, 2012; Grimm et al., 2015). Therefore, FIML estimation was used in all subsequent analyses performed in MPlus 7 (Muthén & Muthén, 2012).

Growth modeling examines intraindividual change, interindividual differences, interrelationships among genetic, behavioral, or environmental factors, and predictors of intraindividual changes and interindividual differences (Grimm et al., 2015). In this study, the structural equation modeling (SEM) approach was used. The linear growth model identifies intraindividual change trajectories that remain constant over time, but differ between individuals. The linear growth model identifies a latent intercept or an initial starting score on the adaptive behavior domain, and a latent slope, representing the rate of change in adaptive behavior scores over the three time points. To examine nonlinearity in trajectories, the quadratic growth model adds a latent quadratic factor of time to the linear growth model and represents the average acceleration of the developmental trajectory (Grimm et al., 2015).

To address the second research question, both linear and quadratic models were specified for communication, daily living skills, and socialization raw scores for each group to identify group differences in the developmental trajectories of adaptive behavior over time. Raw scores are recommended to capture growth (Grimm et al., 2015). Four models were compared for relative fit to identify group differences in the developmental trajectories of adaptive behavior over time. In the first model (M1), the invariance model was estimated where all parameters were identical between groups. In the second model (M2), the latent variable means (β_1 and β_2) were estimated freely for each group (See Figure 2). In the third model (M3) both the latent variable means, variances, and covariances varied while the residual variance and linear structure were identical between groups. The final model (M4) allowed for all parameters to be group specific (means, covariances, and residual variances). These models were compared using

likelihood ratio tests to identify whether the groups varied in their (1) average trajectories or means of adaptive behavior over time (M2), (2), magnitude of between-person variability and covariability of growth trajectories or means and covariances over time (M3) or (3) magnitude of unexplained within-person variability over time or means, covariances, and residuals. (Grimm, Ram, & Estabrook, 2015). A Bartlett Correction with missing data scaling factor was utilized to address small sample sizes and missing data (McNeish & Harring, 2016).

To address the third research question, a linear growth model with time-invariant covariates was tested with a multiple-indicator multiple-cause (MIMIC) model (See Figure 3). Diagnostic status, maternal education in toddlerhood, the overall mental age from the MSEL in toddlerhood, executive function task of Spatial Reversal (i.e., # of correct items), and autism symptoms as measured by the ADI-R at Time 1 were entered as covariates with the communication, daily living skills, and socialization raw scores separately. Model fit was evaluated using RMSEA with good fit indicated by a value of < 0.08 and acceptable fit of < 0.10 (Grimm et al., 2015). The effects of the time-invariant covariates to the latent intercept and slope were examined. The latent variable intercept represents the predicted VABS score at Time 1 or toddlerhood, and the slope represents the annual rate of change in VABS scores for a child with DS, whose mother had average maternal education, mental age, executive function scores, and autism symptoms. These models were also performed with the reference group reversed to represent a child with ASD. Next, the regression parameters were examined to identify the effects of diagnostic status, maternal education, mental age, executive function, and autism symptoms to indicate whether the parameters are related to the intercept and the slope. A nonlinear model was examined by adding a quadratic factor. With the quadratic factor, the linear slope was interpreted as the instantaneous rate of change in toddlerhood (Grimm et al., 2015).

To address the fourth research question, a time-varying covariate (TVC) growth model was tested to examine individual changes across adaptive behavior as measured by the VABS and the interrelationship with autism symptom severity as measured by the ADOS severity score (See Figure 4). This model was examined in the ASD group only. In the TVC growth model, factor loadings for the intercepts of VABS were fixed to 1, while the slopes were fixed to change linearly with respect to measurement occasion beginning with 0 to center the intercept at the first time point, or toddlerhood. The residual variances were constrained to be equal across time, and the VABS intercepts were set to 0. The VABS scores were regressed onto the ADOS severity scores for each time point (e.g., VABS at Time 1 was regressed onto ADOS severity score at Time 1). The effect of the ADOS severity score was constrained to be equal across time. Additional parameters examined included covariances between the VABS intercept and the ADOS severity scores, covariances between VABS intercept and slope, and the covariances between the VABS slope and ADOS severity scores.

The model produced parameter estimates for the mean intercept and mean annual rates of change for VABS and the effect of the time-invariant covariate at each time point. The effect between the intercepts of VABS and ADOS provides information regarding the relationship between VABS scores in toddlerhood and ADOS scores, such that if this parameter is significantly negative, those with higher VABS scores at Time 1 have poorer ADOS scores at Time 1. The effect of the ADOS severity score on the slope of VABS scores provides information regarding whether the VABS scores are associated with the expected rate of change in ADOS scores, such that if this parameter is significant, ADOS scores are associated with VABS rate of change in scores from toddlerhood to middle childhood. The intercept and slope variances of the VABS represent between-person differences in VABS scores in toddlerhood and

the rate of change in VABS scores if ADOS severity scores do not change (Grimm et al., 2015). The residual variance for the VABS scores represents the variability in the VABS scores that not accounted for by the ADOS severity scores and the TVC model.

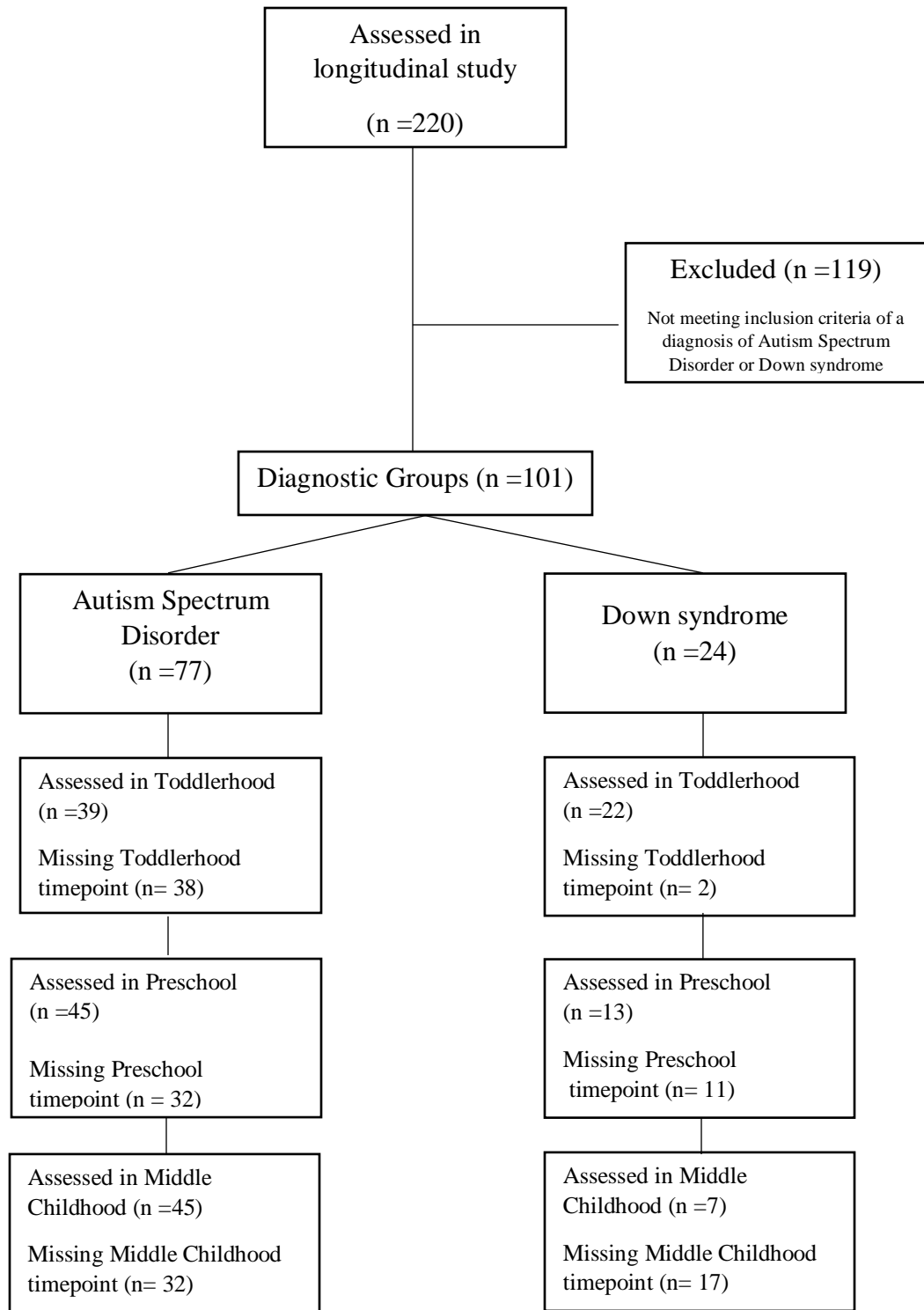


Figure 1. A flow chart of inclusion and missing data for the sample.

Table 1.

Participant Characteristics

Characteristic	ASD group		DS group		F-test statistic	p-value
	n	M or % (SD)	n	M or % (SD)		
Sex					4.70	.033
Male	61	82.4	12	60.0		
Female	13	17.6	8	40.0		
Race					.075	.785
African American	6	1.00	2	16.7		
Asian	2	3.00	0	0.0		
Caucasian/White	59	88.1	12	83.3		
Age (in years)						
Time 1	39	2.83(.446)	22	2.73(.628)	.632	.430
Time 2	45	4.95(.532)	13	4.69(.574)	2.40	.127
Time 3	45	8.88(1.33)	7	9.26(.842)	.611	.438
Mother Education					.193	.662
High School Graduate	3	4.5	1	6.70		
Partial College	17	25.8	3	20.0		
College Graduate	30	45.5	6	40.0		
Post Graduate Training	16	24.2	5	33.3		

Note. ASD= Autism Spectrum Disorder. DS= Down syndrome

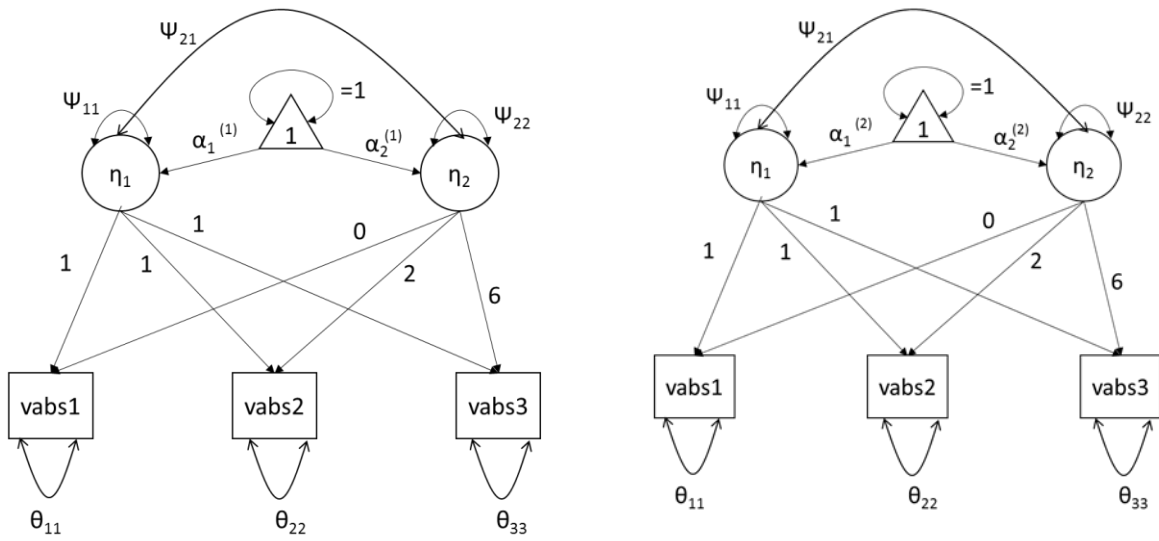


Figure 2. Path diagram of the hypothesized multiple-group linear growth model of adaptive behavior(VABS) over three time points. Group 1 = ASD Group 2= DS

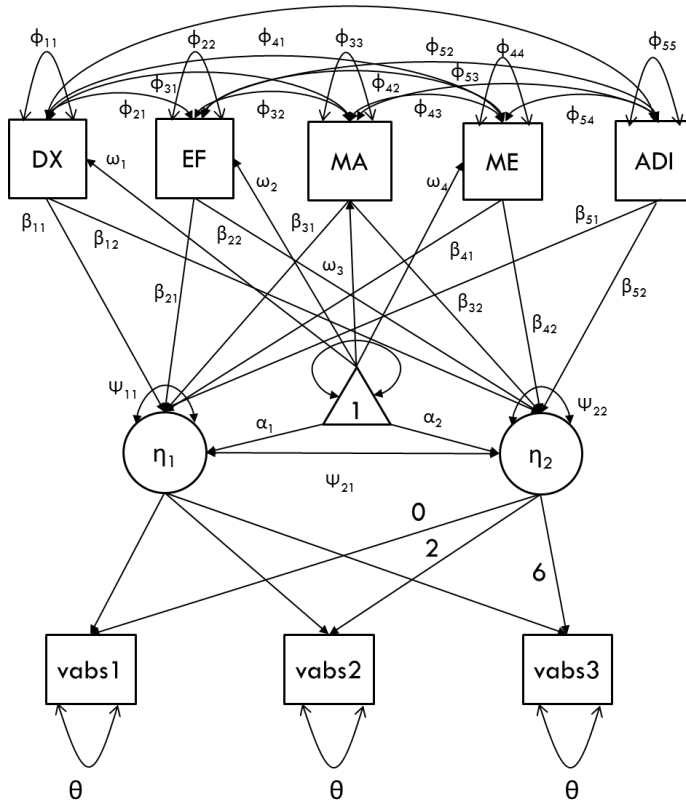


Figure 3. Path diagram of a hypothesized Linear Growth Model of adaptive behavior (VABS) over three time points with Time-Invariant Covariates of diagnostic status(DX), executive function(EF), mental age(MA), maternal education(ME), and autism symptoms(ADI).

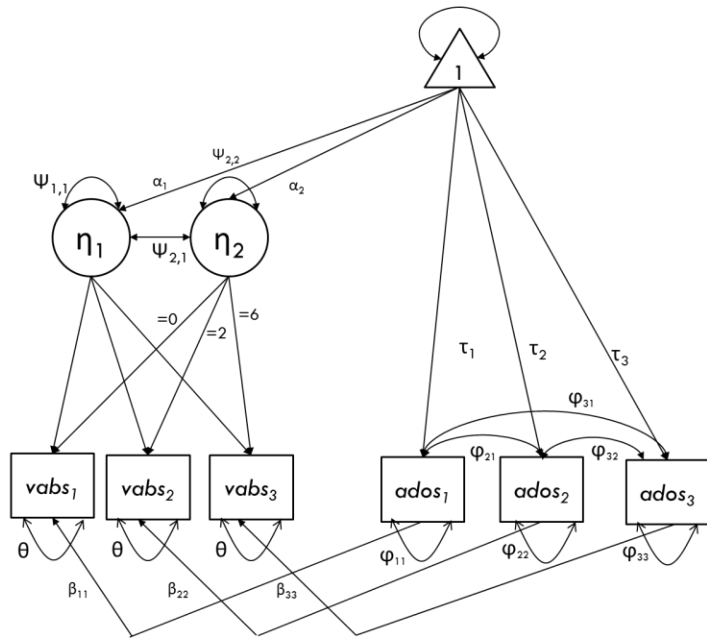


Figure 4. Path diagram of the hypothesized time-varying covariate linear growth model examining interrelationships of adaptive behavior (VABS) and autism severity score (ADOS) over three time points.

CHAPTER 3.

Results

Children in the ASD group and the DS group did not have significant differences using Bonferonni-corrected comparisons in mental age, or executive function scores in toddlerhood, as measured by mental age on the MSEL and number of correct trials on the Spatial Reversal task (see Table 2 for descriptive statistics). Individuals with ASD had significantly higher autism symptoms in toddlerhood as rated by their parents on the ADI-R, $F(1, 52) = 134.9, p < .001, \eta^2 = .726$ and significantly higher autism severity scores as measured by the ADOS in toddlerhood, $F(1, 52) = 117.9, p < .001, \eta^2 = .694$, preschool, $F(1, 56) = 45.89, p < .001, \eta^2 = .450$, and in middle childhood, $F(1, 58) = 18.5, p < .001, \eta^2 = .242$. Although not significant using Bonferonni-corrected comparisons, in middle childhood, children with ASD had higher average nonverbal IQ, as measured by the Brief IQ on the Leiter-R, $F(1, 24) = 7.23, p = .013, \eta^2 = .232^2$.

Group Differences in Adaptive Behavior

In toddlerhood, children with DS had significantly higher communication, $F(1, 57) = 16.5, p < .001, \eta^2 = .224$, daily living skills, $F(1, 58) = 8.93, p = .004, \eta^2 = .133$, and socialization, $F(1, 58) = 40.0, p < .001, \eta^2 = .408$, standard scores as measured by the VABS than children with ASD. In preschool, children with DS had significantly higher socialization, $F(1, 53) = 8.95, p = .004, \eta^2 = .138$, standard scores than children with ASD, but no significant differences in communication or daily living skills standard scores than children with ASD. There were no significant differences in middle childhood in children with DS and children with ASD in communication, daily living skills, or socialization standard scores.

²At Time 3, only 18 participants with ASD were assessed using the Leiter-R. The remaining participants were assessed using the Wechsler Scale for Intelligence- Third Edition Verbal Composite Score ($n = 19, M = 90.7, SD = 19.4$) and Perceptual Reasoning Composite Score ($n = 19, M = 99.8, SD = 19.8$), or the Wechsler Abbreviated Scale of Intelligence Full Scale IQ ($n = 9, M = 112, SD = 17.1$).

As shown in Table 1, at Time 3 there were only 7 participants in the DS group. Across the three time points, most participants scored within the low to moderately low category of adaptive behavior as defined by the VABS comparing their scores to the normative sample of typically developing peers. Table 3 shows the percentages of children within each category at each time point by group.

For raw scores of the VABS, children with DS in toddlerhood had significantly higher communication, $F(1, 56) = 9.89, p < .001, \eta^2 = .150$, and socialization scores, $F(1, 56) = 39.6, p = .001, \eta^2 = .410$, but no significant differences in daily living scores. In preschool, children with DS had significantly higher socialization raw scores, $F(1, 55) = 4.93, p = .031, \eta^2 = .082$, but no significant differences in communication or daily living skills scores. Finally, there were no significant differences in middle childhood in children with ASD and children with DS in communication, daily living skills, or socialization raw scores.

Adaptive behavior profiles. At Time 1, parents and caregivers reported that toddlers with ASD did not demonstrate significant within-group differences in their communication, daily living skills, or socialization standard scores, $F(2, 35) = 2.32, p = .113, \eta^2 = .117$, suggesting a trend towards significant differences. Parents and caregivers reported that toddlers with DS demonstrated significant within-group differences in communication, daily living skills, and socialization standard scores, $F(2, 20) = 22.8, p < .001, \eta^2 = .695$. Specifically, in toddlers with DS, parents and caregivers reported stronger socialization skills than either communication skills, $t(21) = 4.81, p < .001$, or daily living skills, $t(21) = 6.71, p < .001$ (see Figure 5).

At Time 2, parents and caregivers reported that preschoolers with ASD demonstrated significant differences in their communication, daily living skills, and socialization standard scores, $F(2, 43) = 9.25, p < .001, \eta^2 = .301$. Specifically, parents and caregivers reported stronger

communication skills , $t(44) = 2.3, p = .026$, and socialization skills, $t(33) = 4.08, p < .001$ than daily living skills. In addition, significant differences were observed in preschoolers with DS , $F(2, 11) = 16.3, p = .001, \eta^2 = .748$. Specifically, parents and caregivers reported stronger socialization skills than either communication skills, $t(12) = 5.69, p < .001$, or daily living skills, $t(12) = 5.31, p < .001$.

At Time 3, parents and caregivers reported that in middle childhood, children with ASD demonstrated significant differences in their communication, daily living skills, and socialization standard scores, $F(2, 35) = 25.4, p < .001, \eta^2 = .592$ but parents and caregivers reported that in middle childhood, children with DS did not demonstrate significant differences, $F(2, 4) = 3.70, p = .123, \eta^2 = .649$. Specifically, in children with ASD, parents and caregivers reported stronger communication skills than either daily living skills, $t(36) = 6.82, p < .001$, or socialization skills, $t(36) = 6.71, p = .018$. In addition, socialization skills were significantly higher than daily living skills, $t(36) = 4.23, p < .001$.

Adaptive behavior changes over time. Before estimating missing data using FIML, change over time in scores were examined using RM-ANOVAs. There were no significant differences in standard scores for either group in communication, daily living skills, or socialization VABS domains. However, these sample sizes were very small due to a small percentage of participants having data on all three time points. Although non-significant, as observed in Figure 5, scores in communication increased slightly for ASD whereas daily living skills decreased, and for DS, communication and daily living scores decreased. There was evidence for significant increases in raw scores in communication, daily living skills, and socialization across all three time points in both groups.

Developmental trajectories of adaptive behavior. The linear and quadratic growth models were specified for communication, daily living skills, and socialization raw scores as measured by the VABS. Likely due to the small sample size of the DS group, model fit was poor across all models. There was some evidence that M2 was a significantly better fit than M1 for the daily living skills linear growth model, $\Delta-2LL$ $p < .001$, RMSEA = 0.137, 90% CI [.020 .229], and a Bartlett missing-data scalar factor RMSEA = 0.119 90%, CI [.095 .138] (McNeish & Harring, 2016). This may indicate a trend that individuals with ASD and DS differ in their average starting point of daily living skills in toddlerhood or their average rate of change in daily living skills from toddlerhood to middle childhood. In the preliminary analysis, raw scores did not differ on raw daily living skills across the three time points but did differ in standard scores. However, due to the small sample size in the DS group and the amount of missing data, diagnostic status was added as a time-invariant predictor for additional models to identify group differences. Diagnostic status, such as the presence of intellectual disability, has been used in the examination of developmental trajectories in a previous study examining daily living skills in adults with ASD and DS (Smith et al., 2012).

Predictors of Developmental Trajectories of Adaptive Behavior

Linear and quadratic models were specified including the time-invariant predictors for each of the adaptive behavior domain raw scores from the VABS: communication, daily living skills, and socialization. For each domain, only one model produced an RMSEA $< .10$ to indicate acceptable fit. Those models are described below. See Table 4 for a summary of the parameters for the intercept, linear slope, and quadratic slope and the covariates included in the model for each domain.

Communication. Figure 6 depicts the plot of individual developmental trajectories of raw communication scores across three time points by diagnostic status. A quadratic growth model of communication was evaluated that included diagnostic status, maternal education, mental age, executive function, and autism symptoms as predictors. The latent intercept and latent slope were indicated by communication scores at Times 1, 2, and 3. The factor loadings for the intercept were set to 1, and the factor loadings for the linear slope were fixed at 0, 2, and 6, representing the average length of time between measurement occasion. The loadings for the quadratic slope factor were the factor loadings for the linear slope squared. The model that best fit the data included diagnostic status, mental age, and executive function as predictors. This model displayed excellent fit, RMSEA = .07, 90% CI [.00, .22].

Diagnostic status and mental age were significant predictors of the latent intercept. Children with DS had a significantly higher communication score in toddlerhood, controlling for mental age and executive function ($\beta = 7.633$, $p = .008$) than children with ASD. Higher mental ages in children with ASD and children with DS were associated with higher communication scores in toddlerhood, controlling for executive function ($\beta = 1.20$, $p < .001$). Diagnostic status, mental age, and executive function were significant predictors of the linear slope factor. Children with DS and children with ASD had a slower rate of change in communication scores controlling for mental age and executive function ($\beta = -9.43$, $p < .005$). Higher mental age was associated with a greater rate of change in communication scores controlling executive function in individuals with DS and ASD ($\beta = 1.092$, $p < .001$). A higher number of correct trials on the spatial reversal executive function task was associated with a slower rate of change in communication scores controlling for mental age in children with DS and children with ASD ($\beta = -.784$, $p = .045$). Mental age was the only significant predictor of the quadratic slope factor.

These findings suggest that individuals with higher mental ages have a faster rate of change in communication skills increasing in adaptive behavior communication scores by 1.092 points per year in toddlerhood and one-half the acceleration was -.784 communication points per year (See Figure 7).

Daily living skills. Figure 8 depicts a plot of individual developmental trajectories of daily living skills across three time points by diagnostic status. A linear growth model of daily living skills that included diagnosis status, maternal education, mental age, executive function, and autism symptoms was evaluated. The latent intercept and latent slope were indicated by daily living skills at Times 1, 2, and 3. The factor loadings for the intercept were set to 1, and the factor loadings for the linear slope were fixed at 0, 2, and 6, representing the average length of time between measurement occasion. This model displayed acceptable fit, RMSEA= .095, 90% CI [.020, .16].

Mental age was the only significant predictor of the latent factors. Mental age was the only significant predictor of the latent intercept, for individuals with ASD ($\beta = 1.11, p < .01$) and DS ($\beta = 1.09, p < .01$). A higher mental age was associated a higher initial daily living skills score controlling for diagnostic status, executive function, maternal education, and autism symptoms. Mental age was also positively associated with the latent slope for individuals with ASD ($\beta = .518, p < .01$) and DS ($\beta = .503, p < .01$) controlling for diagnostic status, executive function, maternal education, and autism symptoms. These findings suggest that children with higher mental ages in toddlerhood had a faster rate of change, or their daily living skills were growing at a faster rate. Diagnostic status was not associated with the intercept or slope, mother's education, executive function, or mental age (See Figure 9).

Socialization. Figure 10 depicts a plot of individual developmental trajectories of daily living skills across three time points by diagnostic status. A quadratic growth model of socialization that included diagnostic status, maternal education, mental age, executive function, and autism symptoms as predictors was evaluated. The latent intercept and latent slope were indicated by socialization at Times 1, 2, and 3. The factor loadings for the intercept were set to 1, and the factor loadings for the linear slope were fixed at 0, 2, and 6, representing the average length of time between measurement occasion. The loadings for the quadratic slope factor were the factor loadings for the linear slope squared. The model that fit that data only included diagnostic status, maternal education, and mental age as predictors. The model displayed excellent fit, RMSEA = .05, 90% CI [.00, .21].

Diagnostic status, maternal education, and mental age were significant predictors of the latent intercept. Children with DS had higher socialization skills scores in toddlerhood controlling for mental age and maternal education ($\beta = 9.99, p < .001$). Higher maternal education was associated with a higher socialization scores in toddlerhood controlling for mental age in children with DS and children with ASD ($\beta = 2.69, p = .024$). Higher mental age was associated with higher socialization scores in toddlerhood controlling for maternal education in individuals children with DS and children with ASD ($\beta = .316, p = .045$).

Mental age was the only significant predictor of the latent factor linear slope and quadratic factor. Mental age was positively associated with the linear slope ($\beta = .61, p < .001$) and negatively associated with the quadratic slope ($\beta = -.064, p = .007$) controlling for maternal education in children with DS and children with ASD. These findings suggest that individuals with higher mental ages have a faster rate of change in socialization skills increasing in adaptive

behavior socialization scores by .61 points per year in toddlerhood and one-half the acceleration was -.064 per year (See Figure 11).

Adaptive behavior and autism symptoms over time. The autism symptom severity scores across three time points were added as time-varying predictors of adaptive behavior scores for each of the domains. These models were only fit for children with a diagnosis of ASD, given that the ADOS severity scores indicated a diagnosis of ASD and individuals with DS had significantly lower severity scores (see Table 2). The models were fit with the best fitting models from the time-invariant covariate models described above. The ADOS severity scores and their trajectories were not significant predictors of communication, daily living skills, or socialization above and beyond the time-invariant predictors.

Table 2.

Descriptive Statistics

Variable	ASD Group			DS Group		
	Time 1 M (SD)	Time 2 M (SD)	Time 3 M (SD)	Time 1 M (SD)	Time 2 M (SD)	Time 3 M (SD)
Adaptive Behavior Raw						
Communication	23.1 (14.1)*	52.4(22.0)	88.5(26.30)	33.8(9.520)	49.4(13.5)	71.9(29.9)
Daily Living Skills	24.7(10.6)	48.5(16.4)	86.4(27.80)	28.4(10.3)	47.0(19.3)	76.1(29.4)
Socialization	28.0(7.67)*	45.5(13.9)	63.1(18.70)	39.8(5.43)	54.9(11.7)	62.7(25.8)
Adaptive Behavior Standard Score						
Communication	59.2 (14.0)*	65.7(22.5)	68.6(23.2)	71.8(5.30)	64.5(10.5)	52.7(18.4)
Daily Living Skills	62.1 (10.6)*	59.2(12.0)	50.3(21.3)	70.1(8.78)	61.9(13.0)	49.4(29.3)
Socialization	60.9(11.4)*	64.8(12.2)*	60.9(14.1)	78.6(8.43)	76.2(12.1)	61.5(16.6)
Adaptive Behavior Age Equivalent (in months)						
Communication	12.4(5.52)*	31.8(18.6)	73.8(32.0)	18.4(4.74)	28.1(9.36)	56.2(30.7)
Daily Living Skills	16.9(3.34)	29.4(9.42)	58.6(21.5)	20.3(7.69)	30.0(11.7)	51.3(21.3)
Socialization	11.7(4.14)*	25.6(11.5)	47.2(22.9)	19.9(4.29)	35.5(12.1)	51.5(26.1)
Autism Diagnostic Observation Schedule Severity Score						
Mental Age (in months)	7.15(1.71)*	6.78(1.72)*	6.90(2.01)*	2.00(1.67)	3.00(1.96)	3.56(2.89)
Intelligence Quotient	58.5(15.1)	63.0(17.0)	80.1(24.3)	58.4(10.2)	53.8(8.07)	56.4(6.32)
Autism Diagnostic Interview Raw Score	34.1(7.23)*			9.62(7.92)		
Spatial Reversal # of trials correct	12.4(4.55)			11.9(4.94)		

Note: * $p \leq .004$ Bonferroni adjusted. ASD= Autism Spectrum Disorder. DS= Down syndrome. Mental age and Intelligence Quotient were measured by the Mullen Scales of Early Learning at Time 1(ASD $n = 35$ DS $n = 22$) and Time 2 (ASD $n = 38$ DS $n = 13$) and by the Leiter International Scales of Performance at Time 3(ASD $n = 18$ DS $n = 7$).

Table 3.

Adaptive Behavior Level Percentages of Individuals with ASD and DS across toddlerhood, preschool, and in the school-aged years

VABS Category	Communication						Daily Living Skills						Socialization						
	Time 1		Time 2		Time 3		Time 1		Time 2		Time 3		Time 1		Time 2		Time 3		
	ASD	DS	ASD	DS	ASD	DS	ASD	DS	ASD	DS	ASD	DS	ASD	DS	ASD	DS	ASD	DS	
Above Average (110+)																			
Average (90-110)			4		5														
Low Average (80-90)	8	4	11	7	16	17	2	9	2	7	5.4	14		22.	8	15			
Moderately Low (70-80)	5	68	17	15	21		10	23	15	7	10		18	54	13	46	21	33	
Low (<70)	86	27	71	76	56	80	87	67	82	8	83	85	81	22	78	37	70	66	

Note. ASD= Autism Spectrum Disorder. DS = Down syndrome. VABS= Vineland Adaptive Behavior Scales. Time 1= Toddlerhood. Time 2= Preschool. Time 3=School-aged years.

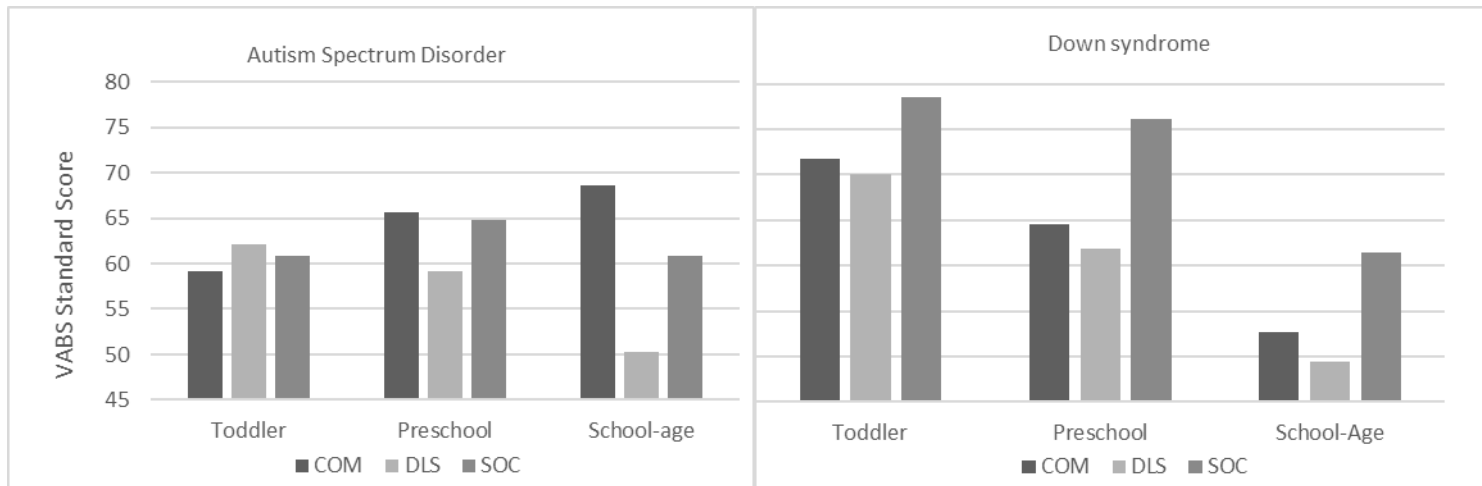


Figure 5. Adaptive behavior profiles in Autism spectrum disorder and Down syndrome from toddlerhood to middle childhood in communication (COM), daily living skills (DLS), and socialization(SOC) standardized scores as measured by the Vineland Adaptive Behavior Scales (VABS).

Table 4.

Parameter Estimates for Growth Models for Communication, Daily Living Skills, and Socialization

Covariate	Communication			Daily Living Skills			Socialization		
	Intercept	Linear Slope	Quadratic Slope	Intercept	Linear Slope	Quadratic Slope	Intercept	Linear Slope	Quadratic Slope
Diagnostic status	7.63**	-9.43**	.990*	.363	-1.40		9.99***	-1.17	-.050
Executive Function	.312	-.784**	.113*	.400	-.327*				
Mental age	1.09***	1.09***	-.143**	.983***	.514***		.316**	.606***	-.064**
Maternal Education			.	-.481	.682		2.69**	-1.97	.351*
Autism Symptoms				-.075	.133				

Note. * $p < .10$ ** $p < .05$ *** $p < .001$

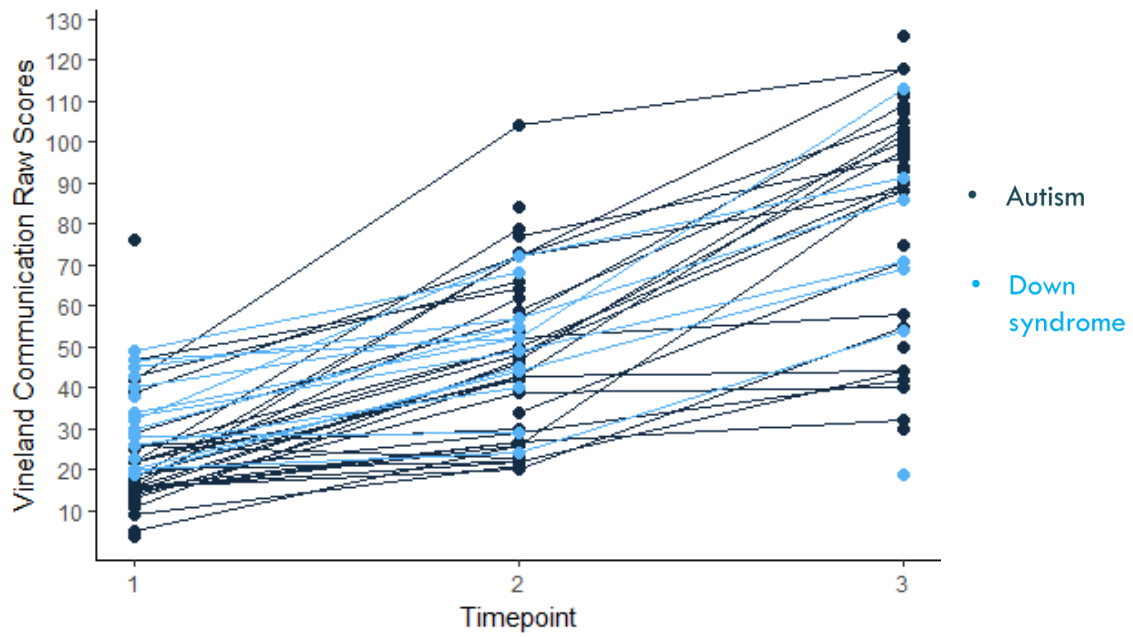


Figure 6. Individual developmental trajectories of communication raw scores as measured by the Vineland Adaptive Behavior Scales in children with Autism Spectrum Disorder and Down syndrome.

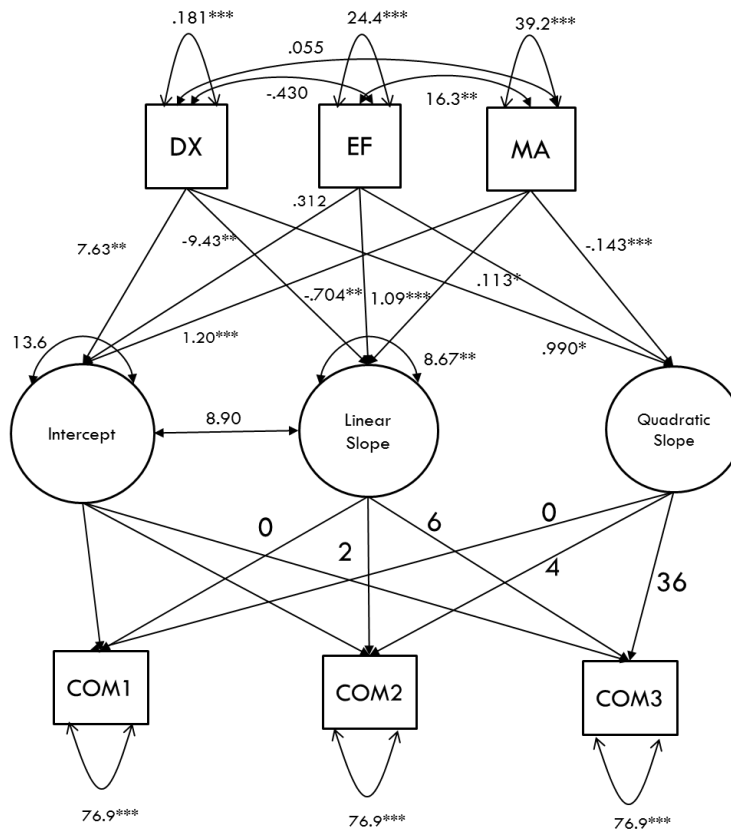


Figure 7. Communication quadratic growth model with time-invariant predictors of diagnostic status(DX), executive function (EF), and mental age(MA).

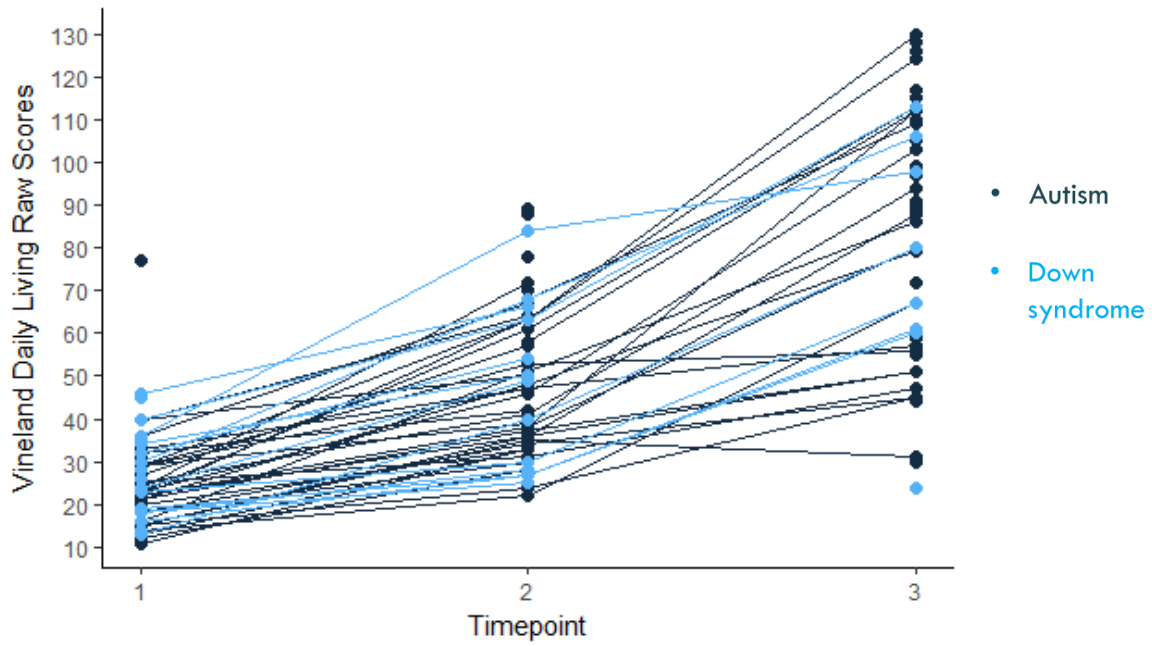


Figure 8. Individual developmental trajectories of daily living skills raw scores as measured by the Vineland Adaptive Behavior Scales in children with Autism Spectrum Disorder and Down syndrome.

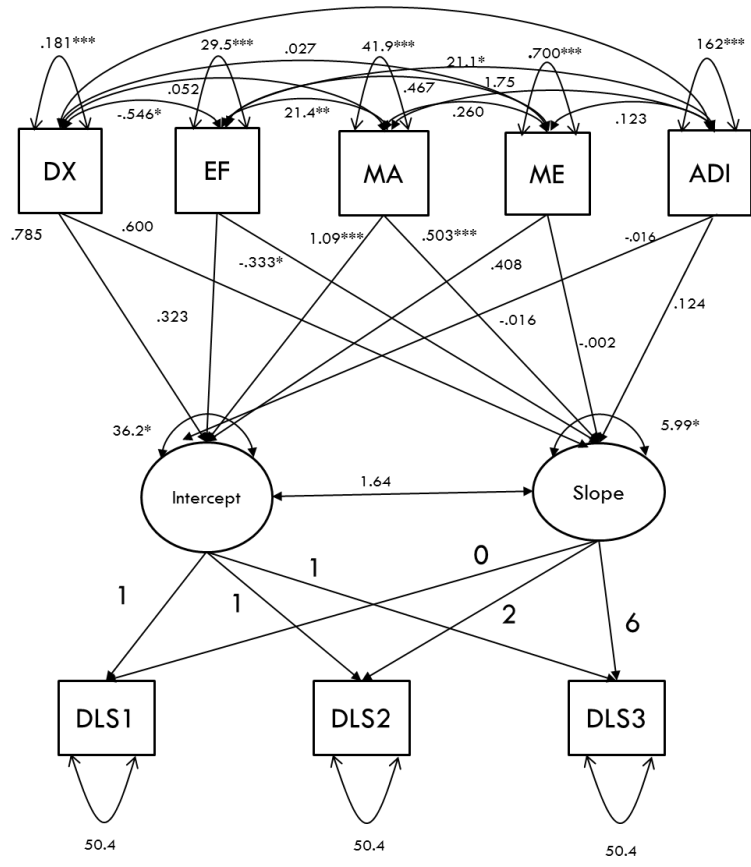


Figure 9. Daily living skills linear growth model with time-invariant predictors of diagnostic status(DX), executive function(EF), mental age(MA), maternal education(ME), and autism symptoms(ADI).

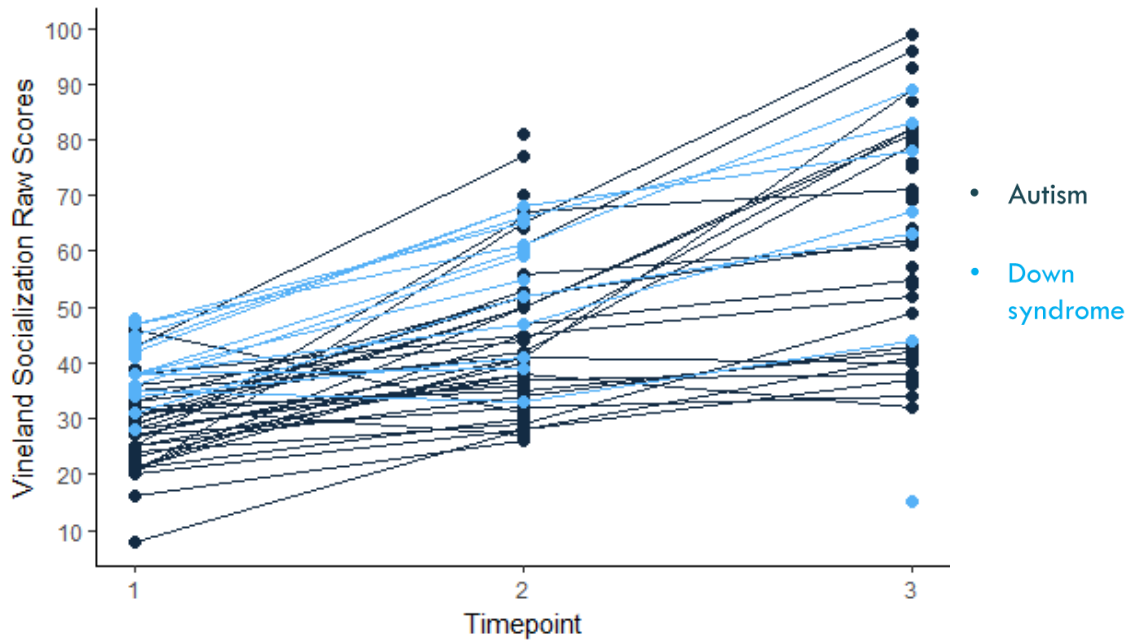


Figure 10. Individual developmental trajectories of socialization raw scores as measured by the Vineland Adaptive Behavior Scales in children with Autism Spectrum Disorder and Down syndrome

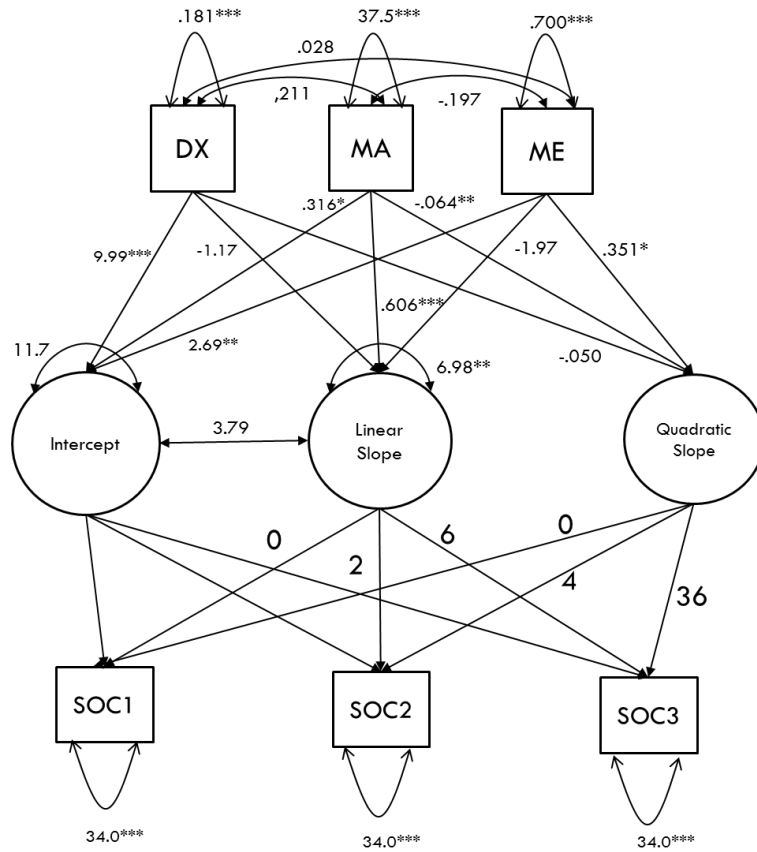


Figure 11. Socialization quadratic growth model with time-invariant predictors of diagnostic status (DX), mental age(MA), and maternal education (ME).

CHAPTER 4.

Discussion

Findings from this dissertation add to the growing literature on examination of developmental trajectories of adaptive behavior in children with ASD and children with DS. This dissertation examined profiles and developmental trajectories of adaptive behavior in children with ASD and children with DS. In this chapter, a summary of findings is presented, followed by a detailed discussion of adaptive behavior profiles, predictors of developmental trajectories of adaptive behaviors, and the interrelationship between autism symptoms and adaptive behavior in the ASD group. Then, the discussion concludes with an examination of current evidence-based practices and early intervention programs and the implications of current findings.

Summary of Findings

Children with ASD and children with DS demonstrated increases in adaptive behavior over time; however, adaptive behavior was still significantly delayed as compared to the standardization sample. Despite an increase in IQ scores in the ASD group across the three time points, adaptive behavior standard scores were still significantly delayed. In terms of adaptive behavior profiles, children with ASD and children with DS showed significant differences in relative strengths and challenges across the three time points. For toddlers with ASD, there were not significant within-group differences in adaptive behavior. In preschool, children with ASD demonstrated a relative difficulty in daily living skills and relative strengths in communication and socialization. During middle childhood, parents and caregivers reported a relative strength in communication and relative difficulties in socialization and daily living skills, although socialization scores were significantly higher than daily living skills scores. For toddlers and

preschoolers with DS, parents and caregivers reported a relative strength in socialization and relative difficulties in communication and daily living skills. For school-aged children with DS, there were not significant within-group differences in adaptive behavior.

Diagnostic status was added as a predictor in developmental trajectories of communication, daily living skills, and socialization to determine whether children with ASD and DS had differences in starting states of adaptive behavior (i.e., adaptive behavior scores in toddlerhood), and rates of change from toddlerhood to middle childhood. The quadratic growth model fit the communication and socialization raw scores models for individuals with ASD and DS, indicating that raw scores increased over time and that the rate of change slowed over time; however, these models only had three time points, so the quadratic factor must be interpreted with caution. The linear growth model fit the daily living raw scores trajectory, indicating that daily living raw scores increased over time. Mental age in toddlerhood was the strongest predictor of developmental trajectories of communication, daily living skills, and socialization.

Adaptive Behavior Profiles

Autism Spectrum Disorder

Findings suggest that a divergent adaptive behavior profile begins to emerge during the preschool years, and is further distinguished in the school years for youth with ASD. Despite a higher average IQ score in middle childhood, children with ASD had significant delays in adaptive behavior compared to the standardization sample at all three time points. This finding is consistent with previous research in children with high functioning ASD (Pugliese et al., 2015;2016). Daily living skills are significantly lower than communication or socialization in preschool and middle childhood, which is surprising, given that communication and socialization

impairments are core features of an ASD diagnosis. This finding contrasts with previous research reporting daily living skills as a relative strength in childhood compared to communication and socialization (Baghdadli et al., 2011; Green & Carter, 2014; Kanne et al., 2011). The previous study in toddlerhood did not compare daily living skills to communication or socialization domains of adaptive behavior (Green & Carter, 2014) and some of these studies included older age ranges (ages 4-23; Baghdadli et al., 2011; Kanne et al., 2011). Kanne et al. (2011) examined adaptive behavior in high-functioning children with ASD, and Baghdadli et al. (2011) compared adaptive behavior domains using age-equivalency scores. The reported age-equivalency scores at age 8 years ($M_s = 2-3$ years) were lower than the present sample at 8 years ($M_s = 4-6$ years; See Table 2). As previously discussed, this study was conducted in France where the predominant conceptualization of ASD is psychodynamic which may explain these differences. The current study suggests that in children with varying cognitive levels with ASD, there is a critical need to target daily living skills.

Down syndrome

The finding that socialization is a relative strength in toddlerhood and preschool is consistent with previous studies (Dykens et al., 2006); however, socialization was not evident as a strength during the school-age years. This finding may be due to the small sample size and warrants replication in larger samples during middle childhood in children with DS; however, previous studies with larger sample sizes reported socialization as a difficulty in school-aged children with DS. (Dressler et al., 2010; Dolva et al., 2006; 2007; Volman et al., 2007). It may be that expectations of socialization skills are raised during the elementary school years, and individuals with DS have difficulties in performing these skills. Socialization developmental expectations for children ages 7-10 include “Respond[ing] appropriately when introduced to

strangers,” “end[ing] conversations appropriately,” and “refrain[ing] from asking questions or making statements that might embarrass or hurt others” (Sparrow et al., 1984 p. 8). As expected, these skills require more cognitive demands than socialization in infancy and toddlerhood (e.g., showing interest in others around them; See Appendix A) or in preschool (e.g., establishing friendships). In this dissertation, during middle childhood, children with DS were not developing socialization skills at the same rate of their typically developing peers. Therefore, this is a critical time for intervention to promote their socialization competencies.

Developmental Trajectories of Adaptive Behavior

Group Differences.

Communication. Diagnostic status was a significant predictor of average communication scores in toddlerhood and average rates of change across the three time points for individuals with ASD and DS. Children with DS had higher communication scores in toddlerhood, controlling for mental age and executive function, and a slower rate of change from toddlerhood to middle childhood. These findings suggest that although toddlers with DS have slightly higher communication scores, they do not gain skills as quickly as children with ASD. These differences may be due to the intervention services received during toddlerhood to middle childhood, as children with ASD potentially receive more services during childhood (Will & Hepburn, 2016). Future research should examine whether interventions account for these group differences.

Daily living skills. Diagnostic group was not a significant predictor of average daily living skills scores in toddlerhood or average rate of change across the three time points. To my knowledge, this is the first study to report this finding in children with ASD and children with

DS. These findings indicate that trajectories of daily living skills are not related to a diagnosis of ASD or DS, and are a significant area for intervention in both groups. This finding highlights the importance of targeting daily living skills in interventions regardless of diagnosis. Later, this point will be discussed by highlighting the implications for early intervention programs and the relative disproportion of available early intervention programs for children with ASD and DS.

Socialization. Diagnostic status was a significant predictor of the initial starting states of socialization skills. Children with DS had a significantly higher socialization raw score in toddlerhood than children with ASD, controlling for maternal education and mental age. However, diagnostic status was not a significant predictor of the rate of change in socialization skills. This finding suggests that individuals with ASD and DS develop socialization skills at the same rate from toddlerhood to middle childhood, suggesting that individuals with DS do not necessarily have a relative strength in the growth of socialization skills over time. These findings have implications for early intervention practitioners to integrate practices differently across the two groups. Toddlers with ASD may benefit from early intervention providers explicitly targeting socialization skills to promote skill development. Toddlers with DS may benefit from early interventionists capitalizing on socialization as a strength to promote later optimal growth trajectories. For example, social reinforcers may be an optimal practice for toddlers with DS rather than ASD to promote skill development.

Predictors of Developmental Trajectories

Communication. Mental age was the only significant predictor of the average communication raw scores in toddlerhood, and mental age and executive function were significantly associated with the rate of change in socialization skills from toddlerhood to middle childhood. Children with higher mental ages in toddlerhood had higher communication scores in

toddlerhood and a greater rate of change from toddlerhood to middle childhood controlling for diagnostic status and executive function. It is important to note that the overall mental age as measured by the MSEL also measures communication. There may be some overlap with items; however, the MSEL is a direct assessment, and the VABS is a parent-reported assessment. For example, for expressive communication on the MSEL, an examiner observes spoken vocabulary and elicits a child between ages 2 and 3 to label objects and pictures and on the VABS parents report on their child's vocabulary and grammar (Mullen, 1995; See Appendix A). The aim of the current study was to examine the influence of overall intellectual functioning on adaptive behavior domains. Previous studies have used total MSEL scores to examine this relationship in individuals with ASD and DS (Marchal et al., 2016; Munson et al., 2008). In this study, overall mental age included average overall age equivalency scores from the MSEL to address floor effects in young children with disabilities and to represent a comparison to typically developing peers. Nonverbal mental age including visual reception and fine motor was highly correlated with overall mental age ($r = .83, p < .001$), suggesting that use of overall mental age was appropriate for the aims of the present study.

Children with higher numbers of correct trials on the executive function task in toddlerhood had a slower rate of change from toddlerhood to middle childhood controlling for diagnostic status and mental age. This finding was unexpected, but may be due to issues of collinearity between mental age and executive function. Mental age and executive function covaried significantly together ($\beta = .16, p = .012$). It may also relate to the measurement issues associated with the ecological validity of executive function laboratory-based tasks (Garon et al., 2008; Gioia et al., 2002) Previous studies that reported a significant association between executive function and adaptive behavior used parent-reports of executive function (Gilotty et

al., 2002; Pugliese et al., 2015; 2016). A recent review in children in clinical and nonclinical samples reported that laboratory-based tasks and ratings of executive function had small associations, suggesting that these measures do not assess the same construct (Toplak, West, & Stanovich, 2013). This finding is consistent with a recent study in school-aged children with DS that compared informant-reports of executive function to an executive function battery including tasks measuring working memory/inhibitory control, inhibitory control, cognitive flexibility, and planning. The working memory/inhibitory control task was the only task associated with parent-report measures (Daunhauer et al., in press). Future studies should seek to use both laboratory-based tasks and ratings of executive function to examine the relationships between adaptive behavior (Toplak et al., 2013).

Daily living skills. Mental age was the only significant predictor of average daily living skills raw scores in toddlerhood and the average rate of change in daily living skills from toddlerhood to middle childhood, controlling for diagnostic status, maternal education, executive function, and autism symptoms. Children with higher mental ages in toddlerhood had higher daily living skills scores and a greater average rate of change, controlling for diagnostic status, maternal education, executive function, and autism symptoms.

Socialization. Mental age and maternal education were significant predictors of initial starting states of socialization scores. Mental age was also significantly associated with the rate of change in socialization scores. Children with higher mental ages in toddlerhood had higher socialization scores in toddlerhood and a greater rate of change, controlling for diagnostic status and maternal education. Maternal education was significantly associated with initial starting states of socialization scores. Children whose mothers had more education obtained higher socialization raw scores in toddlerhood, controlling for diagnostic status and mental age. This

finding supports the general child literature that maternal education is an important indicator of child outcomes; however, contrasts previous studies that reported no association between adaptive behavior and maternal education (De Battista et al., 2016; Bornstein, Hahn, & Suwalsky, 2013; Pugliese et al., 2015). These studies were conducted in older age groups, when children are likely receiving additional educational experiences and opportunities to develop socialization skills in school settings. Maternal education may be more important for younger children and interventions may benefit from educational components for parents regarding socialization skills.

Mental age. Mental age emerged as a significant predictor of both initial starting states of all adaptive behavior domain scores in toddlerhood and the average rates of change in adaptive behavior from toddlerhood to middle childhood. These findings support previous research in preschoolers and school-aged children regarding the relationship between mental age and adaptive behavior cross-sectionally and longitudinally (Baghdadli et al., 2011; Flanagan et al., 2015; Kanne et al., 2015;). Previous studies in toddlers with ASD reported significant relationships between MSEL scores and adaptive behavior scores in toddlerhood (; Paul et al., 2014; Yang et al., 2016); however, this is the first study, to our knowledge, to report this finding longitudinally in toddlers with ASD using the MSEL. This study replicates a previous longitudinal study in toddlers with DS that reported a significant relationship between MSEL scores and adaptive behavior in school-age children with DS (Marchal et al., 2016).

Autism symptoms. Autism symptoms in toddlerhood (as measured by parents using the ADI-R) in toddlerhood were not a predictor of developmental trajectories of communication, daily living skills, or socialization. In children with ASD, the ADOS severity scores were not significantly associated with raw scores in communication, daily living skills, or socialization on

the VABS in toddlerhood, preschool, and during the school years. This finding supports previous reports of non-significant associations between social and communication symptoms and adaptive behavior skills in children ages 7 to 12 with ASD (Klin et al., 2007; Saulnier & Klin, 2007; McDonald et al., 2015). Only one study had reported a significant relationship between autism symptoms and adaptive behavior in toddlerhood (Perry et al., 2009); however, this study assessed autism symptoms using the Childhood Autism Rating Scale (CARS; Schopler et al., 1988). The CARS is criticized for the lack of a cutoff score for ASD, and potentially over-diagnosing children with ASD (Lord, 1995). Higher scores on the CARS may not be representative of higher levels of symptoms as compared to other diagnostic tools, therefore use of this measure may lead to different findings.

Many interventions for children with ASD primarily focus on reducing core symptoms of ASD, including social and communication impairments. These impairments, as measured by diagnostic tools, are not necessarily associated with adaptive behavior outcomes. Interventions targeting autism symptoms may not impact adaptive behavior. Therefore, there is a critical need for interventions to target both autism symptoms and adaptive behavior. Currently there are existing evidence-based practices and intervention programs citing promotion of adaptive behavior; however, few programs report positive adaptive behavior outcomes, in particular, daily living skills.

Implications for Evidence-Based Practices and Intervention Programs in ASD

For toddlers with ASD, there is a growing literature on evidence-based practices and the efficacy of comprehensive early intervention programs; however, these programs are not necessarily targeting adaptive behavior effectively. The following section reviews evidence-based practices and early intervention programs for young children with ASD and describes how

these programs target adaptive behavior skills. Evidence-based practices and early intervention programs are two approaches for promoting skill development that are discussed in the ASD literature (Wong et al., 2014). *Evidence-based practices* are defined as the focus on the development of a specific skill for individuals with ASD (Odom, Boyd, Hall, & Hume, 2010; Wong et al., 2014). *Early intervention programs* incorporate multiple practices focused on broader skill development across multiple domains of development, such as communication and socialization. These programs are typically based on a conceptual framework, have operationalization of procedures, occur over a period of a year or more, and vary in intensiveness (e.g., the number of structured learning opportunities or number of hours per week) (Odom et al., 2010; Wong et al., 2014).

Evidence-Based Practices

For this dissertation, potentially efficacious practices from a recent review will be discussed that are related to improving communication, daily living, and socialization skills. These practices are often utilized in combination for children with developmental disabilities. The National Professional Development Center on ASD (NPDC; Wong et al., 2014) and the Autism Evidence-Based Practice Review Group identified evidence-based practices for individuals with ASD across the lifespan based on a comprehensive review of the literature from 2007-2011. The goal of this project was to provide training and resources for educators and practitioners (Wong et al., 2014). Their comprehensive review focused on intervention practices designed to target individual skill development, rather than specific program efficacy (Odom et al., 2010; Wong et al., 2014). They identified 456 studies that fit qualification criteria, which included: (a) a minimum of five high-quality single-case studies in 20 participants across three different research groups, or (b) a minimum of two high quality experimental or quasi-

experimental studies conducted across two separate research groups, or (c) a combination of a minimum of three high-quality single case studies and one high quality experimental or quasi-experimental study conducted across two research groups.

Many of the evidenced-based practices reviewed by NDBP in children with ASD target communication and socialization. See Table 5 for a detailed description of the evidence-based practices reviewed by NDPB for toddlers, preschoolers, and school-aged children with ASD across communication, daily living skills, and socialization. Fewer practices were identified for daily living skills across all three age groups, which is unfortunate, given the significant daily living skills delays observed in the current study and the significance of targeting these skills in childhood. Many practices focused on communication and socialization skills in toddlerhood may also be useful for building daily living skills. For example, pivotal response training promotes child motivation to learn new social and communication skills that are not intrinsically reinforcing; this approach could be effective in engaging young children in less preferred but important functional activities of daily living (e.g., toileting). Pivotal response training also emphasizes antecedent-based interventions, which focus on modifying the environment. Modifying the environment could promote mastery of daily living skills that are expected to develop in toddlerhood, such as toileting and eating independently (See Appendix A for a description of expectations of adaptive behavior in toddlerhood). It is unclear whether the practices identified in preschool and school-aged children are effective for use with toddlers. For example, discrete trial training was not identified in the literature review for this age range. More research is needed to examine the efficacy of promising practices targeting daily living skills in young children.

Comprehensive Early Intervention Programs Promoting Adaptive Behavior

This section discusses comprehensive early intervention programs that have reported positive adaptive behavior outcomes during toddlerhood and preschool. As described above, comprehensive early intervention programs often include many evidence-based practices and target a range of outcomes, typically the core impairments associated with ASD (Odom et al., 2010;2014; Wong et al., 2014). There has been an increase in efficacy and effectiveness research on early intervention programs for young children with ASD. Some studies report increased adaptive behavior skills after treatment (Cohen et al., 2006; Dawson et al., 2010; Eikeseth et al., 2011; Schertz, Odom, & Baggert, & Sideris, 2013; Smith et al., 2015). See Table 6 for an overview of intervention programs for young children with ASD. The interventions reporting positive adaptive behavior outcomes include: The Early Start Denver Model, Joint Attention Mediated Learning, Early Intensive Behavioral Intervention, and Children’s Toddler School (Cohen et al., 2006; Dawson et al., 2010; Eikeseth et al., 2011; Scherz et al.,2013; Smith et al., 2015). The next section will discuss these programs in greater depth as examples of programs that have reported significant improvements in some areas of adaptive behavior.

Selected Review of Early Intervention Programs in ASD

Early Start Denver Model. The Early Start Denver Model(ESDM) is a comprehensive developmental behavioral intervention for children with ASD ages 18-60 months (Dawson et al., 2010; Rogers & Dawson, 2009). ESDM is a naturalistic intervention that incorporates principles of learning from an applied behavioral analysis perspective. The intervention focuses on social learning and social-cognitive development (Dawson et al., 2010; Rogers & Dawson, 2009). ESDM incorporates the learning needs of the child, the child’s preferences and interests, and the families’ preferences and interests across the home and community (Rogers & Dawson, 2010).

Based on findings across multiple contexts, engagement in high intensity ESDM services for a relatively long period promotes significant gains in communication skills, with less of an impact on daily living skills and socialization (Dawson et al., 2010; Rogers et al., 2012; Vivanti et al., 2014). In a randomized-controlled trial, children who received 20 hours/week of ESDM for one year showed no differences in adaptive behavior scores, compared to individuals receiving community intervention services. After two years of treatment, at the same level of intensity, individuals receiving ESDM increased their overall adaptive behavior composite, communication, and daily living skills standard scores ($M_s = 64-82$), relative to individuals receiving community intervention services at the same time ($M_s = 58-69$). The scores were still considered to be moderately low compared to their typically developing peers and average for their communication skills (Dawson et al., 2010). Both groups decreased their standard scores, comparing their growth to typically developing peers, across adaptive behavior domains over two years, except for a 13-point increase in the communication domain for individuals in the ESDM group.

These findings suggest that while ESDM is promoting higher adaptive behavior skills than treatment as usual, with growth in communication, adaptive behavior is still delayed. Ryberg (2016) reviewed the evidence for ESDM between 2010-2015, and Dawson et al. (2010) was the only study, out of eight, that reported significantly greater improvements in adaptive behavior in young children with ASD receiving ESDM, compared to those receiving treatment as usual. Vivanti and colleagues (2014) reported improvements in communication standard scores in individuals receiving either ESDM or treatment as usual in a childcare setting. The community intervention also employed evidence-based practices for young students with ASD, such as applied behavioral analysis techniques, which may be why both groups improved (Vivanti et al.,

2014). These findings are similar to a parent-based implementation of ESDM (Rogers et al., 2012). In the parent-based ESDM curriculum, parents receive 1 hour per week of instruction for 12-weeks. There were no significant differences in adaptive behavior skills between individuals receiving the parent-based ESDM and individuals receiving the community intervention, and communication was the only adaptive behavior that significantly improved (Rogers et al., 2012). Dawson et al. (2010) did not report significant differences until after two years of treatment, whereas Vivanti et al. (2014) examined outcomes after 12 months and Rogers et al. (2012) after 12 weeks. These findings indicate that the length of the intervention may be related to the acquisition of skills and longer time in the intervention may be required to show meaningful change in adaptive behavior.

Findings support that a parent's ability to respond to their child is associated with developmental outcomes in social-communication (Vismara & Rogers, 2008). This may also be true for adaptive behavior, as parents and caregivers usually have many opportunities to help promote adaptive behavior skills in their children. In fact, parent-implemented interventions are identified as an evidence-based practice to promote adaptive behavior skills in the NDBP review (Wong et al., 2014). Parent-mediated ESDM interventions may benefit from additional instruction regarding adaptive behavior skills.

Joint Attention Mediated Learning. Joint Attention Mediated Learning (JAML; Scherz & Odom, 2007) is a parent-implemented intervention that focuses on building joint attention skills in toddlers with ASD. Parents receive weekly training on how to encourage their children to look at faces, engage in turn taking with their caregivers and focus on sharing attention between an object and a caregiver. A small-scale randomized controlled trial reported significant increases in communication standard scores for toddlers receiving JAML and no significant differences in

standard scores for toddlers in the control group (Scherz, Odom, Baggett, & Sideris, 2013). While these findings warrant replication in a larger sample size, they provide preliminary evidence that a targeted curriculum may support gains in communication adaptive behavior skills.

Early Intensive Behavioral Intervention. Early Intensive Behavioral Intervention (EIBI; Lovaas, 1981;1987;2003) is a comprehensive applied behavior analysis program developed from the UCLA Lovaas model for children with ASD younger than five years (Lovaas, 1987;2003). The 1:1 in-home component focuses on discrete trial training with a focus on communication development. In addition to expressive and receptive communication, the UCLA curriculum incorporates self-help, visual spatial skills, imitation, and compliance with instruction. Generalization activities are also included through structured opportunities to use language within play and during community outings. After about one year of treatment, a peer component is added as the child enters preschool. A tutor facilitates interactions with a typically developing peer. Finally, as the child enters school, a tutor assists with the generalization of skills to the classroom environment (Cohen et al., 2006; Lovass, 1987; 2003).

Several studies report positive adaptive behavior outcomes following EIBI, although some findings are mixed (for reviews see Dawson, 2013 & Reichow, 2012). Toddlers receiving EIBI increased their overall adaptive behavior standard scores significantly by an average of 9 points compared to a decrease of 4 points by individuals receiving services as usual. The EIBI group had significantly higher communication and daily living scores, but not socialization scores than the group receiving services as usual after 1-year of treatment (Cohen et al., 2006). In another follow-up study, young children with ASD showed significant improvements in communication, daily living skills, and socialization standard scores after 1-year in preschoolers and kindergartners compared to the individuals receiving services as usual. There were no

significant increases from 1-year to 2-years (Eikeseth et al., 2011). Smith, Klorman, and Mruzek (2015) reported significant changes in adaptive behavior standard scores across two years for children receiving the intervention, although this study did not have a comparison group. As shown in Table 6 and like ESDM, EIBI uses many evidence-based practices, including discrete trial training and playful generalization. Perhaps, the benefits on daily living skills and socialization not observed in the ESDM are due to the delivery across multiple contexts and focus on the opportunity to generalize skills in community settings in EIBI. EIBI emphasizes the generalization of skills beyond ESDM by incorporating community outings, uses peer-mediated interventions, and facilitates interactions with typically developing peers. It appears that these opportunities to generalize are as strength of this intervention and could be leading to generalization of adaptive behavior outcomes.

Smith et al. (2015) also reported additional predictors for adaptive behavior gains for individuals receiving EIBI. Younger ages at intervention entry were associated with greater adaptive behavior gains during the intervention across two years. In addition, social engagement at baseline was associated better adaptive behaviors following the intervention. Higher IQ at baseline was also associated with higher adaptive behavior scores after two years (Smith, Klorman, & Mruzek, 2015), which supports the findings in the current dissertation. Smith et al. (2015) and this dissertation both utilized the MSEL as a measure of overall developmental functioning. The MSEL assesses developmental domains that may be foundational for adaptive behavior in toddlerhood and are predictive of adaptive behavior growth over time in these studies. In addition to promoting developmental skills in interventions, the MSEL may provide early identification of young children with developmental disabilities to incorporate adaptive behaviors specifically into their interventions.

While the EIBI studies discussed have supported adaptive behavior gains immediately following EIBI, one follow-up study post-treatment has reported no significant group differences. In a follow-up study two years later, individuals who were no longer receiving the EIBI did not show significant differences in adaptive behavior in preschool compared to preschoolers who had received services as usual. This highlights the importance of examination of maintenance of gains following intervention programs, as well as the potential need for interventions in preschool and during the school-years. The researchers found that those who received the parent-implemented intervention maintained their adaptive behavior standard scores, while those receiving university implemented intervention had decreased daily living and communication standard scores (Kovshoff, Hastings, & Remington, 2011). These findings warrant replication in larger sample sizes but suggest that the modality of the intervention may have a significant impact on adaptive behavior. In addition, adaptive behavior is typically assessed from a parent, or caregiver perspective and these findings support that parent-implemented interventions may support the growth of adaptive behavior skills.

Children's Toddler School. Community-based inclusion programs for toddlers also report significant adaptive behavior gains. These inclusive programs incorporate multiple evidence-based techniques in their interventions. The Children's Toddler School is primarily driven by pivotal response training (Stahmer & Ingersoll, 2004). Toddlers who participated in the Children's Toddler School received individualized treatment incorporating a combination of teaching and developmental techniques within the classroom. Toddlers participating in the initial program (n=20) made significant gains in communication and socialization standardized scores after an average of 9.5 months in the intervention program (Stahmer & Ingersoll, 2004). In a study of 102-toddlers who had completed eight months of the program, the toddlers made

significant gains in communication, daily living skills, and socialization standard scores upon exiting the program. At the end of the program, 30% of toddlers were in the average range of communication standard scores, as compared to 5% at entry of the program, 11% were in the average range of daily living skills standard scores, as compared to 6% at entry of the program, and 23% were in the average range of socialization standard scores, as compared to 4% at entry of the program (Stahmer, Akshoomoff, & Cunningham, 2011). As shown in Table 6, the CTS utilizes several evidence-based practices.

Implications for Practice. In the four programs described above, use of evidence-based practices is associated with general gains in adaptive behavior skills for young children with ASD; however significant gains in daily living skills and socialization are rarely observed. Studies examining program outcomes using parent-implemented interventions, naturalistic interventions, and implementation in preschool settings reported positive effects, suggesting that interventions that incorporate opportunities for generalization are needed to improve adaptive skills. While ESDM, JAML, EIBI, and CTS have reported adaptive behavior gains across various domains, most participants' standardized scores are typically considered in the low to moderately low range, with a few participants in the average range. These findings suggest that these interventions are supporting growth; however, children with complex developmental disabilities are not performing as well as their typically developing peers, even when they receive high quality intervention. While the evidence-based practices in these programs were reported to increase adaptive behavior skills, these programs may not necessarily be using evidence-based practices across all domains of adaptive behavior. A more systematic approach to integrating adaptive skills into comprehensive early intervention programs is necessary. These

interventions may benefit from targeting adaptive behavior more intensively, for longer periods of time, and in multiple settings to address daily living skills and socialization.

Early Intervention Programs Reporting No Significant Differences

Many early intervention programs employ evidence-based practices, but report no significant differences in adaptive behaviors or do not report on adaptive behavior as an outcome. The following section describes intervention programs that report no adaptive behavior differences, including Hanen’s “More Than Words” Program (McConachie, Randle, Hammal, & Le Couteur, 2005) and the Comprehensive Autism Program (Young, Folco, & Hanina, 2016). The section concludes with a description of programs that do not report on adaptive behavior outcomes and discusses implications for future research and practice.

Hanen’s “More than Words” Program

Hanen’s “More than Words” program is a parent-implemented intervention designed to promote nonverbal communication for toddlers with ASD. This program is designed to teach parents skills to help improve their children’s social communication, with an emphasis on the use of visual supports (Carter et al., 2011; Girolametto, Sussman, & Weitzman, 2007; McConachie et al., 2005). Given the focus on communication and socialization skills, it would be expected that these areas of adaptive behavior would increase. Parents reported gains in adaptive behavior communication standard scores after nine months of treatment in both the intervention group and individuals receiving community services as usual, but not socialization standard scores (Carter et al., 2011). Therefore, the skills the parents are learning and incorporating with their children in this intervention are not generalizing to everyday communication adaptive behaviors above and beyond services as usual. The duration of the intervention may need to be longer to observe

group differences. The change in communication standard scores is promising, but further examination of how this program can target these skills above and beyond services as usual, and considerations regarding how to improve socialization and daily living skills is needed.

Comprehensive Autism Program

Comprehensive Autism Program is a new school-based program for preschoolers with ASD (Young, Folco, & Hanina, 2016). This program was developed based on the incorporation of evidence-based practices recommended by Wong et al. (2014). In a randomized-controlled trial, the Comprehensive Autism Program was administered to 41 schools for children ages 3 to 5. The 37 schools in the services as usual group implemented evidence-based practices, but the Comprehensive Autism Program had new curriculum and training workshops for educators and parents. No significant differences were reported in adaptive behavior scores compared to the treatment as usual group (Young et al., 2016). Young, Folco, and Hanina (2016) suggest that for adaptive behavior, new curriculum or evidence-based practices may be needed, as well as longer implementation of programs.

Additional Early Intervention Programs

Finally, there are intervention programs that incorporate evidence-based practices but do not report on adaptive behavior outcomes. The Learning Experiences and Alternative Programs for Preschoolers and their Parents (LEAP; Hoysen, Jamieson, & Strain, 1985) is community-based inclusion program that is primarily based on peer-mediated intervention. Preschoolers with ASD attend their preschool classroom with their typically developing peers. Typically developing preschoolers are provided with social skills training and family training is provided regarding behavioral strategies (Strain, 1987, 1996; Strain et al., 1996; Strain & Hoyson, 2000;

Strain & Bovey, 1998). Studies report positive cognitive and language outcomes and reduction in autism symptoms and problem behavior but have not reported on adaptive behavior outcomes (Hoyson, Jamieson, & Strain, 1985; Strain & Bovey, 2011; Strain & Hoyson, 2000).

The Princeton Child Development Institute (PCDI; Fenske, Zaluski, Krantz, & McClannahan, 1985) and Walden Toddler Program (McGee, Morrier, & Daly, 1999) are two comprehensive programs in which students with ASD attend school from their diagnosis of autism with programs available through adulthood. These programs are exclusive for individuals with ASD and rely on applied behavioral analysis techniques. The PCDI places emphasis on picture schedules and use of scripting to help describe routines and social situations (MacDuff, Ledo, McClannahan, & Kranz, 2007; McClannahan & Kranz, 2005; Pelios, MacDuff, & Axelrod, 2003; Wichnick, Vener, Keating, & Poulson, 2010). Most of these studies were single subject designs, examining 2-3 preschool -school-aged children. It is unclear whether in the LEAP, PCDI, or Walden Toddler Program the comprehensive set of skills taught in the school setting generalize to everyday activities promote adaptive behavior skills.

Joint Attention, Symbolic Play, Engagement, and Regulation (JASPER; Kasari, Freeman, & Paparella, 2006) focuses on increasing joint attention and play skills. In the parent-implemented intervention, parents receive structured training in understanding their child's play and social and communication skills and how to use this knowledge to increase their child's engagement during play. This increased engagement during play provides opportunities to learn social and communication skills. Studies report increases in joint attention and play skills, but have not reported on adaptive behavior outcomes (Kasari et al., 2006; Kasari, Gulsrud, Paparella, Helleman, & Berry, 2015; Kasari, Gulsrud, Wong, Kwong, & Locke, 2010). These intervention

programs may benefit from an additional examination of adaptive behavior outcomes to determine whether their positive effects on other outcomes are also generalizable to these skills.

Early Intervention Programs in Other Developmental Disabilities

The interventions discussed only include young children with ASD. It is important to note that, toddlers with DS may also benefit from interventions. In the present study, toddlers with Down syndrome demonstrated higher socialization scores than toddlers with ASD. Based on the study that showed higher social engagement before starting the intervention was associated with higher adaptive behavior scores, toddlers with Down syndrome may benefit the Early Intensive Behavioral Intervention (Smith et al., 2015). Despite their higher socialization scores in toddlerhood, preschoolers and school-aged children with Down syndrome had similar socialization raw scores to preschoolers and school-aged children with ASD. This finding provides further support that individuals with Down syndrome may benefit from interventions targeting these skills as well. However, it is unclear whether interventions designed exclusively for young children with ASD will also benefit children with DS.

There are a few intervention programs that have been studied in ASD, DS, and other developmental disabilities. Mahoney's Responsive Teaching was designed to promote cognitive, language, and socioemotional skills in young children with developmental disabilities. Parents are taught strategies to increase their responsive interactions and support their child's developmental skills (Mahoney & Pareles, 2005). Parental responsiveness during engagement with a child was associated with greater communication, daily living skills, and socialization adaptive behavior skills in toddlers with developmental disabilities (Mahoney, Kim, & Lin, 2007). Mahoney & Pareles (2005) reported that toddlers with ASD, DS, and other developmental disabilities made significant gains after one year of the intervention in cognitive, language, and

socioemotional skills, with the largest gains in expressive and receptive language skills (Mahoney & Paraeles, 2005).

Milieu Language Teaching is another intervention focusing on increased communication that has been tested in individuals with ASD, DS, and other developmental disabilities (Kaiser, 1993; Kaiser, Hancock, & Nietfield, 2000; Wright & Kaiser, 2017). Although these studies did not report specific adaptive behavior outcomes, components of adaptive behavior across language and socioemotional skills were reported, including expressive and receptive language, an area of communication development. Further research is necessary to test interventions in multiple groups and examine adaptive behavior as an outcome.

Limitations

This study had several limitations. First, this study was conducted from 1997-2007. This sample may not represent current children with ASD and an exploration of cohort effects is warranted. Second, there was a large proportion of missing data. Corrections were made using FIML and the Bartlett scaling factor for missing data. More complete data would inform fit of the growth models assessing developmental trajectories of adaptive behavior more accurately. Third, there were only three time points in this study, which limits the ability to capture the true shape of a developmental trajectory. Future research should seek to collect additional time points to determine whether a linear or quadratic fit best describes the developmental trajectories. Additional time points would also allow for the examination of whether predictors in early childhood influence trajectories in adolescence and adulthood. Fourth, executive function was not a significant predictor in the current study, and this may be due to the measurement issues of executive function laboratory-based tasks. The Spatial Reversal task captures both cognitive flexibility and working memory but may have additional issues of task impurity, given the high

correlation with mental age. Future studies should seek to incorporate parent-report based measures of executive function with laboratory-based executive function batteries.

Finally, this study used a variable-centered approach examining the average adaptive behavior trajectories across all participants. This approach does not necessarily capture the heterogeneous nature of children with ASD and DS. In previous research, Szatmari et al. (2015) and Baghdadli et al. (2011) identified trajectories of adaptive behavior and autism symptoms over time in subgroups of children with ASD. By identifying subgroups within diagnosis, treatments can be examined to identify the effectiveness across individuals with disabilities. Future research should seek to incorporate multiple groups and predictors of these trajectories to identify early intervention targets in toddlerhood.

Conclusion

The current study extends the growing literature by examining developmental trajectories of adaptive behavior from toddlerhood to middle childhood and comparing two developmental disabilities. While adaptive behaviors demonstrate growth over time, there is evidence for persistent delays relative to typically developing peers. The research presented in this dissertation makes contributions to understanding the influence of initial starting states of adaptive behavior in growth over time. Diagnosis significantly predicted developmental trajectories of communication and socialization, but not daily living skills. Mental age was identified as a significant predictor for all domains of adaptive behavior. Maternal education predicted initial starting states of socialization scores in toddlerhood. These findings have important implications for interventions, including further evaluations of evidence-based practices and targeting adaptive behavior explicitly within early intervention programs.

Behavioral interventions in early childhood are associated with improved cognitive, language, and adaptive behavior outcomes (Dawson et al., 2010; Warren et al., 2011); however, many intervention programs report significant changes in only one domain of adaptive behavior, no significant differences, or do not report on adaptive behavior outcomes. Therefore, there is a critical need for intervention programs in children with ASD and children with DS to explicitly address adaptive behavior beginning in toddlerhood to promote the growth of adaptive behavior throughout childhood.

Table 5.

<i>Evidence-Based Practices Related to Adaptive Behavior Outcomes</i>										
Evidence-based Practice	Definition	Toddlers			Preschoolers			School-Aged		
		COM	DLS	SOC	COM	DLS	SOC	COM	DLS	SOC
Antecedent-based Intervention	Behaviors are changed or shaped based on modifications to the environment (Hume, 2013a)	•		•	•		•	•	•	•
Discrete Trial Training	Behaviors and skills taught through repeated trials with clear antecedents and consequences using praise and rewards to promote desired behaviors (Fleury, 2013a)				•	•	•	•	•	•
Functional Communication Training	Appropriate communication skills are taught to replace inappropriate communication skills (Fettig, 2013b)				•		•	•	•	•
Modeling	Desired behavior is demonstrated to the individual and then imitated by the individual (Cox, 2013a)	•		•	•		•	•		•
Naturalistic Intervention	Behaviors targeted using individual's interests within the individual's everyday contexts (Wong, 2013a)	•		•	•		•	•		•
Parent-implemented Intervention	Parents are trained by clinicians to conduct interventions with their child (Schultz, 2013)	•	•	•	•	•	•	•	•	•
Pivotal Response Training	Naturalistic intervention used to enhance behaviors through motivation, self-management, initiation, and responses (Wong, 2013b)	•		•	•		•	•		•
Prompting	Behaviors acquired or learned through verbal, gesture, or physical assistance (Cox, 2013b)	•	•	•	•	•	•	•		•
Reinforcement	Behaviors increased through establishing relationship between behavior and consequences through desirable item or activity (Kurcharczyk, 2013b)	•	•	•	•	•	•	•	•	•
Social Skills Training	Group or individual instruction to develop appropriate social skills with typically developing peers (Fettig, 2013d)	•		•	•		•	•		•
Video Modeling	Video used to model behaviors or skills (Plavnick, 2013)	•	•	•	•		•	•	•	•
Visual Support	Concrete cues with information regarding skill, activity, or routine (Hume, 2013b)	•		•	•		•	•	•	•
Peer-mediated instruction	Typically developing peers work with individuals to develop desirable behaviors (Fettig, 2013c)				•		•	•		•

Picture Exchange Communication System	Pictures of the desired item used to teach communication skills in social contexts (Wong, 2013c)	•		•	•		•
Response Interruption/ Disruption	Diverts attention away from repetitive or stereotyped behaviors with a prompt, comment, or distractor (Boyd & Wong, 2013)	•	•	•	•	•	•
Scripting	Verbal and written descriptions provided for various skills and situations (Fleury, 2013c)	•		•	•		•
Social narratives	Detailed descriptions of social situations with relevant cues and appropriate responses (Wong, 2013d)	•	•	•	•		•
Technology-aided instruction and intervention	Technology used to support goals of individual (Odom, 2013)	•		•	•		•
Time delay	Delays used to decrease prompting while learning skills (Fleury, 2013e)	•	•	•	•		•
Extinction	Undesirable behaviors are reduced by removing consequences (Fleury, 2013b)	•			•	•	•
Task analysis	Breaks down behaviors into smaller components for individual to learn skill (Fleury, 2013d)	•			•	•	•
Differential reinforcement of alternative, incompatible, or other behavior	Desired behaviors are increased by providing positive consequences, and undesirable behaviors are ignored (Kurcharzyk, 2013a)	•		•	•	•	•
Cognitive behavioral intervention	Individual taught to understand their cognitive processes involved in behaviors and use their understanding to change thoughts and behaviors (Brock, 2013)					•	•
Functional behavior assessment	Assessment used to determine underlying cause of behaviors (Fettig, 2013a)					•	•

Note. A • indicates that the practice was identified as efficacious for the age group and adaptive behavior. COM= Communication. DLS= Daily Living Skills. SOC= Socialization. Adapted from Wong, C., Odom, S. L., Hume, K. Cox, A. W., Fettig, A., Kurcharzyk, S., . . . Schultz, T. R. (2014). *Evidence-based practices for children, youth, and young adults with Autism Spectrum Disorder*. Chapel Hill, NC: The University of North Carolina, Frank Porter Graham Child Development Institute, Autism Evidence-Based Practice Review Gro

Table 6.

<i>Overview of Early-Intervention Programs and Adaptive Behavior Outcomes</i>						
Program Name	Citations	Inclusion/ Exclusion	Evidence- Based Practices /How Adaptive Skills Are targeted	Context of Delivery	Length	Adaptive Behavior Outcomes
Early Start Denver Model (ESDM)	Dawson et al. 2010	Diagnosis or at-risk for ASD 1.5 years – 5 years	ABI, NI, PII, PRT, M, P, RI, RD, TA; Individualized Goals	-Therapists 4 hours a day 5x/week in home, school, or community, individualized or group -Parents 16 hours/week	2 years	ESDM group had significantly higher communication and daily living skills standard scores than treatment as usual group, but not socialization scores. In ESDM group, communication standard scores increased significantly, whereas daily living and socialization decreased
Joint Attention Mediated Learning (JAML)	Schertz, Odom, Baggert, & Sideris, 2013	Diagnosis of ASD 0-3 years	NI, PII, M, P, RI, RD,	-1 hour per week with parents	6 months	JAML group had significantly higher communication standard scores than the control group, and communication standard scores increased significantly.
Early Intensive Behavioral Intervention (EIBI)	Cohen et al. 2006; Eikeseth et al., 2011; Kovshoff, Hastings, & Remington, 2011; Lovaas, 1987;2003; Smith et al., 2015	Diagnosis of ASD 1.5- 7years	DTT, NI, EX, M, P, RI, RD, TA Individualized Goals	-In-home 1:1 therapist instruction 35-40 hours a week -Parent training -Therapist in preschool or school setting 15-37 hours a week	2-3 + years	EIBI group had significantly higher in communication, daily living skills, and socialization standard scores after one year than the treatment group. In EIBI group, communication, daily living skills, and socialization standard scores increased significantly. No significant increases or differences from 1 year to 2 year or treatment or 2-years following completion of treatment
Children's Toddler School (CTS)	Stahmer, Akshoomoff, & Cunningham, 2011; Stahmer & Ingersoll, 2004	Diagnosis of ASD 1.5- 3 years	ABI, NI, PEC, PII, PRT, M, P, RI, RD, VS Individualized Goals	-15 hours a week in classroom -4 hours of service outside of the classroom -2 hours of in-home parent education	6 months- 1.5 years	Adaptive behavior standard scores increased significantly after treatment.
Hanen's More than Words Program (HMTW)	Carter et al., 2011 McConachie, Randle, Hammal, & Le Couteur, 2005	Diagnosis of ASD 0-5 years	NI, PII, M, RI, VS	Parents attend 2.5-hour group session 1x a week for 8 weeks, and 3 1.5 home sessions with a Speech-Language Pathologist	9 months	No significant changes in adaptive behavior scores from treatment as usual group

Comprehensive Autism Program (CAP)	Young, Folco, & Hanina, 2016	Diagnosis of ASD 3-5 years	ABI, DTT, NI, PECS, PRT, SST, M, P, RI, RD, VS	Parents and school staff attended workshops before school year and children had 16 hours/week of school	9 months	No significant changes in adaptive behavior scores from treatment as usual group
Joint attention, symbolic play, engagement and regulation (JASPER).	Kasari, Freeman, & Paparella, 2006	Diagnosis of ASD and 0-3 years	ABI, DTT, NI, PII, M, P, RI, RD	2x 30-minute sessions per week including parent/child and trained interventionist	10-12 weeks	No adaptive behavior outcomes reported
Learning Experiences and Alternative Programs for Preschoolers (LEAP)	Hoyson, Jamieson, & Strain, 1985; Strain & Bovey, 2014	Preschool	ABI, NI, PEC, PII, PMI, PRT, M, P, RI, RD, TD	Typically developing peers and teachers Skill training for families 17 hours/week in classroom	2-3 years	No adaptive behavior outcomes reported
Responsive Teaching	Mahoney & MacDonald, 2007; Mahoney & Pareles, 2004;2005	Diagnosis of developmental disability 0-6 years	NI, PII, M, P, RI, RD	1-2 hour parent-child sessions per week or bi-weekly	4 months-1 year	No adaptive behavior outcomes reported
Walden Toddler Program	McGee, Morrier, & Daly, 1999	Diagnosis of ASD or typically developing children 0-5 years	ABI, NI, M, P, RI, RD,	30 hours per week home and center-based	0-5 years	No adaptive behavior outcomes reported
Milieu Language Teaching	Kaiser, 1993; Kaiser, Hancock, & Nietfield, 2000;	Developmental Disability 0-5 years	PII, M, P, RI, RD, TD	36 sessions, 24 in clinic and 12 in home	1 year	No adaptive behavior outcomes reported
Princeton Development Institute	McClannahan & Krantz, 1997	Toddlers with ASD under 2 for Early Intervention, 3-adult for Preschool and school	ABI, NI, M, P, RI, RD, S, SN, VS	5.5 hours per day, 5 days a week, 11 months a year	Infancy-adulthood	No adaptive behavior outcomes reported

Note. ABI= Antecedent-based intervention. DTT= Discrete Trial Training. NI= Naturalistic Intervention. SST= Social Skills Training. PEC= Picture Exchange Communication System. PII= Parent-implemented intervention. PMI= Peer-mediated intervention. PRT= Pivotal Response Training. EX= Extinction. M= Modeling. P= Prompting. RI= Reinforcement. RD= Redirection. S=Scripting. SN=Social narratives. TA=Task analysis. TD= Time delay. VS= Visual Supports

REFERENCES.

- Abdul-Rahman, O. A., & Hudgins, L. (2006). The diagnostic utility of genetics evaluation in children with pervasive developmental disorders. *Genetics in Medicine, 8*, 50-54.
doi:10.1097/01.gim.0000195304.45116.96
- Akbar, M., Loomis, R., & Paul, R. (2013). The interplay of language on executive functions in children with ASD. *Research in Autism Spectrum Disorders, 7*, 494-501.
doi: 10.1016/j.rasd.2012.09.001
- Allison, P. D. (2012). Handling missing data by maximum likelihood. Retrieved from <http://www.statisticalhorizons.com/wp-content/uploads/MissingDataByML.pdf>
- American Association on Intellectual and Developmental Disabilities. (2013). Definition of intellectual disability. Retrieved from <http://aaidd.org/intellectual-disability/definition#.WKTfETsrK01>.
- American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders (5th ed.)*. Arlington, VA: American Psychiatric Association
- Baddely, A. (2003). Working memory and language: an overview. *Journal of Communication Disorders, 36*, 189-208. doi:1016/S0021-9924(03)00019-4
- Baghdadli, A., Assouline, B., Sonie, S., Peronon, E., Darrou, C., Michelon, C., ... Pry, R. (2012). Developmental trajectories of adaptive behaviors from early childhood to adolescence in a cohort of 152 children with Autism Spectrum Disorders. *Journal of Autism and Developmental Disorders, 42*, 1314-1325. doi: 10.1007/s10803-011-1357-z

- Billstedt, E., Gillberg, I. C., & Gillberg, C. (2007). Autism in adults: Symptom patterns and early childhood predictors. Use of the DISCO in a community sample followed since childhood. *Journal of Child Psychology and Psychiatry*, *48*, 1102–1110.
- Blair, C., & Razza, R. P. (2007). Relating effortful control, executive function, and false belief understanding to emerging math and literacy ability in kindergarten. *Child Development*, *78*, 647-663. doi: 10.1111/j.1467-8624.2007.01019.x
- Bolton, P. F., Golding, J., Emond, A., & Steer, C. D. (2012). Autism spectrum disorder and autistic traits in the Avon longitudinal study of parents and children: Precursors and early signs. *Journal of the American Academy of Child & Adolescent Psychiatry*, *51*, 249–260.
- Bornstein, M. H., Hahn, C., & Suwalsky, J. T. D. (2013). Developmental pathways among adaptive functioning and externalizing and internalizing behavioral problems from childhood into adolescence. *Applied Developmental Science*, *17*, 76-97.
doi: 10.1080/10888691.2013.774875
- Borella, E., Carretti, B., & Lanfranchi, S. (2013). Inhibitory mechanisms in Down syndrome: is there a specific or general deficit? *Research in Developmental Disabilities*, *34*, 65–71.
doi: 10.1016/j.ridd.2012.07.017
- Boyd, B., & Wong, C. (2013). *Response interruption/redirection (RIR) fact sheet*. Chapel Hill, NC: The University of North Carolina, Frank Porter Graham Child Development Institute, The National Professional Development Center on Autism Spectrum Disorders
- Boyd, B.A., McBee, M., Holtzclaw, T., Baranek, G.T., & Bodfish, J.W. (2009). Relationships among repetitive behaviors, sensory features, and executive functions in high functioning

autism. *Research in Autism Spectrum Disorders*, 3, 959-966.

doi:10.1016/j.rasd.2009.05.003

Boyle, C. A., Boulet, S., Schieve, L. A., Cohen, R. A., Blumberg, S. J., Yeargin-Allsopp, M., Visser, S., & Kogan, M. D. (2011). Trends in the prevalence of developmental disabilities in US children, 1997-2008. *Pediatrics*, 127, 1034-1042. doi:10.1542/peds.2010-2989

Beck, D.M., Schaefer, C., Pang, K., & Carlson, S.M. (2005). Executive function in preschool children: test-retest reliability. *Journal of Cognition and Development*, 12, 1690193. doi:10.1080/15248372.2011.563485

Best, J. R., Miller, P. H., & Jones, L. J. (2011). Executive functions after age 5: Changes and correlates. *Developmental Review*, 29, 180-200. doi: 10.1016/j.dr.2009.05.002

Best, J. R., Miller, P. H., & Nagliere, J. A. (2010). Relations between executive function and academic achievement from ages 5 to 17 in a large, representative sample. *Learning and Individual Differences*, 21, 327-336. doi: 10.1016/j.lindif.2011.01.007.

Brock, M. E. (2013). *Cognitive behavioral intervention (CBI) fact sheet*. Chapel Hill, NC: The University of North Carolina, Frank Porter Graham Child Development Institute, The National Professional Development Center on Autism Spectrum Disorders.

Brock, L. L., Rimm-Kaufman, S. E., Nathanson, L. , & Grimm, K. J. (2009). The contributions of 'hot' and 'cool' executive function to children's academic achievement, learning-related behaviors, and engagement in kindergarten. *Early Childhood Research Quarterly*, 24, 337-349. doi: 10.1016/j.ecresq.2009.06.001

- Bull, M. J., & Committee on Genetics. (2011). Clinical report—Health supervision for children with Down syndrome. *Pediatrics*, *128*, 393-406. doi: 10.1542/peds.2011-1605
- Bull, R., & Scerif, G. (2001). Executive functioning as a predictor of children's mathematics ability: Inhibition, switching, and working memory. *Developmental Neuropsychology*, *19*, 273-293. doi:10.1207/S15326942DN1903_3
- Carlson, S.M. (2005). Developmentally sensitive measures of executive function in preschool children. *Developmental Neuropsychology*, *28*, 595-616.
doi:10.1207/s15326942dn2802_3
- Carlson, S. M., & Wang, T. S. (2007). Inhibitory control and emotion regulation in preschool children. *Cognitive Development*, *22*, 489-510.
- Carneiro, P., Meghir, C., & Parey, M. (2012). Maternal education, home environments, and the development of children and adolescents. *Journal of the European Economic Association*, *11*, 123-160. doi: 10.1111/j.1542-4774.2012.01096.x
- Carriedo, N., Corral, A., Montoro, P. R., Herrero, L., & Rucián, M. (2016). Development of the updating executive function: From 7-year-olds to young adults. *Developmental Psychology*, *52*, 666-678. doi: 10.1037/dev0000091
- Carney, D. P. J., Henry, L. A., Messer, D. J., Danielsson, H., Brown, J. H., & Ronnberg, J. (2013). Using developmental trajectories to examine verbal and visuospatial short-term memory development in children and adolescents with Williams and Down syndromes. *Research in Developmental Disabilities*, *34*, 3421-3432. doi: 10.1016/j.ridd.2013.07.012

Center for Disease Control. (2016a). Autism spectrum disorder. Retrieved from <https://www.cdc.gov/ncbddd/autism/index.html>

Center for Disease Control. (2016b). Facts about Down syndrome. Retrieved from <https://www.cdc.gov/ncbddd/birthdefects/downsyndrome.html>.

Christensen, D. L., Baio, J., Van Naarden Braun, K., Bilder, D., Charles, J., Charles, J., Constantino, J. N., ... Yeargin-Allsopp, M. (2016). Prevalence and characteristic of Autism Spectrum Disorders children aged 8 years—Autism and developmental disabilities monitoring network, 11 sites, United States, 2012. *Morbidity and Mortality Weekly Report Surveillance Summary*, 65(3): 1-23.

Clark, C. A. C., Sheffield, T. D., Chevalier, N., Nelson, J. M., Wiebe, S. A., & Espy, K. A. (2013). Charting early trajectories of executive control with the shape school. *Developmental Psychology*, 49, 1481-1493. doi: 10.1037/a0030578

Cohen, H., Amerine-Dickens, M., & Smith, T. (2006). Early intensive behavioral treatment: Replication of the UCLA Model in a community setting. *Developmental and Behavioral Pediatrics*, 27, 145–155. doi:10.0196-206X/06/2702-0145

Costanzo, F., Varuzza, C., Menghini, D., Addona, F., Gianesini, T., & Vicari, S. (2013). Executive functions in intellectual disabilities: A comparison between Williams syndrome and Down syndrome. *Research in Developmental Disabilities*, 34, 1770-1780. doi:10.1016/j.ridd.2013.01.024

Cox, A. W. (2013a) *Modeling fact sheet*. Chapel Hill, NC: The University of North Carolina, Frank Porter Graham Child Development Institute, The National Professional Development Center on Autism Spectrum Disorders.

- Cox, A. W. (2013b) *Prompting (PP) fact sheet*. Chapel Hill, NC: The University of North Carolina, Frank Porter Graham Child Development Institute, The National Professional Development Center on Autism Spectrum Disorders.
- Dajani, D. R., & Uddin, L. Q. (2015). Demystifying cognitive flexibility: Implications for clinical and developmental neuroscience. *Trends in Neuroscience, 1164*, 1-8.
doi: 10.1016/j.tins.2015.07.003
- Daunhauer, L. (2011). The early development of adaptive behavior and functional performance in young children with Down syndrome: current knowledge and future directions. In Fidler, J.D. (Eds.), *International Review of Research in Developmental Disabilities: Vol. 40. Early development in neurogenetic disorders*, (pp. 109-138). doi: 10.1016/B978-0-12-374478-4.000058
- Daunhauer, L., & Fidler, D. (2011). The Down syndrome behavioral phenotype: Implications for practice and research in occupational therapy. *Occupational Therapy in Health Care, 25*, 7-25. doi:10.3109/07380577.2010.535601
- Daunhauer, L., & Fidler, D. (2013). Executive functioning in individuals with Down syndrome. In K. C. Barrett & G. Morgan (Eds). *The Handbook of Self-Regulatory Processes in Development: New Directions and International Perspectives* (pp 453-472). New York, NY: Psychological Press
- Daunhauer, L. A., Fidler, D. J., Hahn, L., Will, E., Lee, N. R., & Hepburn, S. (2014a). Profiles of everyday functioning in young children with Down syndrome. *American Journal of Intellectual and Developmental Disabilities, 4*, 303-318. doi:10.1352/1944-7558-119.4.303

- Daunhauer, L. A., & Fidler, D. J., & Will, E. (2014b). School function in students with Down syndrome. *American Journal of Occupational Therapy*, *68*, 167-176.
doi:10.5014/ajot.2014.009274
- Daunhauer, L. A., Gerlach-McDonald, B., Will, E., & Fidler, D. J. (under review). Performance and ratings based measures of executive function in school-aged children with Down syndrome. *Developmental Neuropsychology*.
- Dawson, G., Meltzoff, A., Osterling, J., Rinaldi, J., & Brown, E. (1998). Children with autism fail to orient to naturally occurring social stimuli. *Journal of Autism and Developmental Disorders*, *28* 479-485.
- Dawson, G., Rogers, S., Munson, J., Smith, M., Winter, J., Greenson, J., Donaldson, A., & Varley, J. (2010). Randomized ,controlled trial of an intervention for toddlers with autism: the Early Start Denver Model. *Pediatrics*, *125*, e17-e23. doi: 10.1542/peds.2009-0958
- DiGuseppi, C., Hepburn, S., Davis, J. M, Fidler, D. J., Hartway, S., Lee, N. L., Miller, L., Rutenber, M., & Robinson, C. (2010). Screening for Autism Spectrum Disorders with children with Down syndrome. *Journal of Developmental & Behavioral Pediatrics*, *31*, 181-191. doi:10.1097/DBP.0b013e3181d5aa6d
- De Battista, A. M., Huffman, L. C., Cooper, B., Alkon, A., Kennedy, C. M., & Weiss, S. J. (2016). Adaptive behavior trajectories in children born prematurely: the influence of biologic and social risk factors over the first few years of life. *Annals of Pediatrics & Child Health*, *4*, 1101.

- Ditterline, J., & Oakland, T. (2009). Relationships between adaptive behavior and impairment. In S. Goldstein, and A. Jack, (Eds.), *Assessing impairment: From theory to practice* (pp. 31–48). New York: Springer Science + Business Media, LLC.
- Dolva, A. S., Coster, W., & Lilja, M. (2004). Functional performance in children with Down syndrome. *American Journal of Occupational Therapy, 58*, 621-629.
doi:10.5014/ajot.58.6.621
- Dolva, A. S., Lilja, M., & Hemmingsson, H. (2007). Functional performance characteristics associated with postponing elementary school entry among children with Down syndrome. *American Journal of Occupational Therapy, 61*, 414-420.
doi:10.5014/ajot.61.4.414
- Dykens E. M., Hodapp R. M., Evans D. W. (2006). Profiles and development of adaptive behavior in children with Down syndrome. *Down Syndrome Research and Practice, 9*, 45-50. doi:10.3104/reprints.293
- Eagle, R. F., Romanczyk, R. G., & Lenzenweger, M. F. (2010). Classification of children with autism spectrum disorders: A finite mixture modeling approach to heterogeneity. *Research in Autism Spectrum Disorders, 4*, 772-781.
doi: 10.1016/j.rasd.2010.02.001
- Edgin, J. O. (2003). A neuropsychological model for the development of the cognitive profiles in mental retardation syndromes: Evidence from Down syndrome and Williams syndrome. *Dissertation Abstracts International: Section B: The Sciences & Engineering. 3-B, 64*, p. 1522. US: University Microfilms International

- Edgin, J. O., Pennington, B. F., & Mervis, C. B. (2010). Neuropsychological components of intellectual disability: the contributions of immediate, working, and associative memory. *Journal of Intellectual Disability research*, *54*, 406-417. doi: 10.1111/j.1365-2788.2010.01278.x
- Eikeseth, S., Klintwall, L., Jahr, E., & Karlsson, P. (2012). Outcome for children with autism receiving early and intensive behavioral intervention in mainstream preschool and kindergarten settings. *Research in Autism Spectrum Disorders*, *6*, 829-835. doi:10.1016/j.rasd.2011.09.002
- Esbensen, A. J. (2016). Sleep problems and associated comorbidities among adults with Down syndrome. *Journal of Intellectual Disability Research*, *60*, 68-79. doi: 10.1111/jir.12236
- Farley, M. A., McMahon, W. M., Fombonne, E., Jenson, W. R., Miller, J., Gardner, M., et al. (2009). Twenty-year outcome for individuals with autism and average or near-average cognitive abilities. *Autism Research*, *2*(2), 109–118. doi:10.1002/aur.69.
- Fenske, E. C., Zalenski, S., Krantz, P. J., & McClannahan, L. E. (1985). Age at intervention and treatment outcome for autistic children in a comprehensive intervention program. *Analysis and Intervention in Developmental Disabilities*, *5*, 49–58.
- Fettig, A. (2013a). *Functional behavior assessment (FBA) fact sheet*. Chapel Hill, NC: The University of North Carolina, Frank Porter Graham Child Development Institute, The National Professional Development Center on Autism Spectrum Disorders.

- Fettig, A. (2013b). *Functional communication training (FCT) fact sheet*. Chapel Hill, NC: The University of North Carolina, Frank Porter Graham Child Development Institute, The National Professional Development Center on Autism Spectrum Disorders.
- Fettig, A. (2013c). *Peer-mediated instruction and intervention (PMII) fact sheet*. Chapel Hill, NC: The University of North Carolina, Frank Porter Graham Child Development Institute, The National Professional Development Center on Autism Spectrum Disorders.
- Fettig, A. (2013d). *Social skills training (SST) fact sheet*. Chapel Hill, NC: The University of North Carolina, Frank Porter Graham Child Development Institute, The National Professional Development Center on Autism Spectrum Disorders.
- Fidler, D. J. (2005). The emerging Down syndrome behavioral phenotype in early childhood: Implications for practice. *Infants & Young Children, 18*, 86–103.
- Fidler, D. J. (2006). The emergence of a syndrome-specific personality profile in young children with Down syndrome. *Down Syndrome: Research & Practice, 10*, 53– 60.
doi: 10.3104/reprints.305
- Fidler, D. J., Hepburn, S., Mankin, G., & Rogers, S. (2005a). Praxis skills in young children with Down syndrome, other developmental disabilities, and typically developing children. *American Journal of Occupational Therapy, 59*, 129-138.
- Fidler D. J., Hepburn S., & Rogers S. (2006). Early learning and adaptive behaviour in toddlers with Down syndrome: Evidence for an emerging behavioural phenotype? *Down Syndrome Research and Practice, 9*, 37-44.doi:10.3104/reports.297

- Fidler, D. J., Hepburn, S. L., & Osaki, D. (2011). Goal-directedness as a target for early intervention in Down syndrome. In J. Rondal & J. Perera (Eds.) *Neurocognitive Rehabilitation in Down Syndrome: The Early Years*. Cambridge, UK: Cambridge University Press.
- Fidler, D. J., Lunkenheimer, E., & Hahn, L. (2011). Emerging behavioral phenotypes and dynamic systems theory. In Fidler, D. J. (Ed.)'s *International Review of Research in Developmental Disabilities (Volume 40)*. (pp.17-42) San Diego, CA: Elsevier Inc.
- Fidler, D. J., Most, D., & Philofsky, A. (2009). The Down syndrome behavioural phenotype: Taking a developmental approach. *Down syndrome Research and Practice*, *12*, 37-44.
- Fidler, D. J., & Nadel, L. (2007). Education in children with Down syndrome: Neuroscience, development, and intervention. *Mental Retardation and Developmental Disabilities Research Reviews*, *13*, 262-271. doi: 10.1002/mrdd.20166
- Fidler, D. J., Philofsky, A., Hepburn, S., & Rogers, S. J. (2005b). Nonverbal requesting and problem-solving by toddlers with Down syndrome. *Developmental Disabilities*, *110*, 312-322. doi:10.1352/0895-8017(2005)110[312:NRAPBT]2.0.CO;2
- Fidler, D. J., Will, E. , Daunhauer, L. A., Gerlach-McDonald, B. , & Visootsak, J. (2015). Object-related generativity in children with Down syndrome. *Research in Developmental Disabilities*, *35*, 3379-3385. doi:10.1016/j.ridd.2014.07.024
- Fitzpatrick, C., McKinnon, R. D., Blair, C. B., & Willoughby, M. T. (2014). Do preschool executive function skills explain the school readiness gap between advantaged and

disadvantaged children? *Learning and Instruction*, 30, 25-31.

doi: 10.1016/j.learninstruc.2013.11.003

Flanagan, H. E., Smith, I. M., Vaillancourt, T., Duku, E., Szatmari, P., Bryson, S., Fombonne, E., ... Georgiades, S. (2015). Stability and change in the cognitive and adaptive behaviour scores of preschoolers with autism spectrum disorder. *Journal of Autism and Developmental Disorders*, 9, 2691-2703. doi: 10.1007/s10803-015-2433-6.

Fleury, V. P. (2013a). *Discrete trial teaching (DTT) fact sheet*. Chapel Hill, NC: The University of North Carolina, Frank Porter Graham Child Development Institute, The National Professional Development Center on Autism Spectrum Disorders

Fleury, V. P. (2013b). *Extinction (EXT) fact sheet*. Chapel Hill, NC: The University of North Carolina, Frank Porter Graham Child Development Institute, The National Professional Development Center on Autism Spectrum Disorders.

Fleury, V. P. (2013c). *Scripting (SC) fact sheet*. Chapel Hill, NC: The University of North Carolina, Frank Porter Graham Child Development Institute, The National Professional Development Center on Autism Spectrum Disorders

Fleury, V. P. (2013d). *Task analysis (TA) fact sheet*. Chapel Hill, NC: The University of North Carolina, Frank Porter Graham Child Development Institute, The National Professional Development Center on Autism Spectrum Disorders

Fleury, V. P. (2013e). *Time delay (TD) fact sheet*. Chapel Hill, NC: The University of North Carolina, Frank Porter Graham Child Development Institute, The National Professional Development Center on Autism Spectrum Disorders

- Ford, D. H., & Lerner, R. M. (1992). *Developmental systems theory: An integrative approach*. Newbury Park, CA: Sage.
- Fuhs, M. W., Nesbitt, K. T., Farran, D. C., & Dong, N. (2014). Longitudinal associations between executive functioning and academic skills across content areas. *Developmental Psychology, 50*, 1698-1709. doi: 10.1037/a0036633
- Freitag, C. M. (2007). The genetics of autistic disorders and its clinical relevance: a review of the literature. *Molecular Psychiatry, 12*, 2-22. doi: 10.1038/sj.mp.4001896
- Gardiner., E., & Iarocci, G. (2015). Family quality of life and ASD: The role of child adaptive functioning and behavior problems. *Autism Research, 8*, 199–213. doi: 10.1002/aur.1442
- Garon, N., Bryson, S. E., & Smith, I. M. (2008). Executive function in preschoolers: A review using an integrative framework. *Psychological Bulletin, 134*, 31–60.
- Georgiades, S., Boyle, M., Szatmari, P., Hanna, S., Duku, E., Zwaigenbaum, L., Bryson, S., ... Pathways in ASD Study Team. (2014). Modeling the phenotypic architecture of autism symptoms from time of diagnosis to age 6. *Journal of Autism and Developmental Disorders, 44*, 3045-3055. doi: 10.1007/s10803-014-2167-x
- Georgiades, S., Szatmari, P., Boyle, M., Hanna, S., Duku, E., Zwaigenbaum, L., Bryson, S., ... Pathways in ASD Study Team. (2013). Investigating phenotypic heterogeneity in children with autism spectrum disorder: A factor mixture modeling approach. *Journal of Child Psychology and Psychiatry, 54*, 206-215. doi: 10.1111/j.1469-7610.2012.02588.x
- Gioia, G. A., Isquith, P. K. Guy, S. C., and Kenworthy, L. (2000). *Behavior Rating Inventory of Executive Function*. Lutz, FL: Psychological Assessment Resources, Inc.

- Gilotty, L., Kenworthy, L., Sirian, L., Black, D.O., & Wagner, A.E. (2002). Adaptive skills and executive function in autism spectrum disorders. *Child Neuropsychology*, 8, 241-248.
- Girolametto, L., Sussman, F., & Weitzman, E. (2007). Using case study methods to investigate the effects of interactive intervention for children with autism spectrum disorders. *Journal of Communication Disorders*, 40, 470–492. doi: 10.1016/j.jcomdis.2006.11.001
- Granic, I. (2005). Timing is everything: Developmental psychopathology from a dynamic systems perspective. *Developmental Review*, 25, 386–407. doi: 10.1016/j.dr.2005.10.005
- Green, S. A., & Carter, A. S. (2014). Predictors and course of daily living skills development in toddlers with autism spectrum disorders. *Journal of Autism and Developmental Disorders*, 44, 256-263. doi: 10.1007/s10803-011-1275-0.
- Griffith, E.M., Pennington, B.F., Wehner, E.A., & Rogers, S.J. (1999). Executive functions in young children with autism. *Child Development*, 70, 817-832.
- Grimm, K. J., Ram, N., & Estabrook, R. (2017). *Growth Modeling: Structural Equation and Multilevel Modeling Approaches*. New York, NY: The Guilford Press.
- Gotham, K., Risis, S., Pickles, A., & Lord, C. (2007). The Autism Diagnostic Observation Schedule: Revised algorithms for improved diagnostic validity. *Journal of Autism and Developmental Disorders*, 37, 613-627. doi:10.1007/s10803-006-0280-1
- Gottlieb, G. (1992). *The genesis of novel behavior: Individual development and evolution*. New York: Oxford University Press.
- Gur, R. C., Richard, J., Calkins, M. E., Chiavacci, R. , Hansen, J. A., Bilker, W. B., Loughead, J., ... & Gur, R. E. (2012). Age group and sex differences in performance on a

- computerized neurocognitive battery in children ages 8-21. *Neuropsychology*, 26, 251-265. doi: 10.1037/a0026712
- Hill, E. L. (2004). Executive dysfunction in autism. *Trends in Cognitive Sciences*, 8, 26–32. doi: 10.1016/j.tics.2003.11.003.2004
- Hodapp, R. M. & Dykens, E. M. (1994). Mental retardation's two cultures of behavioral research. *American Journal on Mental Retardation*, 98, 675-687.
- Hodapp, R. M., & Dykens, E. M. (2012). Genetic disorders of intellectual disability: Expanding our concepts of phenotypes and of family outcomes. *Journal of Genetic Counseling*, 21, 761-769. doi: 10.1007/s10897-012-9536-4
- Hongwanishkul, D., Happaney, K.R., Lee, S.C., & Zelazo, P.D. (2005) Assessment of hot and cool executive function in young children: Age-related changes and individual differences. *Developmental Neuropsychology*, 28, 617-644. Doi:10.1207/s15326942dn2802_4
- Hoyson, M., Jamieson, B., & Strain, P. S. (1984). Individualized group instruction of normally developing and autistic-like children: The LEAP curriculum model. *Journal of the Division for Early Childhood*, 8, 157–172.
- Hume, K. (2013a). *Antecedent-based intervention (ABI) fact sheet*. Chapel Hill, NC: The University of North Carolina, Frank Porter Graham Child Development Institute, The National Professional Development Center on Autism Spectrum Disorders.

- Hume, K. (2013b). *Visual supports (VS) fact sheet*. Chapel Hill, NC: The University of North Carolina, Frank Porter Graham Child Development Institute, The National Professional Development Center on Autism Spectrum Disorders.
- Itzchak, E. B., & Zachor, D. A. (2011). Who benefits from early intervention in autism spectrum disorder? *Research in Autism Spectrum Disorders, 5*, 345-350.
doi: 10.1016/j.rasd.2010.04.018
- Joseph, R.M. & Tager-Flusberg, H. (2004). The relationship of theory of mind and executive functions to symptom type and severity in children with autism. *Development and Psychopathology, 16*, 137-155. doi:10.1017/S095457940404444X
- Kaiser, A. P. (1993). Parent-implemented language intervention: An environmental system perspective. In A. P.Kaiser & D. B. Gray (Eds.), *Enhancing children's communication: Research foundations for intervention* (Vol. 2, pp. 63–84). Baltimore, MD: Brookes.
- Kaiser, A. P., Hancock, T. B., & Nietfeld, J. P. (2000). The effects of parent-implemented enhanced milieu teaching on the social communication of children who have autism. *Early Education and Development, 11*, 423–446
- Kanne, S. M., Gerber, A. J., Quirnbach, L. M., Sparrow, S. S., Cicchetti, D. V., & Saulnier, C. A. (2011). The role of adaptive behavior in autism spectrum disorders: Implications for functional outcome. *Journal of Autism and Developmental Disorders, 41*(8), 1007–1018.
doi:10.1007/s10803-010-1126-4
- Karmiloff-Smith, A. (1998). Development itself is the key to understanding developmental disorders. *Trends in Cognitive Sciences, 2*, 389–398.
doi: 10.1016/S1364-6613(98)01230-3

- Karmiloff-Smith, A. (2011). Static snapshots versus dynamic approaches to genes, brain, cognition and behavior in neurodevelopmental disabilities. In Fidler, D. J. (Ed.)'s *International Review of Research in Developmental Disabilities (Volume 40)*. (pp.1-16) San Diego, CA: Elsevier Inc.
- Karmiloff-Smith, A., & Thomas, M. (2003). What can developmental disorders tell us about the neurocomputational constraints that shape development? The case of Williams syndrome. *Development and Psychopathology, 15*, 969–990. doi:10.1017/S0954579403000476.
- Kasari, C., & Freeman, S. F. N. (2001). Task-related social behavior in children with Down syndrome. *American Journal on Mental Retardation, 106*, 253-264.
- Kasari, C., Freeman, S., & Paparella, T. (2006). Joint attention and symbolic play in young children with autism: a randomized controlled intervention study. *Journal of child Psychology and Psychiatry, 47*, 611-620. doi: 10.1111/j.1469-7610.2005.01567.x
- Kasari, C., Gulsrud, A., Paparella, T., Helleman, G., & Berry, K. (2015). Randomized comparative efficacy study of parent-mediated interventions for toddlers with autism. *Journal of Consulting and Clinical Psychology, 83*, 554-563. doi: 10.1037/a0039080
- Kasari, C., Gulsrud, A. C., Wong, C., Kwon, S., & Locke, J. (2010). Randomized controlled caregiver mediated joint engagement intervention for toddlers with autism. *Journal of Autism and Developmental Disorders, 40*, 1045-1056. doi: 10.1007/s10803-010-0955-5
- Kaufman, P., Leckman, J., & Ort, S. (1989) Delayed response performance in males with Fragile X. *Journal of Clinical and Experimental Neuropsychology, 12*,69.

- Kenworthy, L., Case, L., Harms, M. B., Martin, A., & Wallace, G. L. (2010). Adaptive behavior ratings correlate with symptomatology and IW among individuals with high functioning autism spectrum disorders. *Journal of Autism and Developmental Disorders, 40*, 416-423. doi: 10.1007/s10803-009-0911-4
- Kenworthy, L., Yerys, B. E., Anthony, L. G., & Wallace, G. L. (2008). Understanding executive control in autism spectrum disorders in the lab and in the real world. *Neuropsychology Review, 18*(4), 320–338. doi:10.1007/s11065-008-9077-7
- Kim, S. H., Macari, S., Holler., J., & Chawarska, K. (2016). Examining the phenotypic heterogeneity of early autism spectrum disorder: subtypes and short-term outcomes. *Journal of Child Psychology and Psychiatry, 57*, 93-102. doi: 10.1111/jcpp.12448
- Kimhi, Y., Shoam-Kugelmas, D., Ben-Artzi, G.A., Ben-Moshe, I., & Bauminger-Zviely, N. (2014). Theory of mind and executive function in preschoolers with typical development versus intellectually able preschoolers with autism spectrum disorder. *Journal of Autism and Developmental Disorders, 4-3-2014*, 1-14. doi:10.1007/s10803-014-2104-z
- Kleinman, J. M., Ventola, P. E., Pandey, J., Verbalis, A. D., Barton, M., Hodgson, S., Green, J., ... Fein, D. (2008). Diagnostic stability in very young children with autism spectrum disorders. *Journal of Autism and Developmental Disorders, 38*, 606-615. doi: 10.1007/s10803-007-0427-8
- Klin, A., Danovitch, J. H., Merz, A. B., & Volkmar, F. R. (2007). Circumscribed interests in higher functioning individuals with autism spectrum disorders: An exploratory study. *Research and Practice for Persons with Severe Disabilities, 32*, 89-100.

- Knowland, V. C. P., & Thomas, M. S. C. (2011). Developmental trajectories in genetic disorders. In Fidler, D. J. (Ed.)'s *International Review of Research in Developmental Disabilities (Volume 40)*. (pp.43-74) San Diego, CA: Elsevier Inc.
- Kovshoff, H., Hastings, R. P., & Remington, B. (2011). Two-year outcomes for children with autism after the cessation of early intensive behavioral intervention. *Behavior Modification, 35*, 427-450. doi: 10.1177/0145445511405513
- Kucharczyk, S. (2013). *Differential reinforcement of alternative, incompatible, or other behavior (DRA/I/O) fact sheet*. Chapel Hill, NC: The University of North Carolina, Frank Porter Graham Child Development Institute, The National Professional Development Center on Autism Spectrum Disorders.
- Kucharczyk, S. (2013). *Reinforcement (R+) fact sheet*. Chapel Hill, NC: The University of North Carolina, Frank Porter Graham Child Development Institute, The National Professional Development Center on Autism Spectrum Disorders.
- Kratochwill, T. R., Hitchcock, J. H., Horner, R. H., Levin, J. R., Odom, S. L., Rindskoff, D. M., & Shadish, W. R. (2013). Single-case intervention research design standards. *Remedial and Special Education, 34*, 26-38.
- Lanfranchi S., Jerman O., Pont E. D., Alberti A., Vianello R. (2010). Executive function in adolescents with Down Syndrome. *Journal of Intellectual Disability Research. 54*, 308–319. doi: 10.1111/j.1365-2788.2010.01262.x
- LeFevre, J., Berrigan, L., Vendetti, C., Kamawar, D., Bisanz, J., Skwarchuk, S., & Smith-Chant, B. L. (2013). The role of executive attention in the acquisition of mathematical skills for

- children in Grades 2 through 4. *Journal of Experimental Child Psychology*, *114*, 243-261.
doi: 10.1016/j.jecp.2012.10.005
- Levy, S. E., Giarelli, E., Lee, L. C., Schieve, L. A., Kirby, R. S., Cuniff, C., Nicholas, J., Reaven, J., & Rice, C. E. (2010). Autism spectrum disorder and co-occurring developmental, psychiatric, and medical conditions among children in multiple populations in the United States. *Journal of Developmental Pediatrics*, *31*, 267-275.
doi: 10.1097/DBP.0b013e3181d5d03b
- Liss, M., Harel, B., Fein, D., Allen, D., Dunn, M., Feinstein, C., et al. (2001). Predictors and correlates of adaptive functioning in children with developmental disorders. *Journal of Autism and Developmental Disorders*, *31*, 219–230.
- Lopata, C., Fox, J. D., Thomeer, M. L., Smith, R. A., Volker, M. A., Kessel, C. M., McDonald, C. A., & Lee, G. K. (2012). ABAS-II ratings and correlates of adaptive behavior in children with HFASDs. *Journal of Developmental and Physical Disabilities*, *24*, 391-402. doi: 10.1007/s10882-012-9277-1
- Lopata, C., Smith, R. A., Volker, M. A., Thomeer, M. L., Lee, G. K., & McDonald, C. A. (2013). Comparison of adaptive behavior measures for children with HFASDs. *Autism Research and Treatment*, *2013*, 1–10. doi:10.1155/2013/415989.
- Lord, C. (1995). Follow-up of two-year-olds referred for possible autism. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, *36*, 1365–1382
- Lord, C., Risi, S., DiLavore, P. S., Shulman, C., Thurm, A., & Pickles, A. (2006). Autism from 2 to 9 years of age. *Archives of General Psychiatry*, *63*, 694-701.
doi:10.1001/archpsyc.63.6.694

- Lord, C., Risi, S., Lambrecht, L., Cook, E. H., Leventhal, B. L., Dilavore, P. C., et al. (2000). The Autism Diagnostic Observation Schedule—Generic: A standard measure of social and communication deficits associated with the spectrum of autism. *Journal of Autism and Developmental Disorders*, *30*, 205–223.
- Lord, C., Rutter, M., DiLavore, P. C., Risi, S., Gotham, K., & Bishop, S. L. (2012). *Autism diagnostic observation schedule (ADOS-2)* (2nd ed.). Torrance, CA: Western Psychological Services.
- Lord, C., Rutter, M., DiLavore, P. C., & Risi, S. (1999). *Autism Diagnostic Observation Schedule*. Los Angeles, CA: Western Psychological Services.
- Lord, C., Rutter, M., & Le Couteur, A. (1994). Autism diagnostic interview-revised: A revised version of a diagnostic interview for caregivers of individuals with possible pervasive developmental disorders. *Journal of Autism and Developmental Disorders*, *24*, 659-685.
- Lovaas, O. I. (1987). Behavioral treatment and normal intellectual and educational functioning in autistic children. *Journal of Consulting and Clinical Psychology*, *55*, 3–9.
- Lovaas, O. I. (2003). *Teaching individuals with developmental delays: Basic intervention techniques*. Austin, TX: Pro-Ed.
- Luu, T. M., Ment, L. R., Schneider, K. C., Katz, K. H., Allan, W. C., & Vohr, B. R. (2009). Lasting effects of preterm birth and neonatal brain hemorrhage at 12 years of age. *Pediatrics*, *123*, 1037-1044. doi: 10.1542/peds.2008-1162

- MacDuff, J. L., Ledo, R., Krantz, P. J. & McClannahan, L. E. (2007). Using script and script-fading procedures to promote bids for joint attention by young children with autism. *Research in Autism Spectrum Disorders, 1*, 281-290.
- Mahoney, G., & Perales, F. (2005). Relationship-focused early intervention with children with pervasive developmental disorders and other disabilities: A comparative study. *Journal of Developmental and Behavioral Pediatrics, 26*, 77–85.
- Mancini, M. C., Carvalho e Silva, P., Goncalves, S. C., & Martins, S. de. M. (2003). Comparison of functional performance among children with Down syndrome and children with age-appropriate development at 2 and 5 years of age. *Arquivos de Neuro-Psiquiatria, 61*, 409-415. doi:10.3104/reviews.307
- Mandell, D. S., Wiggins, L. D., Carpenter, L. A., Daniels, J., DiGuseppi, C., Durkin, M. S., Giarelli, E., ... Kirby, R. S. (2009). Racial/ethnic disparities in the identification of children with autism spectrum disorders. *American Journal of Public Health, 99*, 494-498. doi: 10.2105/AJPH.2007.131243.
- Marchal, J. P., Maurice-Stam, H., Houtzager, B. A., Rugters van Rozenburg-Marres, S. L., Ostrom, K. J., Grootenhuis, M. A., & Paul van Trotsenburg, A. S.(2016). Growing up with Down syndrome: Development from 6 months to 10.7 years. *Research in Developmental Disabilities, 59*, 437-450. doi: 10.1016/j.ridd.2016.09.019
- McAuley, T., & White, D. (2011). A latent variables examination of processing speed, response inhibition, and working memory during typical development. *Journal of Experimental Child Psychology, 108*, 453-468.

- McClannahan, L. E., & Krantz, P. J. (2005). *Teaching conversation to children with autism*. Bethesda, MD: Woodbine House.
- McConachie, H., Randle, V., Hammal, D., & Le Couteur, A. (2005). A controlled trial of a training course for parents of children with suspected autism spectrum disorder. *Journal of Pediatrics*, *147*, 335–340. doi:10.1016/j.jpeds.2005.03.056
- McDonald, C. A., Thomeer, M. L., Lopata, C., Fox, J. D., Donnelly, J. P., Tang, V., & Rodgers, J. D. (2015). VABS-II ratings and predictors of adaptive behavior in children with HFASD. *Journal of Developmental and Physical Disabilities*, *27*, 235-247. doi:10.1007/s10882-014-9411-3
- McGee, G. G., Morrier, M. J., & Daly, T. (1999). An incidental teaching approach to early intervention for toddlers with autism. *The Journal of the Association of Persons with Severe Handicaps*, *24*, 133–146
- McNeish, D., & Haring, J. R. (2016). Correcting model fit criteria for small sample latent growth models with incomplete data. *Educational and Psychological Measurement*, 1-30 doi: 10.1177/0013164416661824
- Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., & Howerter, A. (2000). The unity and diversity of executive functions and their contributions to complex “frontal Lobe” tasks: A latent variable analysis. *Cognitive Psychology*, *41*, 49-100. doi:10.1006/cogp.1999.0734
- Monette, S., Bigras, M., & Guay, M.C. (2011). The role of executive functions in school achievement at the end of Grade 1. *Journal of Experimental Child Psychology*, *109*, 158-173. doi:10.1016/j.jecp.2011.01.008

- Mullen, E. M. (1995). *Mullen scales of early learning*. Circle Pines, MN: AGS.
- Munson, J., Dawson, G., Sterling, L., Beauchaine, T., Zhou, A., Koehler, E., Lord, C., ...
Abbott, R. (2008). Evidence for latent classes of IQs in young children with autism spectrum disorder. *American Journal on Mental Retardation*, *113*, 439-452.
doi: 10.1352/2008.113:439-452
- Muthén, L. K., & Muthén, B. O. (2012). *Mplus user's guide*(7th ed.) Los Angeles, CA: Muthén & Muthén.
- Odom, S. L. (2013). *Technology-aided instruction and intervention (TAII) fact sheet*. Chapel Hill, NC: The University of North Carolina, Frank Porter Graham Child Development Institute, The National Professional Development Center on Autism Spectrum Disorders.
- Odom, S. L., Boyd, B.A., Hall, L. J., & Hume, K. (2010). Evaluation of comprehensive treatment models for individuals with autism spectrum disorders. *Journal of Autism and Developmental Disorders*, *40*, 424-436. doi: 10.1007/s10803-009-0825-1
- Oerlemans, A.M., Droste, K., van Steijn, D.J., de Sonnevile, L.M.J., Buitelaar, J.K., & Rommelse, N.N.J. (2013). Co-segregation of social cognition, executive function and local processing style in children with ASD, their siblings and normal controls. *Journal of Autism and Developmental Disorders*, *43*, 2764-2778. doi:10.1007/s10803-013-1807-x
- Ozonoff, S., South, M., & Provençal, S. (2007). Executive functions in autism: Theory and Practice. In Perez, J.M., Gonzales, P.M, Comi, M.L, & Nieto, C.(Eds) *New Developments in Autism: The Future is Today* (pp. 185-213).

- Ozonoff, S., Young, G. S., Carter, A., Messinger, D., Yirmiya, N., Zwaigenbaum, L., Bryson, S., ... Stone, W. L. (2011). Recurrence risk for autism spectrum disorders: A baby siblings research consortium study. *Pediatrics*, *128*, e488-e495. doi: 10.1542/peds.2010-2825
- Parker, S. E., Mai, C. T., Canfield, M. A., Rickard, R. Wang, Y., Meyer, R. E...Correa, A. (2010). Updated national birth prevalence estimates for selected birth defects in the United States, 2004-2006. *Birth Defects Research (Part A): Clinical and Molecular Teratology*, *88*, 1008-1016. doi:10.1002/bdra.20735
- Pelios, L.V., MacDuff, G. S., & Axelrod, S. (2003). The effects of a treatment package in establishing independent academic work skills in children with autism. *Education & Treatment of Children*, *26*, 1-21.
- Pellicano, E. (2010). Individual differences in executive function and central coherence predict developmental changes in theory of mind in autism. *Developmental Psychology*, *46*, 530-544. doi:10.1037/a0018287
- Pennington, B. F., Moon, J., Edgin, J., Stedron, J., & Nadel, L. (2003). The neuropsychology of Down syndrome: evidence for hippocampal dysfunction. *Child Development*, *74*, 75-93. doi:10.1111/1467-8624.00522
- Pennington, B. F., & Ozonoff, S. (1996). Executive functions and developmental psychopathology. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, *37*(1), 51-87.
- Perry, A., Flanagan, H. E., Dunn Geier, J. D., & Freeman, N. L. (2009). Brief report: The Vineland Adaptive Behavior Scales in young children with autism spectrum disorders at

different cognitive levels. *Journal of Autism and Developmental Disorders*, 39, 1066-1078. doi:10.1007/s10803-009-0704-9

Plavnick, J. B. (2013). *Video modeling (VM) fact sheet*. Chapel Hill, NC: The University of North Carolina, Frank Porter Graham Child Development Institute, The National Professional Development Center on Autism Spectrum Disorders.

Potijik, M. R., Kerstjens, J. M., Bos, A. F., Reijneveld, S. A., & de Winter, A. F. (2013). Developmental delay in moderately preterm-born children with low socioeconomic status: risks multiply. *Journal of Pediatrics*, 163, 1289-1295.
doi: 10.1016/j.jpeds.2013.07.001

Presson, A. P. Partyka, G., Jensen, K. M., Devine, O. J., Rasmussen, S. A., McCabe, L. L., & McCabe, E. R. B. (2013). Current estimate of Down syndrome population prevalence in the United States. *Journal of Pediatrics*, 163, 1163-1168.
doi:2038/10.1016/j.jpeds.2013.06.013

Pugliese, C. E., Anthony, L., Strang, J. F., Dudley, K., Wallace, G. L., & Kenworthy, L. (2015). Increasing adaptive behavior skill deficits from childhood to adolescence in autism spectrum disorder: Role of executive function. *Journal of Autism and Developmental Disorders*, 45, 1579–1587.

Pugliese, C. E., Anthony, L. G., Strang, J. F., Dudley, K., Wallace, G. L., Naiman, D. Q., & Kenworthy, L. (2016). Longitudinal examination of adaptive behavior in autism spectrum disorders: Influence of executive function. *Journal of Autism and Developmental Disorders*, 46, 467-477. doi: 10.1007/s10803-015-2584-5

- Reichow, B. (2012). Overview of meta-analyses on early intensive behavioral intervention for young children with autism spectrum disorders. *Journal of Autism and Developmental Disorders, 42*, 512-520. doi: 10.1007/s10803-011-1218-9
- Rihtman, T., Tekuzener, E., Parush, S., Tenenbaum, A., Bachrach, S. J., & Ornoy, A. (2010). Are the cognitive functions of children with Down syndrome related to their participation? *Developmental Medicine & Child Neurology, 52*, 72-78.
doi: 10.1111/j.1469-8749.2009.03356.x
- Robinson, S., Goddard, L., Dritschel, B., Wisley, M., & Howlin, P. (2009). Executive functions in children with Autism Spectrum Disorders. *Brain and Cognition, 71*, 362-368.
doi: 10.1016/j.bandc.2009.06.007
- Roid, G. H., & Miller, L. J. (1997). *Leiter International Performance Scale-Revised*.
Wood Dale, IL: Stoelting Co.
- Rogers, S. J., Estes, A., Lord, C., Vismara, L., Winter, J., Fitzpatrick, A., . . . Dawson, G. (2012). Effects of a brief Early Start Denver Model (ESDM)-based parent intervention on toddlers at risk for autism spectrum disorders: A randomized controlled trial. *Journal of the American Academy of Child & Adolescent Psychiatry, 51*, 1052-1065.
doi: 10.1016/j.jaac.2012.08.003
- Rogers, S. J., Hepburn, S., & Wehner, E. (2003). Parent Reports of Sensory Symptoms in Toddlers with Autism and Those with Other Developmental Disorders. *Journal of Autism and Developmental Disorders, 33*(6), 631-642.
doi: 10.1023/B:JADD.0000006000.38991.a7

- Rosenthal, M., Wallace, G. L., Lawson, R., Wills, M. C., Dixon, E., Yerys, B. E., & Kenworthy, L. (2013). Impairments in real-world executive function increase from childhood to adolescence in autism spectrum disorders. *Neuropsychology*, *27*(1), 13–18. doi:10.1037/a0031299.
- Saulnier, C.A. & Klin, A. (2007). Brief report: Social and communication abilities and disabilities in higher functioning individuals with autism and asperger syndrome. *Journal of Autism and Developmental Disorders*, *37*, 788–793.
- Schalock, R. L., Bothwick-Duffy, S. A., Bradley, V. J., Buntinx, W. H. E., Coulter, D. L., Craig, E. M. ... Yeager, M. H. (2012). *User's Guide to Intellectual Disability: Definition, Classification, and Systems of Supports*. (11th ed.). Washington, D.C.: American Association on Intellectual and Developmental Disabilities.
- Schertz, H. H., Odom, S. L., Baggett, K. M., & Sideris, J. H. (2013). Effects of joint attention mediated learning for toddlers with autism spectrum disorders: An initial randomized controlled trial. *Early Childhood Research Quarterly*, *28*, 249-258.
doi: 10.1016/j.ecresq.2012.06.006
- Schultz, T. R. (2013). *Parent-implemented intervention (PII) fact sheet*. Chapel Hill, NC: The University of North Carolina, Frank Porter Graham Child Development Institute, The National Professional Development Center on Autism Spectrum Disorders.
- Smith, L. E., Maenner, M. J., & Seltzer, M. M. (2012). Developmental trajectories in adolescents and adults with autism: The case of daily living skills. *Journal of the American Academy of Child and Adolescent Psychiatry*, *51*, 622–631. doi:10.1016/j.jaac.2012.03.001.

- Smith, T., Klorman, R., & Mruzek, D. W. (2015). Predicting outcome of community-based early behavioral intervention for children with autism. *Journal of Abnormal Child Psychology*, *43*, 1271-1282. doi: 10.1007/s10802-015-0002-2
- Smithson, P.E., Kenworthy, L., Wills, M.C., Jarrett, M., Atmore, K., & Yerys, B.E. (2013). Real world executive control impairments in preschoolers with autism spectrum disorders. *Journal of Autism and Developmental Disorders*, *43*, 1967-1975. doi:10.1007/s10803-012-1747
- Sparrow, S., Balla, D. A., & Cicchetti, D. (1984). *Vineland Adaptive Behavior Scales*. Circle Pine, MN: American Guidance Service.
- Sparrow, S., Cicchetti, D., & Balla, D. A. (2005). *Vineland Adaptive Behavior Scales- Second Edition: Survey Forms Manual*. Minneapolis, MN: Pearson.
- Stahmer, A. C., Akshoomoff, N., & Cunningham, A. B. (2011). Inclusion for toddlers with autism spectrum disorders. *Autism*, *15*, 625-641. doi: 10.1177/1362361310392253
- Stahmer, A.C. & Ingersoll, B. (2004). Inclusive programming for toddlers with autism spectrum disorders: Outcomes from the children's toddler school. *Journal of Positive Behavior Interventions*, *6*, 67-82.
- Strain, P., & Bovey, E. (2011). Randomized controlled trial of the LEAP model of early intervention for young children with autism spectrum disorders. *Topics in Early Childhood Special Education*, *31*, 133-154.

- Strain, P. S., & Hoyson, M. (2000). The need for longitudinal, intensive social skills intervention: LEAP follow-up outcomes for children with autism. *Topics in Early Childhood Special Education, 20*, 116–122.
- Strain, P. S., Hoyson, M., & Jamieson, B. (1985). Normally developing preschoolers as intervention agents for autistic-like children: Effects on class deportment and social interaction. *Journal of the Division for Early Childhood, 9*, 105–109.
- Stores G, Stores R. (2013). Sleep disorders and their clinical significance in children with Down syndrome. *Developmental Medicine & Child Neurology, 55*, 126–130.
doi: 10.1111/j.1469-8749.2012.04422.x
- Sussman, F. (1999). More than words: Helping parents promote communication and social skills in children with Autism Spectrum Disorder. Toronto, Ont. The Hanen Centre.
- Szatmari, P., Bryson, S., Duku, E., Vaccarella, L., Zwaigenbaum, L., Bennett, T., & Boyle, M. H. (2009). Similar developmental trajectories in autism and Asperger syndrome: From early childhood to adolescence. *Journal of Child Psychology and Psychiatry and Allied Disciplines, 50*, 1459–1467. doi:10.1111/j.1469-7610.2009.02123.x.
- Tarizi, R. A., Mahone, M., & Zabel, T. A. (2007) Self-care independence in children with neurological disorders: An interactional model of adaptive demands and executive dysfunction. *Rehabilitation Psychology, 52*, 196-205. doi:10.1037/0090-5550.52.2.196
- Tasse, M. J., Schalock, R. L., Balboni, G., Bersani, H., Jr, BorthwickDuffy, S. A., Spreat, S., et al. (2012). The construct of adaptive behavior: Its conceptualization, measurement, and use in the field of intellectual disability. *American Journal on Intellectual and Developmental Disabilities, 117*, 291–303. doi:10.1352/1944-7558-117.4.291

- Taylor, J. L., & Seltzer, M. M (2010). Changes in the autism behavioral phenotype during the transition to adulthood. *Journal of Autism and Developmental Disorders*, *40*, 1431-1446. doi: 10.1007/s10803-010-1005-z
- Thelen, E., & Smith, L. B. (2006). Dynamic systems theories. In R. M. Lerner., W. Damon., R. M. Lerner, and W. Damon, (Eds.), *Handbook of child psychology: Vol 1, Theoretical models of human development*, 6th ed. (pp. 258–312). John Wiley & Sons, Inc, Hoboken, NJ.
- Toplak, M. E., West, R. F., & Stanovich, K. E. (2013). Do performance-based measures and ratings of executive function assess the same construct? *Journal of Child Psychology and Psychiatry*, *54*, 131-143. doi: 10.1111/jcpp.12001
- Viterbori, P., Carmen Usai M., Traverso, L., & De Franchis, V. (2015). How preschool executive functioning predicts several aspects of math achievement in grades 1 and 3: A longitudinal study. *Journal of Experimental Child Psychology*, *140*, 38-55. doi: 10.1016/j.jecp.2015.06.014
- Visootsak, J., Hess, B., Bakeman, R., & Adamson, L. B. (2012). Effect of congenital heart defects on language development in toddlers with Down syndrome. *Journal of Intellectual Disability Research*, *57*, 887-892. doi:10.1111/j.1365-2788.2012.01619
- Vivanti, G., Paynter, J., Duncan, E., Fothergill, H., Dissanayake, C., & Rogers, S. J., & Victorian ASELCC Team. (2014). Effectiveness and feasibility of the Early Start Denver Model implemented in a group-based community childcare setting. *Journal of Autism and Developmental Disorders*, *44*, 3140-3153. doi:10.1007/s10803-014-2168-9

- Volkmar, F. R., Lord, C., Bailey, A., Schultz, R. T., & Klin, A. (2004). Autism and pervasive developmental disorders. *Journal of Child Psychology and Psychiatry*, *45*, 135-170.
- Volman, J., Visser, J. M., & Lensvelt-Mulders, G. J. L. M. (2007). Functional status in 5 to 7-year-old children with Down syndrome in relation to motor ability and performance and mental ability. *Disability and Rehabilitation*, *29*, 25-31. doi: 10.1080/09638280600947617
- Warren, Z., McPheeters, M. L., Sathe, N., Foss-Feig, J. H., Glasser, A., & Veenstra-VanderWeele, J. (2011). A systematic review of early intensive interventions for autism spectrum disorders. *Pediatrics*, *127*, e1303-e1311. doi: 10.1542/peds.2011-0426
- White, S.J., Burgess, P.W., & Hill, E.J. (2009). Impairments on “Open-Ended” executive function tests in autism. *Autism Research*, *2*, 138-147.
- Wichnick, A. M., Vener, S. M., Keating, C., & Poulson, C. L. (2010). The effect of a script-fading procedure on unscripted social initiations and novel utterances among young children with autism. *Research in Autism Spectrum Disorders*, *4*, 51-64. doi: 10.1016/j.rasd.2009.07.006
- Will, E., & Hepburn, S. (2015). Applied behavior analysis for children with neurogenetic disorders. *International Review of Research in Developmental Disabilities*, *49*, 229-259. doi: 10.1016/bs.irrdd.2015.06.004
- Wong, C. (2013a). *Naturalistic intervention (NI) fact sheet*. Chapel Hill, NC: The University of North Carolina, Frank Porter Graham Child Development Institute, The National Professional Development Center on Autism Spectrum Disorders.

- Wong, C. (2013b). *Picture Exchange Communication System (PECS) fact sheet*. Chapel Hill, NC: The University of North Carolina, Frank Porter Graham Child Development Institute, The National Professional Development Center on Autism Spectrum Disorders.
- Wong, C. (2013c). *Pivotal response training (PRT) fact sheet*. Chapel Hill, NC: The University of North Carolina, Frank Porter Graham Child Development Institute, The National Professional Development Center on Autism Spectrum Disorders.
- Wong, C. (2013d). *Social narratives (SN) fact sheet*. Chapel Hill, NC: The University of North Carolina, Frank Porter Graham Child Development Institute, The National Professional Development Center on Autism Spectrum Disorders
- Wong, C., Odom, S. L., Hume, K. Cox, A. W., Fettig, A., Kucharczyk, S., ... Schultz, T. R. (2014). *Evidence-based practices for children, youth, and young adults with Autism Spectrum Disorder*. Chapel Hill, NC: The University of North Carolina, Frank Porter Graham Child Development Institute, Autism Evidence-Based Practice Review Group
- Woodman, A. C. (2014). Trajectories of stress among parents of children with disabilities: A dyadic analysis. *Family Relations*, 63, 39-54. doi: 10.1111/fare.12049
- Woolf, S., Woolf, C. M., & Oakland, T. (2010). Adaptive behavior among adults with intellectual disabilities and its relationship to community independence. *Intellectual and Developmental Disabilities*, 48, 209-215.
- Wozniak, R. H., Leezenbaum, N. B., Northrup, J. B., West, K. L., & Iverson, J. M. (2016). The development of autism spectrum disorders: Variability and causal complexity. *Wiley Interdisciplinary Review: Cognitive Science*, 8, e1426. doi: 10.1002/wcs.1426

- Wright, C., A., & Kaiser, A. P. (2017). Teaching parents enhanced milieu teaching with words and signs using the teach-model-coach-review model. *Topics in Early Childhood Special Education, 36*, 192-204. doi: 10.1177/0271121415621027
- Young, H. E., Falco, R. A., & Hanita, M. (2016). Randomized, controlled trial of a comprehensive program for young students with autism spectrum disorder. *Journal of Autism and Developmental Disorders, 46*, 544-560. doi: 10.1007/s10803-015-2597-0
- Zelazo, P.D., Carter, A., Reznick, J.S., & Frye, D. (1997). Early development of executive function: A problem-solving framework. *Review of General Psychology, 1*, 198—226. doi:10.1037/1089-2680.1.2.198
- Yerys, B. E., Hepburn, S. L., Pennington, B. F., & Rogers, S. J. (2007). Executive function in preschoolers with autism: Evidence consistent with a secondary deficit. *Journal of Autism and Developmental Disorders, 37*, 1068-1079. doi:10.1007/s10803-006-0250-7
- Zelazo, P. D., & Müller, U. (2011). Executive function in typical and atypical development. In Gosami, U. (Eds.). *The Wiley-Blackwell Handbook of Child Cognitive Development* (2nd ed.), (pp. 574-602). Oxford, UK: Blackwell Publishing Ltd.

APPENDIX A.

Adaptive Behavior Developmental Expectations in Infancy and Toddlerhood

Communication	Daily Living Skills	Socialization
Receptive <u><12 months- 12 months</u> Turns eyes and head toward sound Listens at least momentarily when spoken to by caregiver Raises arms when caregiver says, "Come here" or "Up" Demonstrates understanding of the meaning of "no" Demonstrates understanding of the meaning of at least 10 words. Listens attentively to instructions. Demonstrates understanding of the meaning of "yes" or "okay" Follows instructions requiring an action and an object Points accurately to at least one major body part when asked <u>12 months to 24 months</u> Listens to a story for at least 5 minutes <u>24 months to 36 months</u> Points accurately to all body parts when asked Follows instructions in "if-then" form.	Feeding(Personal) <u><12 months- 12 months</u> Indicates anticipation of feeding Opens mouth when spoon with food is presented Removes food from spoon with mouth Sucks or chews on crackers Eats solid food <u>12 months to 24 months</u> Drinks from cup or glass unassisted Feeds self with spoon Sucks from straw Feeds self with fork Feeds self with spoon without spilling Toileting (Personal) <u>12 months to 24 months</u> Indicates wet or soiled pants or diaper by pointing, vocalizing, or pulling at a diaper <u>24 months-36 months</u> Urinates in toilet or potty-chair Defecates in toilet or potty-chair Asks to use toilet Is toilet-trained during the night Dressing (Personal) <u>12 months to 24 months</u> Removes front-opening coat, sweater, or shirt without assistance <u>24 months-36 months</u> Demonstrates interest in changing clothes when very wet or muddy Puts on "pull-up" garments with elastic waistbands Hygiene (Personal) <u>12 months to 24 months</u> Willingly allows caregiver to wipe nose <u>24 months-36 months</u> Bathes self with assistance Safety and Money Management (Community) <u>12 months to 24 months</u> Demonstrates understanding that hot things are dangerous <u>24 months-36 months</u> Demonstrates understanding of the function of money Household Chores (Domestic) <u>24 months-36 months</u> Puts possessions away when asked	Interpersonal Relationships <u><12months-12 months</u> Looks at face of caregiver Responds to voice of caregiver or another person Distinguishes caregiver from others Expresses two or more recognizable emotions such as pleasure, sadness, fear, or distress Shows anticipation of being picked up by caregiver Shows affection toward familiar people Reaches for familiar person Imitates simple adult movements, such as clapping hands or waving good-bye, in response to a model <u>12 months to 36 months</u> Laughs or smiles appropriately in response to positive statements Addresses at least two familiar people by name Shows desire to please caregiver Imitates a relatively complex task several hours after it was performed by another Imitates adult phrases heard on previous occasions Play and Leisure Time <u><12 months-12 months</u> Shows interest in novel objects or new people Shows interest in children or peers other than siblings Plays with toys or other object alone or with others Plays very simple interaction games with others Uses common household objects for play Shows interest in activities of others <u>12 months- 36 months</u> Participates in at least one game with others Engages in elaborate make-believe activities, alone or with others