Who is Placed in Special Education? Assessing the Longitudinal Profiles, Academic Achievement, and Behavioral Adjustment of Students At-Risk for Special Education Identification

by

Adrienne D. Woods

A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
(Education and Psychology)
in the University of Michigan
2018

Doctoral Committee:

Professor Frederick J. Morrison, Chair
Associate Professor Kai Cortina
Professor Pamela Davis-Kean
Assistant Professor Christina Weiland

Adrienne D. Woods

adrwoods@umich.edu

ORCID iD: 0000-0003-1101-6975

DEDICATION

This dissertation is dedicated to my brother. Al, you are constantly inspiring me, challenging me, and pushing me to be better. Your struggles, but more importantly, your successes both within and outside of school drive me to improve education for all students, everywhere. I hope this work and the work to come makes you as proud of me as I am of you. I love you.

ACKNOWLEDGEMENTS

First and foremost, thank you to Fred, for believing in my big ("wacky") ideas and giving me the opportunity to attend the University of Michigan. Thank you for always pulling me back out to the "big picture," for making me laugh at myself, for your unending support, and for keeping my belly and heart full. I have learned so much more from you than just science, and I will forever be grateful to you for taking a chance on me. I've got the next round!

To Pam, for taking me under your wing and shaping me into a stronger scientist. Your mentorship has provided the most helpful guidance at every stage of the research process. I greatly appreciate your investment in the future and your willingness to mold young graduate students into confident methodologists. I will miss our multi-hour meetings, breakfasts at Afternoon Delight, and mussels at the Earle! Thank you, thank you!

To CPEP, for being such an amazing and supportive community. To Janie and Katie, for all of your knowledge and support. To Rackham and AERA, for believing in my big ideas and funding my dissertation. To the members of the Pathways to Literacy lab: being your friend and colleague has made me a stronger and better person in so many ways, and I am glad to have had the opportunity to work with you all (and, to have had windows in my office!). To the Human Development and Quantitative Methods lab, for keeping a smile on my face through all the paper editing, Twitter talk, and methods debates. I would be so much lesser without you #youngscientists. To the Fragile Families team, for letting my do my thing and collect some cool data (and especially to Colter, for your enthusiasm about the School Records project and your willingness to fund my last year). Finally, to the Biodemography group, for teaching me so many

new things (and introducing me to March Mammal Madness). GO BLUE!

To my family, my rock, for everything. I would not be here without your support, love, and understanding while I pursued a dream six years in the making. Thank you for letting me escape to you and for understanding when I couldn't. For all the home-cooked meals, house cleaning, pet sitting, plant watering, and unwavering love when I was stressed, or traveling, or writing feverishly, or a mess… I love you!

To all my friends who have kept me sane throughout the past six years (Alexa S., Sean, Inah + Andrew + Emily + Elena, Valerie + Olive, Brie + Shae + Harper, Zach, Tom, Louis, Christian + Rachel, Sarah M., Alexa E., Shar, Sammy, Amira, Jeffrey + Richard, and so many others…). Especially to Sarah, my best friend, my colleague, my sister. I love you. Thank you all for acknowledging my voice, for knowing when to build me up and when to reorient me, for guiding me through the toughest of times and celebrating alongside me during the best of times. Trivia nights, volleyball, orchestra, Null, Beer Grotto, work dates, #sports, babies, music, dogs, and game nights forever!

To my team. Thank you for allowing me to reconnect with my community, and to keep my link to swimming alive. I am beyond lucky to have had the opportunity to coach you, to know you, to learn from you, and to watch you all grow into amazing young women. I am so blessed, and I am so proud of you all. Let's Go, Dreads! To Cory, for welcoming me back with open arms and believing in my crazy ideas. For giving me autonomy and free reign over drylands (muahaha), for spending hours debating Game of Thrones theories and dissecting Marvel shows, for bringing me into your home and making me a member of your family, especially after my family moved away. You are more than a coach, more than a teacher, more than a friend. Love ya, Berg.

Lastly, thank you to every child who is a bit "different." To every family who shared their story with me. To every principal working to unite general and special education. To every teacher who tirelessly works to connect with all of their students, regardless of (dis)ability. This is for you.

PREFACE

This research was supported by a grant from the American Educational Research Association which receives funds for its "AERA Grants Program" from the National Science Foundation, under Grant #DRL-1749275. Opinions reflect those of the author and do not necessarily reflect those of the granting agencies.

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ABSTRACT

This dissertation is comprised of three studies using restricted data from the ECLS-K:1998 to address the questions *who is placed in special education?* and *what happens after they are placed?* Though these questions have been extensively studied, existing research has largely ignored the intersection of longitudinal developmental pathways and service delivery. In Study 1 ("Examining Longitudinal Patterns of K-8 Special Education Service Receipt") special educational trajectories from Kindergarten through grade 8 were analyzed using latent class growth modeling. Relative to students who never receive services, students with disabilities fell into three trajectories: *Persistent* (students received uninterrupted services from Kindergarten through 8th grade), *Terminal* (students received services for the first few years of schooling, then exited out of special education), and *Delayed* (students were not placed in special education until partway through schooling). Multinomial logistic regression revealed that different combinations of child, home, and schooling factors predicted the odds of following these trajectories of special education, which bears consideration in cross-sectional identification research.

Study 2 ("Contextualizing Patterns of Special Education Placement and Service Receipt") explored how individual likelihoods of receiving special education services were impacted by 1) the contributions of individual and aggregated data, 2) modeling longitudinal trajectories from Kindergarten through eighth grade, and 3) analyzing how the schooling context differentially influences students from varying backgrounds and with different levels of achievement or behavior. Results revealed that individual-level data was most predictive of service receipt, though between a quarter and a third of the variability in special education status occurred

between schools; different factors predicted the likelihood of receiving services early in schooling relative to later in schooling; and that the schooling context did not appear to differentially affect the longitudinal likelihood of service receipt by race/ethnicity, achievement, or behavior. This study is important for researchers and policymakers focused on the early identification of disability and early identification disparities.

Lastly, Study 3 ("What Happens to Students in Special Education? Academic Achievement and Behavioral Adjustment Following Identification") assessed the development of reading, math, problem behaviors, and positive learning habits among students receiving earlier or later services. Though advocates argue that early intervention is the best solution to alleviate academic or behavioral issues, evidence toward the effectiveness of special education as an intervention is meager and mixed. In this study, the propensity to receive services in either 1st grade or 3rd grade was modeled by matching students who received services at least once during grades 1-8 on a host of Kindergarten covariates. Results indicated that students who received initial services in 1st grade made larger reading gains and scored higher tests of reading than students who received services later in schooling. In contrast, students who received initial services in 3rd grade did not significantly differ from their peers on any academic outcomes.

Overall, this dissertation weaves together a coherent story regarding who receives special education services, at what developmental timepoints, and where, as well as what are the consequences of receiving services at different timepoints during K-8 schooling. Addressing developmental trajectories of service receipt also extended and validated existing research by clarifying previous inconsistencies and oversimplifications. Educators and policymakers should continue advocating for early services, and researchers should strive to understand why delayed service receipt occurs, particularly among urban students with less-educated mothers.

CHAPTER I

Introduction:

Revisiting the Problem of Unequal Access to and Opportunity Within Special Education

U.S. special education students and their families have long struggled for equal access and appropriate services. Although which children receive special education services has been extensively studied, few studies have incorporated longitudinal designs with an explicit focus on the developmental timing of service receipt. Moreover, how children fare after receiving services has also been inconsistently studied, despite enormous policy consequences. The goal of this dissertation was to coherently investigate precursors to special education placement, trajectories of service receipt from Kindergarten through 8th grade, and the consequences of service receipt. Beyond a commitment to safeguard the wellbeing of students with disabilities, these questions are especially pressing for districts serving populations with high likelihoods of disability identification, since special education costs roughly double that of general education (US Department of Education, 2010).

Unequal Access to Special Education

Though the *Education for All Children Act* mandating de-segregation for students with disabilities passed in 1974, special and general education largely remain two separate systems (Reedy, 2004) and concern abounds over unequal access to services among various groups. For instance, evidence suggests that about twice as many males are identified for special education as

females (e.g., Hibel, Farkas, & Morgan, 2010; Katusic, Colligan, Barbaresi, Schaid, & Jacobsen, 2001; Marder, 2009; Sullivan & Bal, 2013) likely because males also experience more cognitive delays, behavior problems, and lowered academic achievement at the transition to school (Hillemeier, Farkas, Morgan, Martin, & Maczuga, 2009; Matthews, Cameron, & Morrison, 2009). Racial/ethnic disparities have also been extensively studied, with most recent best-evidence research suggesting that Black students are both disproportionately under-identified for special education (Morgan et al., 2015, 2017a, 2017b) and receive fewer disability evaluations prior to extreme punitive disciplinary actions, resulting in more out-of-school punishment and lost educational opportunities (Collins et al., 2016; McWilliams & Fancher, 2010; Skiba et al., 2011). Once Black students are identified for special education, they also spend less time in general education classrooms relative to White special education students (Fierros & Conroy, 2002; Skiba, Poloni-Staudinger, Gallini, Simmons, & Feggins-Azziz, 2005). These inequalities in service provision and opportunity are especially problematic given the wealth of research demonstrating numerous benefits from increased access to and time physically spent in the general education environment (e.g., Cosier et al, 2013; IDEA, 1997; Kavale & Forness, 2000).

Students' environments also greatly influence risk for disability identification. Rates of disproportionality for emotional disturbances are higher in low-poverty districts (Oswald et al., 1999; Skiba et al., 2005), indicating that whether and when a student is identified may be at least partly dependent on district-wide characteristics. Poorer students are more often exposed to environmental teratogens and toxins that may produce disability (e.g., high lead rates are linked to cognitive delays; see Brooks-Gunn & Duncan, 1997). At the same time, these students disproportionately lack access to trained professionals that could diagnose disabilities (Donovan & Cross, 2002; Glascoe, 2000; Morgan et al., 2014; Peterson et al., 2011), increasingly leading

to delayed identification. This may be especially detrimental since remediation of learning may be best accomplished through early identification and referral (e.g. Sigman, Peña, Goldin, & Ribiero, 2014; Wolery & Bailey, 2002) given the developmental malleability of young children (Glascoe, 2000).

The sum total of research investigating group differences in special education clearly indicates that there is systemic inequality in identification and service delivery across students and districts. This inequality damages the primary aim of special education: to provide *individualized* education to students with disabilities according to their special educational needs. The problem of unequal access to services prompts renewed focus on the questions of *who is placed into special education,* and *what happens to them following identification*. Yet, despite decades of research, consensus is lacking.

Interdisciplinary Focus on Special Education

There is evidence that addressing developmental timing and trajectory differences in special education may clarify the problems we see with policy implementation and service delivery. However, with few exceptions, special education researchers have largely ignored how the developmental timing at which services are delivered influences who is placed in special education and their subsequent schooling outcomes. Special education may therefore benefit from an interdisciplinary focus at pathways through which disorder and disability manifest in schools, as well as which students then receive special education services. The present studies were approached with this interdisciplinary attitude in mind, drawing from three disciplines in particular: developmental psychology, educational psychology, and special education.

Developmental psychology broadly aims to investigate how children and adults change over time by focusing on the biological and social processes generating both stability and change

(Harris & Butterworth, 2002). Similarly, educational psychology brings this focus on development into schools and classrooms, focusing on how children learn, think, and grow as they progress through school (Ormrod, Saklofske, Schwean, Andrews, & Shore, 2005). As a discipline, special education has been more focused on the legal requirements of schools to educate all students with disabilities than on the process by which disability manifests in educational settings over time. In this way, inferences about special education could be strengthened through interdisciplinary research, particularly that which bridges with educational and/or developmental psychology.

This dissertation is situated at the intersection of all three disciplines. Because IDEA has mandated that all schools educate students with disabilities in a free, appropriate, and least-restrictive environment, any research investigating the processes by which students are identified for special education and the consequences of service receipt has readymade policy implications. Yet, research that ignores or glosses over the importance of developmental timing and trajectories, particularly with respect to the manifestation of disability within educational contexts, may result in muddied or misinformed policy. Just as developmental psychology emerged early in the 20th century to dispel the notion that children were just small versions of adults, so too should special education researchers turn to uncovering why and how its youngest students differ from its oldest in both educational need and consequences of service receipt.

The three studies within this dissertation investigate how risk factors for special education placement and the consequences of receiving special education services change over time and with development. Study 1 asks, *Who is placed in special education?* with regard to educational trajectories from Kindergarten through grade 8. Study 2 builds upon this question by contextualizing it within schools, where likelihood of placement depends on hierarchical

interactions between individual characteristics and school-level factors (e.g., individual race/ethnicity interacting with schoolwide proportions of free lunch service). Finally, Study 3 assesses academic and behavioral outcomes for special education students based on the timing of initial service receipt, initial diagnosis, and IEP goals.

Below, I briefly provide the justification for each study, though a fuller review of literature is reserved for each chapter. All analyses were conducted using restricted data from the Early Childhood Longitudinal Study, Kindergarten Class of 1998-1999 (ECLS-K). This study followed a nationally-representative cohort of approximately 21,400 children for eight years, collecting information about schooling experiences in Kindergarten, first, third, fifth, and eighth grade. The longitudinal and comprehensive nature of this dataset lends itself to studying a wide range of factors associated with schooling outcomes.

Study 1: Examining Longitudinal Patterns of K-8 Special Education Service Receipt

Most studies investigating special education identification disaggregate results by disability type. However, pinpointing when certain populations are first identified for special education in one disability category cannot account for the nuances accompanying long-term trajectories throughout schooling. For instance, many students are identified early for speech and language impairment but switch to receiving learning disability services partway through elementary school (Marder, 2009; Snowling, Bishop, & Stothard, 2000). Studies that assess only the timing of diagnosis by disability category and do not account for this category switching may produce erroneous conclusions about the likelihood of identification and consequences of service delivery. The first study of my dissertation therefore makes use of a novel approach in explaining what makes these profiles of students qualitatively different from each other. Specifically, I ask *who is placed in special education?* according to Kindergarten demographic factors that

differentially impact *trajectories* of service receipt throughout schooling.

Study 2: Contextualizing Patterns of Special Education Placement and Service Receipt

Capturing a clear snapshot of individual characteristics informing special education placement is only part of the story, as analytical concerns abound in research examining who is placed into special education. Urie Bronfenbrenner championed the idea that human development takes place through processes of progressively more complex reciprocal interaction nested within the contexts (both immediate and remote) of the developing person. These contexts involve microsystems, such as the family, school, peer group, and workplace; mesosystems, such as the links between the home and school; exosystems, such as the relationship between the home and the parent's workplace or the neighborhood-community context; macrosystems of overarching culture/society; and finally, chronosystems encompassing the change or consistency over time in the person and their environment. He argued that to understand a person, one must understand the context in which that person develops (see Bronfenbrenner, 1993). Thus, in investigating why certain children might receive special education services over others, it is important to deconstruct how individual-level characteristics (e.g., race/ethnicity, gender, socioeconomic status) function alongside and within school-level factors (e.g., available school resources and funding streams, student body characteristics). Yet, much existing research has failed to account for both the dynamic nature of service receipt over time and the hierarchical structure of educational data. Therefore, the goal of the second study in this dissertation was to contextualize special education trajectories *within* schools, therefore addressing the multiplicative, nested effects of individuals operating within larger educational structures. This in turn allows for a more holistic explanation of why some students follow different trajectories of service receipt throughout primary schooling.

Study 3: What Happens to Students in Special Education? Academic Achievement and Behavioral Adjustment Following Identification

Finally, ascertaining who is placed into special education is only the beginning. The goal of special education is to provide individualized services to students with disabilities in the hope that they may be given the greatest opportunity to succeed in school. Advocates argue that early intervention is the best solution to alleviate academic or behavioral issues in the long run (e.g. Sigman, Peña, Goldin, & Ribiero, 2014; Wolery & Bailey, 2002), making it vital to ensure that "at-risk" children have access to these services. Yet, evidence to the effectiveness of special education as an intervention is meager, with some research suggesting that placing a child into special education may set them on a path of reduced academic performance compared to their non-special education peers (Cooc, 2014; Reynolds & Wolfe, 1999; Sullivan & Field, 2013). Still more researchers argue that special education is accompanied by increased stigma, reduced educational expectations by teachers and parents, and greater peer rejection and bullying (e.g., Ashby, 2010; Riddick, 2000; Rose, Monda-Amaya, & Espelage, 2011; Shifrer, 2013). To paraphrase Donovan and Cross (2002), this is the paradox of special education: if placement may lead to poorer outcomes, why advocate for early identification and referral? In elucidating this paradox, the third and final study asks: *what happens to students once they are placed in special education*?

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CHAPTER II

Examining Longitudinal Patterns of K-8 Special Education Service Receipt

Abstract

Understanding the difference between longitudinal prevalence and current incidence of disability is an important, yet untapped, dimension of special education service receipt. The present study used latent class growth curve analysis (LCGA) and multinomial logistic regression to classify longitudinal trajectories of K-8 special education service receipt and assess which Kindergarten individual- and school-level characteristics predict the likelihood of following these different trajectories. Results demonstrated that nearly 22% of students participating in the ECLS-K (1998) received special education services prior to high school. LCGA identified 4 trajectories of special education service receipt: *Never*, *Persistent, Delayed,* and *Terminal*. Results from descriptive analyses and multinomial logistic regression revealed important differences between these trajectories that both align with prior work and offer a fresh perspective into which students experience chronic special education service receipt. For instance, students in the *Persistent* and *Delayed* groups experienced more socioeconomic, academic, and behavioral disadvantage than students in both the *Terminal* and *Never* groups. When coupled with research assessing initial placement into special education, this study informs future research as to how special education placement changes across schooling and development, and for whom.

Keywords: special education; developmental trajectories; longitudinal methodology; secondary data analysis

Introduction

Understanding how to help low-performing students is one of the most chronic issues facing education. Especially challenging is the often-blurred line between low-performers and atypical learners, such as students with disabilities. For instance, under the Individuals with Disabilities Education Act (IDEA, 2004), students are precluded from receiving services for a learning disability if their learning problems arise from "environmental, cultural, or economic disadvantage" (34 CFR 300.309). Yet, children from disadvantaged backgrounds experience environmental and social risk factors (e.g., lead exposure, low birthweight, poverty) that heighten problem behaviors and risk for disability identification (Brooks-Gunn & Duncan, 1997; Donovan & Cross, 2002; Mann, McCartney, & Park, 2007).

For decades, researchers have attempted to pinpoint which environmental, biological, and educational risk factors lead to identification for special education (e.g., Donovan & Cross, 2002; Hibel, Farkas, & Morgan, 2010; Lloyd, Kauffman, Landrum, & Roe, 1991; Mann, McCartney, & Park, 2007). However, most studies rely on a cross-sectional metric of initial referral (e.g., 13% of US students aged 3-21 received special education services in 2013-2014; NCES, 2016), and typically in only one disability category. This metric likely does not fully capture nuances in service delivery and greatly underestimates the burden of disability over time (Jaffee, Harrington, Cohen, & Moffitt, 2005; Forness, Freeman, Paparella, Kauffman, & Walker, 2012). For instance, Chesmore, Ou, and Reynolds (2016) demonstrated that both the number of years receiving special education services and the timing of service receipt (i.e., before or after 3rd grade) may differentially influence young adult outcomes. Forness et al. (2012) noted that the point prevalence (i.e., at a given time) of students with an emotional or behavioral disability has hovered around 12 percent for the past two decades, even though the cumulative (or "lifetime")

prevalence of emotional and behavioral disorders has been 37-39 percent across diverse samples and historical timeframes. Kessler et al. (2005) also estimate that between 20% to 30% of Americans experience a mood or anxiety disorder at some point during their lifespan, though the reported point prevalence of depression or anxiety disorders in any given year is 7% to 18% (Anxiety and Depression Association of America, 2016).

These studies all used longitudinal methods to answer questions about who receives services over time and how longitudinal outcomes may differ as a function of service receipt, instead of the more commonly-assessed cross-sectional estimates. Yet, gaps in the literature still exist. Forness did not broadly explore longitudinal service receipt beyond emotional and behavioral disorders; Chesmore's analyses were conducted on a non-representative sample that did not assess *trajectories* of special education beyond the amount and timing of services received; and Kessler's results do not speak to special education service receipt among schoolchildren. Thus, it remains empirically unclear how nationally-representative samples of individuals move through the special education system, and what factors influence trajectories of special education service receipt. The present study therefore makes use of a primarily descriptive approach to investigating trajectories of K-8 special education service, including the assessment of group differences between trajectories, and the demographic, achievement, and behavioral risk factors that predict longitudinal service receipt.

A recent report from the Institute of Education Sciences (Loeb et al., 2017) described the importance of quantitative descriptive analysis as a partner to causal research methods. Though descriptive research is often overlooked, this method can "distill [large] datasets into meaningful dimensions to uncover patterns and inform and improve decision-making" (p. 3), which further helps researchers understand the types of causal interventions that might be most effective, and

for whom. Moreover, other analytical methods can sometimes mask the clarity of real-world phenomena, particularly when communicating findings to readers. In the same vein, analyzing cross-sectional incidences of special education placement (i.e., the number of students receiving services for learning disabilities in 2015-2016), even within longitudinal data, can mask information about how often and for how long a student may receive services. Thus, understanding the difference between longitudinal prevalence and current incidence of special education service receipt is an important, yet untapped, goal.

Research Questions

The primary aim of this paper is to assess trajectories of special education service receipt and group differences among these trajectories. Following these descriptive estimates, which serve as important precursors to future causal inference models (Loeb et al., 2017), the unique predictive ability of "best-evidence" variables measured at Kindergarten are used to identify which students are most likely to follow certain longitudinal trajectories of special education service receipt. The research questions addressed in this study were:

1) Do students follow different trajectories of special education service receipt from Kindergarten through eighth grade?
2) Which students follow these K-8 special education trajectories?
3) What individual- and school-level sociodemographic, academic, and behavioral characteristics uniquely predict special education trajectories?

The present research is novel in its broad exploration of longitudinal patterns of special education, rather than relying on cross-sectional incidences of first identification alone. Results are presented with hopes that other researchers will be inspired to utilize similar metrics when assessing who receives special education services.

Method

Data

Analyses were conducted using restricted data from the Early Childhood Longitudinal Study, Kindergarten Class of 1998-1999 (ECLS-K). This study followed a nationally-representative cohort of approximately 21,400 children for eight years, collecting information about schooling experiences in Kindergarten, first, third, fifth, and eighth grade. The longitudinal and comprehensive nature of this dataset lends itself to studying a wide range of factors associated with schooling outcomes, including special education. Per stipulations required by the Institute of Education Sciences when using restricted data, all reported sample and group sizes are rounded to the nearest 10. This study was exempted from institutional review by an ethics committee at the University of Michigan since the data were de-identified prior to author receipt and analyses.

Variable Information

Including appropriate controls in analyses aids in accurately identifying individuals who may be at risk for special education placement and reduces the impact of selection bias (Morgan et al., 2017). Yet, many covariates have been linked only to initial risk for disability identification, rather than longitudinal duration of service receipt. As it is unclear how or whether previously-identified risk factors influence the retention or termination of special education services over time, this study also assessed group differences between trajectories using previously-identified "best-evidence" predictors of special education placement, at both the individual- and school-levels; variables included in analyses are described below, and in Table II.1.

Child characteristics. During each wave of data collection, school office staff were

asked to indicate whether each student had an IEP on file. This resulted in binary indicators corresponding to general or special education status at Kindergarten, first, third, fifth, and eighth grade, which were then used to assess latent trajectories of special education receipt. Other child characteristics measured at Kindergarten were also used to describe group differences across trajectories, and to predict which students follow these trajectories over time. At the individual level, identification for special education, disability diagnosis, and/or at-risk status has been extensively studied, and seems to be especially heightened by male sex, parent-reported disability, and non-White race/ethnicity (e.g., Blackburn, Spencer, & Read, 2013; Morgan, Farkas, Hillemeier, & Maczuga, 2012; Morgan, Farkas, & Hillemeier, 2015; Sullivan & Bal, 2013). Older Kindergarteners are also less likely to receive special education services (Dhuey & Lipscomb, 2010). Artiles, Rueda, Salazar, and Higareda (2002) found that English language learners were "overrepresented" in later (but not earlier) grades. Finally, children with a birth weight less than 6 lbs. are more likely to experience cognitive difficulties (Grunau, Whitfield, & Davis, 2002) and be placed in early intervention or special education programs (Morgan, Farkas, Hillemeier, & Maczuga, 2012).

Home characteristics. Sullivan and Bal (2013) describe how nonacademic factors like "social traumas" may influence likelihood of special education placement more than individual learning proclivities. In the home environment, these social traumas may include whether the child lacks access to healthcare services or a regular childcare program prior to Kindergarten; is not exposed to high levels of cognitive stimulation or high levels of parental engagement in the home; has many siblings; grows up in a low-income or impoverished environment; and/or has a young, single, or less educated parent (Donovan & Cross, 2002; Costello et al., 1996; Altarac & Saroha, 2007; Emerson, Einfeld, & Stancliffe, 2011; Sullivan & Bal, 2013).

To capture cognitive stimulation, home resources, and family rules, structure, and routines, 18 variables available at the Kindergarten wave were recoded and combined into a single composite measure. First, 11 binary indicators of whether the child took dance, music, or art lessons; participated in athletic events, organized performances, or organized clubs; read a book outside of school; and visited the library, a museum, a zoo, or an aquarium were summed into one composite variable and z-scored to have a mean of 0 and standard deviation of 1. Next, 2 variables assessing whether the child had a home computer to use and how safe it was to play outside were summed and z-scored. Lastly, a dichotomous variable asking whether the child went to bed at the same time each night was added to 4 variables assessing the number of days per week breakfast and/or dinner was consumed as a family, and how many days per week these meals occurred at regular times. This new variable was then z-scored. Finally, these three composite variables were added together and z-scored again to represent a single predictor of cognitive stimulation and the home environment.

Academic achievement and behavioral ratings. Poor academic achievement, including in both reading and math, is one of the strongest predictors of special education placement (Briesch et al., 2012; Donovan & Cross, 2002; Hosp & Reschly, 2004; Moll, Kunze, Neuhoff, Bruder, & Schulte-Korne, 2014; Morgan et al., 2017). Academic assessments created specifically for the ECLS-K used Item Response Theory (IRT), which algorithmically places each child on a continuous ability scale based on the number of correct, incorrect, and omitted answers in relation to item difficulty. This method also allows scores obtained at each timepoint to be directly comparable, thus permitting longitudinal analyses. IRT-adjusted scores assessing reading and mathematics ability in the spring of Kindergarten were included in these models.

Moreover, behavioral problems, such as self-regulatory, internalizing and/or

externalizing disorders, also have a demonstrable effect on special education referrals and placements (Forness, Freeman, Paparella, Kauffman, & Walker, 2012; Briesch, Ferguson, Volpe, & Briesch, 2012). Five Kindergarten teacher-reported ratings of behavioral capabilities from the Teacher Social Rating Scale (SRS, adapted from the Social Skills Rating Scale; Gresham and Elliott, 1990) were included in analyses. The Approaches to Learning scale measures how children engage with the learning environment, by rating their attentiveness, task persistence, eagerness to learn, independence, flexibility, and organization. The Interpersonal Skills scale rates the child's ability to form and maintain relationships, get along with others, comfort or help others, positively express feelings, ideas, and opinions, and show sensitivity to others' feelings. The Self-Control scale measures the child's ability to control their behavior by responding appropriately to peer pressure, respecting others' property, controlling their temper, and accepting peers' ideas. The Internalizing Problem Behaviors scale rated apparent anxiety, loneliness, low self-esteem, and sadness, while the Externalizing Problem Behaviors scale measured how often the child argues, fights, gets angry, acts impulsively, and disturbs ongoing activities.

School demographic information. School-level resources and policies greatly influence who is placed in special education (Dhuey & Lipscomb, 2013; Oswald, Coutinho, Best, & Singh, 1999). These resources and policies have been captured both directly and indirectly using variables commonly available in large-scale secondary datasets. Studies analyzing school- or district-level predictors of special education placement often include covariates assessing schoolwide socioeconomic status and/or at-risk children's enrollment (including whether the school serves a high-minority, non-English proficient, or disabled population); whether the school received Title I funds (statewide funding reserved for schools serving high percentages of

low-income students; Elementary and Secondary Education Act, 1965); average academic ability and/or behavioral ratings; private or religious school status; urbanicity, census region, or size of the district; teacher demographic information; and school climate (e.g., Artiles, Rueda, Salazar, & Higareda, 2002; Blanchett, Mumford, & Beachum, 2005; Bruns, Walrath, Glass-Siegel, & Weist, 2004; Billingsley, 2004; Hibel, Farkas, & Morgan, 2010; Hosp & Reschly, 2004; Morgan, Farkas, Tufis, & Sperling, 2008; Oswald, Coutinho, & Best, 2002; Oswald, Coutinho, Best, & Singh, 1999; Parrish, Hikido, & Fowler, 1998; Skiba et al., 2005; Sullivan, 2011; Sullivan & Bal, 2013; Wiley & Siperstein, 2011).

Of these predictors, several variables in the ECLS-K may be used to capture specific information about school neighborhood and school climate. For instance, school neighborhood quality was evaluated by summing 5 administrator-reported items: whether there were neighborhood problems with substance abuse, gangs, tension from differences, vacant buildings, and crime in the area (for each item, 1 = no problem, 2 = somewhat of a problem, 3 = big problem; resulting composite scores ranged from 5-15, which were then standardized to have a sample mean of 0 and standard deviation of 1). School climate was assessed by averaging 9 items (with 1 = strongly disagree, 5 = strongly agree): active participation in school programs by parents, problems with teachers absent (reversed), problems with teacher turnover (reversed), problems with student absences (reversed), strong community support, parent and school consensus on expectations, order and discipline maintained, problems with school overcrowding (reversed), and parents being welcome to observe classes; this measure was also standardized to M=0, SD=1.

Missing Data

Though 6 predictor variables were missing no data (male sex, region, urban area, private

school, school size, and average schoolwide mathematics score), most variables did have some missingness, ranging from 0.1 percent (number of disabilities per classroom; average schoolwide reading score) to 25.2 percent (percent of school receiving free lunch; mean amount of missing data was 3.7 percent). Modeling predictors of missingness alongside variables used in analytical models leads to a likely estimation of data missing at random (Allison, 2012). Given the rich nature of the ECLS-K, variables associated with missing patterns were used to multiply impute data in Stata/SE v. 15.0. Multiple imputation fills in missing values multiple times for each variable to create several complete datasets for analysis (Rubin, 1978; Schenker & Taylor, 1996; Van Buuren & Groothuis-Oudshoorn, 2011), which yields reliable estimates of data missing at random. Though imputations in the social sciences have historically been conducted with $m = 3$ to 5 imputed datasets (Spratt et al., 2010), decreasing m tends to reduce power and increase errors (Graham et al., 2007). As there is no negative impact of increasing m (White, Royston, & Wood, 2011), analyses were performed on 40 imputed datasets. All continuous variables were imputed using predictive mean matching, which matches missing values to observed values that have the closest predicted mean using the k-nearest neighbors (knn) approach (Little, 1988); in this model, $k = 10$. Binary variables were imputed using logistic regression, and categorical variables were imputed using multinomial logistic regression. Proportions of missing observations for each variable are represented in Tables 3 and 4.

Normality and Weighting

There were no issues with multivariate outliers, multicollinearity, singularity, or linearity. Analyses were weighted to account for the complex, cluster-sample study design by normalizing the Kindergarten weight *C2CW0* and adjusting it by its spring Kindergarten design effect (Kish, 1965). This procedure ensures that reported results are representative of students who began

Kindergarten in the 1998-1999 school year and continued through eighth grade (for a discussion of weighting in longitudinal samples, see Davis-Kean, Jager, & Maslowsky, 2015).

Analytical Strategy

Trajectories of special education service receipt were captured using latent class growth analysis (LCGA), which uses a categorical or binary outcome variable measured at multiple time points to group latent classes of participants according to their growth curves. Like latent class analysis, LCGA describes unobserved ("latent") groups of individuals, such that participants within subpopulations are grouped with those who are maximally similar to each other. This approach guards against Simpson's paradox (Simpson, 1951), in which statistical inferences obtained from procedures that assume homogenous populations can be misleading (Yang, Shaftel, Glasnapp, & Poggio, 2005). LCGA adds classes stepwise until the smallest number of latent classes that fit the data well are identified, and produces individual probabilities of membership within each growth trajectory (Muthén & Muthén, 2000; Yang, Shaftel, Glasnapp, & Poggio, 2005). Following LCGA, data were multiply imputed using the approach described above. Finally, the relative probabilities of membership in each longitudinal trajectory were assessed using multinomial logistic regression, which is a technique that compares the odds of multiple categorical outcomes with a base referent outcome (Hosmer & Lemeshow, 1989).

Results

Do Students Follow Different K-8 Paths of Special Education Service Receipt?

The first research question asked whether students followed various trajectories of special education service receipt throughout primary schooling. Table II.2 presents fit statistics from 2-, 3-, 4-, and 5-solution LCGAs. Model fit was evaluated by comparing relative goodness-of-fit likelihood ratio test statistics (e.g., VLMR and LMR), entropy, and information criteria (e.g.,

AIC, BIC, sample-adjusted BIC) among each solution. The model with the minimum values of information criteria and high entropy values (≥.90) is considered the best-fitting model. The 3- and 4-class solutions fit the data better than the 2- and 3-class solutions, respectively, as indicated by significant VLMR and LMR likelihood ratio tests (LRTs), and reduced information criteria. However, the 5-class solution did not fit the data better than a 4-class solution (VLMR-LRT p = .203, LMR-LRT p = .210), and the fit statistics did not improve (AIC = 9214.66, BIC = 9400.37, Sample-adjusted BIC = 9308.22, entropy = .891). Given these considerations, the 4-class solution was retained. 79.4% of the sample never received K-8 special education services, meaning that 21.6% did receive special education at some point prior to high school – nearly double that of cross-sectional estimates (i.e., 13% of U.S. students received services in 2013).

Figure II.1 displays growth curve trajectories for the 4-class and 5-class solutions. Both models classified distinct trajectories of students who are most likely to be in general education at all timepoints (labeled *Never*), students who are most likely to be in special education at all timepoints (labeled *Persistent*), students who most likely to receive special education in 5th grade (labeled *Delayed*), and students are most likely to receive services in 1st grade and then may stop receiving special education services thereafter (labeled *Terminal*). In addition to these four classes, the 5-class LCGA classified a group of students who experience a delayed entry into special education but are likely to stop receiving services by 8th grade (labeled *Delay/Terminal*). However, given that this 5-class solution did not appear to fit the data better than the 4-class solution (Table II.2), the 4-class model was retained. The longitudinal patterns within each of these four classes are presented in Table II.3. In contrast to these models, the 2-class solution classified students as general education (i.e., *Never*) or special education (all other students who received services at some point through 8th grade), while the 3-class solution classified students

into the *Never*, *Persistent*, and *Delayed* groups.

Which Students Follow these K-8 Special Education Trajectories?

Special education teachers' report of the student's primary disability at each wave was also useful in determining the proportion of disability categorizations for each trajectory (Figure II.2). The five most common U.S. disability categories at the time of ECLS-K data collection are reported: Learning Disability (LD), Speech and Language Impairment (SLI), Mental Retardation (MR – currently reclassified as Intellectual Disability), Other Health Impairment (OHI), and Serious Emotional Disturbance (SED), as well as an "Other" category encompassing other IEP primary classifications (e.g., Blind/Visual Impairment, Deaf/Hard of Hearing, Autism, Developmental Delay, Orthopedic Impairment, etc.). The *Persistent* category shifted from being mostly comprised of students with SLIs to LDs around first grade, which aligns with prior work demonstrating that as many as 50% of students initially served under the SLI and OHI determination change categories during schooling (Marder, 2009). Given the higher and stable rates of disability status reported for students in the *Persistent* category over time, these students may experience more severe impairments that require constant special education services. The *Delayed* category was almost solely composed of students with LDs. The *Terminal* category, in contrast, appears to be primarily capturing placement for students with SLI. Students with MR, OHI, SED, or other disabilities are mostly represented in the *Persistent* category, albeit at much lower levels than either SLI or LD. This indicates that most students with MR, OHI, SED, and/or other disabilities are identified early and remain on special education services throughout schooling, as opposed to trajectories in which service receipt is terminated or delayed.

Tables 3 and 4 present weighted Kindergarten sample descriptive statistics for each trajectory identified in the 4-class LCGA. Significant differences between groups are denoted by

subscript letters corresponding to each column (e.g., in Table II.4, there are significantly more males in the *Persistent* and *Delayed* categories than in the *Never* category, though the *Persistent* and *Delayed* categories do not significantly differ from each other). Multiple comparisons were corrected using Holm's method for the omnibus tests (*F* and Chi-square), and using Scheffé's method for comparisons between trajectories.

These descriptive Kindergarten statistics reveal that students following different trajectories of special education service receipt come from substantively different groups of children. The largest differences between trajectories at Kindergarten appeared for parent-report of disability ($\chi^2 = 471.49$), math performance ($F = 99.13$), reading performance ($F = 98.38$), teacher-reported positive learning behavior ($F = 79.37$), and public-school attendance ($\chi^2 = 75.44$). Examining both individual- (Table II.4) and school-level (Table II.5) variables, students in the three special education trajectories (*Persistent, Delayed, Terminal*) appear to experience more socioeconomic, behavioral, and academic disadvantage than students who are least likely to receive special education services (*Never*). In other words, they more often come from lower-income families with less educated mothers and less cognitive stimulation in the home, attend public schools of lower average socioeconomic status, reading, and mathematical performance, and are in classrooms that have higher numbers of students with disabilities. In addition, they have lower reading and mathematics scores than students in the *Never* trajectory both initially (Table II.4) and through 8th grade (Figure II.3). By 8th grade, students in the *Persistent* category are about 1.3 standard deviations behind students who *Never* receive services in both reading and math; students in the *Delayed* category are about 0.9 and 0.8 standard deviations behind in reading and math, respectively; and students in the *Terminal* category are about 0.3 standard deviations behind in both reading and math.

Second, it also appears as though students in the *Persistent* and *Delayed* groups experienced more socioeconomic, academic, and behavioral disadvantage than students in the *Terminal* group. The *Persistent* and *Delayed* groups more often come from impoverished families, have a single parent, attend schools with more average behavioral problems, and are rated more poorly for self-regulation, interpersonal relationship skills, externalizing problems, and internalizing problems than students in the *Never* and *Terminal* trajectories (and, there were no differences between *Never* and *Terminal* on any of these variables). Moreover, students in the *Persistent* and *Delayed* trajectories displayed lower reading and mathematical performance than students in the *Terminal* trajectory, both initially and over time (see Figure II.3). Interestingly, students in the *Terminal* trajectory attended schools with more Title I funding than students in the *Never* trajectory, though there were no differences in Title I funding among the *Never, Persistent,* or *Delayed* trajectories.

Finally, there were few significant differences between the *Persistent* and *Delayed* groups. Students in the *Delayed* trajectory had fewer parent-reports of disability, better reading and mathematics performance, and fewer internalizing problem behaviors. On the other hand, students in the *Persistent* group attended Kindergarten classes with higher numbers of students with disabilities, and schools with poorer average reading, mathematics, self-regulation, interpersonal skills, and externalizing problem behaviors than students in the *Delayed* group.

What Individual- and School-Level Sociodemographic, Academic, and Behavioral Characteristics Uniquely Predict Special Education Trajectories?

Results thus far have established that different profiles of students follow various trajectories of K-8 special education service receipt. However, these descriptive statistics do not control for the confounding influence of other variables that could influence special education

placement, nor are they able to *predict* who follows these trajectories longitudinally. Thus, given these group differences, the second research question assessed which factors uniquely predicted each trajectory. That is, statistically controlling for existing group differences, what Kindergarten variables predict the likelihood of following each trajectory over time?

Multinomial logistic regression was used to analyze which variables predicted trajectory membership while simultaneously controlling for sociodemographic, achievement, and behavioral confounds at both the individual and school levels (n = 7,140). The metric of comparison in multinomial logistic regression is a relative risk ratio, which assesses the risk of membership in a certain trajectory relative to a base category (in this case, the *Never* trajectory). Numbers greater than 1.00 correspond to increased risk relative to the referent group, numbers less than 1.00 correspond to decreased risk, and numbers equaling 1.00 indicate equal likelihoods. All predictors were measured during the Kindergarten year, and results are displayed in Table II.6.

Results from the multinomial logistic regression tell a similar story to the sampling demographics displayed for each group, though this method allows us to pinpoint which predictors most influence the likelihood of following different special education trajectories. Relative to students who *Never* receive services, students who follow each special education trajectory (*Persistent*, *Delayed*, and *Terminal*) are more likely to be male and to have a parent-reported disability. Students in the *Persistent* group are most likely to display these qualities relative to the *Never* trajectory, followed by the *Terminal* and then *Delayed* groups. Beyond this, different factors predict the likelihood that students will follow each trajectory. First, it appears that student demographics and home characteristics most influence students following the *Persistent* trajectory. Students in this group are more likely to primarily speak a non-English

language in the home (*RRR* = .27), and less likely to come from homes with more cognitive stimulation and structure (*RRR* = .71). They are older at Kindergarten entry (*RRR* = 1.10), tend to have lower math scores in Kindergarten (*RRR* = .88; but, interestingly, no differences in reading performance), and display poorer learning-related behaviors (*RRR* = .44). Finally, they are the least likely to attend private school (*RRR* = .12), and most likely to attend a school where more students with disabilities are served (*RRR* = 1.13).

In contrast, the relative risk of following the *Terminal* trajectory seems to be more strongly predicted by school-level factors. For instance, students in this trajectory are less likely to attend school in safe neighborhoods (*RRR* = .80) and less likely to attend private school (*RRR* = 32). Beyond male sex and parent-reported disability, there were no significant child-level predictors of following this trajectory – though, increased likelihood of having health insurance (*RRR* = .42) and displaying poorer self-regulation (*RRR* = .47) were marginally significant.

Finally, students in the *Delayed* category are likely to display lower academic achievement (RRR_{read} = .96, RRR_{math} = .92) and poorer learning-related behaviors (*RRR* = .58) during Kindergarten, though they also attend schools with her average mathematics scores (*RRR* = 1.11). This pattern is reversed for externalizing problem behaviors, such that *Delayed* students display fewer of these behaviors in Kindergarten (*RRR* = .67) but seem to attend schools with higher average levels of externalizing problems (*RRR* = 3.31; though, these predictors were marginally significant at $p < .10$). Lastly, they are also much less likely to live in the Western U.S. census region (*RRR* = .35).

Discussion

The purpose of this study was, first and foremost, to provide a new way to evaluate data on special education placement. There is overwhelmingly more evidence available on point

prevalence than on cumulative (or "lifetime") prevalence, and cumulative prevalence has not traditionally been emphasized in discussions of special education services (Forness et al., 2012; Kauffman & Landrum, 2009; Walker, Ramsey, & Gresham, 2004). First, this study assessed whether students follow different K-8 paths of special education service receipt. Results suggest that there are multiple paths that students may follow throughout schooling, which allows novel assessment of who is placed into special education. Using LCGA, these trajectories were also classified into 4 categories for further analysis of the demographic, achievement, and behavioral factors that might inform special education placement: *Never, Persistent, Delayed,* and *Terminal.*

Second, descriptive statistics revealed that students following each K-8 special education trajectory appear to be from fundamentally different groups of children. For instance, students in the *Persistent* category (and, to a lesser extent, the *Delayed* category) have more markers of disadvantage than the *Terminal* and *Never* categories. However, while informative, descriptive group differences are not suitable for predicting future trajectory membership. Thus, and third, multinomial logistic regression was employed to assess which Kindergarten sociodemographic, achievement, and behavioral variables most strongly predicted the odds of following each trajectory, while statistically removing shared variance among predictors from the model. Results confirmed that different profiles of students follow these paths and identified the Kindergarten factors that most strongly predict the likelihood of following each trajectory. For instance, researchers have long speculated that disadvantaged families may be more likely to be exposed to environmental toxins that increase risk for disability identification (e.g., Brooks-Gunn & Duncan, 1997; Losen & Orfield, 2002; Skiba et al., 2005). While results align with the hypothesis that disadvantage begets risk for special education placement, they also demonstrate that this relation is especially true for students experiencing persistent or delayed entry into

special education through eighth grade. Students who exit special education did not display these same risk profiles, which offers the field a fresh perspective into how to study placement. In turn, this socioeconomic disadvantage experienced by those in the *Persistent* category could lead to more medically-diagnosed or severe disabilities requiring services throughout schooling. Indeed, this hypothesis is supported by Figure II.2, in which the largest proportions of students primarily receiving services for MR, OHI, SED, and other diagnoses were found in the *Persistent* trajectory. Moreover, because students in the *Persistent* trajectory come from homes with less cognitive stimulation and structure, and/or where English is not the primary language spoken, there may be cultural differences among these students that produce increased and prolonged likelihood of service receipt. In fact, it is quite interesting that students persistently receiving services do not have poorer reading skills at Kindergarten than students never receiving services - only poorer math skills. Future research should explore and attend to the characteristics of math deficits that may produce or accompany disability, particularly for students from culturally diverse backgrounds, as these students seem most likely to receive special education services throughout their schooling careers.

The evidence also demonstrates that students experiencing K-8 special education are predominantly educated in public schools. In the descriptive statistics, most students attending private school fell into the *Never* category of service delivery, while in the multinomial logistic regression model, attending private school at Kindergarten greatly lowered the likelihoods of following either the *Persistent* or *Terminal* patterns of special education, and to a lesser extent the *Delayed* trajectory (although this was not statistically significant). Students attending private schools are not legally entitled to the same rights under IDEA as students attending public schools, because private institutions do not receive funds for special education from state or

federal governments. Since private schools are not mandated by law to provide special education services or programs (though some do), students with disabilities or special educational needs may have few options but to attend public school, where districts receive funding from state and federal governments to cover the costs of specialized programs.

The *Delayed* trajectory's decreased likelihood of living in the West potentially indicates that identification policies that prevent delayed referral in these states may be more effective. Additionally, students in the *Delayed* group attend schools with higher average mathematics achievement, yet individually display poorer academic achievement and fewer positive learning behaviors. Though marginally significant, results revealed evidence trending toward students in this trajectory displaying fewer externalizing behaviors at Kindergarten but attending schools with higher rates of externalizing problem behaviors. This provides some evidence for the frog pond effect described by Hibel, Farkas, and Morgan (2010), in which students with better-rated behaviors attending schools with poorer overall behaviors may initially be less likely to be noticed and referred for special education. It could be that this group encompasses students who, at the transition to school, display weak academic skills in schools with better academic performance, and who begin acting out over time (perhaps mirroring poorly-behaved peers) and so eventually procure a referral to special education. Though this hypothesis warrants further study with predictors beyond the Kindergarten year, it is directly aligned with prior work by Morgan, Farkas, and colleagues, who have documented a strong relationship between early academic difficulties and later problem behaviors (Forness et al., 2012; Morgan, Fuchs, Compton, Cordray, & Fuchs, 2008; Morgan, Farkas, & Wu, 2009; Morgan, Farkas, & Wu, 2012; Morgan, Farkas, Tufis, & Sperling, 2008).

It was also noteworthy that academic achievement was not as strong a predictor of

following trajectories of special education placement as prior research might suggest (e.g., Briesch et al., 2012; Donovan & Cross, 2002; Hosp & Reschly, 2004; Moll, Kunze, Neuhoff, Bruder, & Schulte-Korne, 2014; Morgan et al., 2017). It is possible that academic achievement factors into longitudinal trajectories of special education service receipt less than for initial identification. In addition, the lack of statistically significant trajectory differences along the lines of race/ethnicity was also surprising. Though there appear to be more Black and Hispanic students in the *Persistent* and *Delayed* categories than in the *Never* or *Terminal* categories when examining unadjusted descriptive statistics (Table II.4), the risk ratios yielded by the multinomial logistic regression for the *Persistent, Terminal,* and *Delayed* trajectories were lower relative to the *Never* trajectory when controlling for individual and schoolwide socioeconomic, academic, and behavioral characteristics. Yet, neither of these analyses was statistically significant, with the sole exception among students reporting a race/ethnicity other than White, Black, Hispanic, or Asian/Pacific Islander being less likely to be classified as *Persistently* needing special education services. This aligns with findings by Morgan, Farkas, and colleagues, who point out that failing to control for individual predictors like academic achievement and socioeconomic status yield special education probability estimates that are biased upwards for students of color (e.g., Morgan et al., 2015; Morgan et al., 2017; Morgan, Farkas, Hillemeier, & Maczuga, 2017). Though the results presented here are mostly non-significant, a longitudinal approach to categorizing who receives special education services may still have implications for the debate on racial disproportionality. Given the apparent pattern of unadjusted socioeconomic, academic, and behavioral disadvantage present among students receiving special education services, future research investigating longitudinal trajectories of service receipt should appropriately control for these confounds to obtain unbiased estimates (e.g., see Morgan et al., 2017).

Limitations

This study has several limitations. First, it is important to note that the ECLS-K 1998 data is nearly twenty years old. Post-2000 legislative changes, such as the No Child Left Behind Act and revisions to IDEA, necessitate newer data to answer questions about trajectories of special education services. These findings also provoke important questions about directionality (e.g., between low academic performance and special education placement) that the nature of this study does not allow for further exploration. It is also possible that there is more variability within and between schools than was captured using these methods. Perhaps by examining these predictors in a hierarchically-nested structure (e.g., through multilevel modeling, where estimates for individuals are nested within schools, for instance), we may see different estimates of relative risk among special education trajectories as a function of which schools children attend. Future research should explore this possibility.

Conclusion

This study captures important dimensionality to service receipt that prior studies fail to yield. Results generally suggest that it is insufficient to assess which students are receiving services only at a given timepoint, but to ensure that their longitudinal trajectories are accounted for when analyzing risk factors for and consequences of special education placement. Although IDEA stipulates no environmental precursors to special education placement, the students who receive special education services for the longest amount of time and/or later in schooling seemingly experience the most environmental disadvantage, the lowest academic performance, and the poorest behavioral ratings. These findings align with previous assertions that disadvantage begets special education placement, largely for students persistently receiving services or who experience delayed entry into special education. In contrast, students who did

not receive services later in their schooling career seemed to display the fewest socioeconomic risks, best academic performance, and best behavioral ratings second to students never receiving special education services. This not only aligns with prior work finding fewer adverse outcomes for students receiving services earlier in K-12 education (e.g., Chesmore, Ou, & Reynolds, 2016; Ehrhardt, Huntington, Molino, & Barbaresi, 2013; Reynolds & Wolfe, 1999), but also reinforces the need for earlier intervention, alongside renewed consideration of how early environments interact with disability status to necessitate longitudinal special education services. Given that the results presented here are mostly descriptive rather than causal, future research should casually evaluate how socioeconomic disadvantage and special education trajectories relate.

In sum, these results indicate that it is important to account for different longitudinal paths through special education to avoid inappropriate generalizations about all students with special needs, particularly when assessing initial disability identification and subsequent developmental trajectories. Future research should causally investigate to what extent earlier timing and shorter duration of service receipt positively impact academic and behavioral outcomes, and/or to what extent students with better academic and behavioral scores require fewer special education services.

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Table II.1 Variable Descriptions

Variable	Description
Individual	
Male	1=Male Sex
Non-English Lang	1=Non-English primarily spoken in the home
Race/Ethnicity	1=Non-Hispanic White, 2=Non-Hispanic Black, 3=Hispanic, 4=Asian, 5=Other
Low Birthweight	1=Born weighing less than 6 lbs.
Disability	1=Parent reports a disability
Age at K Entry	Age at Kindergarten entry, ranging from 38 to 83 months
No Insurance	1=Child does not have health insurance coverage
No Regular Childcare	1=Child did not attend regular childcare (including daycare and Head Start) before Kindergarten
Income	Parent-reported household income, ranging from 1 (less than $5,000) to 13 (greater than $100,000)
Poverty	1=Family is at or below federal poverty line
Single Parent	1=Mother is single, separated, divorced, or widowed
Maternal Education	Level of mother's education, ranging from 1 (8^{th} grade education or less) to 9 (doctoral or professional degree)
Home Cog. Stimulation	Standardized measure of cognitive stimulation in the home environment, ranging from -3.3 to 3.0
No. Siblings	Number of siblings, ranging from 0-10
Reading	IRT-adjusted spring reading score, ranging from 11.6 to 70.8
Mathematics	IRT-adjusted spring mathematics score, ranging from 7.7 to 59.2
App. To Learning	Teacher-reported positive learning behaviors, average scale ranging from 1-4
Self-Control	Teacher-reported self-regulation skills, average scale ranging from 1-4
Interpersonal	Teacher-reported interpersonal relationships, average scale ranging from 1-4
Externalizing	Teacher-reported externalizing problem behaviors, average scale ranging from 1-4
Internalizing	Teacher-reported internalizing problem behaviors, average scale ranging from 1-4
School	
Region	1=Northeast, 2=Midwest, 3=South, 4=West
Urban Area	1=Urban Area (Census Reported Population >250,000)
Neighborhood Safety^{+}	Standardized principal-reported measure of neighborhood quality and safety, ranging from -0.9 to 1.9
Private School	1=Principal reports school is private or religious
School Size^{+}	Principal-reported number of children enrolled in school, ranging from 1 (149 or less) to 5 (750 or more)
School Climate^{+}	Standardized measure of school climate reported by principal, ranging from -3.0 to 2.7

Title I Funding	1=Principal reports that school receives schoolwide Title I Funding
% Free Lunch	Principal-reported proportion of student body receiving free lunch, ranging from 0 to 100
Avg. SES[+]	Student-level measure of SES (created by ECLS-K), aggregated across schools, ranging from -1.5 to 1.7
% Non-White	Principal-reported proportion of student body that reports a non-White race/ethnicity, ranging from 1 (less than 10%) to 5 (75% or more)
% Limited English	Principal-reported proportion of student body that are English Language Learners, ranging from 0 to 99
No. Disabilities/Class	Teacher-reported number of students with disabilities in their classroom, aggregated across the school, ranging from 0 to 28
Avg. Reading	Student-level IRT-adjusted reading scores, aggregated across schools, ranging from 12.3 to 63.7
Avg. Math	Student-level IRT-adjusted mathematics scores, aggregated across schools, ranging from 7.7 to 49.4
Avg. App. To Learn	Student-level IRT-adjusted positive learning behaviors, as rated by teachers and aggregated across schools, ranging from 1.8 to 4
Avg. Self-Control	Student-level IRT-adjusted self-regulation skills, as rated by teachers and aggregated across schools, ranging from 2 to 4
Avg. Interpersonal	Student-level IRT-adjusted interpersonal skills, as rated by teachers and aggregated across schools, ranging from 2.2 to 4
Avg. Externalizing	Student-level IRT-adjusted externalizing problems, as rated by teachers and aggregated across schools, ranging from 1 to 2.5
Avg. Internalizing	Student-level IRT-adjusted internalizing problems, as rated by teachers and aggregated across schools, ranging from 1 to 2.3

[+]Standardized to M=0, SD=1

Table II.2 Fit Statistics for 2-, 3-, 4-, and 5-Solution Latent Class Analysis

	2-class	**3-class**	**4-class**	**5-class**
AIC	9675.16	9376.26	9207.31	9214.66
BIC	9745.60	9485.13	9354.60	9400.37
Sample-Size Adjusted BIC	9710.65	9431.11	9281.52	9308.22
Entropy	.933	.950	.939	.891
VLMR LRT p-value	.000	.000	.000	.203
LMR Adjusted LRT p-value	.000	.000	.000	.210

Note: AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion; VLMR = Vuong-Lo-Mendell-Rubin; LRT = Likelihood Ratio Test; LMR = Lo-Mendell-Rubin.

Table II.3 4-Solution Latent Class Analysis Classification Patterns of Special Education Service Receipt

Class 1		**Class 2**		**Class 3**		**Class 4**	
Never (*n* = 3,790)		*Persistent* (*n* = 210)		*Terminal* (*n* = 160)		*Delayed* (*n* = 310)	
Pattern	%	Pattern	%	Pattern	%	Pattern	%
22222	95.9	11111	40.8	11222	26.9	22111	28.5
22122	1.6	21111	19.0	21222	25.0	22211	23.0
22221	1.4	11112	18.5	11122	18.1	22212	22.6
12222	1.2	21112	10.0	21122	13.8	22112	18.7
		12111	4.3	12122	4.4	22121	3.3
		11121	3.3	21212	3.1	12212	2.0
		12112	3.3	11212	2.5	21211	1.6
		11211	1.0	21221	2.5	12211	0.3
				11221	1.9		
				12121	0.6		
				12221	0.6		
				21121	0.6		

Table II.4 Individual-Level Weighted Kindergarten Descriptive Statistics by Special Education Trajectory

	Never M (SD) or % (a)	Persistent M (SD) or % (b)	Terminal M (SD) or % (c)	Delayed M (SD) or % (d)	Sample Total	*F* or χ^2	% Missing
Demographics							
Male	47.4$_{bd}$	64.3$_{a}$	59	64.1$_{a}$	50	59.98***	0
Non-English Lang	5.9	0.4	0.3	0.8	7.3	4.74	1.7
Race/Ethnicity						19.41	0.2
White	71.9	66.9	68.4	65.4	71		
Black	10.2	14.6	13.1	15	10.9		
Hispanic	12	13.6	13.3	14.9	12.4		
Asian	4	4.6	4	3.2	4		
Multiracial	1.9	0.4	1.2	1.5	1.8		
Low Birthweight	8.7	12	11.8	8	8.9	4.48	6.9
Disability	10.1$_{bcd}$	58.5$_{ad}$	43.8$_{ad}$	19.4$_{acd}$	14.5	471.49***	4.1
Age at K Entry	65.95 (.08)	66.04 (.38)	66.39 (.42)	66.10 (.28)	65.98 (.08)	0.44	4.1
Home/Parenting							
No Insurance	6.9	8.6	8.1	12.2	7.4	12.54	3.7
No Reg. Childcare	24.9	19.4	25.5	25.5	24.7	0.28	21.4
Income	8.08 (.06)$_{bcd}$	6.72 (.24)$_{a}$	7.21 (.28)$_{a}$	6.79 (.22)$_{a}$	7.88 (.05)	21.75***	1.7
Poverty	12.4$_{bd}$	24.4$_{a}$	18.4	25.9$_{a}$	14.2	66.08***	1.7
Single Parent	20.5$_{bd}$	31.2$_{a}$	27.1	30.5$_{a}$	22	30.29***	5.1
Maternal Ed	4.62 (.03)$_{bcd}$	3.94 (.14)$_{a}$	3.95 (.14)$_{a}$	4.15 (.11)$_{a}$	4.52 (.03)	17.77***	3.0
Home Cog. Stim^{+}	.01 (.02)$_{bcd}$	-.41 (.08)$_{a}$	-.33 (.08)$_{a}$	-.21 (.07)$_{a}$	-.04 (.02)	15.9***	4.3
No. Siblings	1.38 (.02)	1.65 (.11)	1.45 (.09)	1.58 (.08)	1.41 (.02)	3.66	4.0
Academics/Behavior							
Reading	34.63 (.18)$_{bcd}$	25.53 (.78)$_{acd}$	29.22 (.78)$_{ab}$	27.50 (.62)$_{ab}$	33.37 (.17)	98.38***	3.4
Mathematics	30.24 (.15)$_{bcd}$	21.03 (.66)$_{acd}$	26.88 (.67)$_{abd}$	24.05 (.56)$_{abc}$	29.17 (.15)	99.13***	0.9
App. To Learning	3.28 (.01)$_{bcd}$	2.58 (.06)$_{acd}$	3.06 (.06)$_{abd}$	2.81 (.05)$_{abc}$	3.20 (.01)	79.37***	1.9

Self-Control	3.30 (.01)$_{bd}$	2.91 (.05)$_{ac}$	3.19 (.05)$_{b}$	3.05 (.05)$_{a}$	3.26 (.01)	27.09***	2.3
Interpersonal	3.24 (.01)$_{bd}$	2.82 (.06)$_{ac}$	3.11 (.05)$_{b}$	2.95 (.04)$_{a}$	3.20 (.01)	32.28***	2.7
Externalizing	1.57 (.01)$_{bd}$	1.92 (.06)$_{ac}$	1.61 (.05)$_{b}$	1.78 (.05)$_{a}$	1.60 (.01)	18.39***	2.1
Internalizing	1.49 (.01)$_{bd}$	1.79 (.04)$_{acd}$	1.61 (.04)$_{b}$	1.64 (.03)$_{abd}$	1.52 (.01)	25.65***	2.6

[+]Standardized measure (M=0, SD=1).

***p < .001, **p < .01, *p < .05 (Holm-corrected significance values)

[a,b,c,d] Letters indicate which columns differ significantly from one another. Multiple comparisons corrected using Scheffé's method.

Table II.5 School-Level Weighted Kindergarten Descriptive Statistics by Special Education Trajectory

	Never M (SD) or % (a)	Persistent M (SD) or % (b)	Terminal M (SD) or % (c)	Delayed M (SD) or % (d)	Sample Total	*F* or χ^2	% Missing
School Demographics							
Region						29.26	0.0
Northeast	17.4	17.1	14.9	19.2	17.4		
Midwest	29.5	27.8	26	30.7	29.3		
South	37.5	46.9	47.5	41.4	38.7		
West	15.6_{d}	8.3	11.6	8.8_{a}	14.6		
Urban Area	81.1	78.6	73.7	78	80.4	8.06	0.0
Neighbrhd. Safety^{+}	-.02 (.02)	.11 (.09)	-.14 (.09)	.02 (.08)	-.02 (.02)	1.35	21.0
Private School	15.5_{bcd}	2.2_{a}	2.7_{a}	5.1_{a}	13.5	75.44***	0.0
School Size^{+}	.11 (.02)	.12 (.07)	.12 (.09)	.18 (.07)	.11 (.02)	0.36	0.0
School Climate^{+}	-.04 $(.02)_{b}$	-.31 $(.08)_{a}$	-.10 (.09)	-.13 (.07)	-.06 (.02)	4.15	14.8
Title I Funding	61.4_{c}	71.4	73.6_{a}	62.3	62.6	18.36**	0.3
Student Demographics							
% Free Lunch	47.25 (.71)	53.02 (2.77)	49.02 (3.01)	49.77 (2.35)	47.81 (.64)	1.67	25.2
Avg. SES^{+}	.08 $(.01)_{bcd}$	-.11 $(.03)_{a}$	-.09 $(.03)_{a}$	-.02 $(.03)_{a}$	.05 (.01)	20.82***	0.2
% Non-White	24.84 (.57)	27.23 (2.44)	25.77 (2.62)	28.79 (2.05)	25.29 (.52)	1.4	1.1
% Lim. English	4.06 (.22)	5.53 (1.11)	4.39 (1.22)	3.47 (.63)	4.11 (.20)	0.91	5.4
No. Disab/Class	1.97 $(.05)_{bc}$	3.63 $(.31)_{ad}$	2.98 $(.25)_{ad}$	1.93 $(.17)_{bc}$	2.10 (.05)	14.37***	0.1
Student Achievement/Behavior							
Avg. Reading	32.62 $(.09)_{bcd}$	30.40 $(.35)_{a}$	30.98 $(.39)_{a}$	31.40 $(.31)_{a}$	32.35 (.09)	20.33***	0.1
Avg. Math	28.48 $(.08)_{bcd}$	26.42 $(.28)_{ad}$	27.19 $(.33)_{a}$	27.48 $(.25)_{ab}$	28.24 (.07)	23.07***	0.0
Avg. App. To Learn	3.13 $(.00)_{b}$	3.04 $(.02)_{a}$	3.10 (.02)	3.11 (.02)	3.13 (.04)	10.49***	0.5
Avg. Self-Control	3.21 $(.00)_{b}$	3.14 $(.02)_{ad}$	3.19 (.02)	3.21 $(.02)_{b}$	3.20 (.00)	6.35***	0.5
Avg. Interpersonal	3.14 $(.00)_{b}$	3.06 $(.02)_{ad}$	3.12 (.02)	3.13 $(.02)_{b}$	3.13 (.00)	6.55***	0.5
Avg. Externalizing	1.65 $(.00)_{b}$	1.72 $(.02)_{ad}$	1.65 (.02)	1.65 $(.02)_{b}$	1.65 (.00)	5.35**	0.5

Avg. Internalizing	1.55 (.00)$_{b}$	1.62 (.01)$_{a}$	1.57 (.01)	1.57 (.01)	1.56 (.00)	7.23***	0.5
Avg. No. Disabilities	1.91 (.04)$_{b}$	2.89 (.22)$_{ad}$	2.34 (.22)	2.05 (.16)$_{b}$	1.97 (.03)	7.43***	1.8

[+]Standardized measure (M=0, SD=1).

***$p < .001$, **$p < .01$, *$p < .05$ (Holm-corrected significance values)

[a,b,c,d] Letters indicate which columns differ significantly from one another. Multiple comparisons corrected using Scheffé's method.

Table II.6 Relative Risk of Placement in LCGA Trajectories by Kindergarten Predictors

	Persistent	Terminal	Delayed
Demographics			
Male	1.77*	1.69*	1.66**
Non-English Lang.	0.27*	1.13	0.92
Race/Ethnicity			
Black	0.53	0.56	0.62
Hispanic	0.73	1.13	0.86
Asian/Pacific Islander	0.29	0.76	0.67
Other	0.22*	0.72	0.88
Low Birthweight	0.60	1.17	0.53
Disability	9.06***	5.35***	2.10**
Age at K Entry	1.10**	1.01	1.02
Home Characteristics			
No Health Insurance	0.53	0.42^{+}	0.94
No Reg. Childcare	0.95	1.21	0.99
Income	1.00	0.98	0.96
Poverty	1.66	1.04	1.02
Single Parent	0.77	0.77	0.95
Maternal Ed.	1.05	0.94	1.02
Home Cog. Stim.	0.71*	0.90	0.90
No. Siblings	0.97	1.06	0.94
Achievement/Behavior			
Reading	0.98	0.97	0.96*
Mathematics	0.88***	0.97	0.92***
App. To Learn	0.44*	0.71	0.58*
Self-Control	0.58	0.47^{+}	0.90
Interpersonal	1.78	1.41	1.13
Externalizing	0.96	0.64	0.67^{+}
Internalizing	1.35	0.95	1.01
School Demographics			
Region of Country			
Midwest	1.12	1.03	0.79
South	0.72	1.44	0.76
West	0.52	0.61	0.35**
Urban	0.50	0.74	1.00
School Neighborhood	0.92	0.80*	1.02
Private School	0.12**	0.32*	0.59
School Size	1.09	0.95	1.06
School Climate	1.00	1.02	1.00
Title I Funding	1.25	1.15	0.80

Student Demographics			
% Free Lunch	0.99	0.99	1.00
% Nonwhite	1.05	1.14	1.08
% Limited English	1.01	1.00	1.00
Avg. SES	1.04	0.69	1.71
Student Achievement/Behavior			
Avg. Reading	1.11	0.95	0.98
Avg. Mathematics	0.93	1.09	1.11*
Avg. App. To Learn	2.12	0.45	0.51
Avg. Self-Control	5.80	2.26	3.85
Avg. Interpersonal	0.33	1.49	0.95
Avg. Externalizing	1.76	0.77	3.31^{+}
Avg. Internalizing	1.81	1.99	0.67
Avg. No. Disabilities	1.13*	1.02	1.00
Constant^	0.00***	0.10	0.03

***$p < .001$, **$p < .01$, *$p < .05$, $^{+}p < .10$

^Constant displays overall likelihood of placement.

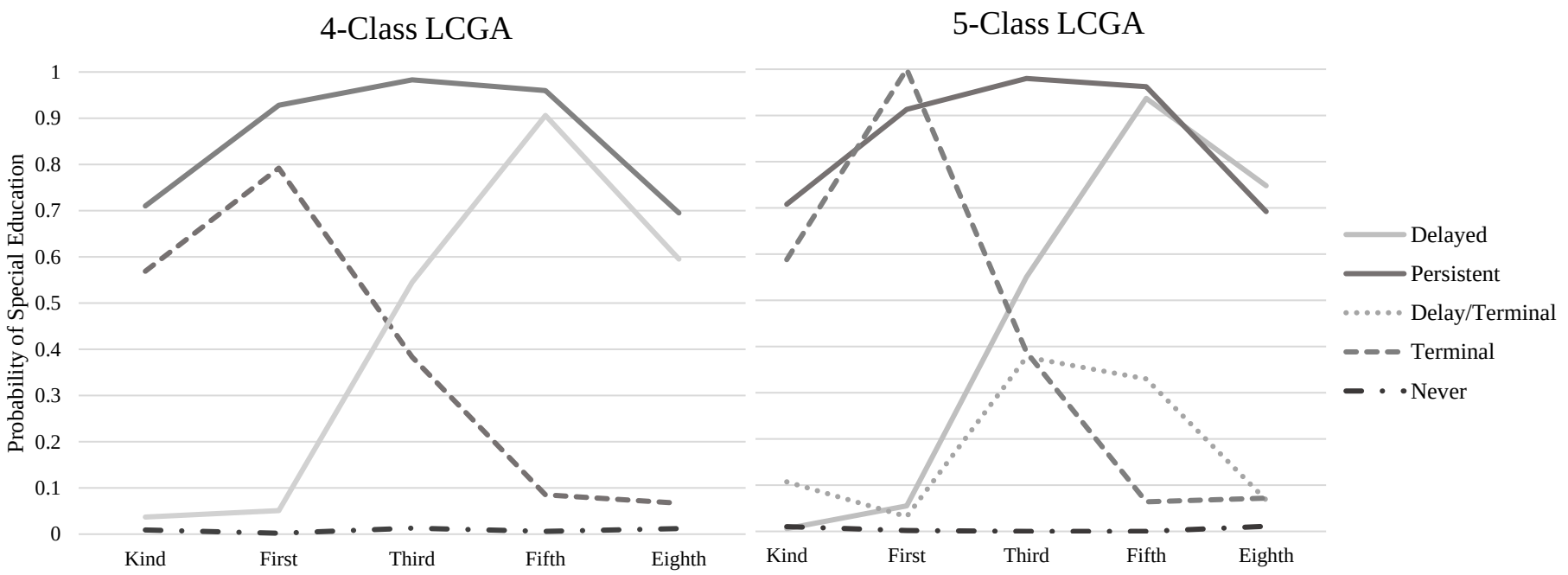

Figure II.1 4- and 5-Solution Latent Class Growth Analyses of Special Education Trajectories

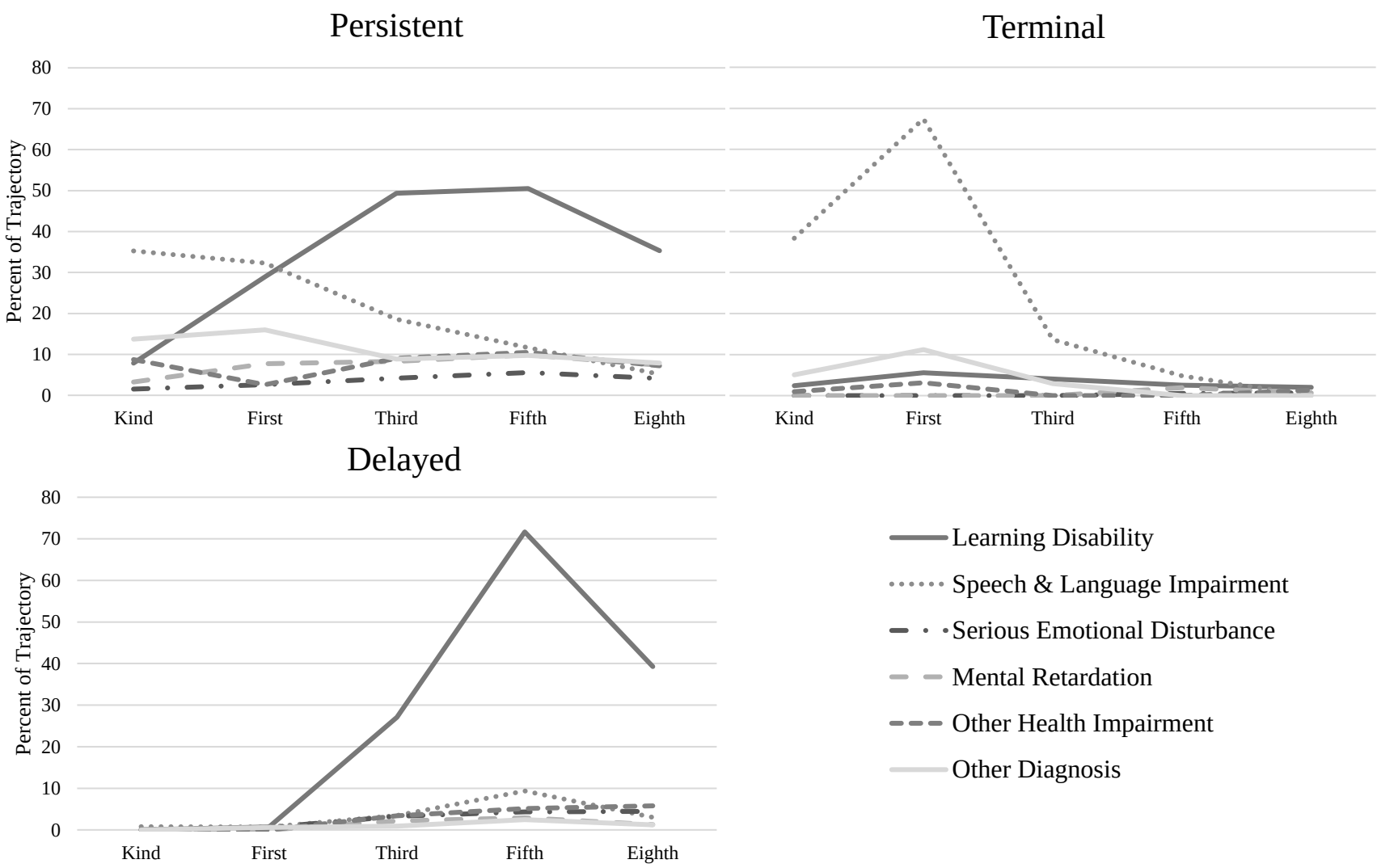

Figure II.2 Weighted Proportion of Students in Each Trajectory by Primary Special Education Disability Category

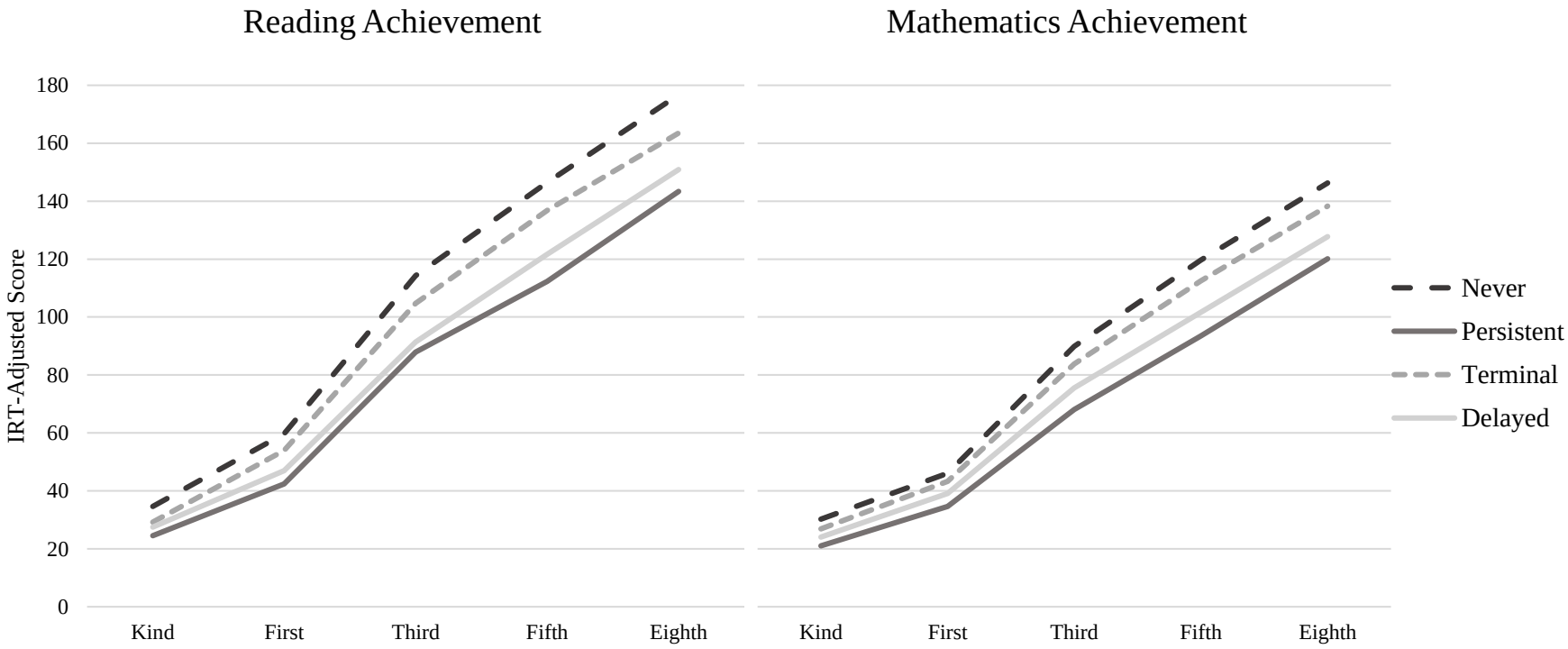

Figure II.3 Longitudinal Academic Achievement by Special Education Trajectory

CHAPTER III

Contextualizing Patterns of Special Education Placement and Service Receipt

Abstract

Though researchers have long been interested in identifying which U.S. students receive special education services, several important gaps in our knowledge remain. In particular, this study addressed how the likelihood of receiving special education services were impacted by 1) the contributions of individual and aggregated data, 2) modeling longitudinal trajectories from Kindergarten through eighth grade, and 3) analyzing how the schooling context differentially influences students from varying backgrounds and with different levels of achievement or behavior. Using the ECLS-K:1998, four multilevel growth analyses were modeled in two samples: the first assessed the likelihood of service receipt in a traditional sample of both general and special education students, while the second investigated which predictors influenced earlier or later service receipt in a sample of students who received services at least once between Kindergarten and eighth grade. Results revealed that individual-level data was most predictive of service receipt, though between a quarter and a third of the variability in special education status occurred between schools; different factors predicted the likelihood of receiving services early in schooling relative to later in schooling; and that the schooling context did not appear to differentially affect certain students' likelihood of service receipt over others, whether that pertain to race/ethnicity, achievement, or behavior. Moreover, implications for researchers and

policymakers were discussed, particularly regarding the importance of early identification of disability and early identification disparities in urban areas and among students with less-educated mothers.

Keywords: multilevel modeling; special education identification; students with disabilities; longitudinal growth modeling

Introduction

From both a financial and civil rights perspective, researchers have long been interested in understanding what influences student likelihoods of receiving special education services. Students with disabilities have had the right to be freely educated in the least restrictive environment since the Education for All Handicapped Children Act was passed in 1975. But problematic and widespread patterns in the demographics of special education students have led to concern that there may be systemic bias in referral policies and procedures. For example, apprehension about the disproportionate identification of non-White students in special education has been likened to a modern-day Jim Crow method of segregation or racism (Blanchett, Mumford, & Beachum, 2005; Skiba et al., 2008), and has led to large-scale policy and funding implementations designed to reduce this disproportionality. In recent years, however, these policies have come under question, as more rigorous methodological research has challenged the idea that non-White students are over-referred for special education (e.g., see Morgan et al., 2015b, 2016, 2017). In this way, the increasing use of more complex methodologies combined with the availability of large-scale datasets is improving researchers' abilities to ascertain who is placed in special education.

Yet, existing studies are incomplete for three reasons. First, most studies fail to consider the impact of multiple levels of influence on special education placement (e.g. child-level factors, such as race/ethnicity, in combination with family-, school-, district-, and state-level factors), choosing instead to model predictors at one level alone (Morgan et al., 2012; Shifrer, Muller, & Callahan, 2011). Though it is imperative to model individual-level predictors that are linked to special education placement, (such as academic achievement, behavior, sex, socioeconomic status, and race/ethnicity), it is also important to account for differences at the

school level, where overarching state and school policies, funding allocations, demographics, teacher characteristics, and available resources may impact who is placed in special education (Aron & Loprest, 2012; Dhuey & Lipscomb, 2013; Oswald, Coutinho, Best, & Singh, 1999; Gordon, 2004). Second, research has also overwhelmingly concentrated on cross-sectional estimates of special education placement instead of accounting for longitudinal trajectories of special education service receipt, which are influenced by factors varying across developmental stages and timepoints. Though some studies utilize longitudinal data to assess how factors measured in early schooling influence later special education placement (e.g., Hibel, Farkas, & Morgan, 2010; Sullivan & Bal, 2013), there appear to be no studies investigating how and for whom likelihood of placement *changes over time* while also accounting for both individual- and school-level data. Third and finally, though several studies have hypothesized the existence of a contextual schooling effect that differentially influences certain students over others (the "frog pond effect"), few studies have modeled this phenomenon using both individual and aggregate data and cross-level interactions.

The goal of this study was to assess the relative contributions of individual- and school-level predictors to special education service receipt, and ascertain how these predictors might interact to differentially influence student likelihoods of service receipt both initially and over time. Given that probabilities of placement likely depend on hierarchical interactions between individual characteristics and school-level factors (e.g. individual race/ethnicity interacting with schoolwide disadvantage), this study builds upon the question *who is placed in special education?* by using multilevel growth modeling to contextualize individuals' longitudinal likelihood of service receipt within schools.

Importance of Analyzing Multiple Levels of Influence

The first problem that has plagued existing research on who receives special education services involves the importance of analyzing both individual-level data (e.g., student's sex, race/ethnicity, family income) and data aggregated across the school, district, or state (e.g., proportions of students receiving free lunch, statewide funding allocations for special education). Whether the researcher examines individual or aggregated data seems to significantly influence their conclusions regarding the factors most related to special education placement.

To illustrate, studies that include only individual-level predictors often assess either risk for disability identification (irrespective of in-school service receipt), which is most strongly predicted by sociodemographic, socioeconomic, and/or social disadvantage (e.g., Altarac & Saroha, 2007; Blackburn, Spencer, & Read, 2013; Costello et al., 1996; Morgan, Hillemeier, Farkas, & Maczuga, 2014), or special education placement, which seems most strongly predicted by poor academic achievement and behavior (e.g., Morgan, Farkas, & Hillemeier, 2015; Morgan, Farkas, Hillemeier, & Maczuga, 2012; Samson & Lesaux, 2009). However, and conversely, studies that use only data aggregated across the school, district, or state typically find that this trend is reversed, such that schoolwide achievement and behavior relate to special education identification only modestly or inconsistently (e.g., Hosp & Reschly, 2004; Skiba et al., 2005) while neighborhood disadvantage and schoolwide demographics have stronger predictive power (e.g., McLaughlin & Owings, 1993; Oswald, Coutinho, Best, & Singh, 1998; Skiba et al., 2005; Parrish & Hikido, 1998). Importantly, school, district, and state-level predictors significantly explain variability in identification rates (e.g., Oswald, Coutinho, Best, & Singh, 1998; Skiba et al., 2005; Wiley & Siperstein, 2011), which necessitates the use of both individual- and aggregate-level data when assessing who is placed in special education.

Yet, gaps remain in our extent knowledge of who receives special education services, given several key methodological decisions among the few studies utilizing both individual- and school-level data cited here. First, many of these studies did not include student-level measures of academic achievement when assessing risk for special education placement (Artiles, Rueda, Salazar, & Higareda, 2002; McLaughlin & Owings, 1993; Oswald, Coutinho, & Best, 2002; Oswald, Coutinho, Best, & Singh, 1998; Parrish & Hikido, 1998; Skiba et al., 2005; Sullivan & Bal, 2013; Wiley, Brigham, Kauffman, & Bogan, 2013; Wiley & Siperstein, 2011), which has been cited as a major methodological error given the strong predictive effect of achievement in individual-level studies (Donovan & Cross, 2002; Hosp & Reschly, 2004; Morgan et al., 2017). Even fewer use analyses that account for the hierarchically-nested nature of children within schools (but, see Hibel, Farkas, & Morgan, 2010; Shifrer, Muller, & Callahan, 2011; Sullivan & Bal, 2013). Failing to account for clustered data has been shown to inflate error estimates and underestimates the contribution of individual- versus school-level effects (Raudenbush & Bryk, 2002). Some researchers even suggest that all analyses should be modeled hierarchically, particularly when using samples in which nesting occurs naturally (such as children within schools) (McElreath, 2017). To combat this issue, the current study utilized multi-level modeling to nest individual predictors within the schooling context.

Importance of Analyzing Change Over Time

The second gap in our understanding of who receives special education services regards the importance of analyzing how probabilities of service receipt change over time, and for whom. Whether and when a child receives special education services depends on many factors, not least of which includes the developmental stage of the child and their concurrent educational needs. Thus, predictors modeled during early schooling may confer a different likelihood of

special education placement than those same predictors modeled later in schooling. For instance, there is evidence that English Language Learners (ELL's) are overrepresented in special education at later grades but underrepresented earlier in schooling, regardless of whether individual- (Samson & Lesaux, 2009) or school-level (Artiles et al., 2002) predictors were modeled. Accounting for longitudinal trajectories of service receipt may therefore change the impact that individual- or school-level predictors have on likelihoods of placement.

Though some research has demonstrated differences in outcomes associated with the timing of service receipt (e.g., Chesmore, Ou, & Reynolds, 2016; Ehrhardt, Huntington, Molino, & Barbaresi, 2013), it is unclear whether these differences are a function of the services rendered or the types of students who receive earlier versus later services. If students who receive earlier services do not differ, outcome variation is more plausibly due to the services received after controlling for the appropriate individual- and school-level covariates. But, if individual and school predictors differentiate those who are placed at earlier or later points in schooling, outcome variation could instead be due to population differences between students who receive services at different times. Thus, we need to better understand how likelihoods change over time for various students, so that we can improve the precision of estimates measuring special education's influence.

Who is Placed in Special Education? The "Frog Pond Effect"

Lastly, the third gap in research assessing who is placed in special education comes from inconsistent methodological choices, specifically the failure to model interactions between individual- and school-level characteristics. To this end, the present study may be best likened to a replication and extension of Hibel, Farkas, and Morgan (2010), who used multilevel logistic regression to assess which first graders receive services by the spring of third grade. Their main

interest was to test the "frog pond effect," a phenomenon in which similar students may seem "worse" when compared with higher- rather than lower-performing peers (Farkas, Sheehan, and Grobe, 1990; Davis, 1966), even after accounting for a wide range of other individual-, family-, and school-level characteristics. Indeed, they found that attending elementary schools with higher levels of academic achievement, better overall behavior, and fewer non-White students increased a student's likelihood of special education placement.

Though the frog pond effect applies to the school as a whole, it is possible that the schoolwide context may also *differentially* affect certain students. School environments could either compound the impact of other risk factors or serve a protective role for children who experience socioeconomically disadvantaged backgrounds or family discord (Morrison & Cosden, 1997; Rutter, 1979). Large populations of low-performing students at the school- or district-level could lead educators to overlook the low-performing students for whom underperformance is due to undiagnosed disabilities (i.e., the big frog stands out in the small pond). Lower-performing students might thus be more likely to receive special education in higher- rather than lower-achieving schools, especially given that teachers' referral decisions often hinge on comparisons to peers (Peterson et al., 2011).

Non-White students in certain schools may also have different experiences with special education than White students. Black and Hispanic families experience more biological and social traumas that increase the likelihood of disability identification (e.g. living in poverty, having a single/teenage parent, etc.) (Hibel et al., 2010). This would not only elevate their risk for special education placement but also for attending high-risk schools, where the frog pond effect could reduce likelihood of service receipt. Numerous researchers have found evidence for this effect, such that Black students are more likely to be placed in special education in higher-

resourced districts (Oswald et al., 1999; Skiba et al., 2005), better-performing schools (Hibel et al., 2010), and in districts with fewer numbers of minority students (Hibel et al., 2010; Oswald, Coutinho, & Best, 2002).

However, the current study differs from Hibel's in several key ways. First, although Hibel and colleagues nested individual- and family-level variables within school-level variables, they did not investigate how these variables influence change in special education placement over time. They also did not include any school-level variables directly assessing the resources used to offset special education services and/or costs (e.g., Title I funds). Lastly and most importantly, they modeled only the main effect of the schooling context and did not consider cross-level *interactions* between school-level characteristics and individual traits. Hibel and colleague's results therefore indicate that in schools with a higher proportion of minority students, *all students* have a reduced chance of special education placement. At the same time, they tended to illustrate the frog pond effect using language more suited to cross-level interactions ("Consider the counterfactual comparison involved in a *low-performing* student simultaneously attending two very different schools… The student should be more likely to be placed in special education when attending the *high-performing* school" pp. 315, emphasis added). Thus, although there are many similarities between the present study and Hibel et al. (2010), the present study may be viewed as an extension of their work in which change over time and cross-level interactions (individual*school) are modeled in a hierarchical framework.

Research Questions and Hypotheses

The present study conducted two series of multilevel analyses. The first set of analyses compared students in general education with students who received special education services between Kindergarten and 8th grade. This analysis aimed to understand whether contextualizing

individual predictors within school predictors influenced the likelihood of special education placement both at Kindergarten and over time. The second set of analyses sampled only students who received special education during at least one timepoint between Kindergarten and 8th grade, which might allow researchers to better understand what influences both a student's initial and longitudinal propensity to receive services without statistical contamination from students who never receive services. Because students who are placed in special education at some point K-8 are fundamentally different from students who never receive services by way of a disability that adversely impacts academic performance (Hanuschek, Kain, & Rivkin, 2002), this second set of analyses not only provides a sensitivity check but allows for pinpointing the differences between special education students who receive services earlier versus later in schooling.

There were three research goals for each set of analyses. First, the relative influence of individual- versus school-level predictors were decomposed through successive iterations of model building in which schoolwide data was added to individual data. This improves understanding of how these levels interact to influence placement both initially and over time. Second, each model assessed not only the factors predicting which students had an Individualized Education Plan (IEP) in the spring of Kindergarten, but how their likelihoods of placement changed between Kindergarten and eighth grade. This analysis of change over time represents an important yet previously unknown element in identification research. Third and finally, the last model for each analysis tested whether individual likelihoods of special education placement were differentially impacted by school demographic compositions (i.e., whether school-level characteristics interact across levels with individual-level predictors). Cross-level interactions would reveal an important extension to the frog pond effect. These analyses tested four types of frog pond interactions: individual achievement by schoolwide achievement;

individual positive learning behaviors by schoolwide aggregates of positive learning behaviors; individual externalizing problem behaviors by schoolwide aggregates of problem behaviors; and individual race/ethnicity by schoolwide proportions of non-White students.

In keeping with prior research, individual factors were hypothesized to more strongly influence a student's likelihood of service receipt than school factors (though these would also have some influence). Alternatively, if modeling school-level factors decreased the impact of individual-level effects, a student's trajectory through special education was not insignificantly impacted by risk factors occurring at the school-level. This distinction is vital to make, given the prior diversity in methodological decisions when measuring risk for special education placement. Moreover, it was expected that these analyses would replicate evidence for frog pond effects based on academic performance, behavioral ratings, and race/ethnicity differences, such that struggling students (particularly non-White students) would be more likely to receive services both initially and over time in better-performing and behaving schools, or in schools with lower proportions of poorer or non-White students. This study may also clarify policy regarding disproportionate representation, as policies that ignore the contextual contributions of school-wide characteristics will subsequently produce unbalanced enforcement across schools with different student and school characteristics.

Method

Data Source and Sample

Data were drawn from the Early Childhood Longitudinal Study – Kindergarten cohort of 1998-1999 (ECLS-K). Funded through the Institute of Education Sciences, this study collected a wide array of data on home and schooling experiences for one cohort of students followed from Kindergarten through 8th grade. The rich, longitudinal nature of the dataset is ideal for studying

educational outcomes, such as the timing and duration of special education service receipt. Students in the ECLS-K were sampled from participating schools, rendering possible the use of multilevel modeling to answer questions about the complexity of educational systems. Moreover, because both U.S. schools and students were sampled in successive stages, applying initial school-level weights and longitudinal child-level weights allows analyses to be representative of students who began Kindergarten in U.S. schools during the 1998 school year, and who participated in the study through 8th grade. This element of national representation is particularly important to consider given the disparities in findings produced by sampling differences among prior research. For example, studies utilizing a primarily white, middle-class sample find that socioeconomic disadvantage *increases* risk for disability identification (e.g., Grunau, Whitfield, & Davis, 2002; Blackburn, Spencer, & Read, 2013; Costello et al., 1996; Emerson, Einfeld, & Stancliffe, 2011), while those using more diverse samples find that disadvantage *decreases* risk for disability identification, especially among non-white youth (e.g., Morgan, Hillemeier, Farkas, & Maczuga, 2014; Morgan, Staff, Hillemeier, Farkas, & Maczuga 2013; Bussing, Zima, Gary, & Garvan, 2003). Students were excluded from analyses if they attended a private school or a school serving only special education students. Per stipulations required by the Institute of Education Sciences when using restricted data, all reported sample and group sizes are rounded to the nearest 10.

Variable Information

Outcome variable. The outcome measure assessed in these analyses was a binary indicator of whether the student was receiving special education services. School office staff were asked to indicate whether each student had an IEP on file in the spring of Kindergarten, 1st, 3rd, 5th, and 8th grade. If students did not have an IEP on file, they were considered to be in

general education.

Individual-Level Predictors. ***Child demographics.*** There are several child-level predictors commonly utilized in studies assessing likelihood of special education placement. First, boys are 2 to 3 times more likely to be in special education as girls (Hibel, Farkas, & Morgan, 2010; Katusic, Colligan, Barbaresi, Schaid, & Jacobsen, 2001; Morgan, Farkas, Hillemeier, & Maczuga, 2012). Parent-reported disability status is also a strong indicator of whether a student needs special education services throughout K-8 schooling, though, Marder (2009) notes that parents are likely to over-report medical diagnoses and under-report the educationally-relevant disabilities necessitating special education services, such as learning disabilities. Much research also demonstrates differential likelihoods of special education service receipt as a function of race/ethnicity, with more recent best-evidence research indicating that non-white race/ethnicity conveys decreased likelihood of special education service receipt (e.g., Morgan et al., 2015b, 2016, 2017). Lastly, low birthweight status has been linked to cognitive development deficits, which could in turn produce learning difficulties once a child reaches Kindergarten (Morgan et al., 2015a; Grunau, Whitfield, & Davis, 2002).

Parenting and the home environment. It is important to model indicators of socioeconomic and sociodemographic risk factors given the rich body of literature demonstrating strong links between these risks and likelihood of disability identification (Blackburn et al., 2013; Bussing, Zima, Gary, & Garvan, 2003; Costello et al., 1996; Emerson et al., 2011; Morgan et al., 2014). Studies incorporating indicators of family risk typically include covariates such as maternal education, single parent status, and household income or poverty status (e.g. Herbers, Reynolds, & Chen 2013; Morgan, Farkas, Hillemeier, & Maczuga, 2012). In addition, ELL students are less likely to receive special education services initially but more likely to receive

services later in schooling (Artiles et al., 2002; Samson & Lesaux, 2009).

In addition to these variables, educational expectations, cognitive stimulation in the home environment, and parent-child interactions likely also influence special education placement. For instance, Davis-Kean (2005) demonstrated that socioeconomic status (parents' education and family income) influences academic achievement indirectly by operating through parental expectations and behaviors and the structure of the home environment. Yet, socioeconomic status is often used in research assessing the likelihood of special education placement at the expense of measures more directly influencing educational attainment. Given the argument that it is poorer practice to use proximal predictors when more direct measures are available (e.g., because proxies may produce differing effects on association than direct measures; Schisterman, Cole, & Platt, 2009), three variables capturing parenting quality and behaviors, educational expectations, and cognitive stimulation in the home environment were created from the rich array of information available in the ECLS-K. Moreover, as variations on these constructs were available at each wave of data collection, several questions developmentally appropriate to each wave of data collection were summed or averaged together and standardized in successive stages to produce time-varying predictors. Information about the specific variables used at each wave of data collection to create these constructs is available in Appendix A.

Achievement and behavior. Measures of academic achievement are the greatest predictors of special education placement, such that young children with greater early reading and/or mathematics skills are less likely to receive early intervention services (Hibel, Farkas, & Morgan, 2010; Hosp & Reschly, 2004; Morgan et al., 2012; Sullivan & Bal, 2013). Inappropriate behaviors are considered especially problematic in a school setting, and often go hand-in-hand with academic ability (Briesch, Ferguson, Volpe, & Briesch, 2012; Morgan, Farkas, & Wu,

2009; Lin, Morgan, Farkas, Hillemeier, & Cook, 2013; Morgan, Farkas, Tufis, & Sperling, 2008). Moreover, teachers often refer students who stand apart from peers academically and/or behaviorally (Peterson et al., 2011).

Academic achievement variables assessing reading and mathematical prowess were measured in the spring of each wave using Item Response Theory (IRT), in which patterns of correct and incorrect responses were used to algorithmically tailor testing to the child's ability at each grade level. To reduce multicollinearity in the model, IRT-adjusted reading and math scores at each wave were averaged together to create one general academic achievement score. In addition, teacher-reported behavioral ratings assessing positive learning-related behaviors ("Approaches to Learning"), internalizing problem behaviors, and externalizing problem behaviors were available at K, 1, 3, and 5. Because these variables were not available at the 8th grade wave, they were imputed at 8th grade from the 5th grade variables in order to model the longitudinal influence of behavior.

School-level predictors. ***School environment and resources.*** To capture students' schooling environments and available resources, several principal-reported variables were included in analyses based on prior research and theory. First, urban schools face a host of challenges, including the stigmatization of city students (who are often students of color), funding shortfalls, city bureaucracies, and general lack of support (Alston, 2002; Ayers, 1994), which has led some to argue that students with disabilities in these schools are disproportionately negatively affected (Blanchett, Mumford, & Beachum, 2005). Moreover, certain characteristics of low-income neighborhoods (i.e., concentrated disadvantage) have been proposed to increase risk for disability identification (Forness et al., 2012; Jenson, 2007; Xue, Leventhal, Brooks-Gunn, and Earls, 2005). The size of a school (as measured by the number of students enrolled)

may also influence special education services. For example, compared to larger districts, the special education budget in small districts can be drained by students with high cost/low incidence disabilities (Dhuey & Lipscomb, 2013), which could lead to downgraded services due to financial instability.

Several variables were included or created to model school environments and demographics. First, school neighborhood safety was computed by summing 5 principal-reported items about the neighborhood in which the school was located: whether there were problems with substance abuse, gangs, tension from differences, vacant buildings, and crime in the area (for each item, 1 = no problem, 2 = somewhat of a problem, 3 = big problem; resulting composite scores ranged from 5-15, which were then standardized to have a sample mean of 0 and standard deviation of 1). To ascertain the general financial climate and resources of the school, a Kindergarten variable capturing starting teacher salary (ranging from less than $25,000 to more than $60,000) and a time-varying indicator of whether the school received schoolwide funding from Title I were included in analyses. Title I funds are distributed by the state to schools serving high percentages of low-income students to improve the academic performance of educationally needy children, particularly those at risk of school failure (Gordon, 2004).

Schoolwide demographics, behavior, and achievement. Finally, student-body characteristics were included in analyses to test cross-level interactions between individual characteristics and school characteristics. These school characteristics included a principal report of the schoolwide percent of students receiving free lunch (a proxy for economically disadvantaged students), the proportion of the student body reporting a non-White race/ethnicity, the proportion of ELL students attending the school, and the average number of students with disabilities per classroom (aggregated within the school from teacher reports).

In line with the frog pond effect, students with academic or behavioral issues may not stand out in schools with higher proportions of academic and behavioral issues across the student body. To assess this theory, variables assessing the average proportion of students performing at or above statewide proficiency levels (as reported by the school principal) were modeled at the school level. The percent of students proficient in reading and mathematics were again averaged together to reduce multicollinearity in the models. In addition, variables measuring average behavior were computed by aggregating individual reports of positive learning behaviors, internalizing problem behaviors, and externalizing problem behaviors within each school. Variable descriptions for all individual- and school-level predictors, along with descriptive statistics for the analytical samples, may be found in Table III.7. Partial and zero-order correlations are available in Appendix B.

Missing Data

Percentages of missing data for each variable at each wave are available in Table III.8. Two variables were missing no data (*male* and *urban*), while the variable missing the highest proportion of data was the eighth-grade principal-reported proportion of students at or above academic proficiency (51.27 percent missing). The average percent of missing data was 5.96 in Kindergarten, 9.50 in first grade, 10.56 in third grade, 6.90 in fifth grade, and 11.92 in eighth grade. Variables with the most missing data tended to come from items drawn from the administrator survey, and/or from the eighth-grade year.

Including predictors in the imputation model that may be related to the missingness mechanism may lead to a reasonable assumption of data that are missing at random (MAR; Allison, 2012). Given the rich nature of the ECLS-K, this MAR assumption was considered satisfied by including in the imputation model all demographic, achievement, and behavioral

variables used in the main analyses (see White, Royston, & Wood, 2011). Data were imputed using Stata's *mi impute chained* command. Though historically $m = 3$ to 5 datasets have been considered sufficient in the social sciences, more recent estimates indicate that setting m too low may increase standard errors and decrease precision (Spratt et al., 2010; Graham et al., 2007). Thus, $m = 40$ datasets were imputed. All continuous variables were imputed using predictive mean matching to the 10 nearest neighbors (Little, 1988); binary variables imputed using logistic regression; and categorical variables imputed using multinomial logistic regression. The author may be contacted for more detailed information about the imputation models.

Analytical Plan and Methodology

Logistic regression estimates the extent to which dichotomous outcome variables relate to categorical and continuous predictor variables (Peng, Lee, & Ingersoll, 2002). Multilevel logistic regression accounts for the clustering of children within schools, which in turn provides more accurate estimates of within- and between-school effects (Raudenbush & Bryk, 2002). This study utilized a three-level logistic regression, modeling within-student random effects (or, how effects change for each person over time), student-level fixed effects within schools, and between-school fixed effects. Allowing the effect of time to vary between students lets analyses account for students who follow different trajectories of special education. Given the longitudinal nature of these data along with their hierarchical, nested structure, this analytical approach allows for examination of how the likelihood of special education placement changes from Kindergarten through eighth grade. Moreover, this method enables testing of cross-level effects to understand the relative contributions of school-level data to specific individual data.

Data were analyzed in four separate models, each of which were three-level fixed-effects hierarchical generalized linear growth models (with the random effect of grade included at the

individual level). Level 1 measured time, corresponding to each wave of data collection; level 2 measured individual-level characteristics contributing to special education placement; and level 3 measured school-level characteristics that could impact placement. Model equations at each level are as follows:

Level 1: $\Pr(SPED_{ijk} = 1|\beta_{jk}) = \phi_{ijk}$

$$\log[\frac{\phi_{ijk}}{1-\phi_{ijk}}] = \eta_{ijk}$$

$$\eta_{ijk} = \pi_{0jk} + \pi_{1jk}(GRADE_{ijk}),$$

where *SPED* corresponds to one of three outcome variables (described below), and *GRADE* corresponds to each of the five timepoints;

Level 2: $\pi_{0jk} = \beta_{00k} + \beta_{01k}(DEMO_{ijk}) + \beta_{02k}(HOME_{ijk}) + \beta_{03k}(ACH_{ijk})$

$$\pi_{1jk} = \beta_{10k} + \beta_{11k}(DEMO_{ijk}) + \beta_{12k}(HOME_{ijk}) + \beta_{13k}(ACH_{ijk})$$

where *DEMO* is a vector capturing demographic characteristics about the child and home environment; *HOME* is a vector capturing information about parenting and the home environment, and *ACH* is a vector capturing academic performance and teacher-reported behaviors;

Level 3: $\beta_{00k} = \gamma_{000} + \gamma_{001}\left(S_{DEM_{ijk}}\right) + \gamma_{002}\left(S_{RES_{ijk}}\right) + \gamma_{003}\left(S_{ACH_{ijk}}\right) + u_{00k}$

...

$$\beta_{13k} = \gamma_{130} + \gamma_{131}\left(S_{DEM_{ijk}}\right) + \gamma_{132}\left(S_{RES_{ijk}}\right) + \gamma_{133}\left(S_{ACH_{ijk}}\right) + u_{13k}$$

where S_{DEM} corresponds to school-level demographic and environmental characteristics, S_{RES} corresponds to school-level resources and staff, and S_{ACH} represents schoolwide achievement and behavioral characteristics that impact likelihood of special education service receipt.

The final model was constructed in a forward stepwise fashion. Model 1 tested only individual-level effects, both initially and over time. Model 2 tested only school-level effects, both initially and over time. Model 3 tested both individual and school effects initially and over time, but no cross-level interactions with individual*school. Model 4 tested the full model with both individual and school effects (initial status, time*individual, individual*school), and included cross-level interactions between individual- and school-level predictors to test the frog pond effect.

Results

Results are reported as a progression of nested models to illustrate how predictors at the individual and school levels interact to influence special education placement. Reported alongside results are indicators of model fit (Akaike Information Criterion [AIC] and Bayesian Information Criterion [BIC]) and the intraclass correlation (ICC). The ICC is a measure of the fraction of total variation in the data that is accounted for by between-school and between-person variation. It can be interpreted as an indication of how similar students in each school are to one another, and how much they systematically differ from students in another school. The ICC ranges from 0 (meaning that all variability lies within groups) to 1 (meaning that all variability lies between groups and students within groups are essentially the same); an exceptionally large ICC is considered to be around .5 (Musca et al., 2011). Two ICC's are reported: between-school (*School ICC*) and between-person within schools (*Child>School ICC*). Results are reported as odds ratios (*OR*), where an OR of 1.00 indicates that students are no more or less likely to have an IEP than their peers.

Analysis 1: Who is Placed in Special Education at the Transition to School and Over Time?

The first set of analyses compared special and general education students to ascertain

who was most likely to receive special education services both during Kindergarten and through 8th grade (Table III.3). Analyses included a large number of individual and school predictors known to be associated with special education placement or disability identification. The contributions of each level were assessed through four successive models, with individual predictors hypothesized to be more impactful than school predictors. In Model 4, the contextual effect of schooling interacted with individual characteristics was tested as an extension to the frog pond effect. It was expected that individual academic performance, behavior, and race/ethnicity would be differentially influenced by schooling compositions.

Model 1: Individual-level predictors only. The first model utilized only individual-level predictors (modeled at level 2) to assess the probability of receiving services during the first year of school and over time. The intercept corresponds to spring of Kindergarten, the first time point at which special education status was recorded. Results indicate that male Kindergartners were 4 times more likely to have an IEP in Kindergarten than females; Kindergartners whose parents reported a disability were 5 times more likely to have an IEP; and Kindergartners who performed better academically were slightly less likely (2%) to have an IEP (*OR* = .98). Next, the intercept for time was modeled at level 1, and indicates that students were 9.67 times more likely to be placed with each passing grade. Students whose mothers were more educated were more likely to have an IEP over time (*OR* = 1.09), and students with better academic achievement were 1% less likely to have an IEP over time (*OR* = .99). Model fit information indicates that 34% of the variance in IEP status occurred between schools and 77% occurred between individuals within each school.

Model 2: School-level predictors only. Next, the influence of school-level predictors (modeled at level 3) was included in analyses without modeling individual-level predictors. This

step was important to model given that much previous research investigating special education service receipt used only school-level variables, as well as to evaluate how including both individual and school predictors in Model 3 would change estimates obtained from only school predictors in Model 2. Students who attended a school with more students with disabilities per classroom were 23% more likely to have an IEP in Kindergarten. At the slope, the overall effect of time did not attain statistical significance in this model and most predictors did not influence change in likelihood of experiencing special education over time. However, attending a larger school decreased the odds of having an IEP over time by 12%. Model fit information indicates that with only school-level predictors included, this model fit the data significantly worse than when only individual-level predictors were modeled (ΔAIC=2,139 and ΔBIC=2,075). 36% of the variability in IEP status occurred between schools, while 85% of the variability in IEP status was due to between-person differences within schools.

Model 3: Individual and school predictors. In the third model, both individual and school predictors were analyzed together (though no interactions were included). Results were similar to those obtained from Model 1 and Model 2 in that males, students with a disability, and lower-achieving students were most likely to have an IEP in Kindergarten. In addition, this model revealed evidence for a frog pond effect in urban schools and in schools with more students with disabilities, as students attending non-urban schools and schools with a higher number of students with disabilities in each classroom were again more likely to have an IEP in Kindergarten.

The factors predicting change in likelihood of having an IEP over time were also similar to Model 1, but the inclusion of both individual- and school-level variables revealed that students whose teachers reported more positive learning-related behaviors were also significantly less

likely to receive an IEP over time (*OR* = .85). Though students attending a larger school were less likely to have an IEP over time in Model 2, including individual-level predictors rendered all school-level predictors non-significant at the slope. Model fit information indicated that this model fit the data better than either Model 1 (ΔAIC = -423 and ΔBIC = -223) or Model 2 (ΔAIC = -2,563 and ΔBIC = -2,298). Though the variance coefficients were largely similar to Model 1, this model explained 34% of the variance in the school-level intercept and 35% of the variance in the individual-level intercept over Model 2. The ICC's were most similar to Model 1, with 33% and 78% of the variability in IEP status occurring between and within schools, respectively.

Model 4: Full model with cross-level interactions. In the fourth and final model, an extension to frog pond effect was assessed by interacting individual-level achievement, race/ethnicity, and behavior with their corresponding school-level counterparts. To improve model parsimony and reduce degrees of freedom, several non-significant terms in Model 3 were dropped in Model 4 (e.g., the Level 1 by Level 3 interactions, or change in school-level variables over time). Further analyses not reported here indicated that the exclusion of these terms did not influence the estimates of other variables.

Including cross-level interaction terms did not change the significant individual-level estimates reported at either the intercept or slope in Model 3. However, at the school level, attending an urban school ceased to be a statistically significant predictor of special education status, while attending a school with a higher proportion of students performing above academic proficiency on statewide testing did attain statistical significance at the $p < .05$ level (*OR* = .98). Attending schools with a higher classroom numbers of students with disabilities continued to be a strong predictor of individual special education status (*OR* = 1.30). However, there was no significant evidence for a differential effect of schooling context on certain individuals, whether

that be student race/ethnicities interacting with schoolwide proportions of non-White students or students receiving free lunch; individual academic performance interacting with schoolwide proportions of proficient students; or individual behaviors interacting with schoolwide aggregates of student behaviors. Moreover, this model appeared to fit similarly to Model 3 (though, slightly worse: ΔAIC = -64 and ΔBIC = -40), again indicating little evidence for differential individual likelihoods of placement as a function of schoolwide characteristics.

Analysis 2: Among Special Education Students, What Predicts Earlier or Later Service Receipt?

The second set of analyses was conducted on a sample of students who received special education services at some time K-8, as indicated by the presence of an IEP on file during at least one wave of data collection (Table III.4). By utilizing this sample, significant predictors at the intercept correspond to students who received special education services early in schooling (i.e., Kindergarten), while significant predictors at the slope correspond to the factors influencing change over time in IEP status (or, which students were more likely to receive services later). By analyzing this sample, we remove the endogeneity problem of comparing two incomparable groups: one having a disability requiring special education intervention, and the other students who remain in general education throughout schooling. Thus, we are better able to understand which factors predict initial service receipt and which predict later special education placement among a sample of students who require at least some special education intervention.

Model 1: Individual-level predictors only. Similar to Analysis 1, the first model in Analysis 2 included predictors at only the individual level. Male sex, parent-reported disability, and poorer academic performance again increased likelihood of having an IEP in Kindergarten, as was the case in Analysis 1. However, in this sample, students with a single parent were also

1.5 times more likely than students from two-parent households to receive special education services at Kindergarten. The ICC's were lower in these analyses compared to Analysis 1, indicating that less of the variability in IEP status was explained by differences between schools (30%) and differences between individuals within schools (61%) when modeling the same predictors in a sample of only special education students. Thus, there may be other important predictors of earlier vs. later special education service receipt that are not included here.

Model 2: School-level predictors only. The second model again analyzed predictors at only the school level in order to understand their contributions to individual probabilities of special education service receipt prior to combining both individual and school factors in Model 3. Like in Analysis 1, students attending urban schools were 80% less likely (*OR* = .20) to have an IEP during Kindergarten, while students attending schools with higher numbers of children with disabilities per classroom were 1.2 times more likely to have an IEP during Kindergarten. Students who attended larger schools (as indicated by the number of enrolled students) were also 11% less likely (*OR* = .89) to receive an IEP over time. The ICC's were similar to Model 1, with 32% of the variability in IEP status occurring between schools and 63% occurring between individuals within schools.

Model 3: Individual and school predictors. Modeling individual and school level predictors together resulted in similar outcomes as modeling each level separately, though some terms ceased to be significantly predictive of special education status. Among students who experienced some special education between grades K-8, students who received services in Kindergarten were again 4 times more likely to have a parent-reported disability. However, after modeling school predictors alongside individual predictors, male sex and single parent status ceased to be significantly related to special education service receipt during Kindergarten.

Attending an urban school decreased a student's likelihood of service receipt by 82% in Kindergarten and attending a school with a higher number of students with disabilities per classroom increased likelihood of Kindergarten placement by 24%. Over time, students with better academic achievement were again less likely to have an IEP (*OR* = .99) and students with more educated mothers were more likely to have an IEP (*OR* = 1.06). In addition, although school size ceased to significantly predict longitudinal change in IEP status, students attending an urban school were 17% more likely to have an IEP through 8th grade. Coupled with the significant *urban* term at the intercept, this last result indicates that students attending an urban school are less likely to be identified during Kindergarten but increasingly likely to be identified as time progresses.

Model fit information again indicated that modeling individual and school level predictors together fit the data better than modeling each level separately (ΔAIC = -1279, ΔBIC = -1119). Relative to Models 1 and 2, respectively, this model explained 28% and 36% of the variance in the school-level intercepts, 2% and 14% of the variance in the child-level intercepts, and 14% and 22% of the variance in the child-level slopes.

Model 4: Full model with cross-level interactions. Like in analysis 1, the same non-significant terms in Model 3 were dropped from Model 4. Results are largely identical to those obtained in Model 3. At the intercept, Kindergarteners with a disability were 4 times more likely to have an IEP, higher-achieving Kindergartners were 2% less likely to have an IEP, and Kindergartners attending a school with more children with disabilities were 1.2 times more likely to have an IEP. Including cross-level interactions reduced the urban term to non-significance, indicating that the lowered likelihoods of service receipt among urban students may be more related to schoolwide proportions of non-White students, students receiving free lunch, and

compositions of behavior and/or achievement. The only significant predictors of change in IEP status over time were again higher maternal education (*OR* = 1.07) and lower academic achievement (*OR* = .99). Though slightly worse, model fit does not appear significantly different than for Model 3 (ΔAIC = 90, ΔBIC = 69), and the ICC's mirror those obtained in both Models 1 and 3.

Discussion

Although scientists have long debated who is placed in special education, there have been three major issues with existing research that limits our ability to answer this question. First, failing to model special education placement in a multilevel format controlling for both the individual- and school-level predictors that influence identification has led to tenuous assumptions. Second, it is important to model how a student's likelihood of receiving special education services changes over time given developmental considerations that impact children's academic and behavioral needs at various timepoints. Not only can this potentially clarify educational policy tied to special education service provisions, but it may aid researchers in model building and covariate selection depending on the age and developmental timeframe of their samples. Third and finally, researchers who have cited evidence for a "frog pond effect" of special education placement, in which an individual's likelihood of receiving services is dependent on extant school characteristics, have not modeled cross-level interactions within clustered data. The present study is an attempt to rectify these issues and to replicate previous work assessing which students receive special education services over time.

The first aim of this study was to decompose the contributions of individual data to school-level data in predicting IEP status. Consistent with hypotheses, sets of individual-level variables were more predictive than sets of school-level variables in all analyses, though the best

fitting models included both levels. This aligns with prior studies finding that certain individual predictors had the strongest relation to special education identification even while also modeling school-level data (e.g., Hibel, Farkas, & Morgan, 2010; Oswald, Coutinho, & Best, 2002; Sullivan & Bal, 2013). Therefore, researchers or policymakers trying to predict which students receive special education services should not analyze aggregated data alone. Additionally, though most of the variability in who had an IEP was explained at the individual level (particularly in Analysis 1), roughly 30% was also explained by one's school. These same estimates for Analysis 2 were lower, such that about a quarter of variability in IEP status was explained by differences between schools and just over half explained by differences between individuals within schools. Thus, the variables modeled here may do more to differentiate general education students from special education students but do less to explain why certain students receive services earlier or later in schooling. Lastly, school-level variables in Analysis 1 (general vs. special education) did not decrease or change the significance of individual predictors, though they did improve model fit. However, in Analysis 2 (early vs. later special education), the inclusion of school-level variables reduced the male sex and single parent terms to non-significance. This implies that research assessing the timing of service receipt among special education students may overstate the predictive power of being male or having a single parent if the schooling context is unaccounted for. Relatedly, the effect of attending a larger school in both Analysis 1 and 2 was reduced to non-significance once both individual and school predictors were modeled. Studies using only aggregate data may thus overstate the predictive power of school size for early special education identification.

The second focus of this study was to explore what factors predicted initial IEP status as opposed to change in IEP status over time, given developmental differences in educational needs

throughout schooling. Throughout all models and both analyses, parent report of disability status was consistently the strongest predictor of Kindergarten special education service receipt, highlighting the importance of ensuring that children are screened for disability early. Though being diagnosed with a disability prior to school entry dramatically increases the likelihood of receiving Kindergarten special education services (e.g., Weiland, 2016; Peterson et al., 2011), having a parent-reported disability did not differentially influence the probability of receiving services after Kindergarten. This speaks to an important distinction between *disability* and *special education*. If a student's disability does not adversely affect educational performance, the student is ineligible for special education even though they are protected from disability discrimination through section 504 of the Americans with Disabilities Act. In her analysis of the SEELS dataset, Marder (2009) noted that parents may be more likely to follow the medical model of disability and report conditions that do not necessarily affect the child's education, while teachers appear to focus predominantly on disabilities influencing schooling and may even be unaware of medical impairments. In the present study, there were more students with parent-reported disabilities in both analytical samples than students who receive special education services (averaged across waves, 18% and 48% report a disability, while 10% and 36% receive services in Analyses 1 and 2, respectively). Results indicate that students who enter Kindergarten with parents reporting a disability are most likely to receive services during this transition to school, perhaps because the disability was severe enough to be noticed early and/or to impair academic performance. Thereafter, parent report of disability does not impact change in IEP status over time.

The factors influencing change over time also reveal important information about who is likely to receive services longitudinally. Over time, students were more likely to have an IEP if

they had more educated mothers and attended schools with higher numbers of students with disabilities. Importantly, this may indicate that parents who are able to more effectively communicate with schools and advocate for their child's needs are also more likely to have services delivered to their children. In addition, more students with an IEP attended schools with higher proportions of students with teacher-reported disabilities. Though some have hypothesized that resources may become scarce in schools with large special education populations, crowding out new referrals (Dhuey & Lipscomb, 2013), the present results suggest otherwise. Alternatively, however, parents may be more proactively seeking out these schools for their children in the hopes that services will be provided (c.f. Woods, Morrison, & Palincsar, 2017). This dynamic certainly warrants further study.

Lastly, though sex disparities in special education are commonly noted, there were no sex differences in the change over time in the likelihood of service receipt, even though males were consistently more likely to receive services in Kindergarten. Thus, one could hypothesize that the relatively larger number of male students receiving special education services in the United States may primarily occur during the first few years of schooling. There may be biological differences in the manifestation of disability between males and females, particularly for disabilities emerging early in development, a theory that is consistent with research demonstrating sex differences in behavioral self-regulation early in elementary school (e.g., Matthews, Ponitz, & Morrison, 2009). However, this hypothesis failed to hold in the second set of analyses assessing how early students with special educational needs receive services. Once school-level variables were included in the model, males were not significantly more likely to receive earlier services than females with special educational needs. In other words, although males appear to be referred earlier within representative samples of both general and special

education students, being male does not uniquely predict receiving earlier services among samples of special education students alone.

Third and finally, the last focus of this study was to expand upon the frog pond effect by modeling cross-level interactions between individual characteristics and the schooling environment. The school context did influence individual likelihoods of placement, such that students attending urban schools had a lower probability of receiving early services, and students attending schools with more students with disabilities per classroom had a higher probability of receiving early services. However, contrary to hypotheses, this study did not replicate results from Hibel and colleagues (2010). Students were not more likely to receive services if they attended schools with better overall behavior, higher academic performance, and lower proportions of non-White students. In eight models across two samples, there were no significant cross-level interactions. Moreover, modeling interactions between individual and school level predictors did not appear to substantively change fit from Model 3 in either analysis, though it reduced the urban term to non-significance in Analysis 2. Thus, although the school context explains between a quarter and a third of the variability in overall rates of identification, this study suggests that schools do not appear to *differentially* influence placement according to individual racial/ethnic background, achievement, or behavior. This is an important clarification to the literature on the frog pond effect, which is often described in terms that are consistent with these types of cross-level interactions (i.e., *low-performing* students do not appear to have a higher likelihood of placement in *high-performing* schools; rather, *more students* may simply receive services in higher-performing schools).

In addition to these three research aims, two separate analyses were conducted on different samples to provide both a sensitivity analysis and to remove the problem of contrasting

students with and without disabilities. In Analysis 1, special education students were compared to general education students (as is the norm in most research identifying who receives services). In Analysis 2, only special education students were sampled, meaning that the intercept corresponded to students receiving the earliest possible services while the slope corresponded to students who were more likely to receive services later in schooling. The effect of parent-reported disability, maternal education, number of students with disabilities per classroom, and urban areas were consistently predictive across these two analyses. However, Analysis 2 revealed that the factors predicting how early students with special educational needs get services are more strongly tied to the schooling context than to individual differences. Male sex, single parent status, and to some degree, individual academic achievement ceased to have predictive power once schooling variables were included. Instead, students in urban schools appeared more likely to experience delayed service receipt, given the lower odds of placement at the intercept (*OR* = .18) and the higher odds at the slope (*OR* = 1.17). This result in particular is important for those concerned with educational inequities in urban schools and warrants closer scrutiny. There may also be factors capturing schools' ability to put services in place during the transition to school that were unmodeled here, but that contribute to the differences between earlier and later service receipt (particularly given the relatively lower ICC's in Analysis 2).

There were several interesting departures from previous literature that emerged within this study. One such example was the surprisingly weak effect of academic achievement. Male sex, parent-reported disability, maternal education, and the number of students with disabilities per classroom all had larger effect sizes than individual academic achievement. It is logical that the effect of schoolwide academic performance would have a quite small or negligible impact on students' likelihood of placement, but the effect of individual academic achievement was not

often much different from schoolwide achievement. In addition, lower-performing students were no more or less likely to receive earlier services in Analysis 2 than higher-performing students. Given prior assertions that academic achievement is one of the most important predictors to model when identifying students for special education (Donovan & Cross, 2002; Hosp & Reschly, 2004; Morgan et al., 2017), this result is somewhat puzzling.

Another departure from previous literature was the lack of significant differences in placement by race/ethnicity. Though many studies have reported differential likelihoods of placement among non-White students, here, non-White students were no more or less likely to receive services at the transition to school, nor was race/ethnicity a significant predictor of receiving services over time. Moreover, there was no evidence that the schooling context differentially influenced students of varying racial/ethnic backgrounds. Perhaps this occurred because these analyses accounted for longitudinal trajectories of special education rather than only first identification, with "initial" service receipt occurring in Kindergarten. It is possible that if the current study had specifically modeled an intercept occurring later, like third or fifth grade, differences in placement by race/ethnicity may have been observed. However, this seems unlikely, given the concurrent lack of significant differences in growth trajectories for students of various race/ethnicities (i.e., non-White students were no more or less likely to receive services over time than White students). The present study's results also somewhat align with Shifrer and colleagues (2011), who noted that including sociodemographic information in a multilevel framework entirely accounted for Black and Hispanic disproportionality. This ultimately led them to recommend that researchers investigate disproportionality specifically through multilevel modeling. Otherwise, the current results could differ from prior research finding significant disproportionality among non-White students because studies either collapsed data

across ages and thus likely washed out longitudinal trends (Sullivan & Bal, 2013), failed to include both individual and school level predictors (Parrish & Hikido, 1998; Oswald et al., 1998; Skiba et al., 2005; Wiley et al., 2013), or analyzed data among older children (Hibel et al., 2010; Shifrer et al., 2011).

Conclusion

Though early services are often presumed to improve outcomes (Bailey, Aytch, Odom, Symons, & Wolery, 1999; Wolery & Bailey, 2002), more research has been called for to investigate the relationship between early identification of risk, continued or later identification of risk, and participation in special education services – particularly for those interested in redesigning special education policy (Peterson et al., 2011). By modeling predictors of early service receipt alongside predictors of change over time in a multilevel framework, the current study is an important addition to the literature investigating who receives services, and when. Specifically decomposing the effects of predictors at the individual and school levels allowed for clarification regarding how the schooling context influences students at-risk for special education identification and confirmed that researchers should account for clustering and/or analyze data across multiple levels of influence. Moreover, analyzing data across two samples of students further clarified how students who received earlier services differed from those who received later services, which is important for both researchers and policymakers alike. For instance, researchers addressing variation in outcomes as a function of when students received services should be careful to account for early disability status, urbanicity, and the schoolwide proportion of students with disabilities at the very least. Lastly, researchers and policymakers need not be too concerned with schoolwide characteristics differentially influencing certain students over others, even though schools account for about a third of the variability in who receives special

education services. Future research should more closely investigate how disability identification influences special education service receipt during the transition to schooling. In particular, policymakers should focus on how to improve early identification procedures in urban areas, and on improving identification for children from families with less educated mothers who may experience barriers to communicating with schools around service receipt.

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Table III.1 Descriptive Information for Weighted Analytical Samples

	Analysis 1 M (SD) or %	Analysis 2 M (SD) or %	Variable Description
Individual-Level			
IEP	10.4	35.8	1=Individualized Education Plan on file (indicating special education status)
Grade	3.91 (2.86)	4.01 (2.84)	0.5=Spring K, 1.5=Spring 1st, 3.5=Spring 3rd, 5.5=Spring 5th, 8.5=Spring 8th
Male	50.0	61.1	1=Male Sex
Race/Ethnicity			Student's race/ethnicity:
Black	11.7	13.0	1=Non-Hispanic White, 2=Non-Hispanic Black, 3=Hispanic, 4=Asian
Hispanic	12.1	13.1	
Asian	4.5	2.8	
Low Birthweight	6.6	6.7	1=Born weighing less than 6 lbs.
Single Parent	24.7	27.7	1=Mother is single, separated, divorced, or widowed
No Regular Childcare	25.9	26.7	1=Child did not attend regular childcare (including daycare and/or Head Start) before Kindergarten
Non-English Lang.	7.0	7.2	1=Non-English primarily spoken in the home
Disability	18.3	47.5	1=Parent reports a disability
Maternal Ed.	4.47 (1.73)	4.24 (1.75)	Level of mother's education, ranging from 1 (8th grade education or less) to 9 (doctoral or professional degree)
Income	8.44 (3.04)	8.00 (3.18)	Parent-reported household income, ranging from 1 (less than $5,000) to 13 (greater than $200,000)
Home Cognitive Stimulation	.06 (.97)	-.04 (.98)	Standardized measure of cognitive stimulation in the home environment, ranging from -3.3 to 3.0
Parenting Quality	.01 (.97)	.08 (.98)	Standardized measure of high quality parent-child interactions, ranging from –4.4 to 2.7
Educational Expectations	3.98 (1.04)	3.79 (1.11)	1=Receive less than a high school diploma, 2=Graduate from high school, 3=Attend 2+ years of college, 4=Finish a 4- or 5-year college degree, 5=Earn a master's degree or equivalent, 6=Finish a PhD, MD, or other advanced degree
App. to Learn	3.12 (.67)	2.89 (.70)	Teacher-reported positive learning behaviors, scale ranging from 1-4

Externalizing	1.62 (.59)	1.73 (.65)	Teacher-reported externalizing problems, scale ranging from 1-4
Internalizing	1.59 (.52)	1.72 (.57)	Teacher-reported internalizing problems, scale ranging from 1-4
Achievement	96.25 (48.29)	90.25 (47.31)	Average of IRT-adjusted spring reading score and spring math score, ranging from 8.68 to 190.32
School-Level			
Urban	10.2	28.9	1=Urban Area (Census Reported Population >250,000)
Neighborhood	1.15 (1.57)	1.15 (1.58)	Standardized principal-reported measure of neighborhood quality and safety, ranging from -0.9 to 1.9
% Free Lunch	29.83 (25.07)	31.48 (25.47)	Principal-reported proportion of student body receiving free lunch, ranging from 0 to 100
Title I Funding	39.2	43.6	1=Principal reports that school receives schoolwide Title I Funding
% Non-White	2.40 (1.39)	2.38 (1.38)	Principal-reported proportion of student body that reports a non-White race/ethnicity, ranging from 1 (less than 10%) to 5 (75% or more)
% Limited English	5.40 (11.96)	5.01 (11.80)	Principal-reported proportion of student body that are English Language Learners, ranging from 0 to 99
School Size	3.54 (1.04)	3.54 (1.03)	Principal-reported number of children enrolled in school, ranging from 1 (149 or less) to 5 (750 or more)
K Teacher Salary	3.65 (.91)	3.62 (.90)	1=Less than $25,000, 2=$25,000-$35,000, 3=$35,001-$45,000, 4=$45,001-$60,000, 5=More than $60,000
% Academically Proficient	65.13 (22.03)	64.26 (21.82)	Averaged principal-reported proportion of school that scores at or above proficiency in reading and math on statewide testing, ranging from X to Y
Avg. Approaches to Learning	3.07 (.30)	3.03 (.31)	Student-level positive learning behaviors, as rated by teachers and aggregated across schools, ranging from 1.8 to 4
Avg. Externalizing	1.65 (.27)	1.64 (.26)	Student-level externalizing problems, as rated by teachers and aggregated across schools, ranging from 1 to 2.5
Avg. Internalizing	1.61 (.24)	1.64 (.26)	Student-level IRT-adjusted internalizing problems, as rated by teachers and aggregated across schools, ranging from 1 to 2.3
No. Disabilities/ Class	2.11 (1.64)	2.31 (1.83)	Teacher-reported number of students with disabilities in their classroom, aggregated across the school, ranging from 0 to 28

Note: descriptive statistics reported are averaged across waves.
Analysis 1: n = 5,037 students in 700 schools, avg. 32.8 students per school, average 4.6 waves per student
Analysis 2: n = 2,048 students in 563 schools, avg. 11.8 students per school, average 3.2 waves per student

Table III.2 Percent of Missing Data at Each Wave for Individual and School-Level Predictors (Unweighted)

	Kindergarten	1st Grade	3rd Grade	5th Grade	8th Grade
Individual-Level Predictors					
IEP on file	19.32	17.52	13.84	16.72	0.00
Disability Status	4.08	4.54	6.15	3.39	10.39
Family Income	1.68	3.46	5.77	3.10	9.07
Single Parent	5.14	6.22	5.80	3.16	9.26
Home Cog. Stim.	4.30	5.23	8.94	5.82	12.10
Parent-Child Interactions	4.40	4.59	10.10	7.50	17.88
Educational Expectations	4.44	3.26	6.11	3.21	9.19
Approach to Learning	1.86	5.77	12.41	4.31	--
Externalizing Behavior	2.09	6.31	12.67	4.92	--
Internalizing Behavior	2.56	6.75	13.28	5.90	--
Avg. Achievement Score	3.43	1.33	1.10	0.64	1.10
Male Sex	0.00	--	--	--	--
Race/Ethnicity	0.15	--	--	--	--
Maternal Education	2.95	--	--	--	--
Low birthweight	6.85	--	--	--	--
No regular pre-K childcare	21.42	--	--	--	--
Non-English Home Language	1.74	--	--	--	--
School-Level Predictors					
Schoolwide Title I Funding	0.34	13.08	14.09	6.05	--
Neighborhood Quality	21.00	28.87	31.14	21.01	--
Free/Reduced Lunch	25.23	33.62	15.01	20.30	18.45
Minority Enrollment	1.11	1.49	1.33	0.82	1.24
Limited English Proficient	5.39	14.20	15.96	6.17	8.97
Total Enrollment	0.01	1.11	1.04	0.54	6.02
Avg. # Proficient Students	31.05	36.40	35.20	25.86	51.27
Avg. Approaches to Learning	0.45	3.61	5.55	2.94	--
Avg. Externalizing Behavior	0.45	3.62	5.58	3.04	--
Avg. Internalizing Behavior	0.45	3.62	5.60	3.02	--
Avg. # Disabilities/Class	1.81	4.49	5.65	3.32	--
Urban Area	0.00	--	--	--	--
Average K Teacher Salary	5.04	--	--	--	--
Average % Missing	5.96	9.50	10.56	6.90	11.92

Table III.3 Full Results of Multilevel Logistic Regression Assessing Likelihood of Placement Over Time (m = 40 Imputed Datasets).

	Model 1 n_{child} **= 5,108** n_{school} **= 702** **OR**	**Model 2** n_{child} **= 5,182** n_{school} **= 701** **OR**	**Model 3** n_{child} **= 5,037** n_{school} **= 700** **OR**	**Model 4** n_{child} **= 5,037** n_{school} **= 700** **OR**
Intercepts				
Level 1: Time				
Grade	9.67***	2.42	9.51**	10.53***
Level 2: Individual				
Male	4.44***		4.56***	4.67***
Black	.81		.68	.46
Hispanic	.71		.80	.73
Asian	.23		.19	.32
Disability	5.36***		5.62***	5.66***
Income	.98		1.00	.98
Maternal Ed.	.78		.81	.78
Cognitive Stimulation	.89		.89	.87
Parenting Interactions	.88		.87	.88
Educational Expectations	.98		.99	1.01
Approaches to Learning	1.15		1.14	9.31
Externalizing Behaviors	1.31		1.15	.55
Internalizing Behaviors	1.47		1.60	1.42
Achievement	.98***		.98***	.96***
Non-English Home Lang.	1.60		2.29	2.27
No Regular Childcare	1.00		.98	.97
Low Birthweight	.88		.83	.82
Single Parent	1.15		1.06	1.08
Level 3: School				
Urban		.25	.18*	.57
Neighborhood Safety		.93	.92	1.01
% Free Lunch		1.00	1.00	1.00
Title I Funding		.92	1.96	1.16
% Nonwhite		1.19	1.04	.91
% Limited English		1.01	1.01	1.00
School Size		1.28	1.20	.91
Kindergarten Teacher Salary		1.03	1.06	1.05
% Above Proficiency		1.00	.98	.98*
Avg. Learning		.96	1.04	11.39
Avg. Externalizing		.99	1.30	.33
Avg. Internalizing		2.16	.71	1.31
Avg. # Disabilities/Class		1.27**	1.26**	1.30***
Level 2 x Level 3				
Black*Non-White %				1.05
Hispanic*Non-White %				1.22
Asian*Non-White %				1.07
App. Learn*Avg. Learn				.48
Externalizing*Avg. Extern.				1.59

Achievement*Proficient %				1.00
Black*Free Lunch %				1.01
Hisp*Free Lunch %				.99
Asian*Free Lunch %				.97
Slopes				
Level 1 x Level 2				
Male*Grade	1.04		1.04	1.04
Black*Grade	.87		.95	.89
Hisp*Grade	.96		.97	.96
Asian*Grade	1.02		1.11	1.11
Disab*Grade	1.04		1.04	1.04
Income*Grade	1.00		1.00	1.00
Maternal Ed.*Grade	1.09**		1.07*	1.08**
Cog. Stim*Grade	1.05		1.05	1.05
Parenting*Grade	.99		.99	.99
Expectations*Grade	.98		.99	.98
Learning*Grade	.89		.85*	.87
Externalizing*Grade	.90		.94	.91
Internalizing*Grade	1.02		.98	1.02
Achievement*Grade	.99***		.99***	.99***
Language*Grade	.95		.92	.92
Level 1 x Level 3				
Urban*Grade		1.08	1.16	
Neighborhood*Grade		1.01	1.03	
Title I*Grade		1.01	.92	
% Non-White*Grade		.97	.97	
% Free Lunch*Grade		.99	1.00	
% Limited Eng.*Grade		1.00	1.00	
Size*Grade		.88***	.93	
% Proficient*Grade		1.00	1.00	
Avg. Learn*Grade		.89	1.13	
Avg. Extern*Grade		.98	.91	
Avg. Intern*Grade		.97	1.14	
Avg. Disabilities*Grade		1.01	1.00	
Random Effects				
School				
Var(Intercept) (SE)	4.78 (.92)	7.29 (1.53)	4.80 (.91)	4.81 (.92)
Child>School				
Var(Slope) (SE)	.32 (.09)	.25 (.09)	.30 (.09)	.32 (.09)
Var(Intercept) (SE)	5.77 (1.81)	9.09 (3.63)	5.91 (1.84)	5.92 (1.81)
Covar(Slope, Intercept)	-.62 (.25)*	-.10 (.28)	-.61 (.25)*	-.64 (.25)**
Model Fit				
School ICC	.34	.36	.33	.33
Child>School ICC	.77	.85	.78	.77
AIC	13961.18	16100.49	13537.77	13601.68
BIC	14275.30	16350.37	14052.45	14092.24

***$p < .001$, **$p < .01$, *$p < .05$

Table III.4 Full Results of HGLM Among Students Who Receive At Least One Wave of Special Education Services (m = 40 Imputed Datasets)

	Model 1 n_{child} **= 2,396** n_{school} **= 598** **OR**	**Model 2** n_{child} **= 2,535** n_{school} **= 594** **OR**	**Model 3** n_{child} **= 2,059** n_{school} **= 566** **OR**	**Model 4** n_{child} **= 2,059** n_{school} **= 566** **OR**
Intercepts				
Level 1: Time				
Grade	5.59***	1.90	4.06	4.32***
Level 2: Individual				
Male	2.13*		1.69	1.70
Black	.83		.79	.42
Hispanic	.97		1.16	1.36
Asian	.58		.75	.63
Disability	4.19***		4.18***	3.86***
Income	.99		1.01	1.01
Maternal Ed.	.83		.89	.85
Cognitive Stimulation	.88		.88	.87
Parenting Interactions	.88		.90	.88
Educational Expectations	1.03		1.10	1.08
Approaches to Learning	1.32		1.45	8.40
Externalizing Behaviors	1.34		1.15	.97
Internalizing Behaviors	1.45		1.49	1.14
Achievement	.99		.99	.98*
Non-English Home Lang.	1.01		1.40	1.28
No Regular Childcare	.95		1.00	.98
Low Birthweight	.87		.94	.94
Single Parent	1.51*		1.22	1.20
Level 3: School				
Urban		.20*	.18**	.74
Neighborhood Safety		.91	.95	1.08
% Free Lunch		1.00	.99	.99
Title I Funding		1.09	1.80	1.10
% Nonwhite		1.12	1.00	.89
% Limited English		1.03	1.02	1.00
School Size		1.28	1.20	.92
Kinder. Teacher Salary		.86	.92	.92
% Above Proficiency		.99	.99	.98
Avg. Learning		.87	.68	5.56
Avg. Externalizing		.76	1.09	.63
Avg. Internalizing		1.63	.62	1.11
Avg. # Disabilities/Class		1.23*	1.24**	1.19***
Level 2 x Level 3				
Black*Non-White %				1.08
Hispanic*Non-White %				1.13
Asian*Non-White %				1.45
App. Learn*Avg. Learn				.54
Extern.*Avg. Extern.				1.14

Achievement*Proficient %				1.00
Black*Free Lunch %				1.01
Hisp*Free Lunch %				.99
Asian*Free Lunch %				.97
Slopes				
Level 1 x Level 2				
Male*Grade	1.03		1.02	1.02
Black*Grade	.92		.97	.92
Hisp*Grade	.93		.92	.89
Asian*Grade	.97		.98	1.0
Disab*Grade	1.03		1.01	1.01
Income*Grade	1.00		.99	.99
Maternal Ed.*Grade	1.07**		1.06*	1.07*
Cog. Stim*Grade	1.05		1.04	1.05
Parenting*Grade	1.00		1.00	1.00
Expectations*Grade	.98		.98	.99
Learning*Grade	.92		.92	.93
Externalizing*Grade	.92		.99	.96
Internalizing*Grade	1.03		1.01	1.08
Achievement*Grade	.99***		.99***	.99***
Language*Grade	.95		.92	.91
Level 1 x Level 3				
Urban*Grade		1.11	1.17*	
Neighborhood*Grade		1.03	1.03	
Title I*Grade		.99	.93	
% Non-White*Grade		.97	.98	
% Free Lunch*Grade		1.00	1.00	
% Limited Eng.*Grade		.99	1.00	
Size*Grade		.89**	.94	
% Proficient*Grade		1.00	1.00	
Avg. Learn*Grade		.96	1.13	
Avg. Extern*Grade		1.07	.91	
Avg. Intern*Grade		.97	1.14	
Avg. Disabilities*Grade		1.00	.99	
Random Effects				
School				
Var(Intercept) (SE)	2.75 (.53)	3.08 (.57)	1.97 (.34)	1.97 (.36)
Child>School				
Var(Slope) (SE)	.21 (.06)	.23 (.07)	.18 (.04)	.22 (.05)
Var(Intercept) (SE)	2.44 (.91)	2.80 (.94)	2.40 (.70)	2.29 (.75)
Covar(Slope, Intercept)	-.63 (.19)***	-.64 (.19)***	-.66 (.14)***	-.65 (.17)**
Model Fit				
School ICC	.30	.32	.26	.26
Child>School ICC	.61	.63	.55	.57
AIC	10833.38	11879.11	9554.43	9644.31
BIC	11109.35	12094.70	9990.50	10059.94

***$p < .001$, **$p < .01$, *$p < .05$

CHAPTER IV

What Happens to Students in Special Education? Academic Achievement and Behavioral Adjustment Following Identification

Abstract

It is vital to understand how effective special education services are. Yet, results of empirical studies on effectiveness are largely mixed and often ignore the implications of receiving services at various developmental timepoints. The current study assessed growth of academic achievement, problem behaviors, and positive learning habits among special education students participating in the ECLS-K:1998. The propensity to receive services in either 1st grade or 3rd grade was modeled by matching students who received services at least once during grades 1-8 on a host of Kindergarten covariates. Results indicated that students who received initial special education services in 1st grade made larger gains through both 3rd and 5th grade and scored higher on 3rd and 5th grade tests of reading than students who received services later in schooling. In contrast, students who received initial services in 3rd grade did not significantly differ from their peers on any academic outcomes. Moreover, there were no significant behavioral differences between students who received earlier (1st or 3rd grade) versus later services (5th or 8th grade). These results were robust to the method of propensity score analysis used, covariates used in propensity matching, and specifications of improvement over time. This study finds that receiving special education earlier in schooling is associated with better reading performance and

greater reading improvement over time than receiving services later in schooling.

Keywords: special education; propensity matching; quasi-experimental design; developmental timing; longitudinal analyses.

Introduction

It is important to ensure that services are effective at remediating academic and behavioral problems related to disability, given both the increased costs associated with special education and a responsibility to student wellbeing. Advocates argue that the best approach is through early intervention (e.g., Wolery & Bailey, 2002), making it vital to ensure that at-risk children have access to services as soon as possible. Yet, concern also exists regarding the perceived stigma and ineffectiveness of special education, particularly for non-white students (e.g., Burns & Ysseldyke, 2009; Collins et al., 2016; Shifrer, 2013; Sullivan & Proctor, 2016). Correlational evidence is often used to support the idea that special education services might not be effective (Morgan, Frisco, Farkas, & Hibel, 2010); for instance, 83% and 88% of U.S. students with disabilities performed at or below basic proficiency in mathematics and reading, respectively, relative to 56% and 60% of students without disabilities (National Assessment of Education Progress, 2015). Moreover, developmental trajectories are often ignored in studies assessing the consequences of receiving special education services, though students receiving earlier services likely have different educational needs than students receiving later services (e.g., Marder, 2009). These differences necessitate caution when making claims about the effectiveness of special education without accounting for who receives services, and when.

The current study assessed the development of academics, problem behaviors, and positive learning habits among special education students participating in the Early Childhood Longitudinal Study, Kindergarten Cohort of 1998-1999 (ECLS-K:1998). The propensity to receive services in 1st grade or 3rd grade was modeled by matching students who received services at least once during grades 1-8 on a host of Kindergarten covariates, ensuring that they began schooling with similar levels of achievement and behavior, came from similar

backgrounds, attended similar schools, and experienced similar diagnoses, educational goals, services, and "amounts" (or "dosage") of special education through 8th grade. Because much research evaluating the effectiveness of special education does not account for the timing of service receipt, this important yet often unmeasured confound could have strong implications for conclusions about the effectiveness of special education. Thus, the present study represents an attempt to more precisely understand how the consequences of receiving special education services depend on when they were delivered, and to whom.

Background

For Whom are Special Education Services Effective?

Differences in the diagnoses or needs of the population under study could drive the perceived effectiveness of special education as delivered at various timepoints. To illustrate, services for speech and language impairments (SLI) are predominantly delivered earlier in schooling. Figure IV.1 displays estimates from the most recent publicly-available data on the proportion of U.S. schoolchildren receiving special education services for each diagnosis (National Center for Education Statistics [hereafter NCES], 2011). In particular, note the inverting shift between the proportion of students served either for SLI or for learning disabilities (LD) between ages 6-11. Thus, studies investigating the influence of early special education services relative to later special education may in some part be investigating the influence of services for SLI relative to LD.

Even when studies disaggregate effects by disability type (e.g., Chesmore, Ou, & Reynolds, 2016; Hanuschek, Kain, & Rivkin, 2002; Reynolds & Wolfe, 1999), results not accounting for the longitudinal trajectories of students who receive such services may still be biased. Marder (2009) notes that among students who receive several consecutive years of

special education services, as many as 50% switch categories away from a SLI determination as they progress through school, with 20% switching to a primary diagnosis of LD. Conclusions are thus rendered suspect from research finding, for example, students with speech disorders are not influenced by special education services received after 4th grade (e.g., Hanuschek et al., 2002) or that 1st grade students with LD increasingly lag behind non-disabled peers over time (e.g., Morgan, Farkas, & Wu, 2011). These results may be confounded by the fact that it may be atypical for students to receive these services during these timeframes.

When Are Special Education Services Effective?

It is possible that the developmental timing of service receipt may explain some of the discrepant outcomes, though such implications are not often discussed. For example, most studies evaluating the effectiveness of preschool and/or Head Start programs find that high-quality programs targeting 3 to 5-year-olds significantly boost academic achievement for children with special needs (Bloom & Weiland, 2015; Lee & Rispoli, 2016; Phillips & Meloy, 2012; Weiland, 2016) and/or substantially reduce later special education placement (McCoy et al., 2017). Studies examining the effects of K-12 special education placement also generally find that earlier services produce better academic outcomes (Ehrhardt, Huntington, Molino, & Barbaresi, 2013), or at least mitigate the negative or poorer outcomes observed among students receiving later services (e.g., after about 3rd grade; Chesmore, Ou, & Reynolds, 2016; Morgan et al., 2010; Reynolds & Wolfe, 1999). As those receiving earlier intervention may also be exhibiting the poorest initial academic or behavioral skills (Ehrhardt et al., 2013), services may be producing greater gains among students who receive them relatively earlier.

Yet it is commonly acknowledged that it is impossible to know how outcomes would differ if the same students did not receive services (e.g., Reynolds et al., 1999; 2016). It may be

that services received later are still "effective" insofar as they halt or slow academic entropy. To address this hypothesis, studies should have an appropriate comparison group (i.e., students receiving services at different time points instead of a comparison group comprised of non-disabled students), and ideally utilize a nationally-representative sample to make wider claims about the effectiveness of special education. The lack of descriptive information about why earlier services might more strongly influence outcomes is also concerning. Are there differences in the types or amounts of services received earlier that could explain why these services are more effective than later service receipt? Moreover, for how long are services effective – that is, do their effects persist across development, or do they fade out after a few years? Though important, these questions have not been explicitly examined in a quasi-experimental manner.

Quasi-Experimental Designs in Special Education

Randomized control trials (RCT) would be the most statistically rigorous way to contrast causal outcomes of special education service receipt. However, this would necessitate randomly assigning equivalent students to general or special education and is thus not an ethical or legal solution (Morgan, Frisco, Farkas, & Hibel, 2010; Sullivan & Field, 2013). Therefore, researchers interested in making causal inferences about the effectiveness of special education should conduct studies that use quasi-experimental designs to isolate intervention effects (Schneider, Carnoy, Kilpatrick, Schmidt, & Shavelson, 2007; Sullivan & Field, 2013). Such methods include regression discontinuity (e.g., Phillips & Meloy, 2012; Weiland, 2016), propensity-score matching (e.g., Morgan, Frisco, Farkas, & Hibel, 2010; Sullivan & Field, 2013), and value-added or fixed effects modeling (e.g., Hanuschek, Kain, & Rivkin, 2002; Reynolds & Wolfe, 1999).

A handful of studies across the past two decades have used these methodologies to make claims about the effectiveness of special education, to mixed results. Research has found

negative (Chesmore, Ou, & Reynolds, 2016; Reynolds & Wolfe, 1999; Sullivan & Field, 2013), statistically negligible (Chesmore et al., 2016; Morgan et al., 2010), and/or positive effects of special education service receipt (Ehrhardt et al., 2013; Hanuschek, Kain, & Rivkin, 2002; Lee & Rispoli, 2016; Morgan et al., 2010; Phillips & Meloy, 2012; Weiland, 2016). Results have also been mixed across and within methods, which could be due to either methodological limitations (even when methods are designed to infer causality) or to the sampling design. For example, propensity score matching has been touted as closely approximating RCT given its ability to contrast naturally occurring "treatment" and "control" groups with similar odds of receiving the treatment (Morgan et al., 2010). Yet, it is difficult to disentangle the fact that having a disability inherently creates differences between students in special and general education. Thus, even propensity-matched controls are not entirely "equal" when the comparison group is comprised of general education students (Hanuschek, Kain, & Rivkin, 2002).

Fixed effects or value-added models remove the problem of having a poor comparison group by comparing each child to him/herself over time to estimate the effects of service receipt. However, like all regression-based designs, specification errors may produce bias in results (such as an unmodeled non-linear relationship between predictor and outcome; Sullivan & Field, 2013). A within-child approach also largely removes our ability to assess the consequences of the timepoint at which services are received (earlier or later in schooling). Moreover, the two studies utilizing this method to investigate special education effectiveness utilized samples that were non-representative of the U.S. population, and produced opposite conclusions (Hanuschek, Kain, & Rivkin, 2002; Reynolds & Wolfe, 1999). Hanuschek's group found positive effects of service receipt among Texan children between grades 4-7, while Reynolds and Wolfe found negative effects of service receipt among low-income Chicagoan children, especially between

grades 4-6. Thus, more precise methods and sampling procedures are needed to isolate the effects of special education service receipt.

The Present Study

Because it is difficult to disentangle the confounds endogenous to having a disability when evaluating later academic achievement and behavioral adjustment, the current analyses included only students who were placed in special education at some point during grades 1-8. This provides a better comparison group than what is typically used in matched analyses, as all students sampled have a special educational need or disability that eventually requires intervention (though some receive earlier services than others). Students were matched on a host of Kindergarten covariates, ensuring that students started out at roughly the same levels of achievement and behavior, came from similar backgrounds, attended similar schools, and experienced similar "amounts" of special education through 8th grade. Importantly, during the wave(s) prior to treatment, no students were reported to have an Individualized Education Plan (IEP; the federally-mandated document outlining service provisions and goals required for all special education students). This means that the effects of special education are estimated among children who receive services for the *first* time. Effects of services were evaluated using three propensity-analyzing techniques: estimation of treatment effects by stratification, kernel-matching, and nearest-neighbor with random draw (c.f. Morgan et al., 2010).

In general, this use of propensity score matching allows for comparison of students receiving services to others who theoretically *could have* received services at that same time but did not until later in schooling. This study design also allowed for evaluation of the following specific research questions: first, did services have a stronger impact more proximally (i.e., from 1st to 3rd grade) or did their effects persist over time (i.e., from 1st to 5th grade)? Although

services received earlier may influence outcomes at both timepoints, given fadeout effects following most child or adolescent interventions (see Bailey, Duncan, Odgers, & Yu, 2017), one hypothesis was that effects would be stronger when measured more proximally to initial service receipt. Alternatively, if treatment effects remained stable or increased through 5th grade, one could hypothesize that receiving services in 1st grade allowed children to "catch up" to their peers (also referred to as a "compensatory growth model;" see Morgan, Farkas, & Wu, 2011).

Second, is there a threshold or developmental timepoint during which early services are most effective? In other words, would the effects of services received in 3rd grade differ from those received in 1st grade? Given the relatively larger body of research demonstrating positive effects of early service receipt (or, at least, an absence of negative effects relative to services received later), it was hypothesized that services received in 1st grade would have larger effects on academic and behavioral outcomes than services received in 3rd grade.

However, given the apparent differences between students who receive special education services at various developmental timepoints (e.g., Marder, 2009; NCES, 2011), it may also be possible that students receiving early services are not drawn from the same population of children with special needs as those receiving later services. The third and final research question addressed how students who received initial services in 1st grade differ from those who received initial services in 3rd grade, in terms of disability identification, services received, and IEP goals. In keeping with Figure IV.1, it was hypothesized that there would be more students with SLI than LD served in 1st grade, which would accompany differences in IEP goals and services.

Method

Sample

Data were drawn from the ECLS-K:1998. Though there are newer ECLS data available

(the 2011 cohort), these data are not yet available through 8th grade, rendering the ECLS-K:1998 the best available dataset to answer these research questions. The ECLS-K:1998 followed approximately 21,400 students who began Kindergarten in 1998 through 1st, 3rd, 5th, and 8th grade, and provides a rich collection of information on home and schooling experiences. During each wave of data collection, school office staff indicated whether the target child had an IEP on file. If staff responded "yes" at any wave, the child was included in the analytical sample regardless of whether data were missing at other waves. Though this sampling method likely underestimates the duration of time students received services given the presence of missing data, it also maximized the potential sample from which propensity scores were created, which improves the scores' precision (Frisco, Muller, & Frank, 2007; Morgan et al., 2010). Additionally, if students were reported to have an IEP during the spring Kindergarten wave of data collection, they were excluded from the analytical sample. This ensured that the sample was comprised of students in general education during Kindergarten, and thus allowed for the possibility of a comparison group comprised of students who had not yet received services but would at least once by 8th grade.

The first set of propensity-matched analyses (N = 640) included students who received initial services in 1st grade (n = 230) relative to students who received them later in schooling (n = 410). The second set of propensity-matched analyses (N = 250) included students who received initial services in 3rd grade (n = 160) relative to students who received initial services in 5th or 8th grade (n = 90); no students in this latter analysis had an IEP on file during either Kindergarten or 1st grade. All reported sample and group sizes are rounded to the nearest 10, as is required by the Institute of Education Sciences when publishing results obtained from the restricted-data files.

Propensity-Matching Procedure

Propensity matching was conducted in Stata/SE v. 15.1 using the *pscore* program (Becker & Ichino, 2002). A wide range of covariates measured during the Kindergarten year that were theoretically related to either special education service receipt or academic or behavioral outcomes (including individual characteristics, the home environment and parenting, initial levels of academic achievement and behavior, and schoolwide characteristics) were used to create propensity scores. Covariates that could not be balanced across strata were dropped, leaving 41 covariates that were used to construct the 1st grade propensity scores, and 47 covariates that were used to construct the 3rd grade propensity scores. Information about covariates used in propensity score creation is available in Appendix C (Table C.1). Descriptive statistics by propensity stratum and across the full samples are represented in Table C.2 for 1st grade analyses, and in Table C.3 for 3rd grade analyses. In both analyses, the *logit* option was used instead of the default *probit* (though similar results were obtained with both options). Results are reported as average treatment effects on the treated (ATT). Outcomes were adjusted for multiple comparisons using the Benjamini-Hochberg correction.

Sensitivity analyses revealed similar results when the common support was used in generating propensity scores (e.g., removing those with the highest and lowest propensity for receiving services to more conservatively estimate treatment effects; see Sullivan & Field, 2013). However, as this decreases the sample size and thus reduces the power to detect effects, results reported here are based on propensity scores that did not utilize the common support. As a robustness check for effect sizes, and like other research investigating the effectiveness of special education using propensity matching analyses (specifically, Morgan et al., 2010), three types of estimators were used to evaluate the treatment effect among propensity-matched students:

stratification matching (Stata's *atts* command), nearest-neighbors with random draw (*attnd*), and kernel-matching (*attk*). In stratification matching, the full range of propensity scores are divided into blocks of equivalent propensity scores between students receiving or not receiving the treatment, balanced to differences that were non-significant at $p < .01$. Average treatment effects are then produced within each stratum and averaged together to produce the total ATT. Nearest-neighbor matching pairs treated cases with maximally similar control cases based on their propensity scores, while unmatched control cases are excluded. The *attnd* program also allows for matching with replacement, in which control cases that are the best match for more than one treatment case may be reused in analyses to minimize bias in the calculation of the ATT (Frisco et al., 2007). Finally, kernel-matching compares treatment cases to a weighted mean of control cases based on the distance between their respective propensity scores. To minimize bias given the use of multiple control observations contributing to multiple matches, standard errors for the ATT's were bootstrapped 1,000 times (Morgan et al., 2010). A simple meta-analysis of effect sizes weighted across each propensity-matching technique is also presented alongside these estimates.

Missing Data and Weighting

Only cases with complete data on all covariates used for matching analyses may be used to construct propensity scores using the *pscore* program. Among students who did not have an IEP in Kindergarten, 1,020 students had IEP information reported in 1st grade. Of these, 60 percent had complete data to be matched on all covariates used in the construction of propensity scores. This led to a total sample of 640 students for the 1st grade propensity-matched analyses. In 3rd grade, 590 students who were not reported to have an IEP in Kindergarten or 1st grade had information reported about their special education status (approximately 42 percent of the total

number of students with IEP information reported in 3rd grade). Of these, 44 percent had complete information on all covariates used in the construction of propensity scores, leading to a sample of 250 students for the 3rd grade propensity-matched analyses.

A normalized Kindergarten weight (*C2CW0*) adjusted for the cluster-sample design of the study (Kish, 1965) was applied during the creation of the propensity scores and the estimation of treatment effects. The spring Kindergarten weight was chosen given that most covariates used to estimate propensity scores were obtained from this wave of data collection. Moreover, since only complete cases may be used with the *pscore* program to create the propensity scores, weighting the analyses helps to further minimize selection bias introduced by dropping incomplete cases, and allows results to be described as nationally representative of U.S. Kindergarteners who began school in the fall of 1998.

Variables of Interest

Academic Achievement. Academic assessments created specifically for the ECLS-K:1998 used Item Response Theory (IRT), which algorithmically uses the number of correct, incorrect, and omitted answers in relation to item difficulty to estimate each child's point on a continuous ability scale. This method also allows scores obtained at each timepoint to be directly comparable, thus permitting longitudinal analyses. The 3rd grade reading assessments evaluated mastery of phonemic awareness, word decoding, vocabulary, and passage comprehension. The 5th grade reading assessment was largely the same, with the addition of items capturing students' ability to comprehend biographical and expository text. The 3rd grade mathematics assessments evaluated number sense, properties, and operations; measurement; geometry and spatial sense; data analysis, statistics, and probability; and pattern, algebra, and functions. These same properties were assessed in 5th grade, with the addition of problem solving using fractions and

problem solving using the concepts of area and volume.

Behavioral Adjustment. In the spring of Kindergarten, 1st grade, 3rd grade, and 5th grade, students' behaviors were described by their primary teachers using five subscales from the Teacher Social Rating Scale (SRS, adapted from the Social Skills Rating Scale; Gresham & Elliott, 1990). These measures were not collected in 8th grade, so data were only analyzed through 5th grade. The Approaches to Learning scale captured positive learning behaviors, including attentiveness, task persistence, eagerness to learn, independence, flexibility, and organization (K-5th grade α = .89-.91). The Interpersonal Skills scale rates the child's ability to form and maintain relationships, get along with others, comfort or help others, positively express feelings, ideas, and opinions, and show sensitivity to others' feelings (α =.89-.88). The Self-Control scale measures the child's ability to control their behavior by responding appropriately to peer pressure, respecting others' property, controlling their temper, and accepting peers' ideas (α = .80-.79). Lastly, the final two scales captured Externalizing Problem Behaviors and Internalizing Problem Behaviors, respectively (α_{extern} = .90-.89 α_{intern} = .78-.77). The Internalizing Problem Behaviors scale rated apparent anxiety, loneliness, low self-esteem, and sadness, while the Externalizing Problem Behaviors scale measured how often the child argues, fights, gets angry, acts impulsively, and disturbs ongoing activities.

Gain scores. In studies investigating intervention effects, it is common to utilize a measure of growth such as gain scores to ensure that observed differences in outcomes are not a statistical artifact of initial learning or behavior differences (e.g., Morgan et al., 2010). Because students were propensity-matched on baseline academics and behavior, gains measured over time are less likely to be biased by measurement error (i.e., students starting out at higher or lower levels). Moreover, when tests are matched to student ability in IRT methods, all students

have an equal chance to gain on the vertical scale (i.e., that spans several time points) even though the scale units are non-equivalent (Ballou, 2002). However, gain scores may produce biased estimates of growth trajectories when they are not computed from adaptive testing procedures (Rock, 2007). Because only the academic assessments utilized IRT methodology, the academic gain scores should be less biased than the behavioral gain scores. The validity of the behavioral gain scores is weakened due to potential floor or ceiling effects in teacher ratings. Yet, gain scores were still utilized given the absence of other longitudinal behavioral measures in the ECLS-K:1998, so they should be interpreted with reservation.

To compare gains made in the treatment group relative to the control group, a measure was computed capturing simple difference scores between the outcome and the timepoint immediately prior to the indication of special education status. For instance, 3rd grade gain scores were computed by taking the difference between spring 3rd grade and spring Kindergarten assessments (the last wave of data collection prior to indication of a 1st grade IEP). Similarly, 5th grade gain scores were computed by taking the difference between spring 5th grade and spring Kindergarten assessments (for students receiving initial services in 1st grade) or spring 1st grade assessments (for students receiving initial services in 3rd grade; as there was no data collection during 2nd grade, this was the most recent timepoint prior to treatment estimation).

Covariates. Covariates used to match students are drawn from the Kindergarten wave of data collection and capture five elements: student demographics (e.g., race/ethnicity, disability, age at Kindergarten entry), baseline achievement and behavior, family and home environment (e.g., maternal education, income, single or teenage parent, cognitive stimulation in the home), and school demographics (e.g., region of country, average socioeconomic status, proportion of non-White students, whether school receives Title I funding). Children are less likely to receive

early intervention services if they display greater early reading and/or mathematics skills (Hibel, Farkas, & Morgan, 2010; Hosp & Reschly, 2004; Morgan, Farkas, Hillemeier, & Maczuga, 2012; Sullivan & Bal, 2013) and better behavior (Briesch, Ferguson, Volpe, & Briesch, 2012; Morgan, Farkas, & Wu, 2009; Peterson et al., 2011). However, to reduce endogeneity given that academic achievement may be used to refer students for special education, fall achievement scores were used in propensity matching instead of the more recent spring Kindergarten assessment. This ensured that students were matched on academic ability occurring as closely as possible to the transition to school, and as far away as possible from the spring 1st grade indication of special education status.

Results

Propensity-Matching Results

Matching 1st graders on their propensity to have an IEP resulted in 6 strata (Table IV.1). Students with the lowest propensity of having an IEP in 1st grade were in stratum 1, whereas students with the highest propensity were in stratum 6. Students with the highest propensity scores spent the most time in special education from 1st through 8th grade ("dosage," as indicated by the number of waves in which they were reported to have an IEP), had a parent-reported disability in Kindergarten; had a low birthweight; were older at Kindergarten entry; had lower fall Kindergarten mathematics scores; were not Black or Hispanic; had less-educated mothers and a lower family income; had lower educational attainment expectations but more involved parents (i.e., based on how often they did activities with the child, such as reading together or playing games); and attended public, rural schools located mostly in the Midwest. Descriptive statistics by 1st grade strata and for the full sample are presented in Table C.2.

Students were also matched on their propensity to have an IEP in 3rd grade, which

resulted in 5 strata (Table IV.2). Like those matched in 1st grade, students with the highest propensity of having an IEP in 3rd grade also had the highest "dosage" of special education between 1st and 8th grade and had the lowest Kindergarten mathematics scores. However, unlike those matched in 1st grade, students with the highest 3rd grade propensities also displayed more teacher-reported externalizing problem behaviors in Kindergarten; came from single- or teenage-parent households with an absent biological father; spoke a non-English language at home; received some type of center-based care prior to Kindergarten; attended large, urban, Western schools receiving schoolwide Title I funding; and attended schools with higher proportions of English language learners, non-White students, and students with a disability. Descriptive statistics by 3rd grade strata and for the full sample are presented in Table C.3.

RQ1: Distal/Proximal Outcomes

The first research question addressed how early services (1st grade) impacted more proximal services (3rd grade) relative to more distal services (5th grade) among otherwise-similar students who also received comparable "amounts" of services through 8th grade. Academic results are displayed in Table IV.3. 1st grade students with an initial IEP tested higher in both 3rd (average ES = .28) and 5th grade reading (ES = .31), and in 5th grade mathematics (ES = .31) relative to students who received later services. Moreover, 1st graders with an initial IEP made larger reading gains from Kindergarten through both 3rd grade (ES = .31) and 5th grade (ES = .31) and made larger mathematics gains from Kindergarten through 5th grade (ES = .27; though, the stratification-matching estimate was not statistically significant). Fifth grade effect sizes were comparable to 3rd grade for reading achievement, suggesting little evidence of a fadeout effect through at least the next four grades following initial service receipt. However, estimates for mathematics appeared larger in 5th grade than in 3rd grade, suggesting that special education

services received in 1st grade allow for some longitudinal remediation relative to peers who receive later services.

Table IV.4 displays the estimated treatment effect of receiving 1st grade services on 3rd and 5th grade teacher-reported behavioral outcomes. Results are largely non-significant, with most average effect sizes less than .10. This indicates that students who had their first IEP in 1st grade did not have significantly different behavior as perceived by teachers than their peers who received later services, nor do they appear to make larger or smaller behavioral gains over time.

RQ2: Timing of Service Receipt

The second research question evaluated the relative timing of service receipt. Specifically, research supports the idea that earlier service receipt is more beneficial than later service receipt. But, what does "early" mean? Relative to students who receive later services, are the effects of special education similar when initially received in 3rd grade as in 1st grade? To answer this question, students' propensity to receive services was modeled in 3rd grade relative to a sample of peers receiving initial services in 5th or 8th grade. Importantly, these estimates do not *directly* compare students receiving services in 1st grade to students in 3rd grade. Rather, each analytical sample is comprised of otherwise-similar students who receive services earlier (i.e., in 1st or in 3rd grade) relative to later (5th or 8th grade). Indirectly evaluating the differences between the two analyses permits inferences on the question, how early is early enough?

Results confirm the hypothesis that there are larger academic effects among students receiving 1st grade services than 3rd grade services. Relative to peers who experienced later services, 3rd graders with an IEP appeared to score lower on 5th grade tests of reading and especially mathematics given the negative directionality of estimates (though these estimates did not reach statistical significance) (Table IV.5). There were no significant associations between

3rd grade service receipt and 5th grade teacher-reported behaviors (Table IV.6).

RQ3: Who Receives Earlier vs. Later Services?

The third research question built upon the results of the second. Because earlier services (1st grade) were associated with larger, positive effects in both 3rd and 5th grade relative to later services, and because services received in 3rd grade were not associated with these same effect sizes in 5th grade, could results be impacted by inherent differences between students who receive services for the first time at these different timepoints? If so, this research question arguably represents one of the most important caveats to researchers assessing the impact of special education services.

To assess the differences between students who receive services in 1st grade and 3rd grade, information about the IEP and services received was drawn from the Special Education Teacher Survey B at each wave. Simple mean differences between 1st and 3rd graders with IEP's are presented in Table IV.7. Of the students in this sample who were receiving services in either 1st grade or 3rd grade, 66 and 59 percent were missing data on the teacher survey, respectively. Thus, the information reported in Table IV.7 represents a subsample of students with a reported IEP in 1st or 3rd grade with linked special education teacher survey data.

In this subsample, there were several significant differences between students who received initial special education services in 1st (n = 180) or 3rd grade (n = 310). More 1st graders had a primary diagnosis of SLI (18% more) or developmental disability (5%), while about 25% more 3rd graders were served for LD. 1st graders were also more likely to have IEP goals for auditory processing (11%), listening comprehension (12%), oral expression (33%), gross motor skills (5%), and orientation/mobility (6%), and received more language therapy services (18%). 3rd graders more often had IEP goals for reading (16%) and language arts (20%) than 1st graders.

Additionally, more 1st graders reportedly met their IEP goals than 3rd graders (M_{1st} = 2.50, *SD* = 1.19; M_{3rd} = 2.08, *SD* = 1.05; scale range 1-5). More 3rd graders received small group instruction (4%), large group instruction (33%), cooperative learning (13%), and peer tutoring (13%). Lastly, more 1st graders received a general education curriculum without modification (18%), while more 3rd graders had some curricular modifications (16%). There were no significant differences in the number of hours per week receiving services, the percent of students whose primary placement was general education, or time spent outside a general education classroom.

Extensions

IEP Characteristics. The propensity-matching program used in this study requires complete cases for statistical analysis. Given the large amount of missing data on the special education teacher survey items, including items from this survey in the construction of propensity scores would result in fewer complete cases, and thus, lowered analytical power. However, given the significant differences between students who receive 1st grade services relative to 3rd grade services, conclusions about the effectiveness of earlier service receipt are confounded and weakened when students are not initially matched using these variables. Though there were fewer students who had linked special education teacher survey data, a follow-up set of analyses were carried out to ascertain whether the effects of special education services initially delivered in 1st or 3rd grade differed when students were matched on initial diagnosis, services received, and initial IEP goals (in addition to the rich sets of covariates modeled in the main analyses). All results are available in Appendix D.

Variables created and used for these analyses captured information about the IEP during the first wave the student was reported by a special education teacher to be receiving services, regardless of whether data were missing at other waves. Primary diagnosis (1=LD, 2=SLI,

3=Other), IEP goals (reading, mathematics, language arts, auditory processing, oral expression, gross motor skills, and orientation/mobility, where 1=yes), and average amount of special education services received per week were included in the propensity score estimation alongside the set of covariates used in initial analyses. This resulted in 310 students matched in 1st grade (37 percent receiving treatment), and 210 students matched in 3rd grade (65 percent receiving treatment; see Tables D.1 and D.2 for the balance of propensity scores and sample sizes).

Results were similar to initial analyses. Students who received 1st grade special education services but who also experienced similar diagnoses, IEP goals, and amounts of services per week again displayed significantly higher reading achievement test scores and made larger reading gains through 3rd and 5th grade (Table D.3) relative to those who received services later in schooling. No estimates from the nearest-neighbor propensity analyzing technique were statistically significant, though estimates appear similar to those obtained in the other two methods. Reading effect sizes were slightly higher than those presented in the main analyses, though the 95% confidence intervals presented alongside the simple meta-analysis of effect sizes across the three propensity-analyzing techniques all include zero. The higher effect sizes could therefore be a function of the non-significant nearest neighbor results, or reduced sample size and lowered precision (e.g., see Ioannidis, 2008). However, results reported for reading are in the same direction as those presented in the main analyses. Effects for mathematics achievement ceased to be statistically significant and, in some propensity-analyzing techniques, reversed in directionality. Effect sizes ranged from .01-.10 for mathematics, indicating relatively little effect of 1st grade special education services on later mathematics achievement once initial diagnosis, IEP characteristics, and amount of services per week were accounted for.

There were again no significant differences between students receiving initial services in

3rd grade relative to those receiving services later in schooling (Table D.5), and no significant effects of having an IEP in 1st or 3rd grade on later behavior (Tables D.4 and D.6, respectively). The 3rd grade academic estimates also changed in directionality relative to initial analyses. After accounting for IEP characteristics, 3rd graders with an IEP showed marginally significant gains in reading through 5th grade and appeared to have higher reading and mathematics test scores than non-treated peers. Though these estimates remained non-significant likely because of the small sample size in this subgroup, the large magnitude of effects suggests that matching students on particular IEP diagnoses, goals, and services may reduce some noise associated with different special educational needs.

Gain Scores. Measuring gains can be noisy because they are typically computed as the difference between two test scores, each of which is subject to measurement error. Some have argued that difference scores subtract out a good deal of true ability, leaving a disproportionate amount of this measurement error (Ballou, 2002). It may also be difficult to compare gain scores between students at different years given the non-equivalence of scale units. For instance, a student gaining 10 points on the lower end of the scale is mastering different skills (e.g., letter recognition) than a student gaining 10 points on the higher end of the scale (e.g., evaluation of text). Thus, gain scores from 3rd to 5th grade may be inherently smaller than gain scores from 1st to 3rd grade, given the relative difficulty of mastering more advanced skills. This could explain why there were few significant gains among 3rd grade students receiving services.

Though gain scores have typically been used to measure improvement over time and thus capture an important dimension of longitudinal change, the issues with this type of measure may cloud reported conclusions. To test this theory, a second set of follow-up analyses were conducted on the achievement data using theta scores (T-scores) and proficiency levels. ECLS-

K:1998 T-scores used the same testing procedure as the IRT-scores but were norm-referenced to a mean of 50 and a standard deviation of 10 in order to directly compare students to their peers. T-score means may be used in the ECLS-K:1998 to measure longitudinal improvement or deterioration of subgroups relative to peers. In both 3rd and 5th grade, variables were also available indicating the highest level of proficiency achieved in the subject (ranging from 1=*letter recognition* to 9=*evaluating non-fiction* for reading; and ranging from 1=*number and shape* to 9=*area and volume* for mathematics). Both the T-scores and highest proficiency levels were modeled to ascertain what students know and how they compare to their peers both preceding and following service receipt in 1st or 3rd grade. Unfortunately, similar items were not available for behavioral data. Results are presented in Appendix E, Tables E.1 and E.2.

Figure E.1 presents a graphical representation of the reading and mathematics T-scores among students receiving or not receiving initial services in 1st or 3rd grade. In Kindergarten, students who receive an IEP in 1st grade display the largest gap between both their general education peers (normed at a T-score of 50) and the control group of students who receive services sometime after 1st grade. However, students with an IEP appear to close this gap for both reading and mathematics through 5th grade. In contrast, 3rd graders with an initial IEP have mathematics and reading scores that begin closer to those of their normed general education peers but generally appear to decline or remain stagnant over time. This representation of T-scores also indicates that students who receive an initial IEP after 3rd grade (the control group for the second set of analyses) may be unlikely to receive special education services for mathematics, as their mathematics achievement closely approximates the normed general education students through 5th grade.

Turning to Tables E.1 and E.2, the same pattern is evident for the T-scores and highest

proficiency level indicator as we observed for the gain scores. Receiving initial services in 1st grade is associated with both a higher reading T-score in 3rd and 5th grade, and with a higher mathematics T-score in 5th grade. 1st graders with an IEP also had achieved a slightly higher reading proficiency level in 3rd (M_{treat} = 5.88, $M_{control}$ = 5.71; where level 5 = *comprehending words in context*) and 5th grade (M_{treat} = 6.80, $M_{control}$ = 6.46; where level 6 = *literal inference*). There were again no statistically significant 5th grade outcomes among students receiving 3rd grade special education services. However, reading and mathematics T-scores and mathematics proficiency levels were negative in directionality, indicating that 3rd graders with an initial IEP may fall even further behind their peers during this timeframe.

Timing of Assignment. Measures of special needs that include the presence of an IEP document on file are likely to underrepresent the true population of students with disabilities, as it can take up to several months to refer and evaluate the child and draft the initial IEP. If students were still undergoing this process at the time of ECLS-K:1998 data collection in spring of 1st or 3rd grade, their special needs status would be unreported. For example, students could have been undergoing evaluation during data collection in 1st grade, which would place them in the control group during 1st grade analyses. One would expect that this scenario would result in depressed treatment effects, which means that outcomes for 1st graders receiving special education may be somewhat underestimated.

More importantly, given the timing of ECLS-K:1998 data collection (fall and spring of Kindergarten, followed by spring of 1st, 3rd, 5th, and 8th grades), it is possible that assignment to special education occurred prior to data collection in the sample of propensity-matched 3rd graders. For example, students might have been assigned an IEP as early as the end of 1st grade (following data collection for the year) or the beginning of 2nd grade, which was a timepoint not

collected in the ECLS-K:1998 study. This uncertainty in timing clearly threatens the internal validity of this 3rd grade subgroup and could provide an explanation for the lack of significant outcomes among 3rd graders with an IEP. There was a 3rd grade special education teacher survey variable asking when students first had an IEP (with 1 = *before Kindergarten*, 2 = *during Kindergarten*, 3 = *during 1st grade*, 4 = *during 2nd grade*, and 5 = *during 3rd grade*). Though 75% of this variable was missing data in the propensity-matched sample, 20 students were indeed initially diagnosed prior to 3rd grade (12% of the 3rd grade treatment group). Removing those cases from analyses did not significantly change results. But, the possibility remains that students missing teacher survey data were also diagnosed earlier than 3rd grade given the degree of missing data, so to what extent these estimates are biased continues to be unclear. Results for 3rd grade should therefore be interpreted cautiously given the lack of confirmed internal validity on this measure.

Discussion

The purpose of this study was to more precisely estimate the effects of special education as delivered at various timepoints during schooling. Analyses utilized a propensity-matched sample of students who had ever received special education in grades 1-8 to investigate how the timing of initial service receipt (in 1st or 3rd grade) influenced later academic and behavioral adjustment (in 3rd and 5th grade). Because the students included in these samples were indicated to have an IEP at least once between 1st and 8th grade, the effects of service receipt reported here are not in reference to students who never receive special education services (a poor comparison group), but to students who receive those services at different developmental timepoints. This method allows for closely approximating causal estimates of special education's effectiveness, allowing us to more confidently say that students who receive earlier initial services experience

larger academic gains and achieve higher test scores than students who receive initial services later in schooling.

Initially, results indicated that students who received special education in 1st grade made larger reading gains through both 3rd and 5th grade, scored a third of a standard deviation higher on 3rd and 5th grade tests of reading, and scored a third of a standard deviation higher on 5th grade tests of mathematics than students who received initial services later in schooling. In contrast, students who received initial services in 3rd grade did not significantly differ from their peers receiving later services on any academic or behavioral outcomes. Further analyses in a subsample of students with linked special education teacher survey data revealed significant differences in the types of students receiving initial services, the goals for special education, and the types of services received in 1st grade relative to 3rd grade. This finding made tenuous previous assumptions about the effectiveness of early services, as effects for 1st grade special education could be confounded by the services received commensurate with the student's primary diagnosis.

Given these differences, follow-up analyses in this subsample used initial diagnosis, special education goals, and the average amount of special education received per week to again match otherwise-similar students on their propensity to receive special education services in 1st or 3rd grade. Effect sizes increased and significant effects for mathematics achievement dropped out entirely after accounting for specific IEP-related information available for a subset of propensity-matched students (though, the graphical representation of T-scores in Figure E.1 indicates that, given the upward trajectory of students with a 1st grade IEP, these students may have significantly higher mathematics achievement in 8th grade). Reading results for 1st graders largely remained the same, but newly-matched 3rd graders experienced some marginally

significant reading growth through 5th grade. These results were also robust to the types of scores used to measure improvement over time (e.g., gain scores, T-scores, and proficiency levels).

It is important to note that these latter analyses were underpowered given the large amount of missing survey data provided by special education teachers. But, matching students on these variables means that estimates more closely reflect the "true" impact of receiving or not receiving special education among otherwise-similar students, which allows clearer inferences about the relative impact of receiving initial services in 1st grade or 3rd grade. (Indeed, it is possible that the lack of power explains why the 3rd grade estimates did not reach statistical significance, though they appeared to follow the trend of the 1st grade estimates.) Unfortunately, looking at outcomes for students receiving earlier or later services by disability type was also unfeasible given sample size constraints. Yet, by at least matching students on initial diagnosis, effects should be generally independent of specific disability. Overall, results imply that – among students who come from similar backgrounds, display similar Kindergarten levels of achievement and behavior, and who have similar diagnoses, services, and IEP goals – receiving special education earlier in schooling (at 1st grade) is robustly associated with better reading performance and greater reading improvement over time than receiving later services.

These results are important for educational policymakers concerned with identifying at-risk students and providing the necessary special education services as early in schooling as possible. The first research question specifically tested whether services would have a stronger proximal or distal impact on academic and behavioral outcomes. Services could either fadeout after 3rd grade or allow students to "catch up" to peers through at least 5th grade. Relevant to policymakers, this latter hypothesis was largely supported by the data. Moreover, a set of follow-up analyses using T-scores revealed that 1st and 3rd grade students in the treatment groups began

formal schooling at relatively lower levels of both reading and mathematics than both general education peers and peers who received later services. However, only 1st graders receiving services made larger gains over time, eventually surpassing or catching up to the control group in reading and mathematics, respectively. This same pattern was not evident for students who received initial services in 3rd grade, whose T-scores remained lower than both the control group and general education students even though they entered school with roughly similar relative levels of academic performance.

Given the similarities in Kindergarten T-scores around the transition to school for both 1st and 3rd grade treatment groups, it is unclear why certain students did not receive services earlier than 3rd grade. Perhaps these students were a more heterogeneous population than students who receive initial services earlier, which could explain the fewer statistically significant effects. Alternatively, many educators hesitate to refer students to special education too early in the hopes that their academic problems may remediate with minimal intervention, a model that has been criticized as waiting for the student to fail (e.g., see National Council on Disability, 2002; Reedy, 2004; Woods, Morrison, & Palincsar, 2017). Coupled with the evidence suggesting that preschool special education services are largely effective (e.g., Lee & Rispoli, 2016; Phillips & Meloy, 2012; Weiland, 2016), these results again imply that services received earlier in K-12 may be most efficient at remediating academic problems related to disability. Policymakers and educators should continue to direct at-risk populations toward the earliest available services.

These results also provide some evidence for the existence of a developmental timeframe during which receiving special education services is associated with the largest academic improvements. The second research question tested the relativity of "early" special education service receipt by indirectly comparing outcomes for students receiving initial services in either

1st grade or 3rd grade. In contrast to the results for 1st graders receiving initial services, 3rd graders did not exhibit significantly different effects of service receipt relative to students who received services after 3rd grade. Receiving initial services in 3rd grade may therefore be too late to allow for academic remediation. On the other hand, estimates for 3rd grade may be less stable than for 1st grade given the uncertainty around timing of initial service receipt, so further research is sorely needed to confirm this hypothesis.

It is also impossible to entirely rule out the counterfactual that a diagnosis of LD is harder to remediate than a diagnosis of SLI. The third research question assessed who receives services at 1st or 3rd grade using a subsample of students with linked special education teacher survey data. Consistent with hypotheses and NCES data (e.g., Figure IV.1), more 3rd graders had primary LD diagnoses and subsequently academically-oriented goals (i.e., reading and language arts), while more 1st graders had primary SLI diagnoses and goals related to speech therapy (i.e., auditory processing, listening comprehension, oral expression). 1st graders also reportedly met more of their goals than 3rd graders. In conjunction, 1st graders received fewer modifications to curriculum than 3rd graders, and had comparatively fewer special services rendered (i.e., large group instruction, cooperative learning, peer tutoring). These differences could imply that LD's are more resistant to academic remediation than SLI's, given the higher prevalence of academic services delivered. The additional services delivered later in schooling (i.e., large group instruction, cooperative learning, peer tutoring) may have increased in frequency because 3rd graders with disabilities were more resistant to remediation. Alternatively, services delivered more often later in schooling may have been less effective than services delivered earlier. Researchers interested in approximating causal inferences are encouraged to investigate these hypotheses as potential mechanisms through which special education services affect students.

Interestingly, special education received in 1st or 3rd grade did not appear to be significantly associated with teacher perceptions of behavior. Perhaps because teachers' ratings of student behaviors are subjectively measured, these ratings are more stable over time. Yet, given the largely academic focus of special education, behavior may not be as affected by earlier service receipt relative to later services. This stands in contrast to Morgan and colleagues (2010), whose comparison of special education students to "similar" general education peers revealed small positive impacts of 3rd grade service receipt on 5th grade behavior. In addition, a more objective measure of behavior that would reflect longitudinal development (such as IRT-adjusted scores, or T-scores) was unavailable in the ECLS-K:1998. It is possible that the gain scores used to capture change over time in teacher-reported behaviors are inadequate for this purpose, since they are not IRT-adjusted to student ability and thus may not accurately reflect longitudinal development. There may be other behavioral improvements associated with the receipt of special education services that were not captured by these methods. Future research should take care to more accurately assess the influence of special education on behavioral outcomes.

Limitations. There were several limitations of this study in addition to the few named above. First, it is possible that 3rd grade service receipt may have stronger effects more distally, in the same way that 1st grade effects were similar or stronger in 5th grade than in 3rd grade. However, data were not collected between 5th and 8th grade in the ECLS-K:1998, and behavioral data were unavailable at the 8th grade wave, so this was impossible to ascertain and should be explored in future research. Second, though it is the most commonly-used method for assessing special education status, utilizing the IEP indicator may not be as accurate as would be ideal for causal research since it relies on school office staff to indicating the presence of an IEP on file or not. However, it was also the best option given the sheer amount of missing data on teacher

surveys (which is also a limitation in itself). Third, analyses excluded students who had an IEP in Kindergarten. Likely, this excluded students with more severe disabilities who had services put in place during the transition to school, but it could have also excluded some early-serviced students who had completed their evaluations and referral prior to first grade. It is impossible to disentangle these two groups given the timing of data collection on special education status, which is why this study included only students who did *not* have an IEP at the first timepoint (spring Kindergarten) for internal validity. Fourth, differences in special educational policy implementation between schools and districts have been noted and may contribute to different rates of identification in these areas (e.g., Alston, 2002; Dhuey & Lipscomb, 2013). However, including school variables in propensity matching served to at least reduce these between-group differences and lessen this threat to external validity.

Fifth and finally, the ECLS-K:1998 did not collect data in 2nd, 4th, 6th, or 7th grades, which would have provided stronger and more sensitive estimates of effectiveness through elementary school. The ELCS-K:1998 is also older data collected before the implementation of the No Child Left Behind Act (2001) and the Individuals with Disabilities Education Improvement Act (2004), both of which had important consequences for K-12 special education. Therefore, this study warrants replication with newer data (such as the ECLS-K:2011). At the time of data analysis, the ECLS-K:2011 did not have enough available waves of data to investigate the longitudinal influence of special education beyond the first few years of schooling. Thus, the ECLS-K:1998 was the best available dataset to answer these questions pertaining to special education effectiveness.

Conclusion

This study presents a more statistically rigorous take on the effectiveness of special

education services. By matching students who receive earlier or later services in a sample of only special education students, these analyses not only removed the problem of a poor comparison group, but also helped to clarify when services are most effective. The possible existence of a developmental timeframe during which special education services are most effective should be of interest to a diverse body of scientists, parents, and practitioners. Results speak to the long-held assumption that earlier services produce better outcomes, and support both educators and parents who advocate for special educational assistance among young children. Moreover, by demonstrating the differences between students receiving services at different timepoints, this study suggests caution for researchers interested in further approximating the causal estimates of special education service receipt when matching "otherwise-similar" students who receive services at different timepoints. Policymakers should situate these results among other studies demonstrating the positive impacts of early special education services and should orient researchers to understanding why some students fail to receive services until later in schooling. Overall, results indicate that early services are associated with better reading performance, and that these effects may persist throughout most of elementary school.

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Table IV.1 Balance of the Propensity Scores for Spring 1st Grade Placement (n = 640)

	1st Grade Special Education N = 230			1st Grade General Education N = 410		
Stratum	***n***	**M**	**SD**	***n***	**M**	**SD**
1	27	.15	.04	136	.13	.04
2	18	.25	.03	103	.24	.03
3	39	.35	.03	64	.35	.03
4	78	.50	.06	72	.48	.06
5	54	.68	.06	30	.67	.06
6	18	.87	.04	4	.87	.07

Table IV.2 Balance of the Propensity Scores for Spring 3rd Grade Placement (n = 250)

	3rd Grade Special Education N = 160			3rd Grade General Education N = 90		
Stratum	***n***	**M**	**SD**	***n***	**M**	**SD**
1	4	.18	.01	12	.11	.05
2	17	.32	.05	23	.30	.06
3	17	.52	.06	25	.47	.05
4	34	.71	.06	21	.67	.05
5	92	.92	.05	10	.88	.05

Table IV.3 Estimated Effects of Spring 1st Grade Special Education Services on 3rd And 5th Grade Academic Outcomes

	Stratification		Nearest-Neighbor		Kernel Matching		Summary	
	ATT	**ES**	**ATT**	**ES**	**ATT**	**ES**	**ES**	**95% CI**
Reading IRT score 3rd	5.95**	.26	7.00**	.30	6.12*	.27	.28	.09, .46
Reading Gain K-3rd	5.21***	.29	6.12***	.34	5.34***	.29	.31	.12, .50
Reading IRT score 5th	7.31***	.27	10.16***	.38	7.27**	.27	.31	.12, .49
Reading Gain K-5th	614***	.28	8.46***	.38	6.22**	.28	.31	.12, .51
Math IRT score 3rd	3.16	.16	3.31	.17	3.44*	.18	.17	-.01, .35
Math Gain K-3rd	0.81	.08	2.44	.18	2.59*	.19	.16	-.04, .35
Math IRT score 5th	6.25**	.25	9.35***	.37	6.44**	.25	.29	.09, .49
Math Gain K-5th	2.60	.17	7.48***	.37	5.02**	.25	.27	.06, .48

Note: ATT=Average Treatment on Treated; ES=Effect Size; CI=Confidence Intervals
Benjamini-Hochberg corrected significance levels: *$p < .05$, **$p < .01$, ***$p < .001$

Table IV.4 Estimated Effects of Spring 1st Grade Special Education Services on 3rd And 5th Grade Behavioral Adjustment

	Stratification		Nearest-Neighbor		Kernel Matching		Summary	
	ATT	**ES**	**ATT**	**ES**	**ATT**	**ES**	**ES**	**95% CI**
App. to Learning 3rd	0.11	.16	0.07	.10	0.12+	.18	.15	-.05, .35
App. Learning Gain K-3rd	0.09	.13	0.11	.16	0.11	.16	.15	-.05, .35
App. to Learning 5th	0.15+	.23	0.11	.16	0.16	.23	.21	.01, .41
App. Learning Gain K-5th	0.09	.13	0.08	.10	0.10	.14	.13	-.08, .33
Self-Control 3rd Grade	-0.06	.09	-0.05	.07	-0.04	.05	.07	-.14, .28
Self-Control Gain K-3rd	-0.05	.07	0.02	.02	-0.04	.05	.05	-.16, .25
Self-Control 5th Grade	0.06	.09	0.02	.03	0.06	.10	.07	-.13, .27
Self-Control Gain K-5th	0.03	.04	0.03	.04	0.02	.03	.03	-.17, .24
Interpersonal Skills 3rd	-0.01	.02	-0.03	.04	0.02	.02	.03	-.19, .24
Interpersonal Gain K-3rd	0.01	.01	0.01	.01	0.01	.01	.01	-.19, .22
Interpersonal Skills 5th	0.11	.17	0.09	.14	0.14+	.21	.18	-.03, .38
Interpersonal Gain K-5th	0.10	.14	0.08	.11	0.11	.15	.13	-.08, .34
Externalizing Probs 3rd	-0.04	.06	-0.11	.15	-0.07	.09	.10	-.10, .31
Externalizing Gain K-3rd	-0.03	.04	-0.13	.18	-0.03	.04	.08	-.12, .28
Externalizing Probs 5th	-0.03	.05	0.02	.03	-0.04	.06	.05	-.16, .25
Externalizing Gain K-5th	-0.01	.01	0.03	.04	0.01	.01	.02	-.19, .23
Internalizing Probs 3rd	-0.10	.15	-0.08	.12	-0.08	.13	.13	-.08, .35
Internalizing Gain K-3rd	-0.04	.05	-0.12	.16	-0.01	.02	.07	-.15, .30
Internalizing Probs 5th	-0.06	.11	-0.03	.05	-0.05	.08	.08	-.13, .28
Internalizing Gain K-5th	0.02	.03	0.01	.01	0.05	.07	.04	-.18, .26

Note: ATT=Average Treatment on Treated; ES=Effect Size; CI=Confidence Intervals
Benjamini-Hochberg corrected significance levels: $^{+}p < .10$

Table IV.5 Estimated Effects of Spring 3rd Grade Special Education Services on 5th Grade Academic Outcomes

	Stratification		Nearest-Neighbor		Kernel Matching		Summary	
	ATT	**ES**	**ATT**	**ES**	**ATT**	**ES**	**ES**	**95% CI**
Reading IRT score 5th Grade	-0.67	0.03	-4.74	0.18	-1.37	.05	0.10	-.36, .56
Reading Gain 1st-5th	3.84	0.21	-1.04	0.05	3.60	.20	0.13	-.27, .54
Math IRT score 5th Grade	-3.28	0.13	-6.93	0.27	-5.20	.21	0.22	-.20, .65
Math Gain 1st-5th	0.05	0.00	-3.53	0.23	-0.41	.03	0.11	-.33, .55

Note: ATT=Average Treatment on Treated; ES=Effect Size; CI=Confidence Intervals

Table IV.6 Estimated Effects of Spring 3rd Grade Special Education Services on 5th Grade Behavioral Adjustment

	Stratification		Nearest-Neighbor		Kernel Matching		Summary	
	ATT	**ES**	**ATT**	**ES**	**ATT**	**ES**	**ES**	**95% CI**
App. Learning 5th Grade	-0.01	0.02	0.17	0.24	-0.05	0.07	0.14	-.31, .59
App. Learning Gain 1st-5th	0.00	0.00	-0.02	0.02	0.00	0.00	0.01	-.38, .40
Self-Control 5th Grade	-0.10	0.15	0.10	0.15	-0.12	0.18	0.17	-.28, .61
Self-Control Gain 1st-5th	-0.19	0.27	-0.34	0.47	-0.27^{+}	0.39	0.41	-.02, .84
Interpersonal Skills 5th Grade	-0.03	0.05	0.16	0.25	-0.05	0.08	0.15	-.32, .62
Interpersonal Gain 1st-5th	-0.04	0.06	-0.14	0.19	-0.09	0.12	0.15	-.37, .66
Externalizing Probs 5th Grade	0.10	0.15	-0.10	0.15	0.10	0.15	0.15	-.28, .57
Externalizing Gain 1st-5th	0.08	0.11	0.22	0.30	0.08	0.12	0.20	-.25, .64
Internalizing Probs 5th Grade	0.05	0.09	-0.12	0.20	0.03	0.05	0.12	-.30, .54
Internalizing Gain 1st-5th	0.11	0.15	-0.11	0.15	-0.01	0.01	0.08	-.36, .53

Note: ATT=Average Treatment Effect on Treated; ES=Effect Size; CI=Confidence Intervals
Benajamini-Hochberg corrected significance levels: $^{+}p < .10$

Table IV.7 Descriptive Statistics for Subsample of First-Graders (n = 180) and Third-Graders (n = 310) with Linked Special Education Teacher Survey Data

	1st Grade IEP % or M (SD)	3rd Grade IEP % or M (SD)	*p*-value
Primary Disability			
Learning Disability	33.0	57.8	.000
Speech or Language Impairment	39.8	22.2	.000
Developmental Delay	5.7	1.0	.002
Other Disability	21.6	16.0	.124
IEP Goals			
Reading	57.4	73.0	.000
Mathematics	47.2	42.0	.268
Language Arts	46.0	66.1	.000
Auditory Processing	25.6	14.3	.002
Listening Comprehension	29.5	17.6	.002
Oral Expression	54.0	20.8	.000
Social Skills	17.6	12.7	.141
Adaptive Behavior	8.0	6.5	.535
Fine Motor Skills	14.8	10.1	.124
Gross Motor Skills	9.1	3.3	.007
Orientation/Mobility	6.3	0.1	.000
Hours/Week of Special Ed.	6.97 (8.30)	6.36 (8.54)	.448
Types of Services Received			
Audiology	3.9	5.4	.459
Counseling	12.9	15.1	.505
Occupational Therapy	11.7	9.3	.401
Physical Therapy	4.4	1.6	.065
Psychological Services	3.9	4.4	.792
School Health Services	10.7	6.0	.063
Social Work Services	5.0	6.4	.528
Language Therapy	64.0	45.7	.000
Other Services	8.3	6.3	.408
Primary Placement in Gen Ed.	84.4	89.9	.073
Time Outside Gen Ed.	3.01 (1.45)	3.08 (1.25)	.575
Special Services Rendered			
One-On-One Instruction	80.1	79.4	.853
Small Group Instruction	92.3	96.5	.040
Large Group Instruction	32.3	64.8	.000
Cooperative Learning	52.5	65.7	.004
Peer Tutoring	32.0	45.1	.004
Direct Instruction	85.1	89.0	.206
Cognitive Strategies	61.3	62.7	.758
Self-Management	44.8	51.6	.146
Behavior Management	41.4	37.5	.393

Curricular Modifications			
General Ed. Curriculum	45.3	27.3	.000
Some Modifications	37.7	53.9	.001
Substantial Modifications	13.2	15.5	.515
Specialized Curriculum	0.6	0.0	.202
% General Ed. Goals Expected to Achieve	1.78 (.91)	1.78 (.76)	1.000
% IEP Goals Met	2.50 (1.19)	2.08 (1.05)	.001

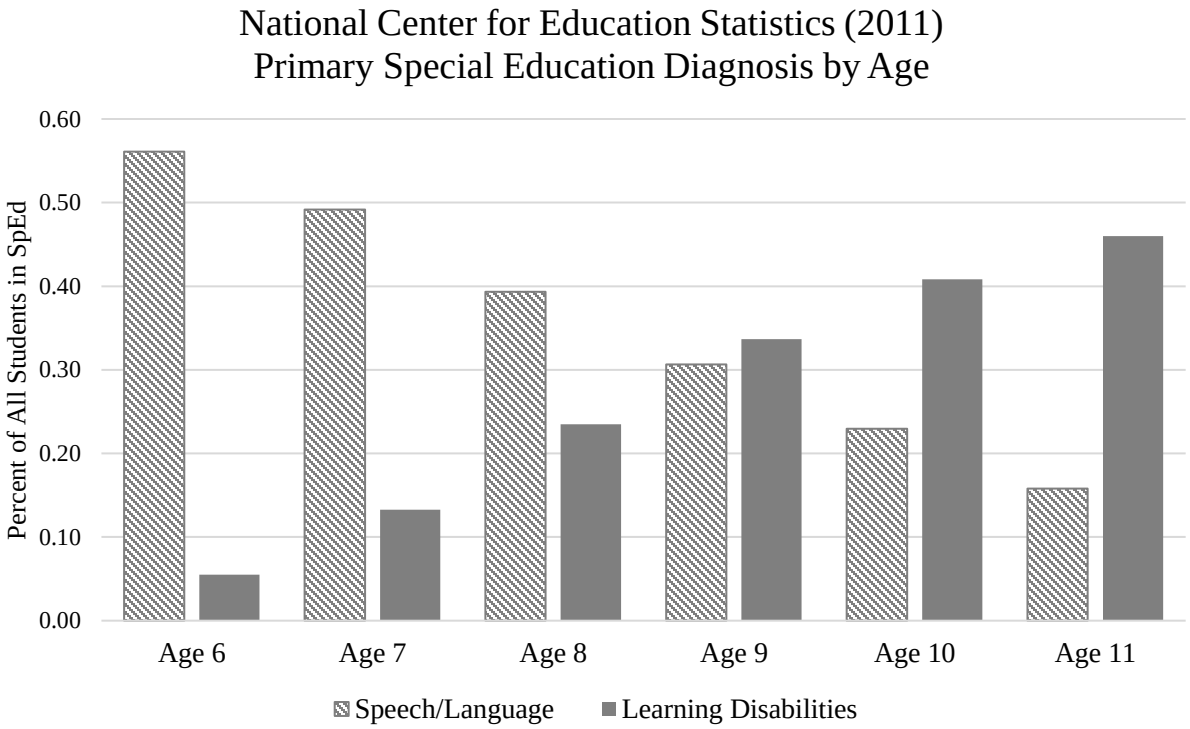

Figure IV.1 Publicly-Available Data Provided by The National Center for Education Statistics (2011) Contrasting the Proportion of U.S. Students Aged 6-11 with Speech/Language Impairments versus Learning Disabilities

CHAPTER V

Conclusion:

What Does Examining Developmental Trajectories Tell Us About Special Education?

Implications Within and Across Studies

The three studies of this dissertation weave together a clearer picture of who receives special education services, at what developmental timepoints, and where, as well as what are the consequences of receiving services at different timepoints during K-8 schooling. First, Study 1 demonstrated that students follow different trajectories through the special education system, and that these trajectories are composed of students from varied backgrounds. Although prior studies have revealed global risk factors for special education placement, Study 1 demonstrates that precursors to and consequences of special education placement differ according to *pattern* of service receipt – not just the category in which students are served. This also helps to clarify differences within disability categories that may emerge in other research. For instance, a Kindergarten student with a speech or language impairment (SLI) who follows the *Persistent* trajectory may be older at school entry, have poorer mathematics skills, and poorer learning-related behaviors than a Kindergarten student with SLI who follows the *Terminal* trajectory. However, in research assessing the timing of first identification or consequences of having an IEP for SLI during the first few years of schooling, these two types of students may be collapsed into the same category, so these differences would be washed out. In sum, this study aids in understanding why and how the experiences of some students in special education are markedly

different than others, and ultimately may allow for more precise intervention targeting.

Study 2 contextualized the results of Study 1 within schools. Not only do students have diverse experiences within the special education system, but there has been speculation that their experiences with identification and service receipt may be dependent in some part on the type of school that they attend. Indeed, Study 2 revealed that schools are important in predicting which students receive special education, but that individual data is more important. At the very least, one could argue that a more mildly impaired student's likelihood of receiving special education services depends in part on the school they attend. Therefore, future analyses predicting special education placement need to account for clustered data, though it would be preferable to include a few school-level predictors such as the proportion of students with disabilities in the school and a measure of urbanicity.

Another important implication from Study 2 is that students with parent-reported disabilities get the earliest services. (This also aligns with findings from Study 1 in which students following the *Persistent* and *Terminal* trajectories – i.e., the students who received the earliest services – appeared more likely to have a parent-reported disability in Kindergarten than students following the *Delayed* category.) Then, as time progressed, whether a child received a disability diagnosis did little to change their likelihood of service receipt over time. Instead, their mother's highest education level was the most important predictor of change over time. Therefore, students may be more likely to receive special education if their parent is able to advocate for this educational service – a point that is supported by prior research finding that parents who are more able to communicate with their school, more able to understand the legalese of the IEP, and more able to recognize problems with their child and/or advocate for services are more apt to get services in place (Fitzgerald & Watkins, 2006; Howland et al., 2006;

Trainor, 2010). Interestingly, maternal education had an even larger influence on whether the child received services over time than academic achievement. Overall, Study 2 clarifies how differences between schools contribute to special education placement, and which factors predict who receives services both initially and over time.

Lastly, Study 3 provided a more practical answer to the question of "so, what?" – in other words, why does it matter if students from diverse backgrounds experience varied trajectories through the special education system? Primarily, this study revealed that different academic outcomes may be a function of receiving services at different timepoints, and that students who receive earlier or later services may also come from substantively different populations. Results support the idea that earlier services produce better outcomes, particularly for reading achievement. However, students who receive earlier services may also be served more often for SLI as opposed to LD, which might also be easier to remediate. This is an important counterfactual to address in future research because it implies that prior evaluations of special education effectiveness could be more strongly tied to student-level background characteristics than to receiving services themselves. Study 3 reduced the impact of this problem by matching similar students who were "equally" likely to receive similar services at a given timepoint (but only some of whom did receive those services) and comparing them to students who did not receive special education until later. This analytical method revealed that earlier special education services continue to produce larger reading effects through 5th grade, but that earlier or later services do not differentially impact behavior or mathematics outcomes.

Findings from Study 3 also provide insight into prior studies on special education effectiveness. Specifically, results suggest that prior research may be over- or understating the effects of service receipt even while using statistically rigorous, quasi-experimental methods. In

other words, it is incorrect to make broad claims about the (in)effectiveness of special education by simply picking a baseline pre-test point and an outcome post-test point without accounting for developmental trajectories. Studies need to account for the facts that 1) general education students are a poor comparison group because they do not have a disability requiring special education intervention; 2) students have varying special educational needs at certain developmental time periods; and 3) the goals of special education and services delivered vary widely at different developmental time periods. Within the context of longitudinal trajectories of special education, Study 3 demonstrated that although the initial timing of service receipt matters for later outcomes, it matters beyond the simple conclusion that "earlier is better."

Theoretical Implications

Beyond these study-specific implications, there were several noteworthy findings within this dissertation. First, there were no race/ethnicity findings in either of the first two studies. In other words, non-White students were no more or less likely to follow different trajectories of service receipt, nor were their longitudinal likelihoods of placement differentially affected by the school context. This is a very large departure from the literature on identification, which has predominantly focused on issues of significant racial disproportionality and consistently found that non-White students are underrepresented in special education (Morgan et al., 2015, 2017a, 2017b; but see also Hosp & Reschly, 2004; Skiba et al., 2008). However, with few exceptions this literature has not focused on longitudinal trajectories of service receipt. It is therefore possible that accounting for longitudinal pathways through the special education system washes out any racial effects present at first identification.

To better illustrate this phenomenon, Table V.1 presents a simple visualization of the proportion of White and Black students in the ECLS-K:1998 performing in the bottom 10th

percentile in reading at each year of data collection. At each wave cross-sectionally, there are significantly fewer Black students with a reading score in the bottom 10th percentile who have an IEP relative to White students in the bottom 10th percentile. Moreover, if one were to compare the difference between White and Black students over time from Kindergarten to 5th grade (for example), they would find that significantly more poorly-performing White students obtain an IEP by 5th grade. This is consistent with existing literature (Morgan et al., 2015; Morgan et al., 2017b). However, when examining the growth curves of Black and White students over time, the *shapes* of these trajectories do not appear to significantly differ. This latter point is demonstrated throughout my dissertation, which consistently failed to find evidence that race/ethnicity significantly predicted *trajectories* of special education service receipt. In other words, though there may be differences in the proportions of White and non-White students receiving special education services both concurrently and over time, these students follow relatively similar longitudinal pathways through the K-8 special education system. This is an important caveat for both researchers and policymakers who have been following this disproportionality debate and provides a point of caution to judgments about racial/ethnic representation in special education.

Another departure from previous literature regards the importance of individual academic achievement in predicting special education service receipt. Though several authors have regarded academic achievement as one of the most important variables to include in analyses assessing identification (e.g., Donovan & Cross, 2002; Hosp & Reschly, 2004; Morgan et al., 2016), here, achievement was predictive but not overly so. The effect sizes for reading and mathematics were some of the smallest relative to other predictors (e.g., male sex, cognitive stimulation in the home, private school attendance) in predicting the likelihoods of following various special education trajectories in Study 1. In Study 2, though consistently predictive,

better academic achievement decreased the likelihood of special education status by only 2 percent in Kindergarten and by 1 percent over time.

However, parsing out the importance of individual achievement across studies reveals interesting truths about methods used to assess both precursors to and consequences of placement. For example, in Study 1 the descriptive statistics reveal that students *Persistently* receiving special education services appear to have the poorest long-term academic outcomes, while those in the *Terminal* category have the best academic outcomes (second only to general education students). Conversely, Study 3 finds that students who receive these early services have *better* academic outcomes than those receiving later services. This comparison is especially useful in illustrating why researchers should not assess or predict the effects of special education services at only one timepoint and ignore these longitudinal pathways. On the other hand, there may have been students with more severe disabilities captured by Study 1's *Persistent* category than were represented in Study 3's analytical sample, as none of this latter group received services in Kindergarten while most of the *Persistent* group did. Indeed, only 29 percent of the *Persistent* category who received 1st grade special education services would have been analyzed in Study 3, while 45 percent of the *Terminal* category would have been analyzed (see Table II.3). Therefore, the students receiving earlier services in Study 3 may have had milder disabilities that were more amenable to special education intervention. If the students in the *Persistent* category require the most intensive intervention, this would not only explain their reduced academic outcomes, but why they had services put in place during Kindergarten. This would also align with the results of Study 2 finding that the students who have services during Kindergarten are significantly more likely to have a parent-reported disability.

Future Directions

One problem facing both educators and researchers regards our ability to identify and remediate different types of impairments. For instance, Study 3 suggests that educators may be relatively good at the early identification and remediation of SLI or early literacy issues. However, special educational needs emerging later in development may be both harder to identify and remediate, given the nonsignificant effect of later service receipt in Study 3. There could also be more mathematics disabilities in this later-identified group, particularly since mathematics as a discipline is not taught as intensively in early schooling as reading/literacy (Early et al., 2010). To this point, students who received services for the first time in 3rd grade had lower math scores than students who received initial services in 5th or 8th grade. Perhaps we are not as good at remediating math disabilities as we are at remediating literacy or speech disabilities, which is why outcomes did not appear to improve in the same way as for students receiving earlier services. Students who receive later services may also be a more diverse group relative to those who experience special education within the first few years of formal schooling. Evidence suggests that behavioral difficulties interrelate with academic difficulties throughout elementary school (e.g., Lin, Morgan, Farkas, Hillemeier, & Cook, 2013; Morgan, Farkas, & Wu, 2009), which may contribute to more difficulty remediating later-identified students.

In any case, it is imperative that we understand these students who are receiving delayed services. Why were these students not referred earlier? Why was this group so heterogeneous? Why were their learning problems not remediated in the same way as they were for the 1st graders who received services? The answers to these questions may provide practical guidance for educators working with at-risk students. If interventions are not designed to address heterogeneity in student needs at various stages in development, they will fail large groups of

children. In the meantime, educators should continue to push for the earliest possible referrals to special education, since these appear to be associated with the best literacy outcomes regardless of diagnosis, IEP goals, or the amount of special educational services received.

Another future direction regards the importance of disentangling the covariate pathway contributing to disability identification and/or special education referral. As demonstrated in Studies 1 and 2, parent-reported disability status was one of the largest predictors of early special education placement. This is an important point because the factors that predict the likelihood of having a disability may differ from those that predict the likelihood of receiving special education services, but this difference is often glossed over. For instance, low birthweight is more prevalent among Black children and has been linked to increased risk for cognitive delay or disability (Morgan et al., 2015; Grunau, Whitfield, & Davis, 2002), which may indirectly boost the likelihood of special education placement. However, though a student may have a disability, the student is ineligible for special education if their disability does not adversely affect educational performance. To my knowledge, no research has modeled the varying risk pathways leading up to and moving between both disability identification and special education identification. This oversight may lead to research studying the likelihood of disability identification yet making claims about special education placement when the appropriate predictors have not been modeled, and vice versa (for further discussion, see Donovan & Cross, 2002; Hosp & Reschly, 2004; Morgan et al., 2016; Wu, Morgan, & Farkas, 2014). Exploring these covariate pathways will offer clarity to future researchers interested in correctly modeling risk for special education placement.

Conclusion

Written about a decade after the *Education for all Handicapped Children* Act, Gerber and

Semmel (1984) believed that characterizing a child based on statistical deviations from the norm represented an intolerance of social institutions to accommodate individual differences in learners. They asserted that existing state and federal policy would result in children who are identified for special education not on the basis of disability, but as "a function of how and why one chooses to measure these characteristics" (p.137). Thirty years later, their unfortunate prediction seems to align with the presence of population-level patterns in special education enrollment based on individual- and school-level characteristics, indicating at least some systemic bias.

This dissertation represents an important step toward understanding the full measure of these inequities. Addressing the questions of *who is placed in special education?* and *what happens after they are placed?* within developmental trajectories of service receipt served to clarify inconsistencies and oversimplifications, as well as to extend and validate existing research. Moreover, this dissertation demonstrated that accounting for developmental trajectories of service receipt partially explains the paradox of special education, in which early identification has been coupled with poorer academic achievement across primary schooling. This not only has enormous policy consequences but supports the idea that research in special education must be more strongly bridged with developmental psychology. As a field, we sorely need an interdisciplinary focus at pathways through which disorder and disability manifest in schools, as well as which students then receive special education services over time. In addition, addressing special education identification from this framework may clarify for whom special education is most effective. It is my hope that this dissertation can therefore help illuminate systemic factors influencing service delivery and push toward identifying the students who would be most benefitted by specialized services in various educational environments.

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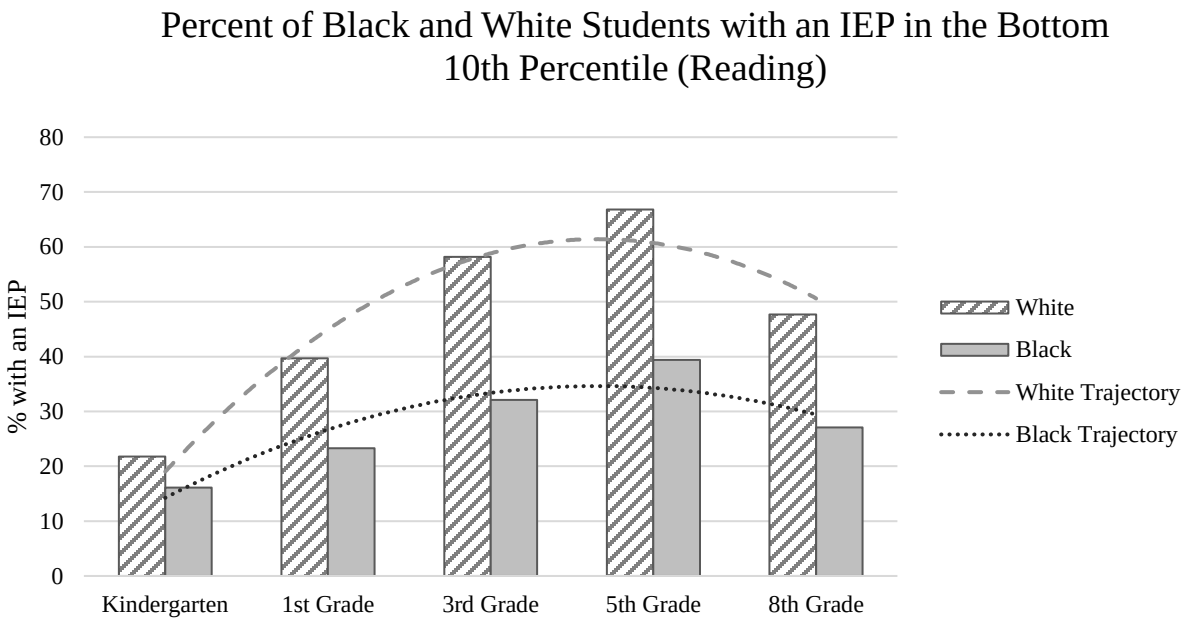

Figure V.1. Percent of Black and White Students with an IEP who Score in the Bottom 10th Percentile for Reading at Each Wave of Data Collection.

APPENDICES

Appendix A

Information and Justification for Home Environment and Parenting Variable Creation

Cognitively stimulating and enriched home environments have strong links with both brain development (e.g., Kolb et al., 2012; Perry, 2002) and achievement (e.g., Bradley & Caldwell, 1984; Davis-Kean, 2005). To create the time-varying information about the home environment and the child's experience with cognitive stimulation, variables capturing three broad constructs available at each wave were summed and standardized (Table A.1). Predictors assessing cognitive stimulation consisted of activities the child participated in, such as taking music lessons or visiting the library, and the frequency with which they read outside of school. Variables measuring home resources included whether the home had a library card or home computer, how many books the child had (capped at 600 and then z-scored), and how safe it was to play outdoors. Lastly, family routines and structure were assessed through predictors capturing information about household rules and the number of days per week the family shared meals together. The items within each block were summed together and standardized, and the resulting three scores were again summed and standardized to create a composite variable assessing the home environment and cognitive stimulation.

High quality parent-child interactions and parenting behaviors (e.g., reading books together, attending museums or cultural events like sporting games) have also been demonstrated to result in improved educational expectations and outcomes (Hao & Bonstead-Bruns, 1998; Davis-Kean, 2005). To create the time-varying information about parenting behaviors (Table

A.2), variables capturing four broad constructs at each wave were utilized. First, items measuring the frequency of parent-child interactions, such as reading to the child, telling stories, or singing songs, were averaged together into one score. Next, two variables measuring help with homework were re-scaled into a 1-4 scale (response category 6 was dropped) and averaged together. A block of variables assessing parents' conversations with children, including discussing friends, drug use, and sexual activity, was also averaged into one score. Lastly, a block of variables assessing household rules and parent-child relationships (available only in the 8th grade wave of data collection) were averaged together. Each of these blocks were then averaged into one score and standardized to capture general parenting behaviors.

Finally, parents' educational expectations for their children strongly influence educational attainment (e.g., Fan & Chen, 2001; Englund, Luckner, Whaley, & Egeland, 2004), and these expectations are negatively impacted by disability status (Shifrer, 2013). Educational expectations were assessed using a question at each wave asking parents what academic degree they expected of their child (with 1 = to receive less than a high school diploma, and 6 = to finish a PhD, MD, or other advanced degree).

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Table A.1 Home Environment and Cognitive Stimulation Variable Creation Items

	Variable Information and Scale	Grade Available				
		K	1	3	5	8
1	**COGNITIVE STIMULATION**					
	TAKES DANCE LESSONS (0/1)	X	X	X	X	
	PARTCP IN ATHLETIC EVENTS (0/1)	X	X	X	X	
	PARTICP IN ORGANIZED CLUBS (0/1)	X	X	X	X	
	TAKES MUSIC LESSONS (0/1)	X	X	X	X	
	TAKES ART LESSONS (0/1)	X	X	X	X	
	PARTCP IN ORGANIZED PERFORMING (0/1)	X	X	X	X	
	READ A BOOK IN LAST YEAR (0/1)					X
	FREQ READ OUTSIDE OF SCHOOL (1-4)	X	X	X	X	
	VISITED LIB IN PAST YEAR (0/1)			X	X	
	VISITED THE LIBRARY (PAST MONTH) (0/1)	X	X			
	GONE TO A PLAY, CONCERT, SHOWS (PAST MONTH) (0/1)	X		X		
	VISITED A MUSEUM (PAST MONTH) (0/1)	X		X		
	VISITED A ZOO, AQUARIUM (PAST MONTH) (0/1)	X		X		
2	**HOME RESOURCES**					
	CHILD HAS OWN LIBRARY CARD (0/1)		X	X	X	
	HAVE HOME COMPUTER CHILD USES (0/1)	X	X	X	X	
	HOW SAFE IN TO PLAY OUTSIDE (0-2)	X	X	X	X	X
	HOW MANY BOOKS CHILD HAS (0-600) – z-scored		X	X	X	
3	**FAMILY RULES/STRUCTURE/ROUTINES**					
	GO TO BED SAME TIME EACH NIGHT (0/1)	X	X	X	X	
	FAMILY RULES FOR TV (0/1)			X	X	X
	TV RULE HOW LATE WATCH TV (0/1)			X	X	X
	FAM RULES - HRS WEEKDAY TV (0/1)			X	X	X
	FAM RULES - HRS EACH WEEK TV (0/1)			X	X	X
	PLACE SET ASIDE FOR HOMEWORK (0/1)			X	X	X
	FAMILY RULES FOR GRADE PT AVG (0/1)					X
	FAMILY RULES FOR HOMEWORK (0/1)					X
	FAMILY RULES COMPUTER GAMES (0/1)					X
	# DAYS EAT BREAKFAST TOGETHER (0-7)	X	X	X	X	X
	# DAYS CHD EAT BRKFST REG TIME (0-7)	X	X	X	X	X
	# DAYS EAT DINNER TOGETHER (0-7)	X	X	X	X	X
	# DAYS EAT DINNER REG TIME (0-7)	X	X	X	X	X
	TOTAL NUMBER OF ITEMS	***18***	***17***	***25***	***22***	***14***

Table A.2 Parenting Quality and Behaviors Variable Creation Items

	Variable Information and Scale	Grade Available				
		K	1	3	5	8
1	**PARENT-CHILD INTERACTION**					
	HOW OFTEN YOU READ TO CHILD (1-4)	X	X	X		
	HOW OFTEN YOU TELL CHD STORIES (1-4)	X	X	X		
	HOW OFTEN YOU ALL SING SONGS (1-4)	X	X	X		
	HOW OFTEN YOU HELP CHD DO ART (1-4)	X	X	X		
	HOW OFTEN CHILD DOES CHORES (1-4)	X	X	X		
	HOW OFTEN YOU ALL PLAY GAMES (1-4)	X	X	X		
	HOW OFTEN YOU TEACH CHD NATURE (1-4)	X	X	X		
	HOW OFTEN YOU ALL BUILD THINGS (1-4)	X	X	X		
	HOW OFTEN YOU ALL DO SPORTS (1-4)	X	X	X		
	HOW OFTEN PRACTICE NUMBERS (1-4)		X	X		
2	**HELP WITH HOMEWORK**					
	OFTEN HELP WITH READING HW (1-5)			X	X	X
	OFTEN HELP WITH MATH HW (1-5)			X	X	X
3	**CONVERSATIONS WITH CHILDREN**					
	OFTEN TALK ABOUT DAY AT SCH (1-4)				X	X
	OFTEN TALK ABOUT FRIENDS (1-4)				X	X
	OFT TLK ABOUT SMKING/TOBACCO (1-4)				X	X
	OFT TLK ABOUT ALCOHOLIC BVRG (1-4)				X	X
	OFTEN TALK ABOUT SEX (1-4)				X	X
	OFTEN TALK ABOUT DRUGS (1-4)				X	X
4	**HOUSEHOLD RULES & PARENT-CHILD RELATIONSHIP**					
	HOW OFT CHECK HOMEWORK (1-4)					X
	HOW OFT DISCUSS REPORT CARD (1-4)					X
	HOW OFT KNOW WHERE CHILD IS (1-4)					X
	HOW OFTEN SET CURFEWS (1-4)					X
	HOW OFTEN REQUIRE CHORES (1-4)					X
	OFTEN GET ALONG WELL WITH CHD (1-4)					X
	OFTEN MAKE DECISIONS TOGETHER (1-4)					X
	OFTEN DO NOT UNDERSTAND CHILD (1-4) – reversed					X
	OFTEN REALLY TRUST CHILD (1-4)					X
	OFT CHD INTERFERES WTH PLANS (1-4) – reversed					X
	TOTAL NUMBER OF ITEMS	***9***	***10***	***12***	***8***	***18***

Appendix B

Partial and Zero-Order Correlations

Table B.1 Partial and Zero-Order Correlations for Individual-Level Variables

		1		2		3		4		5		6		7		8	
1	IEP			0.11	***	0.01		-0.02	***	-0.05	***	0.00		-0.06	***	-0.07	***
2	Male	0.05	***			-0.01	***	-0.01		-0.01	**	0.00		0.00		0.01	*
3	Black	-0.05	***	-0.01	*			-0.22	***	-0.12	***	-0.11	***	-0.09	***	-0.27	***
4	Hisp	-0.03	***	-0.01		-0.20	***			-0.13	***	-0.12	***	-0.26	***	-0.21	***
5	Asian	-0.01	*	0.00		-0.07	***	-0.28	***			-0.06	***	0.04	***	0.01	**
6	Other	-0.02	***	-0.01		-0.16	***	-0.15	***	-0.07	***			-0.01		-0.05	***
7	Maternal Ed.	-0.01		0.03	***	0.00		-0.08	***	0.04	***	0.01				0.51	***
8	Income	-0.01	*	0.03	***	-0.17	***	-0.06	***	0.00		-0.07	***	0.29	***		
9	Disability	0.28	***	0.02	***	-0.03	***	-0.01		-0.01	*	-0.01	*	0.03	***	-0.02	***
10	Home Cog.	-0.01	*	-0.06	***	-0.10	***	-0.08	***	-0.03	***	-0.04	***	0.19	***	0.14	***
11	Parent Qual.	0.02	**	0.01	*	0.02	***	0.02	**	-0.02	***	0.03	***	-0.01		-0.06	***
12	Ed. Expect.	-0.03	***	-0.03	***	0.13	***	0.11	***	0.06	***	0.04	***	0.14	***	0.08	***
13	App to Learn	-0.04	***	-0.16	***	0.00		-0.01	*	0.02	**	0.00		0.02	**	0.02	*
14	Externalizing	-0.01	*	0.11	***	0.07	***	0.01		-0.02	**	0.01		0.00		-0.03	***
15	Internalizing	0.05	***	-0.07	***	-0.07	***	-0.02	***	0.00		0.00		0.00		-0.03	***
16	Achievement	-0.14	***	0.07	***	-0.14	***	-0.06	***	0.00		-0.06	***	0.11	***	0.11	***
17	Low Birthweight	0.02	**	-0.03	***	0.07	***	0.02	***	0.04	***	0.01		-0.01		-0.01	
18	Single Parent	0.00		-0.02	***	0.17	***	0.03	***	0.00		0.05	***	0.04	***	-0.38	***
19	No Childcare	-0.01		0.01	*	-0.08	***	0.04	***	0.02	***	0.02	*	-0.12	***	-0.01	
20	Language	-0.01		0.02	**	-0.05	***	0.44	***	0.38	***	0.02	**	-0.08	***	-0.13	***
21	Grade	0.14	***	-0.07	***	0.13	***	0.06	***	0.00		0.06	***	-0.12	***	-0.04	***

Note: Partial correlations below diagonal, zero-order correlations above diagonal.
***$p < .001$, **$p < .01$, *$p < .05$

(cont'd)

		9		10		11		12		13		14		15		16	
1	IEP	0.35	***	-0.05	***	0.04	***	-0.14	***	-0.22	***	0.12	***	0.15	***	-0.08	***
2	Male	0.08	***	-0.06	***	0.00	***	-0.06	***	-0.24	***	0.21	***	0.04	***	-0.02	***
3	Black	-0.01	*	-0.15	***	0.04	***	-0.02	***	-0.14	***	0.16	***	0.02	***	-0.12	***
4	Hisp	-0.04	***	-0.21	***	-0.05	***	0.10	***	-0.04	***	-0.02	***	0.00		0.00	
5	Asian	-0.06	***	-0.02	***	-0.06	***	0.11	***	0.11	***	-0.10	***	-0.06	***	0.03	***
6	Other	0.01		-0.02	***	0.03	***	-0.04	***	-0.02	***	0.03	***	0.02	***	-0.03	***
7	Maternal Ed.	0.00		0.41	***	0.05	***	0.21	***	0.17	***	-0.09	***	-0.09	***	0.12	***
8	Income	-0.03	***	0.41	***	0.01	*	0.16	***	0.21	***	-0.15	***	-0.13	***	0.28	***
9	Disability			-0.01	*	0.04	***	-0.11	***	-0.19	***	0.13	***	0.16	***	-0.04	***
10	Home Cog.	0.02	**			0.23	***	0.18	***	0.17	***	-0.10	***	-0.09	***	0.10	***
11	Parent Qual.	0.02	**	0.24	***			0.05	***	-0.03	***	0.01	*	0.02	***	-0.03	***
12	Ed. Expect.	-0.05	***	0.10	***	0.05	***			0.18	***	-0.10	***	-0.10	***	0.09	***
13	App to Learn	-0.05	***	0.03	***	-0.01		0.06	***			-0.56	***	-0.40	***	0.14	***
14	Externalizing	0.03	***	0.00		-0.01		0.01		-0.44	***			0.31	***	-0.09	***
15	Internalizing	0.07	***	-0.01	*	0.00		0.00		-0.26	***	0.10	***			-0.03	***
16	Achievement	-0.01		0.06	***	-0.14	***	0.10	***	0.23	***	0.03	***	-0.01			
17	Low Birthweight	0.04	***	-0.01		0.02	***	0.03	***	-0.02	**	-0.02	**	0.02	***	-0.03	***
18	Single Parent	0.00		-0.05	***	-0.01	**	0.01		-0.02	**	0.01		0.04	***	0.01	
19	No Childcare	-0.01		-0.04	***	0.03	***	-0.02	***	0.01		-0.04	***	0.01		-0.02	***
20	Language	-0.02	***	-0.02	***	-0.05	***	0.13	***	0.01		-0.02	**	-0.01		-0.05	***
21	Grade	0.00		-0.07	***	0.13	***	-0.10	***	-0.22	***	-0.03	***	0.03	***	0.94	***

Note: Partial correlations below diagonal, zero-order correlations above diagonal.
***$p < .001$, **$p < .01$, *$p < .05$

(cont'd)

		17		18		19		20		21	
1	IEP	0.03	***	0.04	***	-0.01	***	-0.05	***	0.04	***
2	Male	-0.02	***	0.00		0.01	*	0.00		0.00	
3	Black	0.10	***	0.30	***	-0.12	***	-0.18	***	0.00	
4	Hisp	-0.01	**	0.02	***	0.15	***	0.50	***	0.00	
5	Asian	0.00		-0.08	***	0.03	***	0.36	***	0.00	
6	Other	-0.01	*	0.05	***	0.02	***	-0.06	***	0.00	
7	Maternal Ed.	-0.03	***	-0.20	***	-0.18	***	-0.24	***	0.00	
8	Income	-0.06	***	-0.47	***	-0.08	***	-0.22	***	0.16	***
9	Disability	0.05	***	0.04	***	-0.04	***	-0.08	***	0.02	***
10	Home Cog.	-0.03	***	-0.23	***	-0.11	***	-0.20	***	0.02	***
11	Parent Qual.	0.03	***	0.00		-0.01		-0.09	***	0.02	***
12	Ed. Expect.	-0.01		-0.09	***	-0.03	***	0.16	***	0.00	
13	App to Learn	-0.05	***	-0.16	***	0.00		0.03	***	-0.01	**
14	Externalizing	0.02	***	0.15	***	-0.06	***	-0.07	***	-0.01	*
15	Internalizing	0.04	***	0.12	***	0.01		-0.03	***	0.04	***
16	Achievement	-0.03	***	-0.10	***	-0.01	*	0.04	***	0.93	***
17	Low Birthweight			0.05	***	-0.01	*	-0.02	***	0.00	
18	Single Parent	0.01				-0.02	***	-0.06	***	-0.03	***
19	No Childcare	0.00		-0.02	***			0.15	***	0.00	
20	Language	-0.01	*	-0.12	***	0.01				0.00	
21	Grade	0.02	***	0.02	**	0.02	**	0.06	***		

Note: Partial correlations below diagonal, zero-order correlations above diagonal.
***$p < .001$, **$p < .01$, *$p < .05$

Table B.2 Partial and Zero-Order Correlations for School-Level Variables

		1		2		3		4		5		6		7		8	
1	IEP			-0.03	***	-0.01		0.01		0.02	**	-0.04	***	-0.03	***	-0.03	***
2	Urban	0.00				0.23	***	0.26	***	0.12	***	0.43	***	0.31	***	0.19	***
3	Neighborhood	-0.02	**	0.01				0.51	***	0.35	***	0.48	***	0.34	***	0.07	***
4	Free Lunch	0.00		0.05	***	0.19	***			0.53	***	0.59	***	0.38	***	-0.01	**
5	Title I Funds	0.01		-0.06	***	0.08	***	0.37	***			0.34	***	0.20	***	-0.01	*
6	Non-White	-0.01		0.17	***	0.16	***	0.38	***	-0.02	*			0.52	***	0.23	***
7	Lim. English	0.01		0.17	***	0.09	***	0.05	***	0.03	***	0.26	***			0.20	***
8	School Size	-0.02	*	0.04	***	0.00		-0.08	***	-0.04	***	0.17	***	0.09	***		
9	K Teacher Salary	-0.03	***	0.09	***	0.03	***	-0.26	***	-0.03	***	0.17	***	0.10	***	0.07	***
10	Acad. Proficient	0.00		0.02	**	-0.14	***	-0.21	***	-0.04	***	-0.05	***	-0.08	***	0.03	***
11	Avg. Learn	-0.07	***	0.01		-0.03	***	-0.03	***	-0.04	***	-0.03	***	0.02	**	-0.01	
12	Avg. Extern	-0.01		-0.02	**	0.01		0.02	**	0.03	***	0.10	***	-0.04	***	-0.09	***
13	Avg. Intern	0.04	***	0.03	***	0.04	***	0.04	***	-0.04	***	-0.10	***	0.02	*	0.02	*
14	# Disab/Class	0.12	***	-0.02	**	0.04	***	0.05	***	0.01		-0.06	***	-0.06	***	0.04	***
15	Grade	0.04	***	-0.02	*	-0.09	***	0.12	***	-0.13	***	-0.01		0.03	***	0.11	***

Note: Partial correlations below diagonal, zero-order correlations above diagonal.
***$p < .001$, **$p < .01$, *$p < .05$

(cont'd)

		9		10		11		12		13		14		15	
1	IEP	-0.05	***	-0.01		-0.09	***	0.07	***	0.07	***	0.14	***	0.04	***
2	Urban	0.15	***	-0.17	***	-0.04	***	0.01	***	-0.01	**	-0.09	***	0.00	
3	Neighborhood	-0.02	**	-0.42	***	-0.19	***	0.18	***	0.10	***	0.02	***	-0.03	***
4	Free Lunch	-0.19	***	-0.47	***	-0.25	***	0.24	***	0.11	***	0.02	***	0.02	***
5	Title I Funds	-0.16	***	-0.33	***	-0.21	***	0.19	***	0.07	***	0.01	**	-0.11	***
6	Non-White	0.09	***	-0.41	***	-0.17	***	0.14	***	0.02	***	-0.09	***	-0.01	
7	Lim. English	0.14	***	-0.31	***	-0.06	***	-0.01		0.03	***	-0.09	***	0.01	
8	School Size	0.15	***	-0.07	***	0.02	***	-0.10	***	-0.04	***	-0.03	***	0.10	***
9	K Teacher Salary			0.02	***	0.13	***	-0.19	***	-0.07	***	-0.04	***	0.00	
10	Acad. Proficient	0.00				0.17	***	-0.17	***	-0.07	***	0.03	***	0.03	***
11	Avg. Learn	-0.01		0.02	**			-0.62	***	-0.43	***	-0.07	***	-0.03	***
12	Avg. Extern	-0.11	***	-0.02	**	-0.44	***			0.44	***	0.08	***	-0.03	***
13	Avg. Intern	0.02	*	0.00		-0.27	***	0.27	***			0.09	***	0.10	***
14	# Disab/Class	0.01		0.02	**	0.00		0.02	**	0.02	**			0.04	***
15	Grade	-0.02	**	-0.01		0.00		-0.09	***	0.14	***	0.02			

Note: Partial correlations below diagonal, zero-order correlations above diagonal.
***$p < .001$, **$p < .01$, *$p < .05$

Appendix C

Covariate Descriptions Used in 1st and 3rd Grade Propensity Score Generation

Table C.1 Descriptions of Variables Used in Propensity Score Creation

Variable	Description
Demographics	
Male	1=Male Sex
Non-English Lang	1=Non-English primarily spoken in the home
Race/Ethnicity	1=Non-Hispanic White, 2=Non-Hispanic Black, 3=Hispanic, 4=Asian, 5=Other
Low Birthweight	1=Born weighing less than 6 lbs.
Disability	1=Parent reports a disability
Age at K Entry	Age at Kindergarten entry, ranging from 46 to 83 months
Family and Home	
No Insurance	1=Child does not have health insurance coverage
No Regular Childcare	1=Child did not attend regular childcare (including daycare and Head Start) before Kindergarten
Last Doctor Visit	Most recent visit for routine healthcare checkup, with 1=2+ years, 2=1-2 years, 3=6 months-1 year, 4=less than 6 months
Income	Parent-reported household income, ranging from 1 (less than $5,000) to 13 (greater than $100,000)
Poverty	1=Family is at or below federal poverty line
Single Parent	1=Mother is single, separated, divorced, or widowed
Teenage Mother	1=Mother is less than 20 years old at time of first birth
Absent Bio. Father	1=Biological father is absent from the home
Maternal Education	Level of mother's education, ranging from 1 (8th grade education or less) to 9 (doctoral or professional degree)
Home Cog Stimulation	Standardized measure of cognitive stimulation in the home environment, ranging from -3.73 to 2.34
Educational Expect.	Educational attainment parent expects of child, ranging from 1=Receive less than a high school diploma, to 6=Finish a PhD, MD, or other advanced degree
Parenting Interactions	Standardized measure of high quality parent-child interactions,

	ranging from -3.59 to 2.47
No. Siblings	Number of siblings, ranging from 0-9
Achievement and Behavior	
Reading	IRT-adjusted spring reading score, ranging from 11.4 to 69.02
Mathematics	IRT-adjusted spring math score, ranging from 7.59 to 56.21
App. To Learning	Teacher-reported positive learning behaviors, average scale ranging from 1-4
Self-Control	Teacher-reported self-regulation skills, average scale ranging from 1-4
Interpersonal	Teacher-reported interpersonal relationships, average scale ranging from 1-4
Externalizing	Teacher-reported externalizing problem behaviors, average scale ranging from 1-4
Internalizing	Teacher-reported internalizing problem behaviors, average scale ranging from 1-4
Dosage	Number of data collection waves child is reported to have an IEP on file, ranging from 1-4
School Demographics	
Region	1=Northeast, 2=Midwest, 3=South, 4=West
Urban Area	1=Urban Area (Census Reported Population >250,000)
Rural Area	1=Rural Area (Census Reported Population <2,500)
Neighborhood Safety[1]	Standardized principal-reported measure of neighborhood quality and safety, ranging from -0.84 to 1.98
Private School	1=Principal reports school is private or religious
K. Teacher Salary[1]	Highest annual base salary for Kindergarten teachers, ranging from 1=less than $25,000 to 5=more than $60,000
School Size	Principal-reported number of children enrolled in school, ranging from 1 (149 or less) to 5 (750 or more)
School Climate[1]	Standardized measure of school climate reported by principal, ranging from -2.94 to 2.67
Title I Funding	1=Principal reports that school receives schoolwide Title I Funding
% Free Lunch[1]	Principal-reported proportion of student body receiving free lunch, ranging from 0 to 100
Avg. SES[1]	Student-level measure of SES (created by ECLS-K), aggregated across schools, ranging from -1.46 to 1.37
% Non-White	Principal-reported proportion of student body that reports a non-White race/ethnicity, ranging from 1 (less than 10%) to 5 (75% or more)
% Limited English[1]	Principal-reported proportion of student body that are English Language Learners, ranging from 0 to 99
No. Disabilities/Class	Teacher-reported number of students with disabilities in their classroom, aggregated across the school, ranging from 0 to 28
Avg. App. To Learn	Student-level IRT-adjusted positive learning behaviors, as rated by teachers and aggregated across schools, ranging from 2.2 to 4.0

Avg. Self-Control	Student-level IRT-adjusted self-regulation skills, as rated by teachers and aggregated across schools, ranging from 2.2 to 4.0
Avg. Interpersonal	Student-level IRT-adjusted interpersonal skills, as rated by teachers and aggregated across schools, ranging from 2.3 to 4.0
Avg. Externalizing	Student-level IRT-adjusted externalizing problems, as rated by teachers and aggregated across schools, ranging from 1.0 to 2.4
Avg. Internalizing	Student-level IRT-adjusted internalizing problems, as rated by teachers and aggregated across schools, ranging from 1.0 to 2.3

Note: [1] Covariate used in 3rd grade propensity-matching analysis only

Table C.2 Weighted Descriptive Statistics [M (SD) or %] by Spring 1st Grade Strata

	Propensity-Matched Stratum						Full
	1	**2**	**3**	**4**	**5**	**6**	**Sample**
Special Education							
Dosage	1.21 (.46)	1.34 (.59)	1.72 (.81)	1.89 (.91)	2.04 (1.00)	2.64 (1.08)	1.62 (.82)
IEP 1st gr.	17.4	15.7	37.4	51.9	65.9	86.9	37.8
IEP 3rd gr.	47.7	63.7	68.5	74.7	75.7	81.5	66.7
IEP 5th gr.	65.0	50.6	72.8	75.8	74.4	83.7	70.2
IEP 8th gr.	32.5	50.0	59.6	57.8	61.2	70.0	57.1
Demographics							
Male	55.5	61.0	63.3	69.1	75.6	62.2	66.7
White	67.3	77.8	65.5	74.7	69.0	69.9	60.3
Black	16.7	12.8	16.2	11.3	6.6	8.8	15.2
Hispanic	13.7	6.9	9.4	7.4	15.0	8.7	18.0
Asian	1.3	0.0	0.8	0.9	1.9	0.0	1.4
Other	1.0	2.5	8.0	5.7	7.4	12.6	5.1
Disability	0.1	5.5	12.0	40.8	77.5	100.0	25.9
Low BW	0.6	2.7	7.5	10.9	13.6	19.7	7.9
K Age mo.	65.04 (4.22)	65.49 (3.86)	65.71 (4.23)	66.24 (4.23)	66.78 (4.63)	68.12 (4.76)	65.70 (4.40)
Achievement and Behavior							
Reading	18.91 (6.21)	19.76 (6.79)	18.85 (7.42)	18.84 (7.88)	18.60 (7.20)	19.02 (10.54)	18.73 (7.35)
Mathematics	19.10 (8.17)	17.10 (6.62)	15.74 (5.59)	15.86 (5.69)	14.71 (5.21)	13.21 (6.04)	15.91 (6.66)
Learning	2.90 (.76)	2.77 (.70)	2.68 (.68)	2.67 (.71)	2.65 (.65)	2.47 (.63)	2.65 (.71)
Self-Control	3.07 (.70)	3.10 (.61)	2.97 (.67)	2.98 (.64)	3.04 (.67)	3.17 (.57)	2.96 (.67)
Interpersonal	3.01 (.74)	3.00 (.65)	2.87 (.65)	2.90 (.64)	2.87 (.65)	2.90 (.55)	2.86 (.67)
Extern Probs	1.71 (.68)	1.75 (.75)	1.85 (.73)	1.87 (.74)	1.86 (.78)	1.89 (.73)	1.88 (.75)
Intern Probs	1.55 (.47)	1.62 (.51)	1.67 (.55)	1.66 (.58)	1.78 (.55)	1.80 (.43)	1.70 (.57)
Family and Home							
Maternal Ed.	4.21 (1.76)	3.94 (1.62)	4.00 (1.73)	3.82 (1.59)	3.91 (1.44)	3.78 (1.77)	3.91 (1.78)
Income	7.34 (3.35)	7.38 (3.31)	6.75 (3.34)	6.93 (3.16)	7.53 (3.01)	5.98 (3.00)	6.70 (3.38)
Poverty	25.2	24.8	25.8	20.9	16.5	21.8	26.4
Single Par.	28.0	34.8	31.6	31.8	31.0	41.7	33.2
Home Env.	-.05 (1.02)	-.03 (.95)	-.12 (1.03)	-.13 (.98)	-.08 (.94)	-.13 (.81)	-.20 (1.00)
Ed. Expect	4.01 (1.16)	3.85 (1.12)	3.77 (1.21)	3.56 (1.09)	3.72 (1.19)	3.06 (1.33)	3.81 (1.20)
Parenting	-.32 (.95)	.12 (1.00)	.11 (1.01)	.17 (1.00)	.41 (.87)	.61 (.99)	-.03 (1.03)
# Siblings	1.76 (1.26)	1.55 (1.06)	1.56 (.97)	1.54 (1.16)	1.47 (.98)	1.47 (.96)	1.54 (1.19)
Teen Mom	33.2	27.0	28.3	28.4	27.0	41.2	31.4
Non-English	10.4	2.9	1.0	3.3	2.8	0.0	11.0
Abs. Father	22.5	34.6	35.6	32.8	37.9	42.1	37.1

Doctor Visit	2.48 (.66)	2.47 (.66)	2.52 (.62)	2.52 (.63)	2.58 (.59)	2.67 (.47)	2.54 (.62)
No childcare	22.8	25.5	25.6	38.0	36.8	37.4	32.4
Not insured	14.3	5.4	4.4	6.4	7.5	4.5	9.6
School Demographics							
Midwest	20.4	27.7	24.5	30.0	27.4	44.1	23.5
South	44.6	35.8	42.4	37.4	36.9	23.3	40.1
Northeast	20.9	28.6	24.7	20.7	22.6	26.6	20.2
West	14.0	7.9	8.4	11.9	13.0	5.9	15.6
Avg. SES	-.01 (.47)	.01 (49)	-.01 (.51)	-.05 (.43)	.10 (.46)	-.07 (.38)	-.08 (.49)
% Minority	2.43 (1.38)	2.08 (1.30)	2.30 (1.40)	2.26 (1.36)	2.18 (1.30)	2.27 (1.48)	2.67 (1.50)
Size	3.18 (1.21)	3.35 (1.09)	3.52 (1.11)	3.36 (.95)	3.54 (1.02)	3.16 (1.14)	3.44 (1.10)
Avg. Learn	3.16 (.27)	3.11 (.25)	3.04 (.25)	3.01 (.26)	3.10 (.28)	2.98 (.23)	3.06 (.26)
Avg. Control	3.25 (.26)	3.21 (.24)	3.15 (.24)	3.11 (.23)	3.19 (.25)	3.06 (.22)	3.15 (.26)
Avg. Interp.	3.19 (.27)	3.15 (.23)	3.07 (.23)	3.05 (.24)	3.11 (.25)	2.99 (.22)	3.09 (.26)
Avg. Extern.	1.62 (.23)	1.64 (.22)	1.69 (.24)	1.73 (.22)	1.64 (.23)	1.71 (.23)	1.68 (.24)
Avg. Intern.	1.53 (.20)	1.57 (.22)	1.58 (.20)	1.62 (.21)	1.57 (.20)	1.59 (.21)	1.59 (.20)
Avg.# Disab	1.93 (2.01)	2.09 (1.70)	2.29 (1.77)	2.45 (2.24)	2.05 (1.84)	2.72 (2.98)	2.20 (2.06)
Title I Funds	59.9	61.1	60.2	54.7	37.7	56.2	54.9
Urban	6.6	6.5	4.5	9.5	8.6	8.9	12.7
Rural	10.9	17.7	23.4	19.4	17.3	31.9	15.4
Private	11.6	4.7	5.0	2.1	4.3	0.0	6.7

Table C.3 Weighted Descriptive Statistics [M (SD) or %] by Spring 3rd Grade Strata

	Propensity-Matched Stratum					Full
	1	2	3	4	5	Sample
Special Education						
Dosage	1.14 (.36)	1.23 (.46)	1.25 (.46)	1.42 (.59)	2.05 (.84)	1.62 (.76)
IEP 3rd gr.	16.6	38.7	41.4	66.2	91.9	66.3
IEP 5th gr.	76.1	60.3	76.2	68.2	83.7	76.2
IEP 8th gr.	43.7	64.4	45.6	54.5	61.3	57.0
Demographics						
Male	67.0	56.4	62.9	62.3	59.7	60.8
White	77.0	76.6	73.7	72.1	71.1	72.9
Black	19.9	12.8	14.5	15.5	11.7	13.7
Hispanic	3.1	0.0	4.9	8.8	14.2	8.9
Asian	0.0	2.3	2.0	0.0	0.4	0.8
Other	0.0	8.2	4.9	3.5	2.6	0.4
K Disability	10.1	9.8	14.5	19.5	22.1	17.9
Low BW	0.0	4.5	0.0	3.5	11.5	6.3
K Age mo.	67.09 (4.51)	65.00 (4.76)	65.09 (3.93)	66.05 (3.86)	65.95 (4.38)	65.78 (4.30)
Achievement and Behavior						
Reading	19.56 (4.33)	21.09 (9.41)	22.14 (9.13)	19.72 (6.47)	18.42 (5.68)	19.73 (7.07)
Mathematics	21.64 (10.39)	21.57 (11.36)	20.84 (8.16)	16.54 (6.21)	15.81 (4.81)	17.91 (7.61)
Learning	2.50 (.70)	2.95 (.89)	3.06 (.74)	2.78 (.74)	2.71 (.68)	2.80 (.75)
Self-Control	3.01 (.55)	3.26 (.65)	3.33 (.54)	3.05 (.62)	2.91 (.66)	3.06 (.65)
Interpersonal	2.90 (.64)	3.19 (.74)	3.27 (.61)	2.97 (.64)	2.90 (.66)	3.01 (.67)
Extern. Probs	1.68 (.44)	1.60 (.61)	1.54 (.60)	1.71 (.75)	1.93 (.72)	1.76 (.70)
Intern. Probs	1.87 (.51)	1.55 (.48)	1.40 (.37)	1.58 (.46)	1.70 (.53)	1.62 (.50)
Family and Home						
Maternal Ed.	3.46 (1.15)	4.26 (1.96)	4.30 (1.75)	3.69 (1.62)	4.15 (1.82)	4.04 (1.78)
Income	7.73 (2.86)	6.96 (3.41)	7.74 (3.30)	7.28 (3.50)	7.28 (3.39)	7.33 (3.39)
Poverty	19.9	19.4	12.6	27.8	24.4	22.4
Single	17.5	27.4	24.0	25.7	40.5	31.4
Home Env.	.22 (.83)	.12 (.97)	.10 (1.09)	-.12 (.80)	-.11 (1.01)	-.03 (.97)
Ed. Expect	4.55 (1.07)	4.02 (1.19)	4.19 (1.13)	3.50 (1.13)	3.60 (1.03)	3.79 (1.14)
Parenting	.11 (.88)	.08 (.94)	-.01 (1.21)	-.22 (.85)	.04 (1.02)	-.01 (1.00)
# Siblings	2.26 (1.76)	1.59 (1.15)	1.27 (.99)	1.52 (.92)	1.44 (1.24)	1.50 (1.19)
Teen Mom	23.0	15.8	19.4	21.2	40.8	31.0
Non-English	0.0	0.0	3.4	1.8	7.4	4.0
Abs. Father	17.5	22.2	29.0	29.5	37.0	30.8
Doctor Visit	2.46 (.72)	2.53 (.62)	2.58 (.58)	2.45 (.60)	2.46 (.61)	2.49 (.62)
No childcare	52.4	16.5	17.9	25.2	12.3	19.1
Not insured	7.4	9.4	1.6	7.7	8.0	7.1

School Demographics						
Midwest	37.2	19.5	21.6	24.2	25.9	24.7
South	48.6	32.8	27.8	45.3	35.8	38.6
Northeast	14.1	36.8	33.3	21.5	22.7	25.5
West	0.0	10.9	7.3	9.0	15.6	11.2
Avg. SES	-.13 (.46)	-.12 (.38)	.10 (.48)	-.02 (.44)	.03 (.52)	-.00 (.48)
Neighborhood	1.64 (1.98)	1.96 (2.08)	1.08 (1.57)	1.27 (1.59)	.97 (1.48)	1.24 (1.68)
Climate	49.84 (5.40)	47.69 (7.15)	50.39 (4.06)	48.62 (6.09)	49.81 (5.39)	49.33 (5.74)
Lim. English	.29 (.55)	3.57 (8.21)	2.17 (6.05)	2.20 (8.06)	4.18 (10.58)	3.10 (8.93)
% Free Lunch	27.82 (25.85)	35.90 (27.84)	28.96 (25.43)	28.46 (23.92)	30.50 (25.69)	30.41 (25.72)
% Minority	1.83 (1.42)	1.96 (1.30)	2.06 (1.33)	2.12 (1.41)	2.26 (1.27)	2.13 (1.34)
Size	3.10 (.88)	3.08 (1.19)	2.99 (1.22)	3.20 (1.23)	3.49 (1.01)	3.27 (1.13)
Avg. Learn	3.08 (.24)	3.13 (.28)	3.17 (.29)	3.12 (.24)	3.09 (.25)	3.12 (.26)
Avg. Control	3.21 (.24)	3.23 (.29)	3.28 (.29)	3.23 (.24)	3.20 (.26)	3.22 (.26)
Avg. Interp	3.10 (.25)	3.15 (.26)	3.23 (.30)	3.17 (.23)	3.14 (.25)	3.16 (.26)
Avg. Extern	1.66 (.22)	1.67 (.23)	1.60 (.27)	1.66 (.22)	1.65 (.22)	1.65 (.23)
Avg. Intern	1.65 (.26)	1.56 (.30)	1.52 (.22)	1.55 (.19)	1.53 (.20)	1.55 (.22)
Avg. # Disab	1.76 (1.63)	1.49 (1.30)	1.61 (1.79)	1.84 (1.81)	1.91 (1.36)	1.78 (1.56)
Title I Funds	36.0	53.8	44.7	42.7	62.2	52.3
Urban	0.0	16.1	2.6	2.8	10.8	7.8
Rural	23.3	33.5	23.4	19.4	18.2	21.7
Private	7.8	9.1	7.7	7.1	3.8	6.1
K Tch Salary	3.65 (.81)	3.22 (.92)	3.49 (1.03)	3.48 (.75)	3.64 (.89)	3.52 (.89)

Appendix D

Treatment Effects for Students Propensity-Matched on Special Education Teacher Survey Variables

Table D.1 Balance of Propensity Scores for Spring 1st Grade Placement, Matched on Special Education Teacher Survey Variables (n = 310)

	1st Grade Special Education ***N* = 110**			**1st Grade General Education** ***N* = 200**		
Stratum	***n***	**M**	**SD**	***n***	**M**	**SD**
1	12	.13	.06	112	.08	.06
2	19	.29	.05	45	.28	.05
3	19	.50	.06	18	.49	.06
4	21	.71	.07	17	.70	.06
5	43	.92	.05	3	.88	.05

Table D.2 Balance of Propensity Scores for Spring 3rd Grade Placement, Matched on Special Education Teacher Survey Variables (n = 210)

	3rd Grade Special Education ***N* = 140**			**3rd Grade General Education** ***N* = 80**		
Stratum	***n***	**M**	**SD**	***n***	**M**	**SD**
1	7	.13	.05	24	.10	.05
2	7	.32	.07	22	.29	.05
3	11	.51	.05	11	.53	.06
4	23	.71	.05	12	.70	.07
5	89	.94	.06	6	.91	.06

Table D.3 Estimated Effects of Spring 1st Grade Special Education Services on 3rd and 5th Grade Academic Outcomes, Matched on Special Education Teacher Survey Variables

	Stratification		Nearest-Neighbor		Kernel Matching		Summary	
	ATT	**ES**	**ATT**	**ES**	**ATT**	**ES**	**ES**	**95% CI**
Reading IRT score 3rd	5.23+	.23	3.96	.17	6.16*	.27	.22	-.11, .56
Reading Gain K-3rd	6.30***	.35	4.69	.26	6.51**	.36	.32	-.02, .66
Reading IRT score 5th	8.85***	.33	4.54	.17	9.37**	.35	.28	-.08, .63
Reading Gain K-5th	7.70***	.35	4.34	.20	8.30**	.38	.30	-.06, .67
Math IRT score 3rd	-1.07	.06	-0.35	.02	1.14	.06	.04	-.37, .46
Math Gain K-3rd	-0.65	.05	-0.60	.04	0.60	.04	.01	-.43, .45
Math IRT score 5th	1.25	.05	1.27	.05	3.95	.16	.10	-.29, .49
Math Gain K-5th	-1.12	.06	-0.61	.03	1.54	.08	.06	-.36, .47

Note: ATT=Average Treatment Effect on Treated; ES=Effect Size; CI=Confidence Intervals
Benjamini-Hochberg corrected significance levels: *$p < .05$, **$p < .01$, ***$p < .001$

Table D.4 Estimated Effects of Spring 1st Grade Special Education Services on 3rd and 5th Grade Behavioral Adjustment, Matched on Special Education Teacher Survey Items

	Stratification		Nearest-Neighbor		Kernel Matching		Summary	
	ATT	**ES**	**ATT**	**ES**	**ATT**	**ES**	**ES**	**95% CI**
App. to Learning 3rd	0.03	.04	-0.16	.24	0.02	.03	.12	-.37, .61
App. Learning Gain K-3rd	-0.02	.04	-0.09	.12	-0.01	.02	.06	-.29, .41
App. to Learning 5th	0.14	.20	-0.15	.22	0.06	.09	.16	-.44, .75
App. Learning Gain K-5th	0.05	.06	-0.11	.14	0.01	.02	.07	-.34, .49
Self-Control 3rd Grade	0.09	.13	-0.08	.13	0.10	.15	.14	-.37, .65
Self-Control Gain K-3rd	0.04	.06	0.05	.08	0.13	.18	.12	-.27, .52
Self-Control 5th Grade	0.27+	.42	0.11	.17	0.22	.34	.28	-.20, .76
Self-Control Gain K-5th	0.19+	.26	0.19	.26	0.22+	.30	.28	-.13, .69
Interpersonal Skills 3rd	0.01	.01	-0.22	.31	0.02	.04	.14	-.43, .71
Interpersonal Gain K-3rd	-0.15+	.20	-0.26	.35	-0.11	.14	.23	-.13, .59
Interpersonal Skills 5th	0.25+	.37	0.12	.17	0.25+	.38	.30	-.12, .71
Interpersonal Gain K-5th	0.06	.08	0.04	.05	0.09	.11	.09	-.29, .46
Externalizing Probs 3rd	-0.31	.43	-0.13	.18	-0.33	.47	.35	-.32, 1.02
Externalizing Gain K-3rd	-0.09	.13	-0.12	.17	-0.17	.24	.20	-.23, .63
Externalizing Probs 5th	-0.30	.46	-0.12	.19	-0.29	.44	.34	-.19, .87
Externalizing Gain K-5th	-0.06	.08	-0.11	.15	-0.16	.23	.18	-.24, .60
Internalizing Probs 3rd	0.06	.10	0.80	.13	-0.05	.08	.10	-.42, .62
Internalizing Gain K-3rd	0.03	.05	0.00	.00	-0.06	.09	.05	-.51, .60
Internalizing Probs 5th	-0.14	.23	-0.05	.09	-0.11	.19	.16	-.42, .73
Internalizing Gain K-5th	-0.10	.13	-0.04	.06	-0.03	.04	.06	-.41, .52

Note: ATT=Average Treatment on Treated; ES=Effect Size
Benjamini-Hochberg corrected significance levels: $^{+}p < .10$

Table D.5 Estimated Effects of Spring 3rd Grade Special Education Services on 5th Grade Academic Outcomes, Matched on Special Education Teacher Survey Items

	Stratification		Nearest-Neighbor		Kernel Matching		Summary	
	ATT	**ES**	**ATT**	**ES**	**ATT**	**ES**	**ES**	**95% CI**
Reading IRT score 5th Grade	7.17	.27	5.52	.19	3.06	.11	0.16	-.32, .65
Reading Gain 1st-5th	11.28^{+}	.61	12.53^{+}	.68	9.13	.49	0.59	-.04, 1.21
Math IRT score 5th Grade	1.09	.04	5.43	.21	-0.30	.01	0.10	-.43, .63
Math Gain 1st-5th	3.67	.24	7.67	.48	2.77	.18	0.32	-.30, .93

Note: ATT=Average Treatment on Treated; ES=Effect Size
Benjamini-Hochberg corrected significance levels: $^{+}p < .10$

Table D.6 Estimated Effects of Spring 3rd Grade Special Education Services on 5th Grade Behavioral Adjustment, Matched on Special Education Teacher Survey Items

	Stratification		Nearest-Neighbor		Kernel Matching		Summary	
	ATT	**ES**	**ATT**	**ES**	**ATT**	**ES**	**ES**	**95% CI**
App. Learning 5th Grade	0.21	.31	0.15	.22	0.29	.43	.33	-.26, .91
App. Learning Gain 1st-5th	-0.08	.12	-0.06	.09	-0.06	.08	.09	-.54, .72
Self-Control 5th Grade	-0.14	.22	-0.20	.30	-0.16	.24	.27	-.30, .83
Self-Control Gain 1st-5th	-0.39^{+}	.56	-0.14	.20	-0.32^{+}	.46	.36	-.17, .89
Interpersonal Skills 5th Grade	-0.08	.12	-0.17	.26	-0.05	.08	.16	-.44, .76
Interpersonal Gain 1st-5th	-0.41^{+}	.58	-0.14	.20	-0.28	.39	.33	-.28, .94
Externalizing Probs 5th Grade	-0.11	.17	0.10	.15	-0.02	.02	.09	-.55, .74
Externalizing Gain 1st-5th	0.03	.05	-0.06	.08	0.02	.03	.06	-.62, .73
Internalizing Probs 5th Grade	-0.15	.25	0.01	.02	-0.09	.15	.10	-.44, .65
Internalizing Gain 1st-5th	-0.06	.09	0.11	.14	-0.03	.05	.09	-.54, .73

Note: ATT=Average Treatment on Treated; ES=Effect Size

Benajamini-Hochberg corrected significance levels: $^{+}p < .10$

Appendix E

Alternative Specifications for Measuring Academic Gain Over Time

Table E.1 Estimated Effects of 1st Grade Special Education Services on 3rd and 5th Grade Reading and Mathematics Theta Scores and Highest Proficiency Level Achieved

	Stratification		Nearest-Neighbor		Kernel Matching		Summary	
	ATT	**ES**	**ATT**	**ES**	**ATT**	**ES**	**ES**	**95% CI**
Reading T-score 3rd	2.58**	.26	3.02*	.31	2.65**	.27	.28	.08, .49
Reading Proficiency 3rd	0.30*	.24	0.41*	.29	0.31*	.25	.26	.05, .47
Reading T-score 5th	2.73**	.28	3.91**	.40	2.71**	.28	.32	.11, .53
Reading Proficiency 5th	0.33**	.30	0.52***	.48	0.35**	.32	.30	.09, .52
Math T-score 3rd	1.56	.16	1.57	.16	1.69	.17	.21	-.01, .43
Math Proficiency 3rd	0.19	.17	0.20	.18	0.20	.18	.17	-.05, .39
Math T-score 5th	2.58**	.27	3.97**	.41	2.64*	.27	.20	.07, .33
Math Proficiency 5th	0.18	.16	0.31*	.27	0.19	.17	.13	.00, .25

Note: ATT=Average Treatment Effect on Treated; ES=Effect Size; CI=Confidence Intervals
Benjamini-Hochberg corrected significance levels: *p < .05, **p < .01, ***p < .001

Table E.2 Estimated Effects of Spring 3rd Grade Special Education Services on 5th Grade Reading and Mathematics Theta Scores and Highest Proficiency Level Achieved

	Stratification		Nearest-Neighbor		Kernel Matching		Summary	
	ATT	**ES**	**ATT**	**ES**	**ATT**	**ES**	**ES**	**95% CI**
Reading T-score 5th Grade	-0.55	.06	-1.96	.20	-0.85	0.09	0.13	-.37, .63
Reading Proficiency 5th	0.09	.09	-0.12	.11	0.14	0.13	0.12	-.43, .66
Math T-score 5th Grade	-1.69	.17	-2.79	.30	-2.62	0.27	0.27	-.24, .78
Math Proficiency 5th	-0.06	.05	-0.11	.11	-0.15	0.13	0.11	-.37, .59

Note: ATT=Average Treatment on Treated; ES=Effect Size

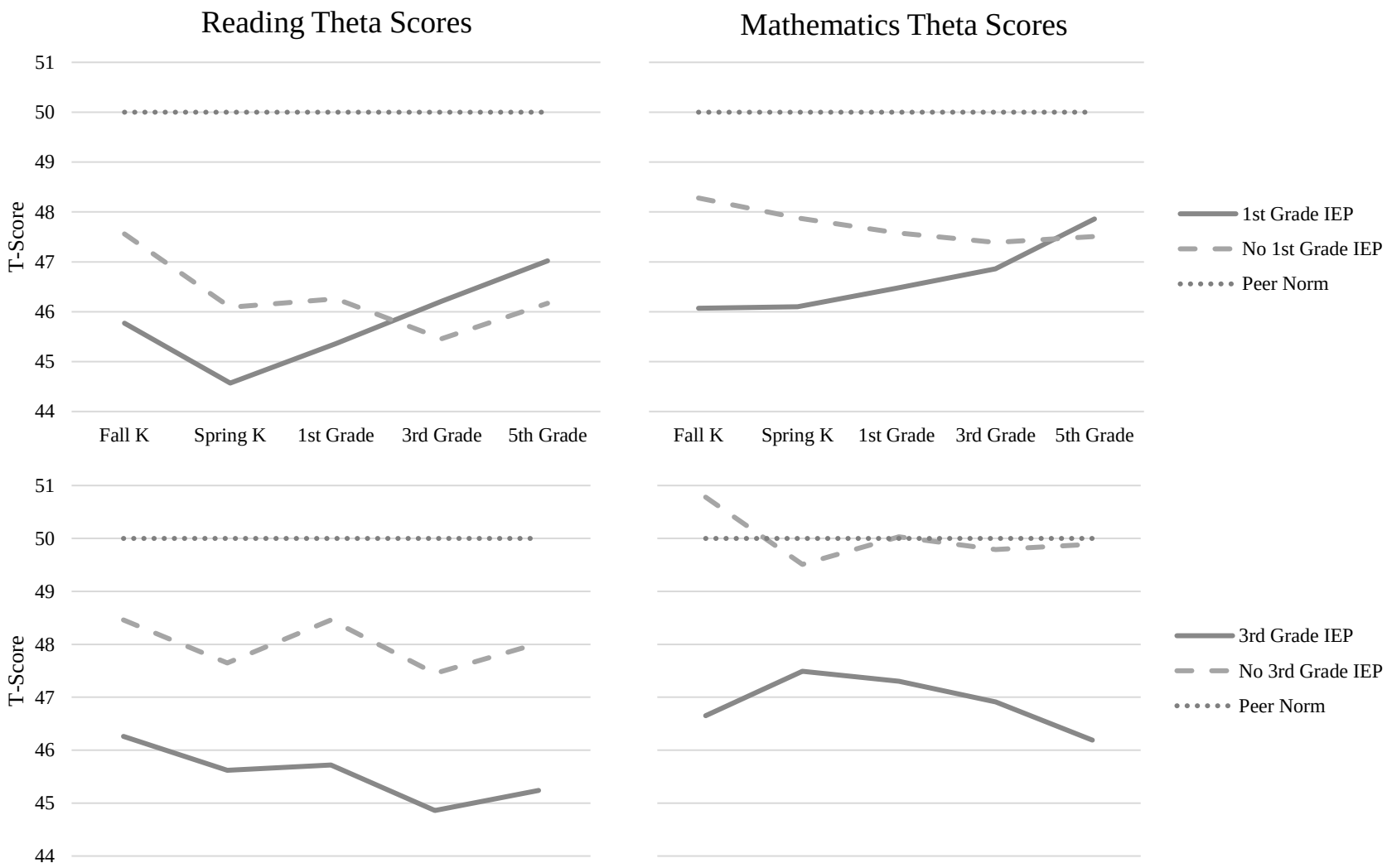

Figure E.1 T-Scores in Reading and Mathematics by IEP Status in 1st or 3rd Grade