Developmental Psychology
2015, Vol. 51, No. 12, 1725–1739

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0012-1649/15/$12.00 http://dx.doi.org/10.1037/a0039795

Does School Mobility Place Elementary School Children at Risk for Lower Math Achievement? The Mediating Role of Cognitive Dysregulation

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Children growing up in poverty have a higher likelihood of exposure to multiple forms of adversity that jeopardize their chances of academic success. The current paper identifies school mobility, or changing schools, as 1 such poverty-related risk. Using a sample of low-income, predominantly ethnic-minority children ($n = 381$) in Chicago, this study tests the hypothesis that repeatedly changing schools during the 5-year period between Head Start (preschool) and third grade is a potent predictor of children's math achievement in fourth grade and that children's cognitive dysregulation serves as a mechanism through which school mobility may negatively affect children's math achievement. Hierarchical linear models controlling for baseline child and family characteristics (including children's early math and dysregulation measured during Head Start) revealed an inverse relation between the number of times low-income children changed schools between preschool and third grade and children's math achievement on state standardized tests in fourth grade. Furthermore, frequently changing schools (3 or 4 school changes over the same time period) was positively associated with teacher-reported cognitive dysregulation in third grade and negatively associated with children's math achievement in fourth grade. Evidence for the role of children's cognitive dysregulation as a partial statistical mediator was found for the relation between frequently changing schools and math achievement, even after accounting for baseline risk. Results are discussed in terms of school policies, practices, and intervention strategies to prevent the disruptive and potentially stressful experiences of school mobility for young, low-income children.

Keywords: school mobility, self-regulation, math achievement, low-income children, poverty-related risk

School mobility, or changing schools, is widespread in the United States, especially for children facing chronic, high levels of economic disadvantage and attending lower resourced, urban schools. Consistent with developmental theory and research that stability is important for children's development, changing schools is harmful for academic achievement (Burkam, Lee, & Dwyer, 2009; Gruman, Harachi, Abbott, Catalano, & Fleming, 2008; Temple & Reynolds, 1999) and is a socially and emotionally destabilizing event (Rumberger, 2003; Singh, Winsper, Wolke, & Bryson, 2014). Changing schools may be driven by institutional, neighborhood, and family factors ranging from district-level decisions to close schools to parents' choices to change schools as a result of dissatisfaction with the quality of instruction. Residential moves may also trigger school changes as families struggle to cope with high housing costs or employment changes (Grigg, 2012; Hartman & Franke, 2003; Kerbow, Azcoitia, & Buell, 2003).

Much prior developmental psychology research has focused on the disruptions introduced by changing schools to children's relationships with teachers and peers, as well as concomitant interruptions in instruction and other educational "inputs" (Gruman et al., 2008; Kerbow et al., 2003; Rumberger, 2003; Sandstrom & Huerta, 2013; Temple & Reynolds, 1999). Less is known about the ways that psychosocial upheaval associated with school mobility may affect children's cognitive development. Specifically, the psychological upheaval of changing schools may serve as one of a number of ecological *toxic stressors*, potentially undermining children's higher order, executive processing and, relatedly, their chances of academic success.

Research on the costs of poverty-related risk more broadly for children's neurocognitive function sheds light on this hypothesized mechanism: Children experiencing higher levels of poverty-related instability in their households or neighborhoods consistently demonstrate greater difficulty, on average, on measures of emotional and cognitive dysregulation as well as lower academic achievement than their more advantaged peers (Anderson, Leventhal, Newman, & Dupéré, 2014; Raver, McCoy, Lowenstein, & Pess, 2013; Roy, McCoy, & Raver, 2014; Ziol-Guest & McKenna, 2014). That is, destabilizing transitions (through changes in residences, neighborhoods, or household composition) predict higher rates of impulsivity and inattention and a more reactive versus

This article was published Online First October 5, 2015.

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The research reported here was supported by the Institute of Education Sciences, U.S. Department of Education, through Grant R305B080019. The project described was also supported by Award R01HD046160 from the Eunice Kennedy Shriver National Institute of Child Health and Human Development. The opinions expressed are those of the authors and do not represent the views of the Institute or the U.S. Department of Education, the Eunice Kennedy Shriver National Institute of Child Health and Human Development, or the National Institutes of Health.

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reflective profile of higher order cognitive processing among young children (Adam, 2004; Leventhal & Brooks-Gunn, 2000; McCoy & Raver, 2014). Children's difficulties with cognitive self-regulation (including attention, inhibitory control, and working memory) in turn predict lower academic performance, particularly in math (Blair & Razza, 2007; Blair, Ursache, Greenberg, Vernon-Feagans, & Family Life Project Investigators, 2015; Clark, Pritchard, & Woodward, 2010; McClelland, Acock, & Morrison, 2006). In the current paper, we use a sample of low-income children in Chicago to test the hypothesis that school mobility is an underrecognized form of poverty-related risk that threatens opportunities for children's academic success. Accordingly, we examine cognitive dysregulation as a mechanism underlying the relationship between changing schools and math achievement.

Poverty, School Mobility, and Math Achievement

Poverty and School Mobility

Beginning at an early age, children growing up in poverty tend to be at greater risk for math achievement problems than their higher income peers, with grave consequences for their chances of school success and future earnings (Duncan & Brooks-Gunn, 2000; Eccles, Vida, & Barber, 2004; McLoyd, 1998; Votruba-Drzal, 2006). Given these high costs of poverty, understanding *why* children living in poverty are at heightened risk for academic difficulty is important for intervention and prevention programs aimed at mitigating these effects of poverty. There are many mechanisms through which poverty may negatively affect children's developing math skills. As highlighted by Sroufe and others, the impacts of poverty on children's academic achievement are likely to be complex and indirect as well as direct. For example, poor children are more likely than their nonpoor peers to attend lower quality schools, have less qualified teachers, have lower access to cognitively enriching materials such as books, and experience disruptions in their home environments (Evans, 2004; Sroufe, Coffino, & Carlson, 2010).

In addition to these forms of environmental adversity, children growing up in poverty are also more likely to change schools and consequently experience disruptions in their learning, including missed days of school, changes in curricula, and reductions in social capital (Burkam et al., 2009; General Accounting Office [GAO], 1994; Grigg, 2012; Parke & Kanyongo, 2012; Rumberger, 2003; Xu, Hannaway, & D'Souza, 2009). Data from the Early Childhood Longitudinal Study, Kindergarten Class of 1998–99 (ECLS–K), a large, nationally representative longitudinal study, indicate that 45% of children changed schools by the end of third grade (Burkam et al., 2009). Rates of school mobility are even higher for low-income, ethnic-minority, and urban students (Burkam et al., 2009; Rumberger, 2003; Xu et al., 2009). In urban, inner-city schools, up to 30% of students switch schools each year (GAO, 1994). According to the 1998 National Assessment of Education Progress (NAEP), 43% of fourth graders eligible for free and reduced-price lunch changed schools over the previous 2 years compared to only 26% of noneligible fourth graders (Rumberger, 2003). Data from predominantly ethnic-minority, low-income children in the Chicago Longitudinal Study suggest that 73% of children moved at least one time between kindergarten and seventh grade, excluding promotional moves between elementary and middle school; 43% of these children moved at least twice, and 21% moved at least three times (Temple & Reynolds, 1999). These high rates of school mobility, especially for low-income, ethnic-minority children in urban school districts, are problematic in light of the evidence that school mobility is associated with lower academic achievement (Mehana & Reynolds, 2004; Temple & Reynolds, 1999). Although children may change schools because parents seek out higher performing schools for their children, research suggests that all types of school changes, regardless of the reason, may negatively affect learning (Grigg, 2012).

School Mobility and Math Achievement

Previous studies highlight the costs of entering and exiting multiple schools over time: Across those studies, children who change schools have demonstrated lower math achievement during elementary and middle school compared to their peers who did not experience school mobility (Blane, 1985; Burkam et al., 2009; Gruman et al., 2008; Mehana & Reynolds, 2004; Temple & Reynolds, 1999; Xu et al., 2009). Although changing schools one time does not spell trouble for later academic achievement, prior research suggests that the negative consequences for children's academic achievement accumulate with each additional school move, suggesting a dose-dependent relationship (Blane, 1985; Burkam et al., 2009) or a threshold effect for an accumulation of school moves (Temple & Reynolds, 1999). In one study of elementary students enrolled in Chicago public schools, children who switched schools frequently performed about a year behind their peers who did not switch schools on math achievement at the end of seventh grade. Although accounting for children's baseline math abilities reduced that estimate of the negative consequences of mobility by half, the academic costs of changing schools were still significant and substantial (Temple & Reynolds, 1999).

These findings highlight the importance of isolating the specific role of school mobility within the broader ecological framework of poverty-related risks as well as the challenge of drawing causal inferences about the association between school mobility and math achievement. Stated differently, children who are at greater risk at baseline may be more likely to experience school mobility and have lower math achievement, highlighting the need to account for selection bias. In addition to higher rates of school mobility, low-income children are also more likely to experience other risks that might jeopardize their math achievement. To address these concerns, the current paper uses an approach commonly used in research estimating the role of other types of mobility for children's outcomes where selection bias is a major concern (Leventhal & Brooks-Gunn, 2000). We statistically control for a rich set of child and family baseline covariates, including pretest measures and poverty-related adversity, to minimize the risk that selection or reverse causality will bias the results. Furthermore, in light of prior research that has found different patterns of association when using different methods of operationalizing school mobility, the current paper includes three measures of school mobility: (a) the number of school changes, (b) if a child has ever changed

schools, and (c) if the child has experienced frequent school changes (i.e., three or four school changes).

How Does School Mobility Undermine Math Achievement? Cognitive Dysregulation as a Mechanism

Although it is largely accepted that school mobility is harmful for math achievement, the question of *how* changing schools undermines children's math skills remains less well understood. On one hand, it may be as simple as that when children change schools, they typically experience a discontinuity in curricula between their old and new schools, which may disrupt learning (Cole & Cole, 1993; Rumberger, 2003). This lack of continuity in curricula may be particularly problematic for math learning, as it is highly dependent on previous instruction and skills. A child who is performing well in one school may enter the new school behind on that school's curriculum and consequently struggle to perform well, particularly in math.

On the other hand, the association between school mobility and math achievement is likely more complex than simply decreased opportunity for or interruption in math learning. Changing schools may be psychologically disruptive, serving as a source of turbulence in children's lives. For example, when children change schools, they are faced with new teachers, peers, rules, routines, school cultures, and curricula. Children who switch schools experience substantially higher levels of psychosocial stress, including feelings of greater disorientation, lower sense of belonging, less close relationships with teachers and peers, and greater risk of being bullied. In turn, they have higher risk of mental health difficulty even after controlling for exposure to other types of adversity (Rumberger, 2003; Singh et al., 2014). Experiential canalization theory highlights the ways in which the disruptive and potentially stressful nature of school mobility and the associated environmental changes may undermine children's developing cognitive self-regulation with correlated difficulties in the planning, cognitive set shifting, and working memory important for math skills (Blair & Raver, 2012; Evans, Gonnella, Marcynyszyn, Gentile, & Salpekar, 2005; Gottlieb, Wahlsten, & Lickliter, 2006).

Cognitive self-regulation refers to the volitional or higher order, top-down aspects of self-regulation that involve attention, inhibitory control, and planning, such as executive control (Espy, Sheffield, Wiebe, Clark, & Moehr, 2011; McCoy, Raver, Lowenstein, & Tirado-Strayer, 2011; Raver et al., 2013). Prior research has illustrated the malleability of cognitive self-regulation in response to psychologically stressful experiences over a short period of time, such as decreases in the quality of caregiving (Blair, Raver, Berry, & Family Life Project Investigators, 2014), exposure to neighborhood violence (McCoy, Raver, & Sharkey, 2015), and residential mobility (Roy et al., 2014). In a similar way, the psychological stress of changing schools may also constrain the development of cognitive self-regulation. Although previous work has highlighted ways that chronic exposure to poverty and poverty-related risk may jeopardize low-income children's cognitive self-regulation (Blair, 2002; Evans, 2003, 2004; Raver, 2004), less is known regarding the specific role of school mobility (and the related instability) as a key poverty-related form of adversity undermining cognitive self-regulation.

Previous research on children's experiences of instability at home suggest that this may be a productive line of inquiry to follow: Residential and family instability are associated with lower levels of cognitive self-regulation in one set of studies (Lewis, Dozier, Ackerman, & Sepulveda-Kozakowski, 2007; McCoy & Raver, 2014; Roy et al., 2014) and with disruptions in the neurobiological stress regulation system (the hypothalamic–pituitary–adrenal [HPA] axis) in another set of studies (Blair et al., 2011). Disruptions in the HPA axis are associated with the development of key brain areas associated with cognitive control (Arnsten, 2000a, 2000b). There is a large body of research using animal models (Arnsten, 2000a, 2000b) and humans (Lupien, King, Meaney, & McEwen, 2001) to suggest that stress impairs self-regulation and that instability in children's lives can be a significant stressor (Blair et al., 2011). For example, children living in poverty have been found to demonstrate higher resting levels of the stress hormone cortisol (an indicator of HPA axis dysfunction) than their higher income peers (Blair et al., 2011; Evans, 2003; Lupien et al., 2001). Experiencing frequent school changes may exacerbate this rise in stress reactivity over and above other poverty-related risks, further compromising cognitive self-regulation. HPA axis stress reactivity is not tested directly in the current paper, but it provides an important framework guiding the analyses.

The current paper builds on prior research and theory and hypothesizes that instability in children's educational contexts—school mobility—will predict lower levels of children's cognitive self-regulation during elementary school, even after accounting for their proneness to higher versus lower levels of regulatory skill during early childhood. In this way, we aim to contribute to the scholarly understanding of the potentially disruptive role of school mobility in influencing children's cognitive dysregulation, which in turn may compromise children's ability to learn math in the school context.

Math and Self-Regulation

Why might cognitive self-regulation be important for children's ability to learn math? More generally, self-regulation has been argued to underlie children's abilities to learn in educational contexts, whereby children who are better able to utilize strategies, plan ahead, pay attention without getting distracted, and persist on tasks are more successful academically (Blair, 2002; Howse, Calkins, Anastopoulos, Keane, & Shelton, 2003). The ability to self-regulate cognition and attention may be more integral to the development of mathematical abilities than to other domains of learning: Learning or doing math requires the use of complex, effortful, and higher order cognitive processes (Blair & Razza, 2007; Nayfeld, Fuccillo, & Greenfield, 2013) such as a flexible use of strategies (inhibiting incorrect ones in favor of correct ones), working memory, reasoning, attention, attention shifting, and suppressing irrelevant information (Blair & Razza, 2007; Bull & Scerif, 2001; Espy et al., 2004; McClelland et al., 2007; Ponitz, McClelland, Matthews, & Morrison, 2009). When solving math problems, children need to hold previously learned rules in their memory (i.e., working memory) as well as inhibit the use of rules that do not apply to the immediate problem they are trying to solve (i.e., inhibitory control). They may also need to switch between applying the correct strategy out of many previously learned

strategies to correctly answer the question (i.e., cognitive set shifting).

An abundance of research with children ranging from preschool to middle school has demonstrated that children with greater cognitive self-regulation tend to also demonstrate greater math abilities over time, even after controlling for general cognitive abilities (Blair & Razza, 2007; Blair et al., 2015; Bull & Scerif, 2001; Clark et al., 2010; Fuchs et al., 2010; Mazzocco & Kover, 2007; McClelland et al., 2006; St Clair-Thompson & Gathercole, 2006). Field experiments of classroom-based interventions also provide support for the contribution of self-regulation to math skills, whereby intervention impacts on children's math abilities and problem solving have been found to be mediated by improvements in self-regulation (Fuchs et al., 2003; Raver et al., 2011). We know less regarding specific features of children's school experiences that may compromise cognitive self-regulation and math skills, including the role of changing schools repeatedly during elementary school.

The Current Study

Building on previous research, the current study first tests whether prior findings of the deleterious relationship between children's experiences of higher levels of school mobility, or changing schools, and their lower math achievement are replicated with a large sample of low-income students in Chicago as they transition from preschool through elementary school. Although much of the previous school mobility research has relied on White middle-class or nationally representative samples of older children (Burkam et al., 2009), fewer studies have tested this question with samples of low-income, ethnic-minority elementary schoolchildren residing in urban neighborhoods of concentrated disadvantage. For these populations, school mobility represents one among many types of poverty-related adversity to which a significant fraction of students in inner cities are exposed. We then capitalize on the rich data available regarding these children's cognitive dysregulation and math skills across multiple periods in early childhood and early elementary school to test a mediational model in which low-income children's cognitive dysregulation is hypothesized to serve as the mechanism through which higher levels of school mobility may be negatively associated with their math achievement in fourth grade. As is common with tests of statistical mediation, we test each component of the mediational model in order to establish empirical relations between (a) school mobility between Head Start (preschool) and third grade and children's math achievement in fourth grade, (b) school mobility between Head Start and third grade and children's cognitive dysregulation in third grade, and (c) children's cognitive dysregulation in third grade and math achievement in fourth grade. We next test the full mediation model. We use multiple definitions of school mobility to elucidate how different patterns of changing schools are related to math and cognitive dysregulation. This is the first study of which we are aware to examine the role of school mobility in predicting elementary school children's cognitive self-regulation as a means of "unpacking" the linkage between higher school mobility and lower math achievement.

By including child and family baseline characteristics such as poverty-related risks and math and dysregulation directly assessed when the child was in Head Start, the current paper advances prior work by addressing the issue of selection bias. Children who are more at risk at baseline are more likely to change schools and have lower cognitive self-regulation and math skills, which could bias the results of the analyses if not accounted for empirically. Although we do not completely eliminate the threat of selection bias, our use of residualized change models (i.e., controlling for baseline measures of the outcomes) and longitudinal data with a rich set of baseline covariates does improve internal validity and reduce the threat of selection bias.

Method

Sample

Data for the current study come from the Chicago School Readiness Project (CSRP; Raver et al., 2008, 2009, 2011), a cluster-randomized efficacy trial. Children were enrolled in Head Start programs that had been invited to participate in a randomized trial of a classroom-based, social–emotional intervention that targeted young, at-risk children's emotional and behavioral adjustment in order to improve school readiness through teacher trainings and provision of mental health consultants. Sites were eligible to participate if they received federal Head Start funding, had two or more full-day preschool classrooms, and were located in 1 of 7 high-poverty neighborhoods in Chicago. Eighteen Head Start centers met the inclusion criteria, were included in the study, and enrolled over two cohorts. Sites were matched on a list of family and child demographic characteristics as well as Head Start site characteristics, and one site from each pair was randomly assigned to the treatment group and the other to the control group. (For a more detailed description of the randomization, see Raver et al., 2009.) Two classrooms from each site were randomly selected to participate in the study. However, after selection into the study, one classroom in the control group lost its federal Head Start funding.

At baseline, 602 predominantly 3- and 4-year-old children were enrolled in 35 Head Start classrooms in 18 Head Start centers (see Raver et al., 2009). Children in the study were followed through 5 years postbaseline (a total of 6 years) when the majority of children were in fourth grade. In order to measure school mobility, only the 509 children for whom information on school of enrollment was available for each year of the study were retained in the analytic sample. Analyses are further limited to the 381 children who also had math achievement data available for the fifth year after baseline, when most children were in fourth grade. These 381 children were enrolled in 173 schools within the Chicago Public Schools (CPS) District during fourth grade. The 381 children in the analytic sample represent 63% of the original 602 CSRP participants. Of the 221 children who were not included in the analyses, 93 were excluded either because they were not enrolled in CPS each year or their school of enrollment was missing at least 1 year. The other 128 students either did not take the math achievement test or their data were not reported to CPS by their school. Importantly, the 128 children missing math achievement data did not differ significantly from the 509 children with full data on school mobility on any measure of school mobility or any observed baseline characteristics, including poverty-related risks (low primary caregiver education, single primary caregiver, and family income-to-needs ratio), demographics (gender and race or

ethnicity), and pretest math and cognitive dysregulation. The 381 children included in the analytic sample also did not differ significantly from the 602 children enrolled in CSRP at baseline on these same observed baseline characteristics.

Children in the analytic sample came from families who had an average income-to-needs ratio of 0.72 over the span of the study, indicating that, on average, children came from families below 100% of the federal poverty level when adjusting for household size and composition. Fifty-two percent of the children were female; 68% were Black or African American; 27% were Hispanic; and 5% were White, Biracial, or another race or ethnicity. During the first year of the study, 27% of children in the sample had a primary caregiver who did not have at least a high school diploma, and 59% of the children lived in a single-parent household. Children were, on average, 9.16 years old when they completed the math achievement test.

Procedures

Data for the current study come from multiple sources, including parent and teacher reports, CPS school records, direct assessments, and standardized achievement tests that were collected over 6 years between baseline when children were in Head Start and 5 years after baseline when the majority of children were in fourth grade. Beginning in Head Start, a group of multiracial data collectors with master's degrees who were extensively trained and certified in direct assessment procedures administered individualized child math and self-regulation direct assessments. The overall battery of assessments was completed in one 20- to 30-min session in the child's Head Start center, with the math and self-regulation portions of the assessment taking approximately 12 to 15 min. Prior to the assessment, children's language comprehension abilities in English and Spanish were screened. Spanish-speaking children were assessed in both English and Spanish, and the highest score was used in the analyses (see Raver et al., 2011). Children's primary caregivers were interviewed by trained data collectors and reported on demographic information, including the child's race or ethnicity, the child's date of birth, household income, number of adults and children in the household, own marital status, and own education. Interviews with caregivers were completed in either English or Spanish based on the primary caregiver's preference. Interviews with primary caregivers were repeated at 1 and 4 years after baseline.

During the spring of the fourth year after baseline when most children were in third grade, the child's teacher rated the child's cognitive dysregulation using a written questionnaire. In addition, during the fifth year after baseline when most children were in fourth grade, each child took the Illinois Standards Achievement Test (ISAT) in math as part of the district's administration of the statewide test. The test was administered during the spring in the child's school.

CPS school records data were obtained each year and used as the primary source of information on the child's school of attendance in order to determine if a child changed schools over 2 consecutive school years. As the only information on school of enrollment during the second and third years after baseline came from CPS school records, all children retained in the analytic sample were enrolled in CPS throughout the data collection period.

Measures

Math achievement. Math achievement was measured using children's scores on the math ISAT during the fifth year after baseline when most children were in fourth grade. The math ISAT measures individual student math achievement relative to the Illinois Learning Standards and consists of multiple-choice, short-response, and extended-response questions. The child's scaled score, which accounts for the number of items correct as well as the item difficulty, was used in the analyses (Illinois State Board of Education, 2009). Scores ranged from 146 to 293, indicating that children in the sample scored within all four performance levels for their grade level (i.e., academic warning, below standards, meets standards, and exceeds standards).

Early math was assessed during the fall of Head Start using the early math assessment from the National Reporting System (NRS; U.S. Department of Health & Human Services, 2003). The NRS was a cognitively oriented, federally mandated, individual assessment of Head Start children's skills. Early math scores reflect children's knowledge of basic addition and subtraction (Zill, 2003). Scores were coded as either correct (1) or incorrect (0) and averaged across all items to create a percentage correct score. Scores ranged from 0 to .84 (or 84% correct).

Cognitive dysregulation. Children's cognitive dysregulation was assessed during the fourth year after baseline, when most children were in third grade, using two teacher-reported measures: the Barratt Impulsiveness Scale (BIS–11; Patton, Stanford, & Barratt, 1995) and the Behavior Rating Inventory of Executive Function (BRIEF; Gioia, Isquith, Guy, & Kenworthy, 2000). Items from the BIS–11 were on a 4-point Likert scale, and items from the BRIEF were on a 3-point Likert scale. Items on each scale were standardized to a 0-to-1 scale so that items from each scale would have equal weight when combined across the two scales. Based on prior factor analysis, nine items from the BIS–11 and 10 items from the BRIEF that measured inattention, impulsivity, and working memory problems were averaged to form the cognitive dysregulation scale used in the current analyses. Scores ranged from 0 to .95, with higher scores indicating higher levels of cognitive dysregulation. Items in the cognitive dysregulation scale include *child can only think about one thing at a time* and *child doesn't pay attention* from the BIS–11 and *has a short attention span* and *has trouble finishing tasks* from the BRIEF. The scale is supported by evidence of high factor loadings (McCoy et al., 2011), high internal consistency (Cronbach's $\alpha = .97$), and high criterion validity for low-income children (Raver et al., 2013). Higher scores on the composite reflect higher levels of cognitive dysregulation, characterized by difficulties with inhibitory control and attention.

Early dysregulation was assessed during the fall of the Head Start year using a combination of direct assessments and an assessor report from the Preschool Self-Regulation Assessment (PSRA; Smith-Donald, Raver, Hayes, & Richardson, 2007; Raver et al., 2011, 2012). Children completed two direct assessments, the Balance Beam (Murray & Kochanska, 2002) and the Pencil Tap (Diamond & Taylor, 1996) tasks, which assessed children's abilities to inhibit prepotent responses, attend to instructions, and use working memory. Following completion of the tasks, assessors rated children's behavior during the tasks on 16 items that measured inattention and impulsivity (Cronbach's $\alpha = .92$). Each item was rated on a Likert scale from 0 to 3, with higher scores

indicating greater dysregulation. Item scores were averaged to create an overall score that ranged from 0.13 to 3.00. Items included *child is distracted by sights and sounds* and *child has difficulty waiting between tasks*. Scores for the Balance Beam task (reverse scored), the Pencil Tap task (reverse scored), and the assessor report were *z* scored and averaged to create a composite score of early dysregulation (Raver et al., 2012; Roy et al., 2014). Although correlations between the three scores were moderate, ranging from .30 to .44, and internal consistency was less than optimal ($\alpha = .58$), creating one composite measure of early dysregulation reduced collinearity in the analyses.

School mobility. CPS school records data on student enrollment each year were used to determine if a child switched schools over 2 consecutive years. A child was coded as changing schools if their school of enrollment changed over 2 consecutive years. The child's primary caregiver and teacher also reported the child's school of enrollment 1 and 4 years after baseline. This information was used to corroborate the school records data and to supplement missing school records data. There were four possible school changes for each child between baseline and third grade. We did not measure school mobility between third and fourth grade to ensure that school mobility was measured prior to the assessment of children's cognitive dysregulation during third grade. The structure of the available data allowed us to only examine school changes over 2 consecutive years and did not capture additional school changes within a school year. Thus, it provides a conservative estimate of the number of school changes.

Operationalizing school mobility. We examined school mobility in three ways in order to develop a nuanced understanding of the ways in which changing schools influence children's math and cognitive dysregulation. We first tested the relation between a linear, dose-dependent school mobility measure (i.e., the number of school changes) and children's math achievement and cognitive dysregulation. Second, we compared nonmovers, children who remained in the same school for all 5 years, with movers, those children who moved one or more times. Third, we compared children who experienced zero, one, or two school moves (low mobility) to children who changed schools three or four times (frequent mobility) in order to capitalize on the disruptive and potentially stressful nature of switching schools frequently. This third method of operationalizing school mobility emphasizes a high-risk condition in which children changed schools almost every year. Switching schools three or four times in 5 years is expected to be disruptive, stressful, and harmful for children compared to changing schools only one time.

We did not differentiate between school moves that are structural or normative and those that are nonnormative; we include *all* school moves as a fair test of our hypotheses. However, one concern might be that our measurement of school mobility potentially inflates or upwardly biases the number of moves that children make between schools, given that we followed our sample from preschool through early elementary school. That is, we do not discriminate between structural moves between preschool and kindergarten and other nonnormative school moves that are more likely to be driven by poverty-related risk. Not all children switched schools as they moved from preschool to kindergarten, as several Head Start programs in our sample are located within a CPS elementary school: Approximately two thirds of the analytic sample attended a Head Start program that was not in a CPS school and thus experienced one school change when they transitioned from Head Start to kindergarten. The other approximate one third of the sample attended a Head Start program within a CPS school and did not experience this structural move upon transitioning to kindergarten. To address the concern that some children experienced a school change for structural reasons while also accounting for all school moves and the heterogeneity of CPS school transition policies, we include an indicator for if the child experienced a school change when he or she transitioned from Head Start to kindergarten. In doing so, we (a) preserved the full analytic sample and (b) used the full 6 years of longitudinal data.

Child, caregiver, and family characteristics. During the baseline year, the child's primary caregiver reported the child's gender, race or ethnicity, and date of birth. The child's age when math achievement was measured was computed using the date of birth and the date of the math ISAT. Primary caregivers also reported their own educational attainment and marital status at baseline as well as the annual household income at baseline and 1 and 4 years after baseline. Primary caregiver education status was recoded into an indicator for if he or she had less than a high school diploma. Primary caregiver marital status was recoded into an indicator for if he or she was not married. For each year, an income-to-needs ratio was computed by dividing the annual household income adjusted for family size and composition by the U.S. Census poverty threshold for the current year. An average income-to-needs ratio across the 3 years was computed. The children's grade levels when the ISAT was administered were obtained from CPS school records.

School characteristics. Two school-level characteristics were obtained from the CPS CEO Report and included in the analyses: (a) the percentage of children in the school meeting or exceeding state standards on math and reading and (b) the percentage of children in the school who were low income, measured when most children were in fourth grade.

Analytic Approach

Multilevel modeling. To test our hypotheses, we estimated two-level hierarchical linear models in which children's math abilities in fourth grade and cognitive dysregulation in third grade were predicted from school mobility and child, family, and school characteristics. In these models, children were nested in their fourth-grade school in order to account for the variance in math achievement associated with the school of enrollment at the time of the math ISAT. Results from an unconditional two-level hierarchical linear model indicate that 9.4% of the variance in children's math abilities was attributable to between-school differences (Intraclass Correlation Coefficient = .094).

Multilevel modeling allows for the simultaneous estimation of variances associated with individual children and schools based on the specification of fixed- and random-effect variables in the model. Accounting for the nested structure of the data minimizes bias in parameter estimates due to the nonindependence of observations (Raudenbush & Bryk, 2002). Associations between children's math skills, cognitive dysregulation, and school mobility were modeled with two equations, with the Level 1 (individual level) equation specified as follows:

$$Y_{ij} = \beta_{0j} + \beta_{1j}M_{ij} + \beta_{2j}D_{ij} + \Sigma n\beta_{3j}X_{ij} + r_{ij} \quad (1)$$

where Y_{ij} is the math achievement score for child i in school j; $\beta_{1j}M_{ij}$ is school mobility for child i in school j; $\beta_{2j}D_{ij}$ is the cognitive dysregulation of student i in school j; $\Sigma n\beta_{3j}X_{ij}$ is a vector of n child and family characteristics, including family income-to-needs ratio, child's gender, child's race or ethnicity, child's age, child's grade when taking the ISAT, primary caregiver has less than a high school diploma, caregiver is single, child's treatment random assignment, child's cohort, and math abilities and dysregulation measured during Head Start; and r_{ij} is the random error term. Conservatively specified models that help reduce the threat of selection bias were estimated. In these models (also called *residualized change models*), we controlled for children's math and dysregulation during the Head Start year. Conceptually, unobserved (or *omitted*) variables that might lead children to both be more prone to higher rates of school mobility and to do worse academically may likely also have been disruptive to children's performance earlier in their educational trajectories. By including early math and cognitive dysregulation scores from when children were in preschool, residualized change models effectively help mitigate the concern about the role of those unobserved, stable (or *time-invariant*) characteristics in the relationship between school mobility and cognitive dysregulation and math.

The Level 2 (school level) equation was specified as follows:

$$\beta_{0j} = \gamma_{00} + \Sigma p\gamma_{01}S_j + u_{0j} \quad (2)$$

where $\Sigma p\gamma_{01}S_j$ is a vector of p school-level characteristics, including the percentage of children in the school meeting or exceeding state ISAT standards in math and reading and the percentage of the school that is low income for the child's school in fourth grade; and u_{0j} is a random error term.

Mediation model. The two-level model was used to test our mediation hypothesis. We first estimated the association between school mobility and children's math achievement in fourth grade while controlling for child, family, and school covariates as well as baseline math and dysregulation. We next estimated the association between school mobility and cognitive dysregulation in third grade, controlling for the same set of covariates. We then estimated the association between cognitive dysregulation and math achievement, controlling for the same set of child, family, and school covariates. Finally, we added cognitive dysregulation at Level 1 in order to test the role of cognitive dysregulation as a statistical mediator of the association between school mobility and math achievement. We used the *Model Indirect* command in Mplus Version 6.12 (Muthén & Muthén, 1998–2010) to estimate the mediated effect.

Missing data. In the analytic sample, data were missing for 13% of early math, 14% of early dysregulation, 0.8% of income-to-needs ratio, 7.3% of caregiver education risk, 3.4% of caregiver marital status, 21.5% of cognitive dysregulation in third grade, and 28% of school-level characteristics. Two methods were used to test for systematic differences between children with and without missing data on these variables: First, we used chi-square tests to determine if there was an association between indicators for missing data and categorical baseline covariates, including child gender, ethnicity, and caregiver education risk and marital status. We found some small but significant differences in missing data by race or ethnicity: Black or African American children were less likely than Hispanic children to have missing data on baseline math ($\chi^2 = 6.50$, $p = .01$) and dysregulation ($\chi^2 = 5.30$, $p = .02$), caregiver education ($\chi^2 = 6.27$ $p = .01$), and caregiver marital status ($\chi^2 = 8.40$, $p = .004$) but were more likely to have missing data on school characteristics ($\chi^2 = 12.57$–13.35, $p < .001$). Second, we tested the correlation between missing data indicators for each variable and continuous baseline covariates, including family income-to-needs ratio, baseline math, and baseline dysregulation. There were a few small but significant correlations between missing data indicators and baseline characteristics. Missingness on baseline math was correlated with baseline dysregulation, $r = .11$, $p = .05$, and missingness on baseline dysregulation was correlated with baseline math, $r = -.16$, $p = .003$. The full information maximum likelihood (FIML) approach in Mplus 6.12 (Muthén & Muthén, 1998–2010) was used to handle missing data (Enders, 2013).

Results

Descriptives

Table 1 reports the number of children who changed schools zero, one, two, three, and four times between baseline and 4 years later. On average, children moved 1.38 times over the 5 years between Head Start and third grade. Fifty-four (14%) children remained in the same school between Head Start and third grade, whereas 327 (86%) children moved at least one time over this time period. Forty (10%) children experienced frequent mobility, changing schools three or four times over 5 years, and 341 (90%) children experienced low mobility, changing schools zero, one, or two times. A total of 237 (62%) children changed schools when they transitioned from Head Start to kindergarten.

Table 2 provides descriptive statistics for the full analytic sample, the nonmovers and movers, and the frequent-mobility and low-mobility subsamples. On average, children scored a 212 on the math ISAT, placing them in the *meets standards* category. Children were rated by their teachers to have a cognitive dysregulation score, on average, of 0.38, indicating moderate levels of cognitive dysregulation. Independent samples *t* tests revealed that the nonmover and mover and frequent- and low-mobility subgroups did not differ significantly on any of the observed baseline child and family characteristics, including math and dysregulation at baseline, reducing the risk of selection bias. That is, at baseline,

Table 1
Frequency of School Changes Over the Five Years Between Head Start and Third Grade

	Number of children (n = 381)	
Number of school changes	*n*	%
0	54	14.17
1	173	45.41
2	114	29.92
3	37	9.71
4	3	.78

Note. Children who changed schools three or four times are coded as *frequent mobility*.

Table 2
Descriptive Statistics for Full Analytic Sample and for School Mobility Subgroups

	Full analytic sample		Nonmover		Mover		Low mobility		Frequent mobility	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Outcome and mediator variables										
Math ISAT (fourth grade)	212.19	27.17	217.70	25.36	211.28	27.38	213.49	27.03	201.15	26.09
Cognitive dysregulation (third grade)	.38	.26	.39	.28	.38	.26	.37	.26	.47	.25
Child and family characteristics (n = 381)										
Child is female (%)	.52	.50	.52	.50	.52	.50	.52	.50	.53	.51
Child is Black (%)	.68	.47	.76	.43	.66	.47	.68	.47	.65	.48
Child early math (Head Start)	.40	.19	.43	.18	.40	.19	.41	.19	.39	.20
Child early dysregulation (Head Start)	−.09	.69	−.14	.66	−.08	.70	−.09	.71	−.05	.58
Age when taking ISAT (years)	9.16	.68	9.22	.66	9.15	.68	9.16	.68	9.18	.71
Child was in third grade when ISAT was taken (%)	.42	.49	.37	.49	.43	.50	.41	.49	.50	.51
Family income-to-needs ratio (average)	.72	.53	.69	.54	.72	.53	.72	.54	.69	.38
Primary caregiver is a single parent (Head Start; %)	.59	.49	.52	.50	.61	.49	.59	.49	.64	.49
Primary caregiver has less than a high school diploma (Head Start; %)	.27	.45	.35	.48	.26	.44	.28	.45	.24	.43
Number of school moves	1.38	.87	.00	.00	1.60	.72	1.18	.68	3.08	.27
At least one school move (%)	.86	.35								
Frequent mobility (three or four school moves; %)	.10	.31								
School characteristics (fourth grade, n = 173)										
Percentage of low-income students in the school	87.45	15.71	94.35	5.73	87.33	15.81	87.88	15.19	85.64	17.99
Percentage of students in the school who met or exceeded state reading and math standards	65.84	14.12	60.90	9.76	65.93	14.20	65.87	13.90	65.71	15.35

Note. ISAT = Illinois Standards Achievement Test.

children who experienced more or fewer school changes were not observed to be more or less at risk based on observed characteristics. Additionally, the three school mobility variables were not significantly correlated with any baseline child or family characteristics (see Table 3). Thus, it is less likely that observed baseline risk is responsible for children's school mobility as well as their math achievement and cognitive dysregulation.

Mediation

We tested the mediation model separately for each of the three ways of operationalizing school mobility, beginning with the number of school changes.

Number of school changes. The total number of school changes was significantly, negatively associated with children's math achievement in fourth grade ($b = -3.35$, $SE = 1.54$, $p = .030$). That is, math achievement was expected to be 3.35 points lower, on average, for each additional school change a child experienced. However, as the number of times a child changed schools did not significantly predict cognitive dysregulation in third grade, we did not find support for the mediation model using this dosage approach to school mobility.

Movers versus nonmovers. Next, we tested the mediation model comparing nonmovers (children who never changed schools) and movers (children who changed schools at least one time). There was no significant difference in math achievement in fourth grade or cognitive dysregulation in third grade for movers compared to nonmovers. Again, we did not find support for the mediation model.

Frequent mobility. Finally, we tested the two-level mediation model comparing children who experienced frequent mobility (three or four school changes) to those who did not (see Table 4). Children who experienced frequent mobility were predicted to be reported by their teachers to have greater cognitive dysregulation in third grade ($b = 0.10$, $SE = 0.04$, $p = .023$), even after controlling for children's dysregulation in preschool. Children who had higher cognitive dysregulation in third grade, on average, tended to have lower math achievement in fourth grade ($b = -43.34$, $SE = 3.56$, $p < .001$), even after controlling for dysregulation and math skills in preschool. Children who experienced frequent mobility were predicted to have, on average, lower math skills in fourth grade ($b = -10.48$, $SE = 3.43$, $p = .002$), net of all baseline family and child characteristics collected when children were in Head Start. Lastly, we tested the indirect effect of frequent mobility on math achievement through cognitive dysregulation by adding cognitive dysregulation into the previous model. The coefficient on frequent mobility decreased ($b = -5.88$, $SE = 2.98$, $p = .048$), and the indirect effect was statistically significant ($b = -4.31$, $SE = 1.88$, $p = .022$), suggesting that the influence of frequently changing schools on children's fourth-grade math achievement is partially mediated by their levels of cognitive dysregulation in third grade (see Figure 1; Baron & Kenny, 1986). Using Selig and Preacher's (2008) parametric bootstrapping method, we obtained an asymmetric 95% confidence interval around the indirect effect to correct for biased standard errors. This bias-corrected confidence interval (−8.16 to −0.54) does not contain zero, providing additional support that the negative influence of changing schools three or four times on math achievement is partially mediated by cognitive dysregulation.

Table 3
Correlations Between All Variables

	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Math ISAT (fourth grade)	−.49***	−.03	−.05	.46***	−.37***	.23***	.32***	.25***	.01	−.10*	−.12*	−.08	−.14**	−.19***	.16**
2. Cognitive dysregulation (third grade)	—	−.22***	.07	−.28**	.23***	−.12*	−.13*	−.13*	−.08	.05	.03	−.02	.11*	.05	.03
3. Child is female		—	−.05	.05	−.11*	.04	−.06	−.03	−.01	.02	−.02	−.00	.01	.03	−.00
4. Child is Black			—	.01	.01	.03	.06	−.16**	.13*	−.12*	.01	−.07	−.02	.07	−.52***
5. Early math				—	−.61***	.46***	−.50***	.17**	−.06	−.04	−.02	−.05	−.03	.20**	.11
6. Early dysregulation					—	−.34***	.40***	−.04	.01	−.08	−.01	.03	.02	.12†	−.08
7. Age at ISAT						—	−.59***	.05	−.10†	−.02	.02	−.04	.01	.01	−.03
8. Child in third grade for ISAT							—	−.09†	.07	.00	.05	.04	.05	.08	−.09
9. Family income-to-needs ratio (average)								—	−.15**	−.31***	−.04	.02	−.02	−.27***	.32***
10. Primary caregiver is single									—	−.03	.03	.06	.03	−.01	−.05
11. Primary caregiver has less than high school diploma										—	−.05	−.07	−.03	.12	−.00
12. Number of school moves											—	.64***	.67***	−.08	.11†
13. At least one school move												—	.14**	−.09	.24***
14. Frequent mobility (three or four school moves)													—	−.06	.01
15. Percentage of low-income students in the school														—	−.53***
16. Percentage of students in the school who met or exceeded state reading and math standards															—

Note. ISAT = Illinois Standards Achievement Test.
† $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

Table 4
Coefficients (and Standard Errors) From Multilevel Analyses Predicting Children's Cognitive Dysregulation and Math Achievement From Frequent School Mobility

	Cognitive dysregulation (third grade)		Math achievement (fourth grade)			
	Path A		Path C		Path C′ (mediation)	
	b	*SE*	*b*	*SE*	*b*	*SE*
Intercept	.87***	.26	214.23***	33.67	236.63***	30.34
Child is female	−.12***	.03	−3.59	2.25	−8.65***	1.92
Child is Black	.03	.04	−7.11†	3.68	−4.27	3.55
Child early math (Head Start)	−.25**	.10	36.07***	8.92	25.34**	8.49
Child early dysregulation (Head Start)	.03	.02	−5.80**	2.96	−4.15*	2.06
Age when taking ISAT (years)	−.03	.03	.25	2.35	−.97	1.87
Child was in third grade when ISAT was taken	−.03	.04	−7.62†	4.02	−8.89**	1.92
Family income-to-needs ratio (average)	−.05†	.03	8.91***	2.20	6.48***	1.97
Primary caregiver is a single parent (Head Start)	−.06*	.03	3.69†	2.17	.98	1.90
Primary caregiver has less than a high school diploma (Head Start)	.03	.03	−3.34	2.63	−2.46	2.51
First cohort	.00	.04	−7.81*	3.37	−8.41**	3.20
Intervention recipient	.01	.03	−.84	2.71	−.62	2.41
Frequent mobility (three or four school moves)	.10*	.04	−10.48**	3.43	−5.88*	2.98
Cognitive dysregulation					−43.51***	3.55
Flag for changed schools between Head Start and kindergarten	−.02	.04	1.44	2.96	.64	2.90
Percentage of low-income students in the school			−.15	.14	−.10	.14
Percentage of students in the school who met or exceeded state reading and math standards			.02	.18	.16	.17

Note. ISAT = Illinois Standards Achievement Test.
† $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

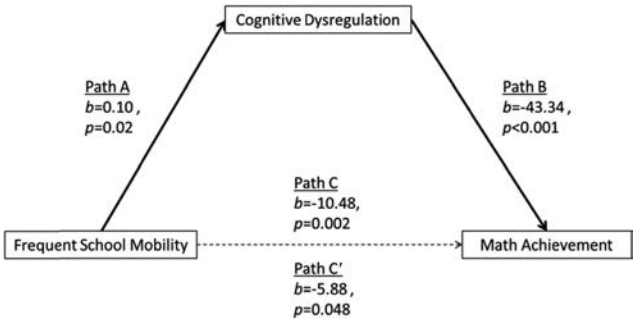

Figure 1. Influence of frequent school mobility on math achievement through cognitive dysregulation. Path C refers to the direct influence of frequent school mobility on math achievement in fourth grade. Path C′ refers to the influence of frequent school mobility on math achievement through the cognitive dysregulation mediator. (Direct test of the indirect path [A × B] is significant, $b = -4.31$, $p = .022$.)

Child and family covariates. Several child and family covariates were associated with math achievement or cognitive dysregulation. The income-to-needs ratio significantly predicted higher math achievement in fourth grade ($b = 6.48$, $SE = 1.97$, $p < .001$) but predicted cognitive dysregulation only at the trend level ($b = -0.05$, $SE = 0.03$, $p = .08$). Having an unmarried primary caregiver in Head Start predicted lower cognitive dysregulation in third grade ($b = -0.06$, $SE = 0.03$, $p = .02$). Gender significantly predicted both cognitive dysregulation and math achievement: Girls tended to be rated by their teachers as having lower cognitive dysregulation compared to boys ($b = -0.12$, $SE = 0.03$, $p < .001$). Girls also tended to have lower math achievement scores than boys, but this difference was only statistically significant when cognitive dysregulation was included in the model ($b = -8.65$, $SE = 1.92$, $p < .001$): Girls and boys were predicted to perform similarly on the math ISAT until the girls' behavior advantage (greater cognitive self-regulation) was accounted for; in this situation, they tended to score almost 9 points lower than boys.

There was a significant inverse relationship between children's early dysregulation measured during Head Start and math achievement in fourth grade ($b = -4.15$, $SE = 2.06$, $p = .04$). Despite a significant correlation, early dysregulation did not significantly predict later cognitive dysregulation over and above other child and family characteristics. Early math abilities during Head Start significantly predicted lower cognitive dysregulation in third grade ($b = -0.25$, $SE = 0.10$, $p = .009$) and higher math achievement in fourth grade ($b = 25.34$, $SE = 8.49$, $p = .003$). Neither of the fourth-grade school characteristics (percentage of low-income children in the school or percentage of children in the school meeting or exceeding state reading and math standards) was significantly associated with students' math achievement in fourth grade.

Discussion

The goal of the current study was to better understand the role of school mobility as a source of poverty-related adversity in predicting low-income children's math skills. In addition, we tested the hypothesis that children's cognitive dysregulation (including problems with memory, inattention, and a lack of inhibitory control) would serve as a mechanism through which changing schools negatively affects math achievement. The results when school mobility was operationalized as frequent mobility supported this hypothesis: Children who changed schools three or four times over a 5-year period had higher cognitive dysregulation and, in turn, lower math achievement in early elementary school, even after taking into account children's early profiles of cognitive dysregulation and math skills during Head Start. These findings provide sobering evidence of the serious challenges faced by a small proportion of young, low-income children in urban schools. Importantly, our findings were robust to the inclusion of the measured indicators of likely confounds, such as families' poverty-related risks. As the current sample of children mirrors the larger population of CPS students in terms of racial composition and eligibility for free or reduced-price lunch (Chicago Public Schools, 2014), these results offer an empirical snapshot of the broader experiences of children in Chicago.

These results provide compelling evidence of the role of children's cognitive dysregulation as one potential mechanism for the association between frequent school mobility and math achievement. In line with experiential canalization theory (e.g., Blair & Raver, 2012) and research finding that stress impairs self-regulation (Lupien et al., 2001), the stress associated with changing schools almost every year may place children on a developmental trajectory toward decreased attentional capacity and inhibitory control and, in turn, lower math skills. This pattern of results held even after controlling for several baseline child and family characteristics, including children's math and dysregulation measured when they were in Head Start, providing further support that an increase in children's dysregulation due to changing schools, rather than baseline levels of dysregulation, drives these results. Taken together, these results suggest that for children growing up in poverty, moving every year or almost every year before third grade interferes with children's self-regulation and math skills. These findings lend support to the idea that increased academic hurdles previously found to be associated with school mobility result not only from a loss of instruction or discontinuity in curricula but also from threats to children's healthy neurocognitive function. This is the first study of which we are aware to examine these aspects of children's cognitive self-regulation in relation to school mobility. Future work examining children's stress response to school mobility can further elucidate the mechanisms through which changing schools interferes with achievement.

In line with prior research finding that changing schools multiple times but not only one time predicts children's lower academic achievement (Blane, 1985; Burkam et al., 2009; Rumberger, 2003; Temple & Reynolds, 1999), it is not surprising that our results differed for the three ways of operationalizing school mobility. Consistent with these prior studies, our analyses yielded null findings for the role of changing schools one or more times compared to never changing schools when predicting children's cognitive dysregulation and math achievement.

We did, however, find a dose-dependent relationship between the number of times a child changed schools and math achievement. Children's math achievement was predicted to decrease by over 3 points for each school move, which could move some students from the *meets standards* to the *below standards* category.

As the threshold for meeting state standards on the math ISAT increases by about 15 points each year, a 3.35-point decrease in math ISAT scores represents over one fifth a year or about 2.5 months of learning math. This effect size is comparable to the 3- to 4-month deficit attributed to school mobility in the Mehana and Reynolds (2004) meta-analysis. It is important to note that a dose-dependent relationship of low, moderate, and high numbers of moves was not found when predicting children's cognitive dysregulation.

How do we reconcile these two sets of findings? One way to interpret these results is that other processes that accompany low or moderate levels of school mobility, such as disruption in the curriculum or loss of instruction, may be responsible for the lower math achievement of children who move infrequently. In contrast, increased stress and concomitant increases in cognitive dysregulation may serve as one mediator (among many others) for the relationship between higher "dosages" of school mobility and students' academic outcomes. In future work, we will pursue the measurement and modeling of other possible mechanisms (that were not measured in the current paper) for ways that school mobility may affect children's educational opportunities over time.

As mentioned earlier, we controlled for child and family characteristics in all of our models to reduce the likelihood that a host of other unmeasured factors in children's lives may have been the driving force leading to both higher school mobility throughout elementary school and their lower math performance in fourth grade. This concern for selection bias (i.e., the role of unmeasured and measured variables as potential confounds) has a strong empirical basis: Children who experience school mobility have been reported to be more likely to experience greater risk in their home lives, to have a parent with lower educational attainment, to face greater material disadvantage, and to demonstrate lower academic skills (Temple & Reynolds, 1999). Our estimates of the influence of school mobility can be viewed as conservative, as the inclusion of those baseline characteristics, in effect, allowed us to compare children who did and did not experience high levels of school mobility who were otherwise nearly identical on baseline characteristics. Importantly, children who experienced high levels of school mobility did not differ significantly from children who did not experience high levels of school mobility on observed baseline characteristics, improving the internal validity of our estimates. That said, we wish to be careful in our conclusions, as undoubtedly many other unmeasured sources of instability such as residential mobility and family hardship may affect children's self-regulation, math achievement, and likelihood of changing schools.

Limitations

The analyses presented in the current study represent methodological and theoretical advancements on prior school mobility research, shedding light on factors beyond teachers' and students' control that have substantial implications for children's academic prospects. With these strengths come several limitations to our study. A key limitation concerns our measurement of school mobility. The available data only enabled us to ascertain if a child moved between 2 consecutive school years. We could not determine if a child moved multiple times within a school year or the reason for the school change (i.e., a family residential move or a parent's desire to enroll his or her child in a higher quality school). Each of these may influence children's self-regulation and math achievement differently and could require different policy interventions. However, research suggests that school moves are harmful, regardless of the timing or cause (e.g., Grigg, 2012). In light of these constraints on measuring school changes, our estimates of the influence of school mobility on children's math achievement and cognitive dysregulation are likely conservative.

Second, these analyses, despite being longitudinal, are correlational and cannot be used to make causal claims about the relationship between school mobility and children's cognitive dysregulation or math achievement (Shadish, Cook, & Campbell, 2002). In particular, our use of static measures of poverty-related risks may have underestimated their effects on children's neurocognitive functioning and academic achievement. Third, although there are high rates of missing data on several variables, data were demonstrated to be largely missing at random, and results were robust to the exclusion of cases with missing data. Fourth, only 10% of the students in our sample experienced three or four moves and were classified as experiencing frequent mobility. Thus, our finding that cognitive dysregulation mediates the role of high levels of school mobility on math achievement is driven by the experiences and outcomes of a small portion of the full analytic sample. Given that the 40 children who experienced frequent mobility were very similar to the low-mobility group and the larger CPS population on observed baseline characteristics, we are confident in the generalizability of our findings. Furthermore, our finding of a dose-dependent relationship between changing schools and math achievement is based on the entire analytic sample. Yet, this area of research warrants replication with a larger sample.

Conclusions and Implications

This study provides compelling evidence that high doses of school mobility, especially when it occurs frequently during the first few years of formal schooling, predict a rougher road ahead for children's development of cognitive self-regulation and math skills. Simply stated, frequently changing schools is a major risk factor for low-income children's school success. On average, children in the current study scored within the *meets standards* range on the math ISAT. However, children who moved frequently were predicted to score, on average, 10 points or over one third of a standard deviation lower than (or over 8 months behind) their peers who did not experience frequent school changes, placing them at greater risk of not meeting state math standards. Although moving once or twice may not be extremely detrimental to the development of children who are already at risk, moving almost every year during elementary school was harmful, suggesting the need for policies at the state, district, and school levels to prevent school mobility and to support students, families, and teachers when children do change schools.

Excluding structural moves between, for example, elementary and middle school, there are likely two main reasons why children change schools: family decisions and school policies. First, in addition to reasons related to family instability and poverty-related adversity, parents may actively seek out a school change if they are dissatisfied with the current school. CPS's open enrollment policy enables children to enroll in schools outside of their neighborhood school, which increases parents' ability to change schools if they

are unhappy with the school climate, teachers, or other students. One promising solution to reducing instances of school mobility related to parents' decisions is to improve their satisfaction with the school. The Families and Schools Together (FAST) intervention was designed to improve families' satisfaction with schools through improved relationships between parents and school staff and between families within the school in order to reduce elementary school students' school mobility. Results from a cluster-randomized trial of FAST with a low-income sample provide support for its effectiveness in reducing school mobility among those children most likely to change schools (Fiel, Haskins, & López Turley, 2013). These findings support Rumberger's (2003) idea that the most effective strategy to decrease student mobility is to improve school quality. Increasing school-related social capital and improving relationships and school quality may be fruitful strategies for reducing school mobility, especially for students who experience frequent school mobility, thus improving self-regulation and math achievement.

Second, school policies are also related to children's school mobility. Under No Child Left Behind, low-performing schools are often closed, resulting in forced school changes for many children. Interventions to improve school quality and increase adequate yearly progress are expected to increase students' self-regulation and math achievement directly as well as indirectly through reductions in school mobility. Low-performing New York City schools improved student performance without closing (and reassigning students to other schools) by leveraging existing school resources. They used innovative practices to increase the school's internal capacity to educate students more effectively, including creating a positive school climate for students and staff, focusing on school safety, and using data to inform instruction (Villavicencio & Grayman, 2012). These schools demonstrate how low-cost interventions can improve student achievement without increasing students' experiences of school mobility due to school closures.

For children growing up in poverty in this urban Chicago sample, school mobility is only one of many risks they face. If school mobility cannot be prevented, providing supports to make the transition to a new school less disruptive and stressful, as well as preparing students in advance of the school change, may be important to mitigate the negative consequences of frequently changing schools. Future research leveraging randomized designs to implement and evaluate innovative school policies and practices to reduce the negative sequelae of school mobility and to prevent school mobility will help address questions regarding the most effective intervention and prevention strategies.

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Received April 4, 2014
Revision received June 1, 2015
Accepted August 26, 2015 ■