Residential mobility, inhibitory control and academic achievement in preschool

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Abstract

The present study investigated the direct effects of residential mobility on children's inhibitory control and academic achievement during the preschool year. It also explored fall inhibitory control and academic skills as mediators linking residential mobility and spring achievement. Participants included 359 preschool children (49% female) studied in the fall and spring of the preschool year (73% were enrolled in Head Start). Residential mobility was significantly and negatively associated with fall inhibitory control and fall math and literacy. Significant indirect effects of mobility were found for spring math and literacy through inhibitory control and fall achievement. Specifically, the negative relation between mobility and spring math and literacy was partially explained by lower scores on fall inhibitory control and academic skills. The current study contributes to existing literature by specifying pathways linking frequent moves and achievement for young children. Policy implications are discussed.

Key words: residential mobility, inhibitory control, academic achievement, preschool

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According to census data from the Current Population Survey in 2011, approximately 12% of children ages 0-17 move residences at least once, and this number nearly doubles for children who are living in poverty (20% of children living in poverty move frequently; U.S. Census, 2011). Although frequent moves, or residential mobility, can create opportunities for families (e.g., upward career mobility), it is often associated with stress in the home, disruptions in family routines and social networks, and changes in school arrangements (Leventhal & Newman, 2010). Decades of research suggest that these sources of instability are deleterious for a wide range of child outcomes, including physical and oral health (Busacker & Kasehagen, 2012), peer and sibling relationships (Haynie, South, & Bose, 2006; Stoneman, Brody, Churchill, & Winn, 1999), externalizing and internalizing behaviors (Ziol-Guest & McKenna, 2014), and children's academic achievement, such that school-age children and adolescents who move frequently tend to perform worse academically (Herbers et al., 2012; Masten et al., 1997; Obradovic et al., 2009; Pribesh & Downey, 1999; Voight, Shinn, & Nation, 2012). Although the link between residential mobility and poor achievement outcomes is established in older children, few studies have explored the effects of residential mobility on preschool children's school readiness skills (e.g., inhibitory control and early academic skills). Additionally, little is known about the underlying mechanisms that may help explain possible relationships. The present study examines the role of residential mobility on children's inhibitory control, math, and literacy skills during the preschool year and explores whether fall inhibitory control and academic achievement mediate relations between mobility and spring achievement.

Housing Instability as an Important Developmental Context

In lieu of recent crises in the United States housing market, there has been a growing interest in housing policy and the effects of housing conditions and characteristics on human development (Leventhal & Newman, 2010). According to many theoretical perspectives, the quality of home and family environments, including housing/residential stability and instability, is a critical factor related to young children's development (Blair & Raver, 2012; Bronfenbrenner, 2005; McClelland, Geldhof, Cameron, & Wanless, in press). However, until recently, residential mobility has been a relatively understudied developmental context for preschool children. Instead, research in this area has focused on more global measures of the home environment with an emphasis on the quality of family interactions and experiences (Bradley et al., 2000; Caldwell & Bradley, 1984). Residential mobility is an important determinant of the quality of the home environment for young children, as it often causes chaos and disruptions to daily routines and social networks related to family stress and instability (Evans & Wachs, 2010). Indeed, a number of studies suggest that family instability is associated with a plethora of adverse child outcomes ranging from lower levels of academic achievement to problems related to socio-emotional development (Brown, Ackerman, & Moore, 2013; Evans, Gonnella, Marcynyszyn, Gentile, & Salpekar, 2005). Family instability is often coupled with additional risk factors, such as poverty and low parent education. In fact, children from low-income families and those with mothers who have no more than a high school degree are almost twice as likely to move compared to children from middle-class families (Murphy, Bandy, & Moore, 2012; U.S. Census, 2011). Cumulative risk models suggest that exposure to multiple indicators of risk (e.g., poverty, low parent education, and frequent mobility) surpass the adverse effects of exposure to singular risks (Evans Li, & Whipple, 2013) and create increased stress for children and families (Evans & Kim, 2007). Elevated stress is a primary mechanism at work between family adversity and negative outcomes (Blair & Raver, 2012). According to the psychobiological framework, early environmental adversity (e.g., economic hardship, family disruption, low parent education levels) is related to heightened stress hormone levels, which negatively influences the neural underpinnings of executive function components, including inhibitory control (Blair & Raver, 2012), and young children may be especially vulnerable to the effects of stress because of rapid brain development characteristic of this period (Shonkoff & Phillips, 2000). Moreover, psychobiological and family stress models indicate that family adversity is related to poor parenting behaviors, less stimulating home environments, and harsher discipline strategies (Blair & Raver, 2012; McLoyd, 1990; Bradley & Corwyn, 2002), all of which could impede children's inhibitory control and academic achievement. Recent work suggests that residential mobility in early childhood impacts family process variables (quality of the home environment, maternal depression, and maternal sensitivity), which then affect children's achievement and internalizing and externalizing behaviors (Anderson, Leventhal, & Dupere, in press) and executive function skills (Sektnan, McClelland, Acock & Morrison, 2010). Because young preschool children may be at elevated risk when experiencing unfavorable family environments, it is important to identify specific factors that contribute to poor outcomes. The present study examined the role that residential mobility plays for young children's development during the transition to kindergarten.

Residential Mobility and Academic Achievement

The impact of residential mobility on elementary and high school students' academic achievement has been well-studied, and the results are consistent: children and adolescents who move frequently perform worse on measures of math, reading, and educational expectations (Cutuli et al., 2013; Herbers et al., 2012; Masten et al., 1997; Obradovic et al., 2009; Prisbesh &

Downey, 1999; Voight et al., 2012). Importantly, there is growing evidence that mobility in the early elementary years predicts academic trajectories into middle school (Cutuli et al., 2013; Herbers et al., 2012; Obradovic et al., 2009; Voight et al., 2012). Recent research suggests that children who are highly mobile or homeless are at elevated risk for poor academic outcomes compared to those experiencing poverty alone. In spite of some evidence showing that achievement gaps may start to narrow for low-income children by the end of eighth grade, gaps continue to widen for children experiencing high rates of mobility (Cutuli et al., 2013). Although a growing body of literature has focused on links between mobility and older students' achievement, less is known regarding the possibility that the effects of mobility occur earlier than elementary school. Moreover, limited research has explored potential mechanisms underlying the negative relation between mobility and academic outcomes. As mentioned above, family stress and chaos have been identified as pathways linking family adversity and poor child outcomes (e.g., Blair & Raver, 2012). Another potential mechanism could be that frequent moving that occurs prior to school entry sets the stage for poor academic and behavioral trajectories operating through a child's lack of preparedness for kindergarten entry. In one study, a large majority (78%) of homeless children entered kindergarten and first grade with unsatisfactory levels of academic competence (Obradovic, 2010). Identifying whether poor school readiness contributes to the effect of mobility on long-term academic difficulties is important because many aspects of school readiness (e.g., executive function) have been shown to be malleable and can be improved through early intervention strategies (Bierman et al., 2008; Raver et al., 2011; Tominey & McClelland, 2011).

To our knowledge, little research has explored the unique impact of residential mobility during the early childhood period on children's school readiness. In one study, Ziol-Guest &

McKenna (2014) investigated the role of early mobility (from child's birth to age 5) on a range of school readiness outcomes measured at one time point (age 5), including cognitive (language and literacy) and behavioral (e.g., aggression, delinquency, anxiety/depression, social withdrawal, attention problems, social problems, externalizing and internalizing behaviors). Results from this study revealed significant associations between frequent moves and increases in attention problems and externalizing behaviors for children from low-income families (Ziol-Guest & McKenna, 2014). A threshold effect of moving was also found, such that when families moved 1-2 times, mobility did not significantly predict school readiness outcomes, but when families moved 3 or more times, mobility was related to poorer attention and more externalizing and internalizing behavior problems. These significant findings suggest that disruptions related to frequent housing instability influence the development of one indicator of school readiness (behavioral/socio-emotional readiness). The current study builds on these findings by exploring the effect of residential mobility on other important school readiness indicators, including inhibitory control, math, and literacy utilizing longitudinal data.

Residential Mobility and Inhibitory Control

One critical area of school readiness that has been understudied in relation to residential mobility is executive function (i.e., a set of cognitive processes that facilitate goal-directed behaviors; Diamond & Lee, 2011), and more specifically, inhibitory control. Inhibitory control (IC) is defined as the ability to stop an automatic, prepotent response in favor of a more adaptive one (Dowsett & Livesy, 2000). IC is considered a central aspect of executive function (Diamond, 2002) because it contributes to individual differences in a wide range of developmental outcomes. For example, it is a necessary component for other executive processes (e.g., attentional systems; Derryberry & Rothbart, 1997) and in some research, it has emerged as a stronger indicator of academic success relative to other components of executive function (e.g., attention shifting; Blair & Razza, 2007). In order to take advantage of learning opportunities, persist on complex and challenging academic problems or tasks, and follow directions, children must inhibit natural, impulsive behaviors in a distracting environment (Blair & Razza, 2007; Razza, Martin, & Brooks-Gunn, 2012).

Emerging evidence suggests that early environmental experiences and family characteristics, including high stress home environments, poverty, low parent education, and learning English as a second language, may be particularly detrimental to the development of IC in young children. For example, in one study, preschool children from low-income families and those experiencing lower quality home environments (e.g., lower cognitive stimulation, fewer learning materials) were more likely to exhibit higher levels of impulsivity during a direct assessment (Dilworth-Bart, Khurshid, & Lowe Vandell, 2007). In another study, low maternal education and poverty was associated with lower levels of parent-rated behavioral regulation (Sektnan et al., 2010). Other recent work suggests that children who come from low-income families and are considered English language learners are also at risk for poorer IC and academic achievement (Galindo & Fuller, 2010; Wanless, McClelland, Tominey, & Acock, 2011). Some evidence suggests that residential instability specifically may undermine or interrupt the development of IC in early childhood. One study of preschool children indicated that greater family adversity, measured broadly to include family instability (residential mobility and entries and exits of individuals living with child) and chaos (confusion and disorganization in the home environment), was related to lower levels of IC in preschool children (Brown et al., 2013). Family instability and chaos may undermine the development of IC for a variety of reasons. First, instability inherently disrupts structured and predictable family environments known to be indicative of strong behavioral control (Schroeder & Kelley, 2009). Second, and perhaps more important, instability and chaos affect the development of stress physiology and neural inhibitory connections, which are linked to the development of executive function, including IC (Blair & Raver, 2012).

Other studies suggest that homelessness, an extreme form of residential mobility, is related to social and behavioral problems (Buckner, 2008; Masten et al., 1997). For example, Masten et al. (1997) reported that homeless children had more difficulties with classroom behavior management (i.e., impulse control) and adjustment, as well as academic achievement. These children typically experience cumulative risks (e.g., poverty, low parent education, instability, chaos, violence), which could help explain some of these outcomes. Moreover, homeless families often lack the basic needs of survival (e.g., food, shelter, and clothing), which can hinder the development of many skills, including inhibitory control. However, studies also suggest that children experiencing homelessness who have high levels of IC demonstrate resilience (Obradovic, 2010). In a sample of children experiencing homelessness, Obradovic (2010) reported that strong scores on measures of IC were related to a number of adaptive behaviors during the transition to kindergarten, including academic functioning. Thus, it appears that IC may be an important indicator of resilience for children experiencing family instability. Little is known, however, about whether residential mobility (at varying levels, not just homelessness) is uniquely related to IC, and whether IC acts as an underlying mechanism linking mobility to achievement outcomes. The current study investigates the complex relations among residential mobility occurring from birth to preschool and children's IC and early academic skills measured during the preschool year.

Inhibitory Control and Academic Achievement

Growth in IC in early childhood has emerged as an important predictor of both concurrent and long-term academic achievement above and beyond other executive function processes (Blair & Razza, 2007; Bull, Espy, & Wiebe, 2008; Clark, Pritchard & Woodward, 2010; Espy et al., 2004; Gonik, 2011). In one study that compared the predictive utility of several aspects of self-regulation (effortful control, false belief understanding, attention shifting and inhibitory control) on academic outcomes, IC emerged as the strongest predictor of young children's math and phonemic awareness (Blair & Razza, 2007). Espy et al. (2004) found that preschool IC accounted for unique variability in concurrent emergent mathematics, after statistically accounting for child age, child verbal intelligence, and maternal education. In another study, IC measured in the winter of preschool predicted concurrent scores on a broader school readiness assessment that focused on number and letter knowledge, colors, shapes, and sizes (Brown et al., 2013). The development of IC also contributes to growth in vocabulary, phonological sensitivity, and print awareness in the preschool period (Bierman et al., 2008). Importantly, several studies indicate a longitudinal relationship between IC and achievement outcomes. For example, Blair and Razza (2007) found that IC measured in preschool accounted for unique variance in kindergarten mathematics, phonemic awareness, and letter knowledge. Similarly, Bull et al. (2008) found that preschool performance on an inhibition task was related to growth in math and reading through age seven. Taken together, studies like these indicate the critical nature of IC for children's preparedness for kindergarten entry and long-term academic trajectories.

Accumulating evidence also suggests that IC may be an important mechanism explaining the relations between family risk and achievement (Brown et al.; 2013; Sektnan et al., 2010). For example, in a recent study, IC mediated the effect of family adversity (i.e., family instability and chaos) in preschool on a school readiness composite (e.g., letter and number knowledge, color and shape recognition; Brown et al., 2013). Moreover, in another study, parent ratings of attention and IC at 54 months and in kindergarten mediated the relation between low maternal education and first grade academic achievement (math, reading, vocabulary; Sektnan et al., 2010). Thus, IC may be especially important for children experiencing frequent mobility and could be a key explanatory mechanism between mobility and achievement outcomes.

Early academic skills (measured in the fall of the preschool year) could also act as key mechanisms linking residential mobility with later preschool achievement (measured in the spring of the preschool year). Developmental cascade models suggest that early academic skills impact subsequent academic functioning (Masten et al., 2005), and a substantial body of literature indicates the relative stability of literacy and math over the preschool year (i.e., fall academic skills are highly correlated with spring academic skills; e.g., McClelland et al., 2007). However, few studies have explored the relative contribution of IC and early academic skills as mechanisms that may underlie relations between family adversity and later academic achievement and whether these may differ for math versus literacy. Considering that previous research indicates a stronger relationship between IC and math than IC and literacy (e.g., Cameron Ponitz, McClelland, Matthews, & Morrison, 2009), there is reason to believe that IC may operate as a mechanism between mobility and spring math achievement (in addition to fall math), but not for spring literacy achievement. The current study examines the relative contribution of fall IC, math, and literacy as possible mechanisms underlying the relationship between residential mobility and spring achievement.

The Present Study

The present study extends existing literature on residential mobility and child development by examining links between mobility, IC, and achievement in a diverse sample of preschool children. We answered three research questions: 1) Is residential mobility from birth to preschool significantly related to IC, math, and literacy during the preschool year? 2) Does fall IC predict spring math and literacy in preschool? 3) Does fall IC and early academic skills mediate relations between residential mobility and spring achievement and what is the relative contribution of each variable (inhibitory control and fall academic scores)? Based on previous research suggesting that residential mobility adversely affects children's behavior (Ziol-Guest & McKenna, 2014) and academic skills (Obradovic et al., 2009; Pribesh & Downey, 1999), we expected that frequent moves between birth and preschool would be negatively related to children's IC, math, and literacy in the fall, and math and literacy in the spring of the preschool year. Based on previous work identifying IC as a mediator between early family adversity and achievement (Brown et al., 2013; Sektnan et al., 2010), we also expected that mobility would be associated with spring math and literacy indirectly, through its relation with fall IC and early academic skills.

In all statistical analyses, we included important covariates related to IC and academic outcomes: child age, whether or not children were English language learners (ELLs), and parent education level (as a proxy for socioeconomic status; Davis-Kean, 2005; Halpern, 2000; Sirin, 2005). We controlled for parent education level based on research showing strong predictive relations to children's behavioral and cognitive outcomes (e.g., Magnuson, Sexton, Davis-Kean, & Huston, 2009; McClelland et al., 2007).

Method

Participants

Participants were recruited from 42 local preschools participating in a larger, longitudinal study focused on children's self-regulation. Participants included 359 children (49% female). Seventy-three percent of children were enrolled in Head Start classrooms. Children ranged in age from 36 to 66 months (*M* = 53.85, *SD* = 5.75) and attended center-based preschools. Children were 49% White; 32% Latino; 1% African American; 4% Asian; 1% Middle Eastern, 12% multi-racial, and 1% other ethnic groups. Twenty-four percent of children were Spanish-speaking and were assessed in Spanish. Average parent education level was approximately one year of college and ranged from less than a high school degree to a PhD (*M* = 13.10 years, *SD* = 3.90). Written consent was obtained from parents/primary caregivers prior to participation, and all participants received a $20 gift card. Prior to administering all assessments, children gave verbal assent to participate in the assessments.

Procedure

Data collection took place during the fall and spring of the preschool year. In the fall, parents completed demographic questionnaires, including a question regarding residential mobility. In addition, trained research assistants administered direct assessments of IC, math and literacy skills in a quiet area of the preschool classroom. In the spring, trained research assistants administered the same direct assessments of early math and literacy as the fall. Fluent, Spanish-speaking research assistants assessed children identified as Spanish-speaking by their teachers.

Measures

Residential mobility. To measure residential mobility, parents answered the following question: "How many moves has your family experienced in the past 5 years?" as part of a larger demographic questionnaire. Responses ranged from 0 - 12 (*M* = 1.67, *SD* = 1.66). This method of assessing residential mobility has been used in a number of previous studies (Brown et al., 2013; Ziol-Guest & McKenna, 2014).

Inhibitory control. Children's IC was assessed using the Day-night Stroop task (Gerstadt, Hong, & Diamond, 1994). During the task, children viewed 16 cards with a picture of either a moon or a sun and were asked to respond with the opposite of what they saw (e.g., say "day" when the card has a picture of a moon). No response and incorrect responses were coded 0, self-corrected or similar responses were coded 1, and correct responses were coded 2. Scores ranged from 0-32. Consistent with past research (e.g., Rhoades, Greenberg, & Domitrovich, 2009), this measure demonstrated strong internal consistency in the current study (α = .90).

Academic outcomes. Academic achievement was assessed using two subtests of either the Woodcock-Johnson III or the Woodcock-Munoz Bateria III depending on the language of the child. Although item-level reliabilities were not available in the present study, previous research has demonstrated high reliability and validity (α > .80) for all of the subtests (Schrank et al., 2005; Woodcock & Mather, 2000). *W*-scores were used in the analyses, which are standardized scores based on the average performance of a typical child at a given age (based on normative data; Jaffe, 2009). *W*-scores are appropriate for

Early math skills. The Applied Problems subtest of the WJ-III or the Batería III Woodcock-Muñoz was used to measure early mathematical problem-solving skills, including counting, reading numbers, and basic addition and subtraction.

Emergent literacy skills. The Letter-Word Identification subtest of the WJ-III or the Batería III Woodcock-Muñoz was employed to measure emergent literacy skills (i.e., decoding), including naming letters and reading words out loud.

Results

The goals of the current study were to examine the direct effects of residential mobility on children's IC and achievement during the preschool year, and to explore IC and fall academic skills as mediators linking mobility and spring achievement.

Analytic Strategy

Data analyses were conducted using Stata 12.0 (StataCorp., 2011). Due to the nested structure of the data (children nested in classrooms), multilevel models were used to measure the direct effects of residential mobility on IC and academic achievement and IC on academic achievement (*ICC*s ranged from .11-.34). Specially, multilevel (classroom = cluster variable) mixed effects linear regression using the xtmixed command was used in Stata. Path models utilizing the sem command in Stata were conducted to answer the third research question.

Missing data. Eighty-seven children in the sample participated in an executive function intervention in the winter of the preschool year, and thus, spring data on these children were omitted from analyses. Additional missing data resulted from attrition or other extraneous circumstances (e.g., child was sick on scheduled data collection). Data were missing on the following variables: fall IC (7%); fall math (8%); fall literacy (8%); spring math (7% from attrition); and spring literacy (6% from attrition). Once all missing data were accounted for, the sample size was 249. Data were assumed to be missing at random (MAR). There is no definitive test of the MAR assumption, however, tests were conducted to determine whether auxiliary variables not included in original models were related to missingness. Logistic regressions were run using dummy variables that were created for all variables with > 5% missingness (0 = present; 1 = missing). Variables already in the model (e.g., maternal education) and demographic variables theoretically related to missingness (e.g., marital status, maternal and paternal employment, parental age) were included as predictors in the logistic regressions. None of the auxiliary variables included in the models predicted missingness, suggesting that it is reasonable to assume that missing data were missing at random. Maximum likelihood estimation was employed to handle missing data to reduce potential bias that could result from using listwise deletion (Acock, 2012).

Descriptive statistics. Means and standard deviations for all study variables can be found in Table 1. Correlations revealed that residential mobility was significantly and negatively related to inhibitory control in the fall and early math and literacy at both time points. Children's performance on the IC task was positively related to math and literacy at both time points. See Table 2 for a summary of correlations.

Research question 1: Does residential mobility predict inhibitory control skills and academic achievement during the preschool year? As expected, results indicated that after controlling for maternal education, child age, and ELL status, residential mobility between birth and the fall of preschool significantly predicted children's IC, math, and decoding measured in the fall. The more moves that children experienced, the poorer they performed on the IC task ($\beta = -.12$, $p = .039$) and the math ($\beta = -.10$, $p = .029$) and literacy assessments ($\beta = -.11$, $p = .035$). No significant direct effects of residential mobility on spring math or decoding were detected when controlling for fall achievement scores.

Post-hoc regression analyses revealed threshold effects of moving for IC and math. Three variables were created to represent: 0 moves (n = 101, 28% of the sample), 1-2 moves (n = 173; 48% of the sample), and 3 or more moves (n = 85; 24% of the sample). Results suggested that moving 3 or more times had the greatest negative impact on IC ($\beta = -.19$, $p = .019$) and fall math ($\beta = -.17$, $p = .02$). Threshold effects were not detected for decoding.

Because maternal education is a demographic characteristic that is frequently associated with residential mobility (Murphy et al., 2012) and could potentially influence the relation between moving and achievement outcomes, follow-up analyses also explored whether maternal education moderated relations between mobility and math and literacy. Regression analyses revealed one significant interaction between maternal education and frequent moves (moving 3 or more times) on math, such that frequent moving was particularly detrimental for children when their mothers had lower levels of education (less than a high school degree).

Research question 2: Does inhibitory control predict spring academic achievement in preschool? Results also revealed that fall IC was a significant predictor of spring math achievement. Higher scores on the fall IC task predicted higher scores on math ($\beta = .23$, $p < .001$) in the spring, controlling for fall math scores, child age, parent education, ELL status, and residential mobility. Importantly, when IC was entered into the original model examining mobility as a predictor of spring math, the marginally significant direct effects of mobility faded, suggesting a possible mediating effect. IC did not emerge as a significant predictor of spring decoding skills when controlling for fall decoding, child age, parent education, ELL status, and residential mobility.

Research question 3: Do inhibitory control and fall academic scores mediate relations between residential mobility and spring academic achievement and what is the relative contribution of each mechanism (inhibitory control and fall academic scores)? Path models revealed significant indirect effects of mobility on spring academic achievement through fall IC and fall academic skills, controlling for maternal education, child age, and ELL status (See Figures 1 and 2). Specifically, significant, albeit modest, indirect pathways were found from mobility to spring math ($\beta = -.07$, $p = .032$) and literacy ($\beta = -.10$, $p = .024$) through fall IC and fall academic scores. In other words, the relations between residential mobility and lower math and decoding scores in the spring, were explained, in part, through the association with lower IC and academic skills in the fall of preschool.

We then examined the breakdown of the total effect (direct versus indirect effect) for each outcome. For math, 50% of the total effect of mobility was indirect. For decoding skills, the majority of the total effect was indirect (98%) through fall decoding and IC. These findings led to us to our next question, which examined the relative contribution of IC and fall academic skills in our models. Nonlinear tests were conducted and revealed that there was no significant *specific* indirect effect (either IC or fall math) linking mobility to spring math. Instead, the indirect effect to spring math scores worked through *both* IC and fall math. For spring decoding, nonlinear tests revealed that the indirect effect worked mainly through fall decoding skills (β = -.09, z = -2.18, p = .029) rather than fall IC.

Discussion

In the current study, we investigated the direct effects of residential mobility on preschool children's inhibitory control (IC) and academic achievement, and the direct effects of fall preschool IC on growth in achievement during the academic year. In addition, we explored fall IC and academic skills as a potential mechanism between the accumulated residential mobility a child experienced in the first few years of life and his/her academic achievement at the end of the preschool year. Results indicated that children who move more frequently between birth and preschool performed significantly worse on an IC task and math and literacy assessments during the preschool year. Furthermore, significant indirect effects of mobility on math and literacy were found through fall IC and academic skills. In other words, the negative relation between mobility and math and literacy measured in the spring was partially explained by lower scores on IC and academic skills measured in the fall.

Links between Residential Mobility, Inhibitory Control, and Academic Achievement

Consistent with past research on school age children and adolescents (Masten et al., 1997; Obradovic et al., 2009; Pribesh & Downey, 1999; Voight et al., 2012), we found significant and negative effects of residential mobility on children's math and decoding in the fall of the preschool year. Furthermore, frequent moves between birth and preschool predicted lower levels of IC. These results indicate that the adverse effects of housing mobility emerge early in life, and could have detrimental effects on children's ability to make successful transitions into formal schooling environments. Indeed, children who do not have the necessary early academic and executive function skills (e.g., inhibitory control) upon kindergarten entry are at greater risk for school difficulties that persist over time (Duncan et al., 2007; McClelland, Acock, & Morrison, 2006; McClelland, Acock, Piccinin, Rhea, & Stallings, 2013).

The family context is particularly important during early childhood given the rapid development characteristic of this period and the role that parents play in supporting children's growth. Early childhood is considered a critical period for children's brain development making young children particularly vulnerable to stress and other risk factors (Shonkoff & Phillips, 2000). Unstable family environments caused by residential mobility can cause significant stress in the home, as well as disruptions in social networks (Pribesh & Downey, 1999), which can adversely affect family processes. Recent theoretical perspectives indicate that familial stress resulting from early adversity, including family instability, influences proximal processes, such as parenting behaviors and parent-child interactions (Blair & Raver, 2012; Leventhal & Newman, 2010), which are associated with various developmental outcomes. Indeed, existing literature has documented the negative effects of other aspects of family risk, such as maternal depression, low-income status, and low parent education on preschool children's executive function and academic achievement (Sektnan et al., 2010). Post-hoc analyses in the current study revealed that when children had mothers with low levels of parent education (less than a high school degree), the negative relation between frequent moving and math achievement was stronger. This finding is in line with cumulative risk hypotheses that suggest that exposure to multiple risks is more detrimental to child development than a single risk (Evans et al., 2013). The current study adds to this literature by revealing that residential mobility is an additional and unique risk factor that contributes to children's preparedness for formal school entry.

Findings in the current study also add to accumulating evidence suggesting that IC is an independent and significant predictor of early math achievement (Bierman et al., 2008; Blair & Razza, 2007; Bull et al., 2008; Espy et al., 2004). Recent evidence suggests that IC is a central aspect of executive function in early childhood (Diamond, 2002), one that is required to do well on complex academic problems or tasks. In other words, the ability to inhibit natural, prepotent responses while engaging in challenging tasks in a distracting environment, such as a preschool classroom, plays a significant role in developing mathematical skills. This view is supported by our findings finding that IC was significantly related to the development of early math skills necessary for school success.

Inhibitory control did not account for unique variance in decoding skills. Other research has also found inconsistent results between aspects of executive function and literacy development. For example, in a recent study, a direct assessment of executive function was a stronger predictor of math than decoding (Schmitt, Pratt, & McClelland, in press). In another study, IC measured in preschool predicted kindergarten math, but it did not significantly predict phonemic awareness or letter knowledge (Blair & Razza, 2007). Finally, other longitudinal work suggests that executive function predicts gains in math over the kindergarten year, but not gains in literacy (Cameron Ponitz et al., 2009). Scholars have speculated that early executive function skills, particularly IC, may be more relevant for the development of math than literacy (Blair & Razza, 2007). In order to succeed on challenging math tasks, children must call upon IC to persist and resist the natural inclination to either give up and abandon the task or use a previously learned rule (Bull, Johnston, & Roy, 1999). Bull and colleagues (1999) found that children with lower mathematical competence have difficulties inhibiting habitual responding to a previous classification system in favor of a new classificiation system, and thus, struggle to successfully reach the correct answer in an arithmetic problem. Brain imaging research also supports the hypothesis that IC and math are closely related in that recent studies indicate that the brain structures and regions that support IC and math overlap (Klingberg, 2006).

Compared to early math development that requires IC and problem solving skills, decoding and other related literacy skills tend to rely more heavily on rote memorization, and as literacy skills become more developed, automaticity likely plays a role. For example, decoding requires children to memorize letter names, and phonemic awareness develops as children memorize letter sounds which become more automatic over time (Fuhs, Nesbitt, Farran, & Dong, 2014). Thus, whereas IC may be more important for the development of early math, children's memory skills may play a larger role in the development of literacy. Indeed, scholars have found working memory to be a strong indepedendent predictor of language and literacy capabilites in kindergarten (Nevo & Breznitz, 2011) and the early elementary grades (Gathercole, Alloway, Willis, & Adams, 2006). Furthermore, Swanson, Orrosco, & Lussier (2012) found that IC did not play a major role in explaining variability in reading for children in grades 1-3, but working memory skills did predict reading problems for Spanish speaking children learning English as a second language. Taken together, this evidence suggests that as literacy skills become more automatic, children are less reliant on IC and more dependent upon complex memory. Thus, the current analyses support the hypothesis that IC may be more important for the development of early math skills than emergent literacy skills.

Although not a primary focus of the study, we found both negative and positive effects for one covariate in our analyses, children who were identified as English language learners (i.e., Spanish-speaking). Similar to other studies, we found that being an English language learner (all of whom were also low-income) was significantly and negatively correlated with inhibitory control (Wanless et al., 2011) and achievement outcomes (Galindo & Fuller, 2010; Han, 2012). However, being an English language learner was also negatively related to residential mobility, suggesting that English language learners were less likely to move than their English-speaking peers. This was somewhat surprising given that our sample of English language learners was considered the most “at-risk” based on demographic characteristics (e.g., lower parent education than other ethnicities: average maternal education for English language learners = 9 years; maternal education for English speakers = 14 years), and previous literature suggests that low-income families and those with lower levels of parent education are more likely to move (Murphy et al., 2012). In contrast, our data suggest that being an English language learner may serve as a protective factor against frequent mobility. However, in spite of less mobility, these children still scored significantly lower on inhibitory control and the achievement measures, all of which were given in Spanish. Although we were not able to examine this in more depth in the current study, future research should focus more specifically on this group of children.

Inhibitory Control as a Mediator Linking Residential Mobility and Achievement

In the current study, indirect effects emerged from mobility to spring math and literacy (i.e., decoding) working through fall IC and academic skills. These findings are consistent with past research suggesting that children's executive function skills, particularly measures of IC, play a mediating role linking family adversity and achievement (Brown et al., 2013; Sektnan et al., 2010), and also suggest that IC may be particularly important for children experiencing high mobility and homelessness (Masten et al., 2012; Obradovic, 2010). In addition, the current study supports a developmental cascade model (Masten et al., 2005) in that accumulated residential mobility resulted in lower fall academic skills, which then influenced subsequent functioning in both math and literacy. These findings suggest that the stability of early family environments plays an important role in the transition to kindergarten and the beginning of children's academic trajectories. Children who move frequently are at risk for greater levels of parental stress, family chaos, and disruption of daily routines (Evans & Wachs, 2010), all of which contribute to their early academic skills and their ability to control behaviors appropriately when introduced to a new classroom environment. This is important because early skills beget later skills, and the skills that children come into preschool with predict the development of later math and literacy skills (Blair & Diamond, 2008). Children with poor IC and early academic skills are more likely to struggle navigating classroom environments, which can influence teacher-child and peer relationships and the ability to engage in classroom content and activities. Recent work indicates that these classroom difficulties persist and influence later academic functioning and educational attainment (McClelland et al., 2013).

Few studies have explored the manner in which mobility operates on developmental outcomes, and in the current study, we were interested in the relative contribution of fall IC and academic skills as mediating effects of spring academic outcomes. Results revealed that the operating mechanisms differed slightly for math and literacy. For spring math achievement, the effect of mobility worked through both IC and fall math, suggesting that children who move frequently between birth and preschool entry begin preschool with lower levels of IC and early math, which could compromise the development of early math skills throughout the preschool year. This finding is in line with the research discussed above on the importance of IC for early math development (Blair & Razza, 2007; Cameron Ponitz et al., 2009).

In contrast, for literacy, findings revealed that mobility was indirectly related to spring literacy primarily through lower levels of fall decoding skills, rather than through fall IC. Again, this finding aligns with the notion that executive function skills may be less predictive of literacy skills than math (e.g., Blair & Razza, 2007). Moreover, emergent literacy skills are fairly stable in early childhood and explain much of the variance in later literacy skills (Lonigan, Burgess, & Anthony, 2000).

Limitations and Future Directions

This study contributes important information to our understanding of the effects of residential mobility on young children's school readiness, but a number of limitations must be noted. For example, our study utilized just one measure of IC. In order to explore the generalizability of the current findings, it is critical that future research include additional measures of IC. Furthermore, future studies should include measures that assess additional aspects of executive function (e.g., working memory, attention shifting) as well as measures that assess the broader executive function construct (i.e., the integration of working memory, attention shifting, and IC; McClelland & Cameron, 2012) in order to further explore the distinct role of IC in the relation between family instability and achievement.

Our study was also constrained by a relatively simple measure of residential mobility. Although this same type of assessment has been used in previous studies of residential mobility and school readiness (Brown et al., 2013; Ziol-Guest & McKenna, 2014), future research could take a more comprehensive approach to measuring mobility by exploring the reasons that families move (e.g., voluntary moves versus involuntary) and the neighborhoods they move to. Utilizing mixed methods approaches and more nuanced measures of mobility, including qualitative interviews and observations in addition to quantitative assessments, would provide a richer glimpse into the effects of family mobility and instability on children's school readiness. Specifically, qualitative data may offer insight into *how* IC may protect children from the adverse effects of frequent residential mobility.

It is also important to note the correlational nature of analyses between mobility and fall assessments, which precludes causality. Future mediation analyses would benefit from measurement of mobility and child outcomes at different time points.

Finally, our results suggest that IC could be an adaptive *mechanism* that may promote resilience among children experiencing early risk. Future research should explore IC as a potential protective factor for children who move frequently. Being able to inhibit natural, dominant responses in favor of more adaptive behaviors may safeguard children from the adverse effects that frequent moves can create. In other words, if young children are able to develop strong IC in the presence of residential mobility they may be better equipped to succeed in school settings. This area of inquiry warrants future investigation.

Practical Implications

These findings have implications for housing policy as well as early interventions aimed at improving children's school readiness. In order for policy to move forward in efforts focused on improving housing conditions, quality, and availability for families, it is imperative to understand how housing characteristics affect families and children. The current study provides critical information regarding the deleterious effects of one feature of housing, residential mobility. These effects appear to be most salient for children who experience frequent mobility and have parents with limited education, suggesting that families with certain background characteristics (e.g., low education) may need additional supports when faced challenges associated with frequent moving.

Results of this study also suggest that it may be helpful to focus intervention efforts on programs that foster IC (and related executive function components) and early academic skills as a way to buffer the deleterious effects of early family instability, such as residential mobility. Children who have the skills to resist natural impulses in favor of adaptive behaviors are able to transition to new classroom settings with ease, persist on challenging tasks, and develop positive teacher and peer relationships, all of which contribute to positive academic trajectories that begin early in life. Recent intervention work suggests that some programs are effective in facilitating executive function skills (including IC) and achievement in young children experiencing risk. For example, a targeted intervention using classroom games has been effective in fostering growth in executive function and academic achievement for children from low-income families and for children learning English as a second language (Schmitt, McClelland, Tominey, & Acock, 2013; Tominey & McClelland, 2011). Helping children develop a broad set of skills, including, IC, other executive function skills, and academic achievement, prior to kindergarten can help prepare children for a successful school transition and positive academic outcomes.

Conclusion

The current study contributes to existing literature by exploring the relationships between residential mobility, IC, and achievement in early childhood, and by specifying potential pathways linking residential mobility and academic achievement in young children. In an era where moving has become a fairly normative and frequent experience for young children, particularly those from socioeconomic disadvantage, it is critical that parents, teachers, researchers, and policy-makers understand and target the development of certain skills that may offset the negative effects of residential mobility. Not only will this improve the well-being of children who experience housing instability, it could also help narrow the achievement gap so pervasive in the United States.

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Table 1. *Descriptive Statistics for Major Study Variables* (N=359)

Continuous Variables	*M*	*SD*	Range
Child age (in months)	53.84	5.75	35.80 – 66.04
Parent education (in years)	13.10	3.90	0 – 26
Residential mobility[a]	1.67	1.66	0 – 12
Fall inhibitory control	21.52	9.97	0 – 32
Fall applied problems	397.42	25.55	319 – 481
Fall letter-word identification	327.60	29.47	276 – 453
Spring applied problems	413.78	30.39	301 – 467
Spring letter-word identification	344.87	28.61	264 – 427
Categorical Variable	%Yes	%No	
English language learner	24%	76%	

[a]Residential mobility between birth and preschool.

Table 2. *Correlations Between all Study Variables*

Variables	1	2	3	4	5	6	7	8
1. Residential mobility	–							
2. Fall inhibitory control	-.17**	–						
3. Fall applied problems	-.12**	.38***	–					
4. Fall letter-word identification	-.19***	.37***	.58***	–				
5. Spring applied problems	-.12*	.40***	.83***	.58***	–			
6. Spring letter-word identification	-.22***	.39***	.57***	.84***	.59***	–		
7. Child age (in months)	-.10[†]	.21***	.44***	.31***	.39***	.21***	–	
8. English language learner[a]	-.19***	.04	-.40***	-.16**	-.48***	-.19*	-.04	–
9. Parent education (in years)	-.11*	.16**	.51***	.46***	.51***	.45***	.15**	-.53***

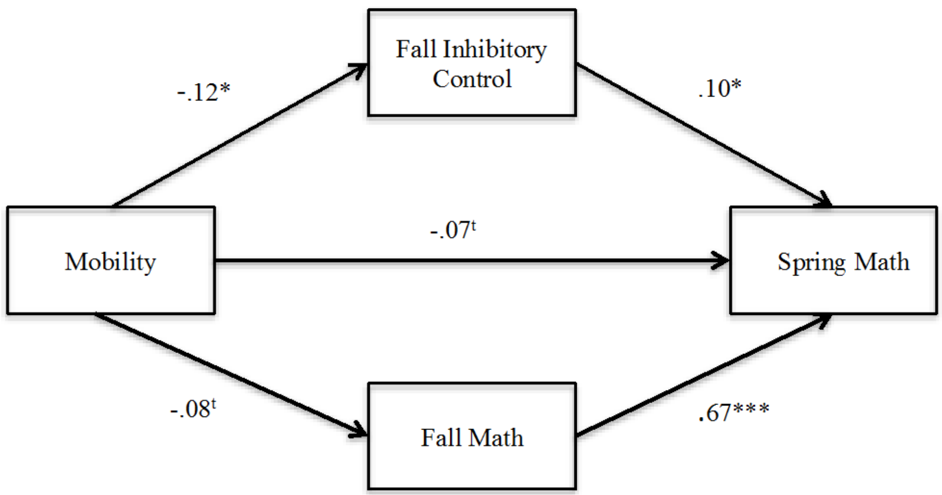
Note. For correlations utilizing spring achievement scores, $N = 272$.
[a]English language learner: 0 = no; 1 = yes.
[†]$p < .10$; *$p < .05$, **$p < .01$, ***$p < .001$

Table 3. *Direct Effects of Residential Mobility on Inhibitory Control and Achievement*

	B	SE B	β
Fall inhibitory control	-.73	.35	-.12*
Fall applied problems	-1.90	.87	-.10*
Fall letter-word identification	-1.88	.89	-.11*
Spring applied problems	-1.01	.60	-.07^{t}
Spring letter-word identification	-.09	.70	-.005

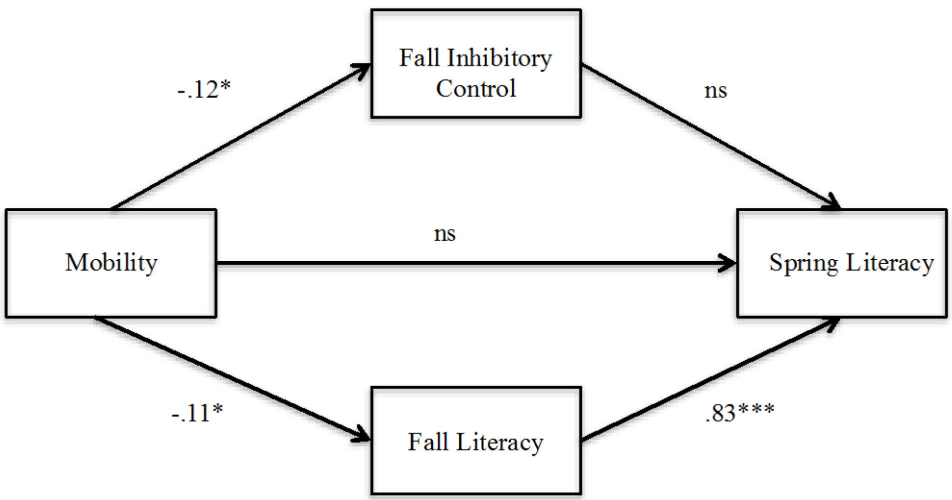
Note. Analyses controlled for child age, maternal education, ELL status, and baseline achievement scores. For analyses utilizing spring achievement scores, $N = 272$.
*$p < .05$. $^{t}p < .10$.

Figure 1. Direct and indirect effects of residential mobility on spring math achievement.



Direct effect: Mobility → Spring Applied Problems = -.07t
Indirect effect: Mobility → Spring Applied Problems = -.07*
Total effect: Mobility → Spring Applied Problems = -.14**
% direct = 50%

Figure 2. Direct and indirect effects of residential mobility on spring literacy achievement.



Direct effect: Mobility → Spring Letter-Word Identification= -.002
Indirect effect: Mobility → Spring Letter-Word Identification= -.10*
Total effect: Mobility → Spring Letter-Word Identification= $-.09^{t}$
% direct = 2%