Early Education and Development, 24: 446–467
ISSN: 1040-9289 print/1556-6935 online
DOI: 10.1080/10409289.2012.693430

Routledge
Taylor & Francis Group

ARTICLES

From Parental Involvement to Children's Mathematical Performance: The Role of Mathematics Anxiety

Rose K. Vukovic
Department of Teaching & Learning, New York University

Steven O. Roberts
Department of Applied Psychology, New York University

Linnie Green Wright
Graduate School of Social Work, Boston College

This study examined whether children's mathematics anxiety serves as an underlying pathway between parental involvement and children's mathematics achievement. Participants included 78 low-income, ethnic minority parents and their children residing in a large urban center in the northeastern United States. Parents completed a short survey tapping several domains of parental involvement, and children were assessed on mathematics anxiety, whole number arithmetic, word problems, and algebraic reasoning. *Research Findings:* The results indicated that parents influence children's mathematics achievement by reducing mathematics anxiety, particularly for more difficult kinds of mathematics. Specifically, the mediation analyses demonstrated that parental home support and expectations influenced children's performance on word problems and algebraic reasoning by reducing children's mathematics anxiety. Mathematics anxiety did not mediate the relationship between home support and expectations and whole number arithmetic. *Practice or Policy:* Policies and programs targeting parental involvement in mathematics should focus on home-based practices that do not require technical mathematical skills. Parents should receive training, resources, and support on culturally appropriate ways to create home learning environments that foster high expectations for children's success in mathematics.

The early school years are a crucial time for young children to develop skills and competencies that have been demonstrated to influence their success both during and beyond their elementary school experience (Institute of Medicine, 2000; McWayne, Green, & Fantuzzo, 2009). For

Correspondence regarding this article should be addressed to Rose K. Vukovic, Department of Teaching & Learning, New York University, 82 Washington Square East, 7th Floor, New York, NY 10003. E-mail: rose.vukovic@nyu.edu

ethnic minority children and children residing in low-income communities, multiple risk factors threaten their early experiences with success in school (Arnold & Doctoroff, 2003). Given the greater accountability and increased standards for academic achievement in Grade 3, identifying and implementing support for young children before they reach that crucial marker is essential for their school success. Thus, not only will identifying factors that can serve as buffers to the challenges that ethnic minority children in low-income communities face aid in the success of these children as they transition to school, but these protective factors can continue to promote children's success throughout their elementary school experience and beyond. Included in the research supporting multiple factors that influence the school success of young children is parental involvement (Jeynes, 2003). Indeed, supporting families' participation in their children's education may be one approach to minimizing the achievement gap that exists between White and ethnic minority children from an early age (Wong & Hughes, 2006). And yet little is known about the underlying mechanisms through which parental involvement influences children's academic achievement. The present study thus sought to extend the literature by examining potential pathways from parental involvement to children's achievement.

We were specifically interested in understanding the relationship between parental involvement and children's mathematics achievement with particular attention to a possible mediating role of mathematics anxiety. Defined as tense or worrisome feelings that significantly hinder mathematical performance in academic and ordinary life situations (Ashcraft, 2002; Richardson & Suinn, 1972), *mathematics anxiety* is an especially promising mediator of the relationship between parental involvement and children's mathematics achievement specifically because of the link between parenting practices and children's anxiety-related behaviors more generally (e.g., McLeod, Wood, & Weisz, 2007; Wood, McLeod, Sigman, Hwang, & Chu, 2003) *and* because of the well-documented relationship between mathematics anxiety and mathematics achievement (Ashcraft, Krause, & Hopko, 2007; Hembree, 1990; Ma, 1999). Indeed, highly mathematically anxious students enjoy mathematics less, are less confident in their mathematical abilities, and, as early as middle school, steer away from mathematics courses (Ashcraft, 2002; Hembree, 1990; Ho et al., 2000; Ma, 1999). Given the growing importance of mathematical proficiency for the overall health, wealth, and well-being of both individuals and the nation (National Mathematics Advisory Panel [NMAP], 2008), coupled with the disproportionately low mathematical performance of ethnic minority children residing in low-income communities (e.g., Attewell & Domina, 2008; Hanushek & Rivkin, 2009; Plantey et al., 2009), there is a pressing need to identify factors that mitigate the negative effects of mathematics anxiety, particularly in vulnerable learners. The focus in this study on the pathway from parental involvement to children's mathematics anxiety to children's mathematics achievement therefore has important theoretical and practical significance for researchers, educators, and policymakers interested in promoting mathematics achievement in ethnic minority children residing in low-income communities.

PARENTAL INVOLVEMENT AND ACADEMIC ACHIEVEMENT

Parental involvement, defined as motivated parental attitudes and behaviors intended to influence children's educational well-being, is a multidimensional and bidirectional construct (Christenson, 2004; Fantuzzo, Tighe, & Childs, 2000) that has been shown to have clear links with social and academic outcomes for children (Dearing, McCartney, Weiss, Kreider, & Simpkins, 2004; El Nokali, Bachman, & Votruba-Drzal, 2010; Zigler & Muenchow, 1992). Parent involvement has traditionally been defined by parents engaging in school-based activities (e.g., attending parent–teacher conferences and school events) related to their child's education (Epstein, 1995). However, over time, a more comprehensive view of parental involvement has evolved beyond just parent activities in school settings.

More recent research has shown that a much broader range of parent involvement activities can influence positive school outcomes for children (Ginsburg-Block, Manz, & McWayne, 2010). In addition to traditional school-based activities, more modern conceptualizations of parent involvement include activities and interactions between parents and their children at home and in their communities (e.g., supervision and monitoring, daily conversations about school, and visiting local community institutions for learning purposes) as well as parental expectations about learning (Ginsburg-Block et al., 2010; Jeynes, 2010; McWayne, Campos, & Owsianik, 2008; Pomerantz, Moorman, & Litwack, 2007). This more comprehensive view of parental involvement is grounded in the understanding that children's success in school is influenced by multiple contexts (e.g., home, school, and community) in a dynamic and bidirectional manner (Bronfenbrenner & Morris, 1998). Broadening the conceptualization of parent involvement to include parental activities in school, home, and community contexts allows for increased opportunities for parents to support their children's academic success in a variety of roles. This study sought to explore a more modern parent involvement construct that includes school and home-based activities as well as expectations about learning.

A large body of research provides support for an overall positive relationship between both home- and school-based parental involvement and academic achievement in young children (e.g., X. Fan & Chen, 2001; Graue, Weinstein, & Walberg, 1983; Jeynes, 2003, 2005; Nye, Tuner, & Schwartz, 2007; Sénéchal, 2006). Although a substantial body of research on parental involvement has focused on outcomes related to literacy, a growing number of studies have specifically targeted mathematics achievement in young children. This literature has demonstrated that various aspects of home-based involvement in particular (e.g., parental expectations and aspirations for their children, parent–child communication, and encouragement for learning in mathematics) are associated with increased mathematics achievement in elementary school children (e.g., X. Fan & Chen, 2001; Fantuzzo, King, & Heller, 1992; Graue et al., 1983; Jeynes, 2003, 2005; Nye et al., 2007). Indeed, a recent review of intervention studies identified specific parental involvement activities, like increasing positive communication between the home and school, providing home-based support for learning, and providing home-based celebrations for accomplishments, as essential to supporting positive mathematics outcomes in children (Ginsburg-Block et al., 2010).

Although they have provided evidence that parental involvement does indeed influence children's mathematics performance, previous studies have not specifically examined *how* or the underlying mechanisms through which parental involvement impacts children's achievement. Grolnick, Ryan, and Deci (1991) hypothesized that parental involvement primarily influences children's attributes and behaviors, which in turn affect mathematics achievement. Similarly, the theoretical framework provided by Hoover-Dempsey and Sandler (1995, 1997) suggests that parental involvement enhances children's academic self-efficacy, intrinsic motivation to learn, self-regulatory use, and social self-efficacy, which in turn operate to enhance achievement.

There is preliminary corroborating evidence that parental involvement is related to such social and motivational attributes in students (e.g., W. Fan & Williams, 2010; Gonzalez & Wolters, 2006; Senler & Sungur, 2009; Steinberg, Lamborn, Dornbusch, & Darling, 1992; Tan & Goldberg, 2009). For instance, W. Fan and Williams (2010) found that parental involvement (i.e., parental advising, parents' educational aspirations for their children, school-initiated contact) was positively related to students' academic engagement, self-efficacy toward mathematics, and intrinsic motivation toward mathematics. Similarly, Izzo, Weissberg, Kasprow, and Fendrich (1999) found that parental involvement (i.e., home involvement, school involvement, parent–teacher communication) was predictive of children's school engagement and socioemotional adjustment. Even still, these studies were not designed to examine whether such attributes served as *mediators* in the relationship between parental involvement and mathematics achievement. Furthermore, such research has not considered the relationship between parental involvement and student attributes beyond social and motivational influences, even though there is substantial evidence of a link between both parenting practices and children's affect—including anxiety-related behaviors (e.g., McLeod et al., 2007; Wood et al., 2003)—and children's affect and their mathematical performance (see NMAP, 2008). Toward this end, the present study focused specifically on examining children's mathematics anxiety as a mediator between parental involvement and children's mathematics achievement. If parental involvement does indeed buffer the effects of children's mathematics anxiety on children's mathematics achievement, the importance of supporting parental involvement initiatives becomes even more evident.

MATHEMATICS ANXIETY

Mathematics anxiety is receiving increasing attention as an important construct to consider when studying influences on children's mathematical development. Considered a performance-based anxiety disorder similar to social phobia and test anxiety, mathematics anxiety is characterized by anxious responding that occurs both in the immediate context of a performance-based setting (e.g., math class) or in anticipation of having to perform publicly (e.g., being called on during math class) and the subsequent potential for negative evaluation by teachers and peers (Ashcraft et al., 2007; Hopko, McNeil, Zvolensky, & Eifert, 2001; Newstead, 1998). As a performance-based anxiety disorder, mathematics anxiety involves physiological arousal, negative cognitions, escape and/or avoidance behaviors, and, when the individual cannot escape the situation, performance deficits (Ashcraft et al., 2007; Hopko et al., 2001).

Mathematics anxiety has been shown to be distinct from both general and test anxiety, is not related to general intelligence, and appears to be a cause versus a consequence of performance deficits (Ashcraft et al., 2007; Hembree, 1990; Ma, 1999). Indeed, mathematics anxiety has consistently been shown to be negatively related to mathematics achievement, with correlations estimated between $-.27$ and $-.34$ for children across fourth grade to secondary school (Hembree, 1990; Ma, 1999). Particularly problematic is that individuals with higher levels of mathematics anxiety tend to avoid taking high school and college mathematics courses, which has especially severe consequences given the growing recognition that higher level mathematics courses, such as algebra, serve as gatekeepers to full economic opportunity and mobility (e.g., Moses & Cobb, 2001).

Despite the severe consequences associated with mathematics anxiety, surprisingly little is known about the early development of mathematics anxiety. Indeed, mathematics anxiety has been studied primarily from fourth grade through adulthood (e.g., Baloglu & Kocak, 2006; Capraro, Capraro, & Henson, 2001; Hembree, 1990; Ma, 1999; Richardson & Suinn, 1972), although recent research suggests that mathematics anxiety—or its precursor—might be detectable as early as first or second grade (Harari, Vukovic, & Bailey, in press; Krinzinger, Kaufmann, & Willmes, 2009). Ashcraft et al. (2007) speculated that mathematics anxiety is likely influenced by a complex interplay among several factors, including a biological predisposition toward anxiety, prior negative experiences with mathematics, maladaptive cognitive schemata, and distal and proximal experiences. Even still, a dearth of studies—with either children or adults—have systematically investigated these sources.

Toward this end, the present study extends the literature by focusing specifically on the distal experience of parental involvement. As noted, there is empirical evidence that parenting practices play a small but significant role in the developmental course of children's anxiety disorder–related behaviors (e.g., McLeod et al., 2007; Wood et al., 2003), and indeed there is evidence that parenting practices related specifically to parent–child *educational* interactions (i.e., punishment and negative reinforcement, positive reinforcement, and parental nonresponsiveness to children's requests for educational assistance) are associated with children's anxiety disorders (i.e., panic/agoraphobia, generalized anxiety, separation anxiety, physical injury, social anxiety, and compulsive behavior; Mellon & Moutavelis, 2011). Yet to our knowledge, the simultaneous relationship among parental involvement, children's *mathematics* anxiety, and children's *mathematics* achievement has yet to be examined within an empirical framework. Such research is necessary to shed light on the onset of mathematics anxiety as well as the role of potential protective factors, such as parental involvement.

DOMAINS OF MATHEMATICAL COGNITION

A final aspect of this study concerns the operationalization of mathematics achievement. The research base in both parental involvement and mathematics anxiety typically conceptualize mathematics achievement as encompassing several domains of mathematical ability. Yet research has shown that mathematical cognition comprises discrete domains (e.g., arithmetic skills, word problems) that draw on different underlying cognitive skills and are influenced by different factors (e.g., Carr, Steiner, Kyser, Biddlecomb, 2008; Fuchs et al., 2010; LeFevre et al., 2010). Furthermore, mathematics anxiety appears to be particularly debilitating for more difficult mathematical tasks, such as percentages and equations with unknowns, as opposed to mathematical problems involving whole number operations (Ashcraft, 2002; Ashcraft et al., 2007). Using global measures of mathematics, therefore, might obscure important developmental relationships. This study thus focused on three different types of mathematics achievement: whole number arithmetic, word problems involving whole number arithmetic, and prealgebraic cognition (e.g., sorting, classifying, describing patterns; Connolly, 2007).

Whole number arithmetic involves both knowledge of the basic number combinations as well as skill at using procedures or algorithms for solving arithmetic problems with whole numbers. Much is understood about how children learn and solve whole number arithmetic problems (e.g., Carpenter, Franke, Jacobs, Fennema, & Empson, 1998; Fuson, 1992), including at least some of the child- and teacher-level factors that facilitate or hinder children's development (NMAP, 2008). Even so, little is known about how parental involvement influences children's whole number arithmetic development specifically, which is unfortunate because it seems to us at least that whole number arithmetic skills can be more easily supported at home than other, more complex domains of mathematics.

Word problem solving involves the ability to solve whole number arithmetic problems embedded within word problems of varying linguistic and mathematical complexity. Many children who can solve whole number arithmetic problems are unable to solve contextual problems using those same digits, suggesting that children lack a conceptual understanding of the deeper mathematical concepts and operations they are learning (Gersten et al., 2009). As with whole number arithmetic, a substantial research base exists concerning effective instructional practices to foster word problem solving (e.g., Gersten et al., 2009), and yet word problems remain a significant source of difficulty across the lifespan (e.g., Kutner et al., 2007). This is particularly problematic because the mathematics homework that young children receive often involves word problems with the assumption that parents can assist their child in completing such homework. More research is therefore needed to understand how parental involvement influences children's word problem solving to inform the development of appropriate policies and practices.

Unlike arithmetic, which concerns solving mathematical problems involving specific known numbers, algebra involves solving mathematical problems that contain unknown values (i.e., variables). Algebraic problems are expressed in mathematical statements (i.e., equations) that describe relationships between known and unknown variables, and these statements are manipulated using the same rules of operation as in arithmetic. Algebra has received increased attention in recent years given its role as a gatekeeper to full economic opportunity and mobility at both the individual and national levels (e.g., NMAP, 2008; Moses & Cobb, 2001). Although algebra instruction typically begins in middle school, a growing body of studies has recognized the importance of teaching prealgebraic concepts and representations to elementary school students (e.g., Carraher, Schliemann, Brizuela, & Earnest, 2006; Fuchs et al., in press; Jacobs, Franke, Carpenter, Levi, & Battey, 2007). Even so, little is known about the sources of individual differences in young children's algebraic cognition (NMAP, 2008). The present study thus extends the literature by examining parental involvement as a source of individual difference in young children's development of competency with algebra.

THE PRESENT STUDY

Building on previous research that seeks to understand how parental involvement influences children's achievement, this study was designed to extend the literature by examining whether mathematics anxiety serves as an underlying pathway in the relation between parental involvement and different domains of children's mathematics achievement. We focused specifically on ethnic minority second-grade children attending urban schools because children living in these contexts face a disproportionate number of challenges in comparison to their more advantaged peers (Franco, Pottick, & Huang, 2010), and parent involvement has been shown to serve as a protective factor in the face of these challenges (Jeynes, 2003, 2005; McWayne, Hampton, Fantuzzo, Cohen, & Sekino, 2004).

Based on the literature reviewed, we tested the model shown in Figure 1, which made three predictions. First, we hypothesized that parental involvement would be negatively related to

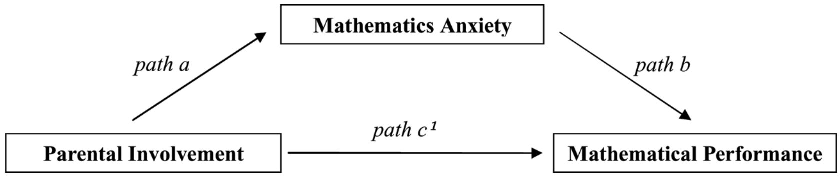

FIGURE 1 Predicted relationships among parental involvement, mathematics anxiety, and mathematical performance.

children's mathematics anxiety (path *a*). Second, we hypothesized that mathematics anxiety would be negatively related to mathematics achievement (path *b*); we expected stronger relationships for word problems and algebraic reasoning compared to whole number arithmetic. Third, we predicted that the relation between parental involvement and mathematics achievement would not be significant when mathematics anxiety was controlled (path c^1), indicating that mathematics anxiety mediates this relationship. Because this mediation model has not previously been tested empirically, we made no predictions on how this model would hold for different types of mathematical outcomes.

METHOD

Participants

The data reported in this study were collected with a sample of second-grade children who were part of a larger research project designed to examine the developmental course and predictors of various mathematical abilities in children. The study occurred in two Title I urban schools characterized largely by low-income, ethnic minority populations. A secondary purpose of the larger study was to identify ecological factors that influence mathematical development, such as parental involvement. Thus, parents were also invited to participate by completing a short survey.

Parental consent for children's participation was obtained for 75.1% (130 of 173) of second graders and 65.9% ($n = 114$) of parent surveys were returned, which is consistent with return rates reported by other researchers working with similar populations (e.g., McWayne et al., 2008). However, not all parent surveys were fully completed because, consistent with informed consent procedures, parents were instructed that they could skip questions; 68.4% ($n = 78$) of the returned surveys were usable for the purposes of the present study. Thus, this study is based on the 78 parents and their children (mean age = 7 years, 10 months; $SD = 6$ months) with complete data. There were no differences on any of the individual items in the parental involvement survey between the 78 complete parent surveys and the 52 from the larger study that did not have complete data. There were also no differences on any of the child-level outcomes between the participants and nonparticipants. Most of the children in this study were eligible for free or reduced lunch (94.9%) and were of an ethnic minority background (Hispanic = 61.5%, Black = 32.1%). Parent respondents were primarily female (85.9%), resided primarily in single-parent households (65.4%), and were primarily employed full time (48.7%). Table 1 provides more detailed demographic characteristics for the sample.

TABLE 1
Demographic Characteristics of Participating Parents and Children

Variable	*n*	%
Parents (self-report)		
Gender		
Female	67	85.9
Employment status of responder:		
Full time	38	48.7
Part time	6	7.7
Unemployed	19	24.4
Student	6	7.7
Missing	9	11.5
Marital status of responder		
Married	27	34.6
Divorced	5	6.4
Separated	6	7.7
Single	34	43.6
Other	6	7.7
Mother's education		
Some high school	20	25.6
High school graduate	30	38.5
Some college	18	23.1
College graduate	6	7.7
Some graduate work/graduate degree	2	2.6
Missing	2	2.6
Father's education		
Some high school	22	28.2
High school graduate	23	29.5
Some college	9	11.5
College graduate	4	5.1
Some graduate work/graduate degree	4	5.1
Missing	16	20.5
Number of children in household		
1	12	15.4
2	32	41.0
3	20	25.6
4	7	9.0
5+	4	5.1
Children (information obtained from school)		
Gender		
Female	43	55.1
Race/ethnicity		
Black	25	32.1
Hispanic	48	61.5
Other (i.e., Asian, White)	3	3.8
Missing	2	2.6
Lunch program		
Free or reduced	74	94.9
Full price	2	2.6
Missing	2	2.6

TABLE 2
Item Loadings, Communalities (h^2), and Percentage of Variance for Principal Component Analysis and Direct Quartimin Rotation on Parental Involvement Items

Item	F_1	F_2	F_3	F_4	F_5	h^2
1. I help my child with his/her homework.	**.71**	.24	.11	.21	−.02	.74
2. I am an active participant in my child's learning.	**.52**	−.13	−.08	.34	.36	.71
3. I communicate with my child's teachers regularly.	**.48**	.36	−.22	.02	.16	.52
4. I was good at math.	−.07	**.88**	−.08	.13	.03	.80
5. I enjoyed math.	−.11	**.88**	−.09	.03	−.01	.73
6. My teachers were attentive to me.	.34	**.64**	.11	.02	−.02	.63
7. I was a good student.	.18	**.58**	.32	.02	.09	.62
8. I enjoyed elementary school.	.30	**.49**	.17	−.26	.12	.51
9. I have difficulty understanding my child's homework. (reversed)	.07	−.19	**.85**	.12	−.04	.74
10. I have difficulty explaining math assignments to my child. (reversed)	−.04	.14	**.69**	−.06	−.09	.52
11. I believe my child has trouble with math. (reversed)	−.36	.22	**.54**	.14	**.48**	.69
12. My child has access to resources to help him/her learn at home.	−.04	.15	.16	**.87**	−.16	.74
13. My child is being well prepared in school to continue his/her education.	.04	−.01	−.07	**.77**	.13	.69
14. I feel successful about my efforts to help my child learn.	.29	−.18	.02	**.55**	.26	.62
15. I expect my child to get good grades in math.	−.20	.12	−.26	.07	**.80**	.71
16. I believe my child will perform well in math in future grades.	.03	.12	−.20	.27	**.65**	.70
17. I never do math activities with my child. (reversed)	.27	−.13	.24	−.11	**.59**	.52
18. I help my child study for math tests at home.	.18	.04	.10	.02	**.53**	.41
Percentage of variance	29.06	13.56	9.78	6.34	5.67	

Note. Loadings in bold are values greater than .45. F_1 = Parental Involvement in Children's Education ($\alpha = .70$); F_2 = Parental Valence Toward School ($\alpha = .81$); F_3 = Perceived Difficulties ($\alpha = .61$); F_4 = Parental Self-Efficacy ($\alpha = .65$); F_5 = Home Support and Expectations for Mathematics ($\alpha = .72$).

Measures

Parental involvement. This researcher-developed survey incorporated 24 items based loosely on the work of Hoover-Dempsey and Sandler (1995, 1997; Walker, Wilkins, Dallaire, Sandler, & Hoover-Dempsey, 2005). The survey utilized a Likert scale ranging from 1 (*disagree strongly*) to 6 (*strongly agree*). Table 2 lists the 18 items from the survey that were subjected to factor analysis to determine whether our survey captured a unidimensional construct of parental involvement or whether we needed to consider multiple dimensions. Six survey items (i.e., ''I volunteer at my child's school,'' ''I support decisions made by my teacher,'' ''I attend parent–teacher conferences,'' ''I talk with my child about his/her school day,'' ''I make a significant difference in my child's school performance,'' and ''My child asks me to explain something about his/her math homework'') were not included in the analyses because a large majority of the respondents omitted these items.[1] The Kaiser–Mayer–Olkin measure of sampling adequacy for this sample was .78, indicating a sufficient number of significant correlations among the items to justify a factor analysis (Pett, Lackey, & Sullivan, 2003).

[1]Deleting participants with missing data would have resulted in a substantially smaller and less representative sample, which would have limited our analyses and conclusions; we thus elected to delete these specific items from the analyses.

Consistent with the recommendations of Fabrigar, Wegener, MacCallum, and Strahan (1999) for factor analysis in psychological research, principal component analysis with direct quartimin rotation was performed on the 18 items. Pattern matrix coefficients, communalities, and percentages of variance are shown in Table 2. Five factors were extracted, three of which were moderately defined by the variables and internally consistent according to standard statistical conventions (Nunnally, 1978): Cronbach's alpha for Factor 1 reached .70, with loadings ranging from .48 to .71; Cronbach's alpha for Factor 2 reached .81, with loadings ranging from .49 to .88; and Cronbach's alpha for Factor 5 reached .73, with loadings ranging from .48 to .80. The reliabilities for Factors 3 and 4 fell below standard conventions and were thus not considered further. The variables were moderately defined by this factor solution, as indicated by the communality values. Interpreting the variables with loadings of .45 and greater, we defined Factor 1 as Parental Involvement in Children's Education, Factor 2 as Parental Valence Toward School, and Factor 5 as Home Support and Expectations for Mathematics.

Mathematics anxiety. Because a measure of mathematics anxiety for young children does not exist, we created a 12-item measure based on existing scales (i.e., Suinn, Taylor, & Edwards, 1988; Wigfield & Meece, 1988), adapting our questions to be developmentally appropriate for young children (Harari, Vukovic, & Bailey, in press). In the present study, we indexed math anxiety with seven items tapping physiological arousal and worry, consistent with conceptualizations of anxiety. These seven items were thus used to index mathematics anxiety in the current study. Sample items included ''I get nervous about making a mistake in math'' and ''When it is time for math my head hurts.'' To standardize administration and reduce the reading demands, questions were read aloud and the children responded by circling their response to each statement using a 4-point scale (yes, kind of, not really, and no). Numerical values were assigned to each item so that higher scores indicated greater anxiety. Cronbach's alpha for this sample was .81.

Whole number arithmetic. We used the Stanford Diagnostics Mathematics Test–Fourth Edition (Harcourt Assessment, 1996) Computation test. For this nationally normed test, children have 25 min to complete 20 grade-level questions that measure the degree to which students have mastered addition and subtraction facts and are able to use procedural skills to solve addition and subtraction problems presented in arithmetic notation, including those that require regrouping. The publisher reports a reliability of .85 for second graders.

Word problems. Adapted from previous research (e.g., Carpenter & Moser, 1984; Jordan & Hanich, 2003), this task requires children to solve 15 brief word problems involving whole numbers (e.g., ''Tanisha had 5 pennies and then Tyra gave her 2 more pennies. How many pennies does Tanisha have now?'' ''Sonia has 7 pennies. Chelsea has 5 pennies. How many more pennies does Sonia have than Chelsea?''). Following the methodology of Fuchs et al. (2006), the experimenter read each item aloud and students had 30 s to respond. Cronbach's alpha for this sample was .84.

Prealgebraic reasoning. On the nationally normed KeyMath Diagnostic Assessment–Third Edition (Connolly, 2007) Algebra subtest, children work with number sentences (e.g., Six plus some number equals ten. Point to the missing number.), describe patterns and functions (e.g., Look at how the pattern is growing. Which shape comes next in the pattern?), and represent mathematical relationships (e.g., Eight equals six plus what number?). The publisher reports a reliability of .83 for second graders.

Procedure

Assessments of children occurred in the spring of second grade. Children were individually assessed on algebraic reasoning and group-assessed on whole number arithmetic, word problems, and mathematics anxiety. Research assistants conducted the assessments in the schools. Research assistants completed an intensive 4-hr training workshop on standardized administration, which included demonstrating 100% accuracy during mock administrations. In addition, a school psychology doctoral student was available to answer questions and provide coaching where necessary throughout data collection. The parental involvement survey was distributed in the fall, and parent surveys were accepted throughout the data collection period. Parents returned completed surveys to the principal investigator in a sealed envelope.

RESULTS

Preliminary analyses focused on descriptive statistics and correlations among the variables in the study are shown in Table 3. The child-level variables were moderately correlated with each other in the expected directions. By contrast, the parental involvement factors were not correlated with each other, and furthermore, only the home support and expectations for mathematics factor was significantly correlated with child-level outcomes. Parental involvement in children's education was correlated only with whole number arithmetic (in an unexpected direction), and parental valence was correlated only with word problems. Thus, we focused mediation analyses only on the home support and expectations for mathematics factor.

Mediation Analyses

Having established significant correlations among the variables of interest, we focused the primary analyses on examining whether mathematics anxiety mediated the relationship between home support and expectations for mathematics and different types of mathematical outcomes. We followed Baron and Kenny (1986) and Preacher and Hayes (2004) to obtain estimates for

TABLE 3
Means, Standard Deviations, and Correlations Among Variables ($n = 78$)

Variable	*M (SD)*	*1*	*2*	*3*	*4*	*5*	*6*	*7*
1. Involvement in child's education (max 18)	15.37 (2.29)	—						
2. Valence toward school (max 30)	23.31 (4.91)	.19	—					
3. Home support and expectations (max 30)	23.85 (4.24)	.21	.01	—				
4. Mathematics anxiety (max 28)	12.71 (5.60)	.10	−.12	−.27*	—			
5. Whole number arithmetic (percentile)	30.60 (23.55)	−.24*	.11	.28*	−.22*	—		
6. Word problems (max 15)	8.19 (4.01)	.03	.26*	.25*	−.36**	.54***	—	
7. Algebraic reasoning (percentile)	25.28 (21.85)	.02	.13	.27*	−.31**	.48***	.68***	—

Note. Variables 1–3 represent parental involvement factors. For ease of interpretation, raw scores are displayed for parental involvement means, although analyses were conducted on factor scores; whole number arithmetic and algebraic reasoning are presented in percentiles, but analyses were conducted on standard scores.

$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

TABLE 4
Direct and Indirect Effects of Home Support and Expectations on Mathematics Outcomes

Outcome	*Effect of IV on M (path a)*	*Effect of M on DV (path b)*	*Direct effect (path c^1)*	*Indirect effect ($a \times b$)*	*Bootstrapped 95% CI*
Whole number arithmetic	−0.26 (0.11)*	−6.30 (5.25)	10.89 (5.12)*	1.68 (1.70)	−1.14–5.68
Word problems	−0.26 (0.11)*	−1.27 (0.44)**	0.64 (0.43)	0.3300 (0.20)	0.01–0.78
Algebraic reasoning	−0.26 (0.11)*	−0.69 (0.29)*	0.50 (0.28)	0.18 (0.11)	0.01–0.43

Note. Values within parentheses are standard errors. A 95% CI that does not include zero is a statistically significant indirect effect. IV = independent variable, which for these analyses was home support and expectations for mathematics; M = mediator, which for these analyses was mathematics anxiety; DV = dependent variable; CI = confidence interval.
$^*p < .05$. $^{**}p < .01$.

direct and indirect effects and used bootstrapping to construct 95% confidence intervals for the indirect effect of home support and expectations. We used the SPSS macro that accompanies Preacher and Hayes to run our analyses. Table 4 summarizes the results.

As shown in Table 4, the effect of home support and expectations for mathematics—path *a*—was statistically significant, which was necessary for mediation analyses to proceed. When we held home support and expectations constant, the effect of mathematics anxiety on mathematical outcomes—path *b*—was statistically significant only for word problems and algebraic reasoning, indicating that whole number arithmetic did not meet the criteria for mediation. Thus, whole number arithmetic was not further considered. When we held mathematics anxiety constant, the direct effect of home support and expectations—path c^1—was not statistically significant for either word problems or algebraic reasoning, indicating that mathematics anxiety fully mediated the relationship. The bootstrapped 95% confidence interval indicated that the indirect effect of home support and expectations on word problems and algebraic reasoning was statistically significant.

DISCUSSION

The primary purpose of this study was to examine whether mathematics anxiety serves as an underlying pathway in the relationship between parental involvement and the mathematics achievement of ethnic minority children in urban schools. These children are not only more likely to live in underresourced communities and experience increased exposure to stress (Franco et al., 2010) but are also especially vulnerable to poor academic outcomes (National Center for Education Statistics, 2007), which has long-term implications for their overall health and psychological well-being. Given that parent involvement has been shown to serve as a protective factor, particularly for vulnerable children (Jeynes, 2003), it is essential to understand the specific nature of the relationship between parental involvement and academic achievement in order to guide prevention and intervention efforts. In general, our results suggest that the pathway from parental involvement to mathematics anxiety to mathematics achievement depends on the type of parental involvement *and* the type of mathematics. To begin with, we found that the home support and expectations factor emerged as the only salient dimension of parental involvement. Subsequently, we found support for a pathway from parental home support and expectations to reduced mathematics anxiety in children to higher levels of children's word problems and algebraic reasoning but not whole number arithmetic.

Before we discuss these findings, we caution readers about our study limitations. First, the cross-sectional design of this study precludes causal claims. This is especially important to emphasize because mediation models assume both that the independent variable (i.e., parental involvement) causes the mediator (i.e., children's mathematics anxiety) and that the mediator causes the dependent variable (i.e., mathematical performance) as opposed to the dependent variable causing the mediator. Second, missing data in the parental involvement survey resulted in the elimination of items from the factor analysis that would be expected to load on a school involvement factor, which has been identified as an important dimension of parental involvement (e.g., Ginsburg-Block et al., 2010; Grolnick & Slowiaczek, 1994; Hill & Craft, 2003). Furthermore, we used only one source to gauge parental involvement, namely parent self-report. Although this is common practice in the field, the findings might differ depending on how parental involvement is measured. Finally, although our results are generally consistent with the larger literature (discussed below), the results of the factor analysis suggest that there may have been methodological limitations in our scale. Specifically, two of the five factors in the parental involvement scale were not internally consistent (i.e., perceived difficulties and parental self-efficacy) and only one factor (i.e., home support and expectations) was consistently related to mathematical performance. Although such limitations precluded a more comprehensive assessment of parental involvement (e.g., home, school, and community activities), our scale does include a picture of home activities, which are important in more modern conceptualizations of parental involvement, therefore allowing for support of this expanded definition of parental involvement. However, our findings require replication with longitudinal and experimental studies. Bearing these limitations in mind, we focus the remainder of the discussion on three key findings.

Mathematics Anxiety as a Mediator for Higher Level Mathematics

The relation between parental involvement and mathematical performance as mediated by mathematics anxiety presented itself to be more nuanced than expected. More specifically, home support and expectations for mathematics influenced word problem solving and prealgebraic reasoning by reducing children's mathematics anxiety, thus suggesting that mathematics anxiety served as a mediator specifically for higher order domains of mathematics. This supposition is further supported by additional analyses in which we found that mathematics anxiety also served as a mediator for geometry and data analysis and probability (results available from the authors). By contrast, mathematics anxiety was not a mediator for whole number arithmetic; instead, home support and expectations for mathematics maintained a direct effect on whole number arithmetic.

We speculate that the nature of the mathematical tasks accounts for this difference. Word problems and algebraic reasoning are mathematical problems embedded within context, often without the formal conventions of mathematics. These higher order mathematical skills encourage conceptual understanding, which means that they are harder to solve—for both children and adults—because there is not a direct route to a correct answer. Furthermore, these types of problems evoke more anxiety both in children—as evidenced by the stronger correlations in this study between mathematics anxiety and higher order mathematics compared to lower order mathematics—*and* in adults (Ashcraft, 2002; Ashcraft et al., 2007). It therefore seems plausible that parents are less likely to provide direct support for higher order mathematics specifically because such problems are difficult for parents to solve and induce anxiety. Instead, our results suggest that parents exert an indirect influence on higher order mathematics by reducing children's mathematics anxiety. These findings indicate that creating a space for children to learn at home and maintaining high parental expectations for children's success in mathematics translates to lower levels of mathematics anxiety in children, which translates to better performance on higher order mathematical tasks.

By contrast, home support and expectations for mathematics maintained a direct effect on whole number arithmetic—mathematical problems presented in standard arithmetic notation—even when children's mathematics anxiety was controlled. Whole number arithmetic problems are easier for both children and adults to solve and induce less anxiety in both children and adults (e.g., Ashcraft, 2002; Ashcraft et al., 2007; Harari, Vukovic, & Bailey, in press). Thus, it makes sense that parents have a direct effect on whole number arithmetic in part because parents are likely to feel more confident in their ability to help their children with lower level mathematics. So, it appears that mathematics anxiety does not underpin the relationship between parental involvement and whole number arithmetic primarily because whole number arithmetic is not particularly anxiety provoking in either children or adults. Future research is needed to determine whether other social, motivational, or affective factors mediate this relationship.

These findings require replication with longitudinal and experimental studies, especially in light of the lack of comparable research in this area. Given that our study was grounded in the parental involvement literature, our results might clarify and extend this literature specifically. For instance, Gill and Reynolds (1999) found minimal evidence for a mediation model whereby children's perceptions of parent and teacher expectations mediated the relationship between actual parent and teacher expectations and children's mathematics achievement; mathematics achievement in that study was operationalized with a standardized test that tapped whole number arithmetic skills, mathematical concepts, and problem-solving ability. Given the finding in the current study of a differential relationship between parental involvement and specific types of mathematics, it is possible that Gill and Reynolds did not find a significant mediation because their measure did not disaggregate different types of mathematics. Future research is necessary to resolve this issue.

Our results are generally consistent with the body of research documenting a relationship between parental involvement and children's social, motivational, and affective attributes (e.g., W. Fan & Williams, 2010; Gonzalez & Wolters, 2006; McLeod et al., 2007; Mellon & Moutavelis, 2011; Senler & Sungur, 2009; Tan & Goldberg, 2009; Wood et al., 2003). Our results extend this research to include young children's mathematics anxiety as an additional affective attribute on which parental involvement exerts an influence. More important, our results further extend this research by demonstrating that such attributes may indeed serve as underlying mechanisms in the pathway from parental involvement to children's achievement. Thus, this research is consistent with the hypotheses espoused by Grolnick and colleagues (1991) and Hoover-Dempsey and Sandler (1995, 1997; Walker et al., 2005) that parental involvement influences children's attributes and behaviors, which in turn affects children's achievement. However, that children's mathematics anxiety did not mediate this relationship for whole number arithmetic indicates that more research is needed to explore the underlying mechanism operating in this relationship. Future research efforts should be sure to consider specific domains of mathematics separately.

Home Support and Expectations as a Salient Dimension of Parental Involvement

In the current study, home support and expectations for mathematics emerged as the most salient dimension of parental involvement. Neither of the other two reliable dimensions of parental involvement identified in this study—involvement in child's education and parental valence toward school—were significantly correlated with children's levels of mathematics anxiety, and indeed the parental involvement in children's education factor was negatively correlated with children's whole number arithmetic skills. Although it is possible that these findings reflect a methodological limitation in our scale (discussed previously), our results are consistent with a substantial body of literature highlighting the important effect home involvement has on children's achievement (Epstein, 1995; Fantuzzo et al., 2000; Walker et al., 2005). Furthermore, these results align with findings from meta-analyses conducted by Jeynes (2005, 2007) that suggest that compared to other dimensions of parental involvement, parental expectations has the largest influence on children's achievement. Indeed, Jeynes (2005, 2007) found that the effect sizes for the influence of parental expectations on students' achievement were .58 and .88 for elementary and secondary school students, respectively.

Such findings suggest that parental involvement policies and programs should in large part focus on the less tangible dimensions of parental involvement—what Jeynes (2010) has termed the ''subtle aspects of parental involvement.'' Subtle aspects of parental involvement include parental expectations, the quality of parent–child communication, and parental style (Jeynes, 2010), which is in general accord with our home support and expectations factor. That subtle aspects of parental involvement might be especially important for children's achievement is especially heartening for parents in urban settings whose life demands often limit their availability for school involvement (e.g., Hoover-Dempsey & Sandler, 1995; Jeynes, 2010).

Numerous studies have documented a pervasive discourse permeating mainstream U.S. society, practitioner circles, policymaking bodies, and even educational research that posits that ethnic minority parents, immigrant parents, and working-class and poor parents are uninterested and uninvolved in their children's education (Beresford & Hardie, 1996; Brantlinger, 1985; Delgado-Gaitan, 1991; Doucet, 2008; O'Connor, 2001; Valdés, 1998). These assumptions are even more pervasive in urban settings (Abdul-Adil & Farmer, 2006; Lightfoot, 2004; A. Y. F. Ramirez, 2003), where a continuous search for solutions to the problems of city children have led to citywide policies designed to incentivize parents to be involved, from mandated parent education to paying parents for attending parent–teacher conferences (Cardwell, 2007; Chrispeels, 1991; Westmoreland, Rosenberg, Lopez, & Weiss, 2009; Wittreich, Jacobi, & Hogue, 2003). These policies reflect the same tendency to overvalue school involvement, such that getting parents to participate more in schools, it is believed, will increase children's academic achievement. Instead, consistent with findings in the field, the current findings suggest that policies and programs aimed at increasing parental involvement should target subtle aspects of parental involvement. This seems to be especially important for higher level mathematics, which is what children will increasingly encounter as they progress through school.

Our findings also suggest that parents should be supported particularly in aspects of parental involvement that do not involve the direct teaching of more difficult and technical aspects of mathematics, which is also consistent with sound pedagogical practice. That is, it seems counterintuitive to make children's success in mathematics contingent upon direct help at home given that most parents have not received formal teacher training. Indeed, our results suggested that direct forms of involvement were *negatively* related to children's mathematics achievement, which converges with other research that has identified negative relations between parental involvement and children's academic outcomes (W. Fan & Williams, 2010; Izzo et al., 1999; Levpuscek & Zupancic, 2009). Complicating the issue is the fact that many adults may not have the mathematical skills expected of elementary and middle school students. For instance, Kutner and colleagues (2007) found that 55% of American adults lack even the most basic quantitative skills that are expected at the middle school level, such as calculating a weekly salary based on hourly wages or calculating the cost of groceries (Kutner et al., 2007). Coupled with the mathematics anxiety evoked in adults when confronted with mathematical problems beyond whole number arithmetic (Ashcraft, 2002; Ashcraft et al., 2007), it does not seem surprising that parents who are ill equipped to help their children academically may be more likely to use aversive forms of parenting, such as negative reinforcement, punishment, or nonresponsiveness (Mellon & Moutavelis, 2011), not because they are uninterested and uninvolved in helping their child but because they do not know *how* to help their child (Gal & Stoudt, 1995; Sheldon & Epstein, 2005). Clearly, then, there is a pressing need to understand how to empower parents to best support their children's mathematical development. Although there is some research on nontechnical ways in which parents can support preschool children's mathematical development—such as by playing numerical board games (e.g., Siegler & Ramani, 2009)—more research is needed to understand how to support parents across all levels of children's education. A particularly promising direction in light of the present findings might be to explore the effectiveness of parents in delivering interventions targeted toward reducing mathematics anxiety in children.

Mathematics Anxiety in Young Children

This study contributes to a small body of research on mathematics anxiety in young children (Harari, Vukovic, & Bailey, in press; Krinzinger et al., 2009; G. Ramirez, Gunderson, Levine, & Beilock, in press). Mathematics anxiety has been studied primarily from fourth grade through adulthood, with researchers noting a critical gap in the study of mathematics anxiety prior to fourth grade (Ashcraft & Moore, 2009; Hembree, 1990; Ma, 1999). Results from the current study suggest that mathematics anxiety–related behaviors are detectable as early as second grade—consistent with the onset of other performance-based anxiety disorders, such as social anxiety, which has been reported to have an onset at 7.3 years old (Costello, Egger, & Angold, 2004).

Of course, this implies that second-grade children have the cognitive maturity to link linguistic expressions with mathematics-related feelings. Although more research is needed to resolve whether 7-year-olds are indeed capable of experiencing mathematics anxiety, the pattern of our findings is consistent with the larger body of research in three ways. First, previous research has demonstrated that children—including children as young as 7 years old—are capable of reporting on their own anxiety levels and responses (e.g., Cobham & Rapee, 1999; Niditch & Varela, 2010). Second, the magnitude and direction of the correlation between mathematics anxiety and mathematics achievement in the current study are similar to what has been reported in the literature with older children and adults (Hembree, 1990; Ma, 1999). Third, our results are consistent with those of Ashcraft and colleagues (Ashcraft, 2002; Ashcraft et al., 2007), who found that whole number arithmetic problems do not evoke mathematics anxiety in adults, whereas more difficult tasks, such as percentages, equations with unknowns, and factoring, do evoke mathematics anxiety. Although more research is clearly needed to determine how mathematics anxiety detected in second graders compares to later mathematics anxiety, the current results provide preliminary evidence that at the very least, young children report experiencing the physiological arousal and negative cognitions characteristic of mathematics anxiety.

Possible sources of mathematics anxiety include peers, siblings, families, teachers, and society at large. Others have discussed the notion of a societal aversion to mathematics and that a corresponding culture of undervaluing mathematics may result in children attending inadequately resourced schools, receiving instruction from teachers who neither understand nor like teaching mathematics, and using deficient textbooks, all of which might exacerbate any negative feelings toward mathematics children bring to school, leading to less than optimal learning environments (e.g., Ashcraft et al., 2007; Ginsburg, 1997). The results of the current study suggest that parents can buffer the negative effects of children's mathematics anxiety, particularly for more difficult kinds of mathematics. More research is needed to determine how to best support parents in this effort. As noted, a particularly intriguing research direction is to examine parent-delivered mathematics anxiety interventions for children.

Conclusion

Despite the complex relationship between parental involvement and mathematical performance identified in this study, there are very clear implications for research, policy, and practice. More research is needed to understand the underlying mechanisms (e.g., mathematics anxiety, self-efficacy, motivation) that catalyze the pathway from parental involvement to children's achievement, including a focus on different dimensions of parental involvement and specific domains of mathematics. More research is also needed to understand how to develop subtle aspects of parental involvement. In the meantime, policies and programs targeting parental involvement in mathematics should focus on home-based practices that do not require parents to teach technical mathematical skills. Furthermore, parents should receive training, resources, and support on culturally appropriate ways to create learning environments at home that foster high expectations for children's success in mathematics, among other things. In sum, that parents can buffer the negative effects of mathematics anxiety in young children is an important finding that has implications for minimizing the achievement gap that exists between White and low-income, ethnic minority children across all ages and grades.

ACKNOWLEDGMENTS

This research was supported in part by challenge grants from New York University and the Steinhardt School of Culture, Education, and Human Development. Thanks to participating principals, teachers, parents, and students. Thanks to research assistants Tanisha Yong, Tyra Bailey, Rachel Harari, Chelsea Ziesig, Sean Bailey, Katie Iorio, Victoria Jackson, and Sarah Klevan.

REFERENCES

Abdul-Adil, J. K., & Farmer, A. D., Jr. (2006). Inner-city African American parental involvement in elementary schools: Getting beyond urban legends of apathy. *School Psychology Quarterly*, *21*, 1–12. doi: 10.1521/scpq.2006.21.1.1

Arnold, D. H., & Doctoroff, G. L. (2003). The early education of socioeconomically disadvantaged children. *Annual Review of Psychology*, *54*, 517–545. doi:10.1146/annurev.psych.54.111301.145442

Ashcraft, M. H. (2002). Math anxiety: Personal, educational, and cognitive consequences. *Current Directions in Psychological Science*, *11*, 181–185. doi:10.1111/1467-8721.00196

Ashcraft, M. H., Krause, J. A., & Hopko, D. R. (2007). Is math anxiety a mathematical learning disability? In D. Berch, & M. Mazzocco (Eds.), *Why is math so hard for some children? The nature and origins of mathematical learning difficulties and disabilities* (pp. 329–348). Baltimore, MD: Brookes.

Ashcraft, M. H., & Moore, A. M. (2009). Mathematics anxiety and the affective drop in performance. *Journal of Psychoeducational Assessment*, *27*, 197–205. doi:10.1177/0734282908330580

Attewell, P., & Domina, T. (2008). Raising the bar: Curricular intensity and academic performance. *Educational Evaluation and Policy Analysis*, *30*, 51–78. doi:10.3102/0162373707313409

Baloglu, M., & Kocak, R. (2006). A multivariate investigation of the differences in mathematics anxiety. *Personality and Individual Differences*, *40*, 1325–1335. doi:10.1016/j.paid.2005.10.009

Baron, R. M., & Kenny, D. A. (1986). The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology*, *51*, 1173–1182. doi:10.1037/0022-3514.51.6.1173

Beresford, E., & Hardie, A. (1996). Parents and secondary schools: A different approach? In J. Bastiani & S. Wolfendale (Eds.), *Home-school work in Britain: Review, reflection, and development* (pp. 139–151). London, England: David Fulton.

Brantlinger, E. (1985). Low-income parents' opinions about the social class composition of schools. *American Journal of Education*, *93*, 389–403. doi:10.1086/443806

Bronfenbrenner, U., & Morris, P. A. (1998). The bioecological model of human development. In W. Damon, & R. Lerner (Eds.), *Handbook of child psychology: Vol. 1. Theoretical models of human development* (6th ed. pp. 793–828). New York, NY: Wiley.

Capraro, M. M., Capraro, R. M., & Henson, R. K. (2001). Measurement error of scores on the Mathematics Anxiety Rating Scale across studies. *Educational and Psychological Measurement*, *61*, 373–386. doi:10.1177/00131640121971266

Cardwell, D. (2007, March 30). New York City to reward poor for doing right. *New York Times*. Retrieved from http://ww.nytimes.come/2007/03/30/nyregion/30poverty.html?ex=1175918400&en=1ccb2df6e664993a&ei=5070&emc=etal

Carpenter, T. P., Franke, M. L., Jacobs, V. R., Fennema, E., & Empson, S. B. (1998). A longitudinal study of invention and understanding in children's multidigit addition and subtraction. *Journal for Research in Mathematics Education*, *29*, 3–20. doi:10.2307/749715

Carpenter, T. P., & Moser, J. M. (1984). The acquisition of addition and subtraction concepts in grades one through three. *Journal for Research in Mathematics Education*, *15*, 179–202. doi:10.2307/748348

Carr, M., Steiner, H. H., Kyser, B., & Biddlecomb, B. (2008). A comparison of predictors of early emerging gender differences in mathematics competency. *Learning and Individuals Differences*, *18*, 61–75. doi:10.1016/j.lindif.2007.04.005

Carraher, D. W., Schliemann, A. D., Brizuela, B. M., & Earnest, D. (2006). Arithmetic and algebra in early mathematics education. *Journal of Research in Mathematics Education*, *37*(2), 87–115.

Chrispeels, J. H. (1991). District leadership in parent involvement: Policies and actions in San Diego. *Phi Delta Kappan*, *72*(5), 367–371.

Christenson, S. L. (2004). The family-school partnership: An opportunity to promote learning competence of all students. *School Psychology Review*, *33*(1), 83–104.

Cobham, V. E., & Rapee, R. M. (1999). Accuracy of predicting a child's response to potential threat: A comparison of children and their mothers. *Australian Journal of Psychology*, *51*, 25–28. doi:10.1080/00049539908255331

Connolly, A. J. (2007). *KeyMath diagnostic assessment–third edition*. Minneapolis, MN: Pearson.

Costello, J. E., Egger, H. L., & Angold, A. (2004). Developmental epidemiology of anxiety disorders. In T. Ollendick, & J. March (Eds.), *Phobic and anxiety disorders in children and adolescents* (pp. 61–91). New York, NY: Oxford University Press.

Dearing, E., McCartney, K., Weiss, H. B., Kreider, H., & Simpkins, S. (2004). The promotive effects of family educational involvement for low-income children's literacy. *Journal of School Psychology*, *42*, 445–460. doi:10.1016/j.jsp.2004.07.002

Delgado-Gaitan, C. (1991). Involving parents in the schools: A process of empowerment. *American Journal of Education*, *100*, 20–46. doi:10.1086/444003

Doucet, F. (2008). How African American parents understand their and teachers' roles in children's schooling and what this means for preparing preservice teachers. *Journal of Early Childhood Teacher Education*, *29*, 108–139. doi:10.1080/10901020802059441

El Nokali, N. E., Bachman, H. J., & Votruba-Drzal, E. (2010). Parent involvement and children's academic and social development in elementary school. *Child Development*, *8*, 988–1005. doi:10.1111/j.1467-8624.2010.01447.x

Epstein, J. L. (1995). School/family/community partnerships: Caring for the children we share. In J. Epstein (Ed.), *School/family/community partnerships: Preparing educators and preparing schools* (pp. 389–414). Boulder, CO: Westview Press.

Fabrigar, L. R., Wegener, D. T., MacCallum, R. C., & Strahan, E. J. (1999). Evaluating the use of exploratory factor analysis in psychological research. *Psychological Methods*, *4*, 272–299. doi:10.1037/1082-989X.4.3.272

Fan, W., & Williams, C. M. (2010). The effects of parental involvement on students' academic self-efficacy, engagement and intrinsic motivation. *Educational Psychology*, *30*, 53–74. doi:10.1080/01443410903353302

Fan, X., & Chen, M. (2001). Parental involvement and students' academic achievement: A meta-analysis. *Educational Psychology Review*, *13*, 27–61. doi:10.1023/A:1009048817385

Fantuzzo, J. W., King, J. A., & Heller, L. R. (1992). Effects of reciprocal peer tutoring on mathematics and school adjustment: A component analysis. *Journal of Educational Psychology*, *84*, 331–339. doi:10.1037/0022-0663.84.3.331

Fantuzzo, J. W., Tighe, E., & Childs, S. (2000). Family involvement questionnaire: A multivariate assessment of family participation in early childhood education. *Journal of Educational Psychology*, *92*, 367–376. doi:10.1037/0022-0663.92.2.367

Franco, L. M., Pottick, K. J., & Huang, C. (2010). Early parenthood in a community context: Neighborhood conditions, race-ethnicity, and parenting stress. *Journal of Community Psychology*, *38*, 574–590. doi:10.1002/jcop.20382

Fuchs, L. S., Compton, D. L., Fuchs, D., Powell, S. R., Schumacher, R. F., Hamlett, C. L., . . . Vukovic, R. K. (in press). Contributions of domain-general cognitive resources and different forms of arithmetic development to pre-algebraic cognition. *Developmental Psychology*.

Fuchs, L. S., Compton, D. L., Fuchs, D., Powell, S. R., Schumacher, R. F., Hamlett, C. L., Namkung, J. M., & Vukovic, R. K. (2012). Contributions of domain-general cognitive resources and different forms of arithmetic development to pre-algebraic cognition. *Developmental Psychology*, *48*(5), 1315–1326. doi: 10.1037/a0027475

Fuchs, L. S., Fuchs, D., Compton, D. L., Powell, S. R., Seethaler, P. M., Capizzi, A. M., . . . Fletcher, J. M. (2006). The cognitive correlates of third grade skill in arithmetic, algorithmic computation, and arithmetic word problems. *Journal of Educational Psychology*, *98*, 29–43. doi:10.1037/0022-0663.98.1.29

Fuchs, L. S., Geary, D. C., Compton, D. L., Fuchs, D., Hamlett, C. L., Seethaler, P. M., . . . Schatschneider, C. (2010). Do different types of school mathematics development depend on different constellations of numerical versus general cognitive abilities? *Developmental Psychology*, *46*, 1731–1746. doi:10.1037/a0020662

Fuson, K. C. (1992). Research on learning and teaching addition and subtraction of whole numbers. In G. Leinhardt, R. Putnam, & R. Hattrup (Eds.), *The analysis of arithmetic for mathematics teaching* (pp. 53–187). Hillsdale, NJ: Erlbaum.

Gal, I., & Stoudt, A. (1995, September). *Family achievement in mathematics*. NCAL Connections. Philadelphia: National Center on Adult Literacy, University of Pennsylvania.

Gersten, R., Beckmann, S., Clarke, B., Foegen, A., Marsh, L., Star, J. R., & Witzel, B. (2009). *Assisting students struggling with mathematics: Response to Intervention (RtI) for elementary and middle schools* (NCEE Publication No. 2009–4060). Washington, DC: National Center for Education Evaluation and Regional Assistance. Retrieved from http://ies.ed.gov/ncee/wwc/publications/practiceguides/

Gill, S., & Reynolds, A. J. (1999). Educational expectations and school achievement of urban African American children. *Journal of School Psychology*, *37*, 403–424. doi:10.1016/S0022-4405(99)00027-8

Ginsburg, H. P. (1997). Mathematics learning disabilities: A view from developmental psychology. *Journal of Learning Disabilities*, *30*, 20–33. doi:10.1177/002221949703000102

Ginsburg-Block, M., Manz, P. H., & McWayne, C. (2010). Partnering to foster achievement in reading and mathematics. In S. Christenson, & A. Reschly (Eds.), *Handbook of school-family partnerships* (pp. 175–203). New York, NY: Routledge.

Gonzalez, A. L., & Wolters, C. A. (2006). The relationship between perceived parenting practices and achievement motivation in mathematics. *Journal of Research in Childhood Education*, *21*(2), 203–217.

Graue, E. M., Weinstein, T., & Walberg, H. J. (1983). School-based home instruction and learning: A quantitative synthesis. *Journal of Educational Research*, *76*(6), 351–360.

Grolnick, W. S., Ryan, R. M., & Deci, E. L. (1991). Inner resources for school achievement: Motivational mediators of children's perceptions of their parents. *Journal of Educational Psychology*, *83*, 508–517. doi:10.1037/0022-0663.83.4.508

Grolnick, W. S., & Slowiaczek, M. L. (1994). Parents' involvement in children's schooling: A multidimensional conceptualization and motivational model. *Child Development*, *65*, 237–252. doi:10.2307/1131378

Hanushek, E. A., & Rivkin, S. G. (2009). Harming the best: How schools affect the Black-White achievement gap. *Journal of Policy Analysis and Management*, *28*, 366–393. doi:10.1002/pam.20437

Harari, R. R., Vukovic, R. K., & Bailey, S. (in press). Mathematics anxiety in young children: An exploratory study. *Journal of Experimental Education*.

Harcourt Assessment, Inc. (1996). *The Stanford Diagnostic Mathematics Test – Fourth Edition*. San Antonio, Texas: Harcourt Assessment, Inc.

Harcourt Assessment. (1996). *The Stanford Diagnostics Mathematics Test–Fourth Edition*.

Hembree, R. (1990). The nature, effects, and relief of mathematics anxiety. *Journal for Research in Mathematics Education*, *21*, 33–46. doi:10.2307/749455

Hill, N. E., & Craft, S. A. (2003). Parent-school involvement and school performance: Mediated pathways among socioeconomically comparable African American and Euro-American families. *Journal of Educational Psychology*, *95*, 74–83. doi:10.1037/0022-0663.95.1.74

Ho, H.-Z., Senturk, D., Lam, A. G., Zimmer, J. M., Hong, S., Okamoto, Y., … Wang, C.-P. (2000). The affective and cognitive dimensions of math anxiety: A cross-national study. *Journal for Research in Mathematics Education*, *31*, 362–379.

Hoover-Dempsey, K. V., & Sandler, H. M. (1995). Parental involvement in children's education: Why does it make a difference? *Teachers College Record*, *97*(2), 310–331.

Hoover-Dempsey, K. V., & Sandler, H. M. (1997). Why do parents become involved in their children's education? *Review of Educational Research*, *67*, 3–42. doi:10.2307/1170618

Hopko, D. R., McNeil, D. W., Zvolensky, M. J., & Eifert, G. H. (2001). The relation between anxiety and skill performance-based anxiety disorders: A behavioral formulation of social phobia. *Behavior Therapy*, *32*, 185–207. doi:10.1016/S0005-7894(01)80052-6

Institute of Medicine. (2000). *From neurons to neighborhoods: The science of early childhood development*. Washington, DC: National Academies Press.

Izzo, C. V., Weissberg, R. P., Kasprow, W. J., & Fendrich, M. (1999). A longitudinal assessment of teacher perceptions of parental involvement in children's education and school performance. *American Journal of Community Psychology*, *27*, 817–839. doi:10.1023/A: 1022262625984

Jacobs, V. R., Franke, M. L., Carpenter, T. P., Levi, L., & Battey, D. (2007). Professional development focused on children's algebraic reasoning in elementary school. *Journal for Research in Mathematics Education*, *38*(3), 258–288.

Jeynes, W. H. (2003). A meta-analysis: The effects of parental involvement on minority children's academic achievement. *Education and Urban Society*, *35*(2), 202–218.

Jeynes, W. H. (2005). A meta-analysis of the relation of parental involvement to urban elementary school student academic achievement. *Urban Education*, *40*, 237–269. doi:10.1177/0042085905274540

Jeynes, W. H. (2007). The relationship between parental involvement and urban secondary school student academic achievement: A meta-analysis. *Urban Achievement*, *42*, 82–110. doi:10.1177/0042085906293818

Jeynes, W. H. (2010). The salience of the subtle aspects of parental involvement and encouraging that involvement: Implications for school-based programs. *Teachers College Record*, *112*, 747–774.

Jordan, N. C., & Hanich, L. B. (2003). Characteristics of children with moderate mathematics deficiencies: A longitudinal perspective. *Learning Disabilities Research & Practice*, *18*, 213–221. doi:10.1111/1540-5826.00076

Krinzinger, H., Kaufmann, L., & Willmes, K. (2009). Math anxiety and math ability in early primary school years. *Journal of Psychoeducational Assessment*, *27*, 206–225. doi:10.1177/0734282908330583

Kutner, M., Greenberg, E., Jin, Y., Boyle, B., Hsu, Y., & Dunleavy, E. (2007). *Literacy in everyday life: Results from the 2003 National Assessment of Adult Literacy* (NCES Publication No. 2007–480). Washington, DC: National Center for Education Statistics.

LeFevre, J., Fast, L., Skwarchuk, S., Smith-Chant, B. L., Bisanz, J., Kamawar, D., & Penner-Wilger, M. (2010). Pathways to mathematics: Longitudinal predictors of performance. *Child Development*, *81*, 1753–1767. doi:10.1111/j.1467-8624.2010.01508.x

Lightfoot, D. (2004). ‘‘Some parents just don’t care’’: Decoding the meanings of parental involvement in urban schools. *Urban Education*, *39*, 91–107. doi:10.1177/0042085903259290

Ma, X. (1999). A meta-analysis of the relationship between anxiety toward mathematics and achievement in mathematics. *Journal for Research in Mathematics Education*, *30*, 520–541. doi:10.2307/749772

McLeod, B. D., Wood, J. J., & Weisz, J. R. (2007). Examining the association between parenting and childhood anxiety: A meta-analysis. *Clinical Psychology Review*, *27*, 155–172. doi:10.1016/j.cpr.2006.09.002

McWayne, C. M., Campos, R., & Owsianik, M. (2008). Family involvement in preschool: A multidimensional, multi-level examination of mother and father involvement among low-income, culturally diverse families. *Journal of School Psychology*, *46*, 551–573. doi:10.1016/j.jsp.2008.06.001

McWayne, C. M., Green, L. E., & Fantuzzo, J. W. (2009). A variable-and person oriented investigation of preschool competencies and Head Start children’s transition to kindergarten and first grade. *Applied Developmental Science*, *13*, 1–15. doi:10.1080/10888690802606719

McWayne, C. M., Hampton, V., Fantuzzo, J., Cohen, H. L., & Sekino, Y. (2004). A multivariate examination of parent involvement and the social and academic competencies of urban kindergarten children. *Psychology in the Schools*, *41*, 363–377. doi:10.1002/pits/10163

Mellon, R. C., & Moutavelis, A. G. (2011). Parental educational practices in relation to children’s anxiety disorder-related behavior. *Journal of Anxiety Disorders*, *25*, 829–834. doi:10.1016/j.janxdis.2011.04.003

Moses, R. P., & Cobb, C. E., Jr. (2001). *Radical equations: Civil rights from Mississippi to the algebra project*. Boston, MA: Beacon Press.

National Center for Education Statistics. (2007). *Nation’s report card—2007*. Washington, DC: Institute of Education Sciences.

National Mathematics Advisory Panel. (2008). *Foundations for success: The final report of the National Mathematics Advisory Panel*. Washington, DC: U.S. Department of Education.

Newstead, K. (1998). Aspects of children’s mathematics anxiety. *Educational Studies in Mathematics*, *36*, 53–71. doi:10.1023/A:1003177809664

Niditch, L. A., & Varela, E. R. (2010). Mother-child disagreement in reports of child anxiety: Effects of child age and maternal anxiety. *Journal of Anxiety Disorders*, *25*, 450–455. doi:10.1016/j.janxdis.2010.11.009

Nunnally, J. C. (1978). *Psychometric theory* (2nd ed.). New York, NY.

Nye, C., Turner, H., & Schwartz, J. (2007). *Approaches to parent involvement for improving the academic performance of elementary school age children in grades K-6*. London, England: The Collaboration. Retrieved from http://campbellcollaboration.org/doc-pdf/Nye_PI_Review.pdf

O’Connor, S. (2001). Voices of parents and teachers in a poor White urban school. *Journal of Education for Students Placed at Risk*, *6*, 175–198. doi:10.1207/S15327671ESPR0603_2

Pett, M. A., Lackey, N. R., & Sullivan, J. J. (2003). *Making sense of factor analysis: The use of factor analysis for instrument development in health care research*. Thousand Oaks, CA: Sage.

Plantey, M., Hussar, W., Snyder, T., Kena, G., KewalRamani, A., Kemp, J., . . . Dinkes, R. (2009). *The condition of education 2009* (NCES Publication No. 2009–081). Washington, DC: National Center for Education Statistics.

Pomerantz, E. M., Moorman, E. A., & Litwack, S. D. (2007). The how, whom, and why of parents’ involvement in children’s academic lives: More is not always better. *Review of Educational Research*, *77*, 373–410. doi:10.3102/003465430305567

Preacher, K. J., & Hayes, A. F. (2004). SPSS and SAS procedures for estimating indirect effects in simple mediation models. *Behavior Research Methods, Instruments, & Computers*, *36*, 717–731. doi:10.3758/BF03206553

Puklek Levpuščsek, M., & Zupančič, M. (2009). Math achievement in early adolescence: The role of parental involvement, teachers’ behavior, and students’ motivational beliefs about math. *Journal of Early Adolescence*, *29*, 541–570. doi: 10.1177/0272431608324189

Ramirez, A. Y. F. (2003). Dismay and disappointment: Parental involvement of Latino immigrant parents. *Urban Review*, *35*, 93–110. doi:10.1023/A:1023705511946

Ramirez, G., Gunderson, E. A., Levine, S. C., & Beilock, S. L. (in press). Math anxiety, working memory and math achievement in early elementary school. *Journal of Cognition and Development*. Advance online publication. DOI: 10.1080/15248372.2012.664593

Richardson, F. C., & Suinn, R. M. (1972). The mathematics anxiety rating scale: Psychometric data. *Journal of Counseling Psychology*, *19*, 551–554. doi:10.1037/h0033-456

Sénéchal, M. (2006). Testing the home literacy model: Parent involvement in kindergarten is differentially related to grade 4 reading comprehension, fluency, spelling, and reading for pleasure. *Scientific Studies of Reading*, *10*, 59–87. doi:10.1207/s1532799xssr1001_4

Senler, B., & Sungur, S. (2009). Parental influences on students' self-concept, task value beliefs, and achievement in science. *Spanish Journal of Psychology*, *12*(1), 106–117.

Sheldon, S. B., & Epstein, J. L. (2005). Involvement counts: Family and community partnerships and mathematics achievement. *Journal of Educational Research*, *98*, 196–206. doi:10.3200/JOER.98.4.196-207

Siegler, R. S., & Ramani, G. B. (2009). Playing linear number board games—but not circular ones—improves low-income preschoolers' numerical understanding. *Journal of Educational Psychology*, *101*, 545–560. doi:10.1037/a0014239

Steinberg, L., Lamborn, S. D., Dornbusch, S. M., & Darling, N. (1992). Impact of parenting practices on adolescent achievement: Authoritative parenting, school involvement, and encouragement to succeed. *Child Development*, *63*, 1266–1281. doi:10.2307/1131532

Suinn, R. M., Taylor, S., & Edwards, R. W. (1988). Suinn Mathematics Anxiety Rating Scale for Elementary School Students (MARS-E): Psychometric and normative data. *Educational and Psychological Measurement*, *48*, 979–986. doi:10.1177/0013164488484013

Tan, E. T., & Goldberg, W. A. (2009). Parental school involvement in relation to children's grades and adaptation to school. *Journal of Applied Developmental Psychology*, *30*, 442–453. doi:10.1016/j.appdev.2008.12.023

Valdés, G. (1998). The world outside and inside schools: Language and immigrant children. *Educational Researcher*, *27*, 4–18. doi:10.3102/0013189X027006004

Vukovic, R. K., Kieffer, M. J., Bailey, S. P., & Harari, R. R. (2013). Mathematics anxiety in young children: Concurrent and longitudinal associations with mathematical performance. *Contemporary Educational Psychology*, *38*, 1–10. doi:10.1016/j.cedpsych.2012.09.001

Walker, J. M. T., Wilkins, A. S., Dallaire, J. R., Sandler, H. M., & Hoover-Dempsey, K. V. (2005). Parental involvement: Model revision through scale development. *The Elementary School Journal*, *106*, 85–104. doi:10.1086/499193

Westmoreland, H., Rosenberg, H. M., Lopez, M. E., & Weiss, H. (2009, July). *Seeing is believing: Promising practices for how school districts promote family engagement*. PTA/Harvard Family Research Project Issue Brief. Cambridge, MA.

Wigfield, A., & Meece, J. L. (1988). Math anxiety in elementary and secondary school students. *Journal of Educational Psychology*, *80*, 210–216. doi:10.1037/0022–0663.80.2.210

Wittreich, Y. M., Jacobi, E. F., & Hogue, I. E. (2003). *Getting parents involved: A handbook of ideas for teachers, schools and communities*. Norwood, MA: Christopher-Gordon.

Wong, S. W., & Hughes, J. N. (2006). Ethnicity and language contributions to dimensions of parent involvement. *School Psychology Review*, *35*, 645–662.

Wood, J. J., McLeod, B. D., Sigman, M., Hwang, W., & Chu, B. C. (2003). Parenting and childhood anxiety: Theory, empirical findings, and future directions. *Journal of Child Psychology and Psychiatry*, *44*, 134–151. doi:10.1111/1469-7610.00106

Zigler, E. F., & Muenchow, S. (1992). *Head Start: The inside story of America's most successful educational experiment*. New York, NY: Basic Books.