Indirect Effects of Child Reports of Teacher-Student Relationship on Achievement

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Abstract

The effect of student-reported teacher-student relationship quality (TSRQ) on academic motivation and achievement was investigated among a sample of 690 academically at risk elementary students (52.8% male). Measures of TSRQ, achievement, and motivation were collected annually for 3 consecutive years, beginning when participants were in grade 2 (24.8%) or grade 3 (74.6%). Child-reported conflict was stable across the 3 years, whereas warmth declined. Boys and African American students reported greater conflict than did girls and Caucasian and Hispanic students. Girls and African American students reported higher warmth than boys and non-African American students. Using path analysis, the authors tested the hypothesis that measures of student motivation in Year 2 mediated the effects of conflict and warmth in Year 1 on reading and math achievement in Year 3. Child-perceived conflict predicted cross-year changes in teacher-rated behavioral engagement, which, in turn, predicted cross-year changes in reading and math achievement. Math competence beliefs also mediated the effect of child-perceived warmth on math achievement. Effects controlled for stability of measures across time, the within-wave association between measures, and baseline measures of IQ and economic adversity. Implications of findings for improving the academic achievement of students at-risk for school failure are discussed.

Keywords

teacher-student relationships; reading achievement; math achievement; elementary students; academic motivation; longitudinal mediation

A number of longitudinal studies provide evidence that a teacher's report of a supportive relationship with a student has positive effects on elementary students' behavioral and academic adjustment (Curby, Rimm-Kaufman, & Ponitz, 2009; Hamre & Pianta, 2001; Hughes, Cavell, & Jackson, 1999; Ladd, Birch, & Buhs, 1999; Meehan, Hughes, & Cavell, 2003; O'Connor & McCartney, 2007; Valiente, Lemery-Chalfant, Swanson, & Reiser, 2008). Taking into account students' characteristics that influence teacher-student relationship quality (TSRQ), including prior academic and behavioral performance, these studies find that the provision of a relationship with one's teacher characterized by high

levels of support and low levels of conflict predicts improved academic performance. Furthermore, the effect of TSRQ on academic outcomes appears to be mediated by student motivation. For example, Hughes, Luo, Kwok, and Loyd (2008) reported that teacher-reported behavioral engagement in 2nd grade mediated the effect of teacher-reported relationship quality in 1st grade on academically at-risk students' performance on standardized measures of reading and math achievement in 3rd grade, above the stability of TSRQ, engagement, and achievement across time. Similarly, in a low-risk sample, O'Connor and McCartney found that children's relationships with their teachers from preschool to third grade predicted students' academic achievement in 3rd grade, above relevant child, family, and classroom variables, and that child engagement in the classroom partially mediated this effect.

A recent meta-analysis of 99 studies published or presented between 1990 and 2010 provides further support for the impact of TSRQ on student engagement and achievement (Roorda, Koomen, Spilt, & Oort, 2011). The association between both positive and negative dimensions of relationships and engagement were medium to large whereas associations with achievement were small to medium. The authors suggested that a smaller effect of relationship quality on achievement than on engagement is consistent with the view that engagement mediates the effects of TSRQ on achievement. These authors did not analyze effects separately by source of report of TSRQ (i.e., student or teacher).

Most studies investigating an effect of TSRQ on achievement among elementary students have relied on teacher reports of the teacher-student relationship. Given the prevalent assumption that the provision of a supportive, low conflict relationship with one's teacher indirectly affects achievement via its effect on student motivation (Furrer & Skinner, 2003), it is surprising that few longitudinal studies have tested the effects of student-perceived teacher relationship quality on student motivation and achievement during the elementary grades. A primary purpose of the current study is to investigate the prospective associations between students' perceptions of TSRQ, student motivation, and reading and math achievement.

The Meaning of Elementary Students' Reports of the Teacher-Student Relationship

Concordance between student and teacher reports

A reliance on teacher reports of TSRQ in studies of elementary students might be explained by researchers' concern that students below grade 4 are not capable of providing reliable and valid information on relationship quality. Indeed, the relatively few studies utilizing both teacher and child reports of TSRQ among students in grades K-2 show low correspondence between the two informants (Henriccson & Rydell, 2004; Hughes et al., 1999; Mantzicopoulos & Neuharth-Pritchett, 2003; Murray, Murray, & Waas, 2008). With children in grades 3–6, correlations between student and teacher reports of teacher support are significant but small (Gest, Domitrovich, & Welsh, 2005; Rey, Smith, Yoon, Somers, & Barnett, 2007; Skinner & Belmont, 1993). Furthermore, teacher reports of relationship support are more highly correlated with peer nominations of teacher-student relationship support than are child reports of relationship support (Li, Hughes, Hsu, & Kwok, in press). These findings suggest that child and teacher reports of the relationship are assessing different constructs. Thus, one cannot assume that elementary students' reports of the quality of their relationships with teachers have the same predictive validity as do teacher reports. In a cross-sectional study of kindergarten students, only teacher reports of TSRQ predicted teacher-rated behavioral adjustment and achievement, whereas only student reports predicted student liking for school (Murray et al).

The finding of low correspondence between student and teacher reports of the teacher-student relationship is consistent with findings of low correspondence between children's and their parents' reports of the parent-child relationship (Tein, Roosa, & Michaels, 1994). Importantly, despite low correspondence between child and parent reports of the relationship, child reports are more predictive of academic-related outcomes than are parent reports (Pelegrina, Cruz Garcia-Linares, & Casanova, 2003). Similarly, adolescents' reports of social support predict improvement in psychosocial adjustment, even when these perceptions are not consistent with more objective data (McElhaney, Antonishak, & Allen, 2008). These findings suggest that perceived teacher support may be as important as enacted support to students' behavioral and academic adjustment.

Theoretical perspectives on student reports of TSRQ

According to attachment theory (Bowlby, 1980), children construct internal models, or mental representations, of relationships based on their experiences with primary caregivers in early childhood. These mental representations include expectations about others' availability, support, and trustworthiness and about one's self as worthy of being loved and cared for (Bretherton & Munholland, 1999). These mental representations of relationships guide children's behaviors and feelings in new relationship and interpretation of relationship events. Although these internal models are open to revision based on new experiences, they contribute to stability in relationships formed with new partners (Cassidy, Kirsch, Scolton, & Parke, 1996; Richters & Waters, 1991; Rydell, Bohlin, & Thorell, 2005). As children grow and encounter new relationship partners, such as teachers and peers, they construct somewhat different generalized mental representations of different categories of relationships (Berlin, Cassidy & Appleyard, 2008). Consequently, a child's mental representation of his or her relationship with a specific teacher is thought to reflect the child's early care-giving experiences, prior experiences with teachers, interactions with a specific teacher, and the broader context in which these interactions occur (Pianta et al., 2003). These mental representations of the teacher-student relationship, in turn, are expected to influence the student's behavioral and attitudinal responses to the teacher. Specifically, a child's perception of the teacher as liking and admiring him or her and as supportive and available is expected to lead to more positive engagement and achievement in the classroom.

Social motivation theories (Deci & Ryan, 1991; Furrer & Skinner, 2003) also provide a basis for expecting that students' perceptions of their relationships with teachers would have implications for the student's engagement in the classroom. Social motivation theories posit that a student's behavioral engagement in the classroom depends, in part, on the degree to which the student's basic psychological needs for relatedness, competence, and autonomy are met. These three needs are integrative, such that the satisfaction of one need promotes the fulfillment of other needs (Ryan, 1995). Thus, a student's perception of the teacher as accepting, trustworthy, respectful, and available, whether congruent with other sources of information on the relationship or not, would be expected to promote a positive sense of school membership, autonomy, and perceived academic competence. In turn, such positive self views are expected to promote greater effort and persistence as well as commitment to school rules and norms. Consistent with this reasoning, elementary students who report positive relationships with their teachers and peers report greater attachment to, liking for, and involvement in school relative to students who report less positive relationships (Flook, Repetti, & Ullman, 2005; Guay, Boivin, & Hodges, 1999; Ladd et al., 1999; Murray et al., 2008; Gest et al., 2005; Skinner & Belmont, 1993).

Whereas no published study has reported an indirect effect of students' perceived teacher support on achievement, several studies document an indirect effect of students' perceived peer acceptance on achievement, via improved perceived academic competence. For example, a short-term longitudinal study with fifth graders found that students' self-reported

peer rejection predicted students' changes in achievement from the beginning to the end of the year, and that students' perceived academic competence partially mediated this effect (Buhs, 2005). In a sample of 6th grade children, Thijs and Verkuyten (2008) found that academic self-concept mediated the effect of negative peer interactions on achievement above the effect of depression or global self esteem.

In a 2-year longitudinal study of students, the majority of whom were in third grade in Year 1, Hughes (2011) provided evidence of the implications of child reports of TSRQ for students' engagement, perceived competence, and achievement. Specifically, child reports of TSRQ at baseline uniquely predicted teacher-reported engagement, child reported academic competency beliefs, and performance on standardized tests of reading and math achievement the following year, above performance on the outcome in Year 1 and other relevant covariates. The authors know of no other published study demonstrating an effect of elementary students' reports of TSRQ on changes in perceived academic competence or or performance on a standardized measure of academic achievement.

Study Purpose and Hypotheses

Utilizing the same sample as Hughes (2011), the current study extends that study's findings in three critical ways. First, we investigate processes that mediate an effect of TSRQ on achievement. Second, we investigate developmental changes in TSRQ across the late elementary grades. Third, we investigate gender and ethnic differences in mean levels of TSRQ and the invariance of the hypothesized meditational models across gender and ethnicity.

Indirect effect of TSRQ on achievement

With three years of data, the current study tests a model positing that teacher-rated engagement and child-perceived academic competence mediate the effects of child-perceived warmth and conflict on both math and reading achievement, above the stability of each construct and the within-wave associations among the constructs. Figure 1 depicts the hypothesized theoretical model. Although the optimal interval for testing the hypothesized indirect effects is not known, it is reasonable to expect that it would take several months for a student's improvement on the mediators (i.e., academic self-concept or behavioral engagement) to affect scores on standardized measures of academic achievement, which assess a student's accumulated knowledge and skills.

With only two waves of data, Hughes (2011) could not provide a strong test of mediation, which requires that the predictor, mediator, and outcome each be assessed at a minimum of three waves, in accordance with the temporal precedence of the hypothesized effects (Cole & Maxwell, 2003). Hughes tested the putative mediators (i.e., engagement and perceived academic competence) and the outcomes (i.e., reading and math achievement) at the same time. Thus, the researcher was unable to distinguish between the hypothesized causal model and a model in which achievement mediates the effect of TSRQ on engagement and perceived competence or a model in which the putative mediators and outcomes have no causal relationship but are merely outcomes of TSRQ. An understanding of the likely causal processes helps focus intervention efforts. For example, a finding that the hypothesized model is correct supports a focus on enhancing children's perceptions of the teacher-student relationship when poor engagement or low perceived competence is observed, as a strategy for increasing achievement.

Reading and math achievement outcomes were tested separately based on previous findings that teacher-reported TSRQ has a stronger effect on reading than math in the early elementary grades but a stronger effect on math than reading after grade 3 (Pianta, Belsky,

Vandergrift, Houts, & Morrison, 2008). These findings may reflect a relative decrease in the amount of instructional time spent in reading versus math from grade 1 to grade 5 (Pianta et al., 2006; Sonnenschein, Stapleton, & Benson, 2010). Student-reported conflict and support are also tested in separate models. Studies of teacher-reported TSRQ consistently find a stronger effect for conflict than for support on achievement (Hame & Pianta, 2001; Spilt, Hughes, Wu, & Kwok, in press; Ladd et al., 1999). Few studies have examined associations of child-reported conflict and support on achievement. In a cross-sectional study of children in preschool to first grade, child-reported conflict and support were significantly correlated with both reading and math achievement scores (Mantzicopoulos & Neuharth-Pritchett, 2003).

The hypothesized mediators are tested within the same models, thereby permitting an estimate of the unique (versus overlapping) effects of each pathway (i.e., the competence beliefs pathway and the behavioral engagement pathway). Thus a total of four mediation models tested the effect of Warmth or Conflict on Reading or Math achievement.

Developmental Changes in TSRQ

We investigate developmental shifts both in mean levels of child perceived conflict and warmth and in the stability of the effect of conflict and warmth on engagement and perceived competence across the late elementary grades. Although studies have documented a decline in students' perceptions of teacher support as they transition to middle school (Barber & Olsen, 2004), this decline may begin during the elementary grades, as students approach adolescence. Furthermore, because children report decreasing reliance on teachers as sources of support and increasing reliance on peers in adolescence (Bokhorst, Sumter, & Westenberg, 2010; Buhrmester & Furman, 1987; Furman & Buhrmester, 1992), one might expect that the effects of TSRQ on engagement and achievement would be stronger at the earlier interval (typically from grade 3 to 4 than the later interval (typically from grade 4 to 5). However, the empirical evidence to support this expectation is sparse. Thus these analyses are exploratory.

Gender differences

Studies using teacher report of TSRQ consistently find that girls experience closer relationships with their teachers than do boys (Baker 2006; Birch & Ladd, 1997; Hughes & Kwok, 2007; O'Connor, 2010). Whereas gender differences in child-perceived TSRQ may be uncommon in the early elementary grades (Murray et al., 2008), by 3rd grade girls report more positive relationships with their teachers than do boys (Blankemeyer, Flannery, & Vazsonyi, 2002; Furrer & Skinner, 2003). In addition to main effects of gender on child reports, gender may moderate the associations between TSRQ and outcomes. According to the academic risk perspective (Hamre & Pianta, 2001), TSRQ is expected to have a stronger effect on engagement and achievement of boys because boys are at greater risk of behavioral and academic problems than are girls. Conversely, according to gender role socialization theory (Ewing & Taylor, 2009), girls may benefit more than boys from a close relationship with their teacher because close interpersonal relationships are valued more by girls and are more consistent with gender role norms. Empirical results on gender moderation of the effect of TSRQ on engagement and achievement have been inconsistent. Some studies find stronger associations for girls than boys (Baker, 2006), other studies report stronger associations for boys (Blankemeyer et al, 2002; Furrer & Skinner, 2003; Hamre & Pianta, 2001), and yet other studies find no evidence of gender moderation (Hughes & Kwok, 2007; Murray et al., 2008; Stipek & Miles, 2008). Inconsistent results may be due to differences in whether students or teachers report on the relationship, whether positive or negative dimensions of the relationship are assessed, and the specific outcome measured. Based on

inconsistent results concerning gender moderation, the current study does not advance *a priori* hypotheses regarding gender moderation.

Ethnic differences

An extensive literature documents racial and ethnic differences in teacher reports of TSRQ. Specifically, teachers report less affectively positive relationships with African American than with Hispanic and Caucasian students (Hamre & Pianta, 2001; Hughes & Kwok, 2007; Ladd et al., 1999; Spilt et al., in press), a difference that is reduced when teachers and students share the same ethnicity (Saft & Pianta, 2001; Zimmerman, Khoury, Vega, Gil, & Warheit, 1995). The few studies examining ethnic and racial differences in children's reports of TSRQ have been conducted with young children and have yielded less clear results. In a study with urban kindergarten children (Murray et al., 2008), no ethnic or racial differences were found for child reports of teacher student support, although kindergarten teachers rated their relationships with African American students as lower in support, relative to their relationships with Hispanic and Caucasian students, In a study with prekindergarten to first grade urban children (Mantzicopoulos & Neuharth-Pritchett, 2003), African American males reported higher conflict but equivalent levels of warmth in their relationships with teachers, relative to Caucasian students. In addition to investigating mean ethnic and racial differences in child reported warmth and conflict, we investigate whether ethnicity and race moderate the hypothesized indirect effects of child-perceived warmth and conflict on achievement. Studies utilizing teacher reports of the relationship find that a positive teacher-student relationship is more predictive of school adjustment for minority children than for Caucasian children (Burchinal et al., 2002; Meehan et al., 2003).

Academically At-Risk Sample

The hypothesized mediation model is tested with a sample of students who scored below the median for their school district on a test of literacy when they were in first grade (see participants section). Because low literacy at school entrance is strongly predictive of poor academic performance throughout the elementary grades and beyond (Alexander, Entwisle, & Horsey, 1997; Sonnenschein et al., 2010), educators and researchers are particularly interested in identifying malleable aspects of school experiences that can buffer at-risk students from academic failure. Furthermore, students who are at risk for academic failure due to low literacy skills or other learner characteristics are more affected by relational supports at school than are students with lower levels of risk (Baker, 2006; Burchinal et al., 2002; Buyse et al., 2008; Gruman, Harachi, Abbott, Catalano, & Fleming, 2008; Hamre & Pianta, 2005; Meehan et al., 2003). The current sample provides a good opportunity to test whether academically at-risk students' perceptions of their relationships with their teachers buffer them from behavioral disengagement, low academic self-efficacy, and low achievement.

Methods

Participants

Participants were drawn from a larger sample of 784 children participating in a longitudinal study examining the impact of grade retention on academic achievement. Participants for the longitudinal study were recruited from three school districts in the Southeastern United States (one urban and two small city districts) across two sequential cohorts in first-grade during the fall of 2001 and 2002. Children were eligible to participate in the larger longitudinal study if they scored below the median score for their school district on a state approved, district-administered measure of literacy, spoke either English or Spanish, were not receiving special education services other than speech and language, and had not been

previously retained in first grade. Details on recruitment of the 784 participants are reported in Hughes & Kwok (2007). No evidence of selective consent for participation in the larger longitudinal study was found.

Of the 784 recruited children, 690 (88%) met the following criteria for the current study: were active research participants during the 3 years of the study, enrolled in public school within 200 miles of one of the recruitment schools, and had data on at least one study variable. All study variables were assessed in Years 1, 2, and 3. At Year 1, these students were located in 82 schools in 318 classrooms. Due to some students being previously retained, 515 (74.6%) were in grade 3 and 171 (24.8%) were in grade 2 at Year 1 of the current study. No evidence of selective attrition was found based on a large number of demographic and school academic and behavioral adjustment variables measured in first grade.

Of these 690 participants, 365 (52.8%) were male, and the racial/ethnic composition was 34.3% White, 38% Hispanic, 23% African American, and 4.7% Other. As of September 1 of Year 1, children's mean age was 8.58 (SD = .39) years. Based on family income, 58.7% of participants were eligible for free or reduced lunch in Year 1. The 318 Year 1 teachers were overwhelmingly female (95%) and Caucasian (82% Caucasian; 14% Hispanic, 2% African American, and 2% Other) and had taught for an average of 4.05 years (SD = 1.74). To account for the dependency issue of students nested within classroom (teachers), TYPE=Complex routine in Mplus v.6.1 (Muthén & Muthén, 2010) was used to provide consistent standard error estimate and statistical inference by utilizing the adjusted degrees of freedom of parameter estimate.

Not all participants had complete data. The overall level of missingness for all study variables was 11.05%. All participants had complete demographic variables. Level of missingness for study variables ranged from 6% for Year 3 child reading and math achievement variables to 27% for Year 2 teacher-rated engagement variables. Because attrition analyses were consistent with the assumption that data were missing at random, we analyzed the model using the full information maximum likelihood (FIML) method under Mplus v.6.1 software (Muthén & Muthén, 2010), which applies the expectation maximization algorithm to missing data (Little & Rubin, 1987).

Assessment Overview

Each year data were collected from teachers (questionnaires) and children (interviews and standardized achievement testing). Teachers received compensation for completing and returning questionnaires for participating students in their class, which were administered in the spring. Research staff individually administered tests of reading and math achievement and interviewed students during each academic year. Students responded orally to interview questions. If children or their parents spoke any Spanish, students were individually administered the Woodcock-Munoz Language Test (Woodcock & Munoz-Sandoval, 1993) by bilingual (English/Spanish) examiners to determine the child's language proficiency in English and Spanish. All measures were administered in the language in which the student demonstrated greater language proficiency. If the student demonstrated equal or greater language proficiency in English for three consecutive years, subsequent tests were administered in English. Child assessments occurred between October and May of each year with the stipulation that at least 8 months separated each annual child assessments. Bilingual staff administered these interviews to students enrolled in bilingual classes.

Measures

Child ratings of teacher-student relationship warmth and conflict—The Network of Relationships Inventory (NRI; Furman & Buhrmester, 1985) is a structured interview that asks children to rate persons in their social network with respect to six types of social support (affection, admiration, intimacy, satisfaction, nurturance, and reliable alliance) and conflict. It is based on Weiss's (1974) theory of the provision of social support. Children's perceptions of support on these dimensions are relevant to both attachment theory and social motivational theories. Confirmatory factor analysis supports the factor structure of the scale (Yi et al., in press). Children were asked to indicate on a 5-point Likert-type scale their level of warmth (13 items) or conflict (6 items,) in their relationships with their teachers. Example Warmth items include "How much does your teacher like or love you?", "How satisfied are you with your relationship with your teacher?", and "How much does your teacher treat you like you're admired and respected?" Example Conflict items include "How much does this teacher punish you?" and "How much do you and your teacher disagree and quarrel?" Across the three years, internal consistency coefficients for warmth ranged from .87 to .92. Internal consistency coefficients for conflict ranged from .78 to .82.

Teacher-rated behavioral engagement—Teachers rated students' classroom engagement with an 11-item questionnaire. Items were adapted from both the teacher and the student ratings of students' engagement (Skinner et al., 1998). Items assess effort, persistence, concentration, and interest. Example items include "tries hard to do well in school", "concentrates on doing work", "tries to look busy" (reverse scored), and "participates in class discussion". Teachers were asked to indicate the extent to which each statement was true of their student on a 1 (Not true at all) to 4 (Very true) scale. These 11 items demonstrate good factorial validity (Chen, Hughes, Liew, & Kwok, 2010). For the current sample, internal consistency reliabilities ranged from .91 to .92 each year.

Child-rated perceived academic competence—Children's perceived reading and math competencies were assessed with the Competence Beliefs and Subjective Task Values Questionnaire (Wigfield et al., 1997). The math and reading scales consist of 5 items each. Specifically, students were asked how good they were in that domain, how good they were relative to the other things they do, how good they were relative to other children, how well they expected to do in the future in that domain, and how good they thought they would be at learning something new in that domain. Students were asked respond by pointing on a thermometer numbered 0 to 30. The end point and midpoint of each scale were also labeled with a verbal descriptor of the meaning of that scale point (e.g., the number 1 was labeled with the words "not at all good," or "one of the worst", the number 15 was labeled with the word "ok," and the number 30 was labeled with the words "very good" or "one of the best"). Scores on the reading and math competence belief domains are associated in expected directions with students' actual achievement, demographic variables, and student attitudes toward achievement (Wigfield et al.). The internal consistency for the reading competence belief scale ranged from .83 to .87. The internal consistency for the math competence belief scale ranged from .82 to .87.

Academic achievement—The WJ-III Tests of Achievement (Woodcock, McGrew, & Mather, 2001) is an individually administered measure of academic achievement for individuals 2 years of age to adulthood. The WJ-III Broad Reading W Scores (letter-word identification, reading fluency, and passage comprehension subtests) and the WJ-III Broad Math W Scores (calculation, math fluency, and math calculation skills subtests) were used. Because W scores are based on the Rasch measurement model, yielding an equal interval scale, they are well-suited for the analysis of longitudinal change. The test-retest reliability

and construct validity of scores on the WJ-III and its predecessor are well established (Woodcock et al., 2001).

If children or their parents spoke any Spanish, children were administered the Woodcock-Munoz Language Test (Woodcock & Muñoz -Sandoval, 1993) to determine the child's language proficiency in English and Spanish and selection of either the WJ-III or the equivalent Spanish version, the Bateria-III (Woodcock, Muñoz-Sandoval, McGrew, Mather, & Schrank, 2004). If the child's academic achievement was measured using the Bateria-III, then the Bateria-III Broad Reading and Broad Mathematics W Scores were used in this study.

Child IQ, Familial Economic Background and Retention Status

Information about children's IQ and family economic adversity was collected. Because these variables were expected to be related to other study variables, they were used as covariates in the path analytic models. Because a fairly large percentage of participants (24.8%) had previously repeated a grade, we also included retention status (coded as 0 for students in Grade 3 and 1 for students in Grade 2) as a covariate. Each measure is described below.

Cognitive ability (IQ)—Children were individually tested at school when in 1st grade with the Universal Nonverbal Intelligence Test (UNIT; Bracken & McCallum, 1998). The UNIT is a nationally standardized non-verbal measurement of the general intelligence and cognitive abilities of children and adolescents. The UNIT assesses general intelligence by measuring complex memory and reasoning abilities using culturally and linguistically universal hand and body gestures rather than receptive or expressive language. We used the Abbreviated version of the UNIT that yields a full scale IQ which is highly correlated with scores obtained with the full battery (r=.91) and has demonstrated good test-retest and internal consistency reliabilities as well as construct validity (Bracken & McCallum; Hooper, 2003).

Economic adversity—Children's eligibility for free or reduced lunch was used as an indicator of children's economic adversity (coded as a dichotomous variable). Information on eligibility was provided by school records and based on children's family income.

Retention status—Grade level information at the beginning of Year 1 of the current study was obtained from schools and used as the indicator of grade retention in grades 2 or 3. Among the samples, 25% of students were in the grade 2 and 75% of students were in the grade 3.

Results

Descriptive and correlational results

All study variables were analyzed for outliers and for distributional properties. Using West and Finch (1997) criteria, no outliers were identified and values for skewness and kurtosis for all variables were within the acceptable limits for the planned analyses.

Table 1 reports within-wave and cross-wave zero-order correlations for study variables. Measures of TSRQ and motivation (teacher-rated engagement and perceived reading and math competence) evidenced moderate 1-year stability, whereas measures of reading and math achievement were highly stable (average 1 year stability of .89 for reading and .83 for math). Within wave correlations between children's perceptions of warmth and conflict were small and negative (range = −.09 to −.18). Within wave correlations between conflict

and warmth and the hypothesized mediators and outcomes were in the expected direction or not statistically significantly different from zero. The stability of within-wave correlations was examined by using the differential chi-square test between the model with freely estimated within-wave correlations and the model that constrained within-wave correlations to be the same across waves. The result was not statistically significant, which indicated that the constrained model was not a significantly worse fit than the freely estimated model. Therefore in the tested path analytic models, the within wave correlations were constrained to be invariant across waves, resulting in a more parsimonious model.

Developmental changes in perceptions of TSRQ

The Repeated Measure Analysis of Variance (RMANOVA) was conducted to investigate the mean shift of repeated measures of child-rated conflict and warmth scores along with the between-subject factor, either gender or ethnicity factor. Firstly, there were no statistically significant interaction terms of within- and between-subject factors, and within-subject mean differences of conflict scores, but significant mean differences were found in between-subject factors: Across three time points, boys tended to report higher conflict score than girls ($F(1,561)=57.27$, $p<.001$); African American students tended to report higher conflict score than Caucasian and Hispanic students ($F(2,535)=8.28$, $p<.001$). Secondly, as for the warmth repeated measures, there were no statistically significant interaction terms of within- and between-subject factors. The significant warmth mean differences in the within-subject factor (i.e. 3-wave repeated measures) were found in the gender analysis ($F(2,1122)=7.78$, $p<.001$) and in the ethnicity analysis ($F(2,1070)=4.62$, $p=.01$) . Students tended to report lower warmth scores as time increased. Significant warmth mean differences were also found in the between-subject factors across 3 time points: girls tended to report higher warmth score than boys ($F(1,561)=38.68$, $p<.001$); African American students tended to report higher warmth score than both Caucasian and Hispanic students ($F(2,535)=7.324$, $p=.001$). The detailed post-hoc analyses were presented in Table 2 as well.

Path Analysis Models

The hypothesized longitudinal mediation model (i.e. cross-lagged panel model, CLPM (Cole & Maxwell, 2003) of predictor (X_t), mediators (M_t) and outcomes (Y_t) at time t (t=1, 2, or 3) is depicted in Figure 1. X_t represents the predictor, which can be either child-rated warmth or conflict; M_t represents the mediators to be both teacher-rated behavioral engagement and child-rated academic competencies (reading or math competence); Y_t represents the outcome can be either student's WJ-III reading or math achievement score. Thus, a total of 4 models were examined in this study: Model 1 = Conflict → Engagement & Reading Competence → Reading Achievement; Model 2 = Conflict → Engagement & Math Competence → Math Achievement; Model 3= Warmth → Engagement & Reading Competence → Reading Achievement; Model 4 = Warmth → Engagement & Math Competence → Math Achievement. The time-specific indirect effect (i.e. $X_1 → M_2 → Y_3$) was of greatest interest (Gollob & Reichardt, 1991) and this effect was tested with the Sobel test (MacKinnon, 2008; Sobel, 1982).

In Table 3, we tested the time invariant effect of the predictor variable (conflict or warmth) on the mediator variables (engagement and academic competence) and the mediator variable on the outcome variable (reading or math) (i.e. Time-specific indirect effect, the $ab_{X1→M2→Y3}$). Freely estimated model and constrained model were specified to examine the stability of time-specific indirect effect. The differential chi-square test statistics for all the 4 models were not statistically significant, meaning the constrained models were not statistically worse than the hypothesized models. All the fit indices were within the conventional cutoff criteria and suggested adequate model fit to the data. The parameter estimates for the time-variant model (the freely estimated model) and the time invariant

model (the constrained model) are presented in Table 4 (Conflict → mediators → outcome variables) and Table 5 (Warmth → mediators → outcome variables). Both unstandardized and standardized estimates are exhibited. As for the effect size of the mediation effect, we calculated the proportion of the unexplained variance in reading and math outcomes at time 3 (after controlling for the stability and covariates) that can be explained by the time-specific indirect effect (i.e. $ab_{X1 \to M2 \to Y3}$).

For Conflict models, we found three statistically significant tests of target time-specific indirect effects as shown in Table 4. The effect of conflict on reading scores was mediated by teacher-rated behavioral engagement ($ab_{X1 \to M2 \to Y3} = -.155$, $SE = .07$, p .01). The effect of conflict on math scores was also mediated by teacher-rated behavioral engagement ($ab_{X1 \to M2 \to Y3} = -.077$, $SE = .03$, $p = .01$). Additionally, the effect of conflict on math scores was mediated by child-rated math competence ($ab_{X1 \to M2 \to Y3} = -.055$, $SE = .03$, $p = .04$). After controlling for longitudinal stability and covariates, the proportion of the unexplained variance in reading and math at time 3 that was explained by the specific indirect effect was 4.9%, 3.0%, and 1.9%, respectively, for the above three models.

For Warmth models (Table 5), only the indirect effect of warmth on math as mediated by child-rated math competence was marginally statistically significant ($ab_{X1 \to M2 \to Y3} = .056$, $SE = .03$, $p = .05$). The proportion of the unexplained variance in math at time 3 that was explained by this indirect effect was 1.9%..

The negative regression coefficients of warmth in predicting engagement ($b = -.104$ for model 3A and $-.112$ for model 4A) are unexpected. The near zero correlation between warmth at time 1 and engagement at time 2 ($r = .01$) and between warmth at time 2 and engagement at time 3 ($r = .06$) and the resulted negative regression coefficients from warmth to engagement suggests that warmth is a suppressor variable which reduced the variance unaccounted for in the effect by increasing the overall multiple R2 in the model (Cohen, Cohen, West & Aiken, 2003).

We tested a model that posits an indirect effect of TSRQ on achievement via the postulated mediators. Theoretical and empirical justification exists for testing alternative pathways. For example, higher levels of achievement may lead to higher levels of perceived academic competence or teacher-rated engagement, and higher levels of engagement may lead to improved TSRQ. Therefore we tested the reverse time-specific indirect paths (i.e. Y1→M2→>X3) in each of the four models. We did not find evidence of an effect of achievement on any of the mediators; we did, however, find a reciprocal negative relationship between engagement and conflict scores.

Gender and Ethnicity Moderation Analyses of Indirect Effects—To test whether the pattern of longitudinal mediation relationships was similar between gender or ethnicity groups, multi-group comparisons were then conducted and the results were represented in Table 3. Models whose parameters were constrained to be the same across gender or ethnicity were compared with models whose parameters were free to vary. The Satorra-Bentler scaled differential chi-square test was conducted with the scaled differential degrees of freedom to take the data dependency into account. The differential chi-square test results were not statistically significant for all four hypothesized models, revealing that gender or ethnicity did not moderate the mediation relationship of the mediation models.

Discussion

Summary of Results

This three-wave longitudinal study tested a conceptual model positing that teacher-rated engagement and student-perceived academic competence mediate the effects of elementary students' reports of teacher-student relational conflict and warmth on a standardized measure of reading and math achievement. Measures of the predictors, mediators, and outcomes were assessed in Years 1, 2, and 3 (grades 3, 4, and 5 for the majority of students). Student-perceived teacher conflict predicted cross-year changes in teacher-rated behavioral engagement, which, in turn, predicted cross-year changes in reading and math achievement. An additional indirect effect of student-perceived conflict on math achievement was also found, via student math competence beliefs. Students' perceptions of teacher warmth did not predict changes in teacher-rated behavioral engagement but did predict changes in students' math competence beliefs (but not reading competence beliefs), which, in turn, predicted students' math achievement. Notably, these results were obtained in models that statistically controlled for the effects of students' IQ and family economic adversity on mediators and achievement outcomes, the stability of each measure across time, and the covariation among measures within assessment waves. These findings, while consistent with results of a recent meta-analytic study of student engagement and achievement (Roorda et al., 2011), extend these results by examining student report of TSRQ and employing a rigorous test of mediation.

Conflict versus warmth—The finding of a stronger effect for negative versus positive aspects of the relationship on engagement and achievement is consistent with results of prospective studies of teacher-reported relationship quality relationship (e.g., Hamre & Pianta, 2001) as well as studies investigating concurrent associations between students' perceptions of their relationships with teachers and adjustment (Henricsson & Rydell, 2004; Mantzicopouolos & Newharth-Pritchett, 2003). Apparently, relational adversity, whether assessed from the teacher's or the child's perception, has a stronger indirect effect on achievement than does relational support.

Relational conflict, versus relationship warmth, may be more visible to each relationship partner, as well as to others, resulting in greater concordance between students' and teachers' perceptions of conflict versus warmth (Hughes, 2011). Additionally, and consistent with attachment theory, child perceptions of warmth may reflect a generalized model of relationships as available and supportive or not. For academically at risk students, such a positive relationship model may offer some protection from low feelings of competence and resulting emotional and behavioral disengagement from learning.

Reciprocal effects—By maintaining the temporal sequence of the hypothesized indirect model, the study supports the hypothesized causal direction between mediators and outcomes. The pattern of results suggests that teacher-rated engagement and student-perceived academic competence represent non-redundant pathways from student-perceived conflict and warmth to math achievement. Perceived academic competence is considered a type of psychological engagement that fuels behavioral engagement (Fredericks, Blumenfeld, & Paris, 2004). In addition to perceived competence, psychological engagement includes liking for and interest in school, a sense of school belonging, and perceived opportunities for self-direction and choice. Although these aspects of psychological engagement were not included in the tested model, they are likely impacted by students' perceptions of the teacher as caring and supportive. Indeed, both attachment theory and self determination theory posit that perceptions of relatedness, competence, and autonomy are integrated such that the satisfaction of one need reinforces and promotes the

other needs (Battistich, Solomon, Kim, Watson, & Schaps, 1995; Grolnick et al., 1991; Ryan, 1995). It will be important for future research to expand the assessment of psychological engagement to determine if psychological engagement, more broadly assessed, explains the effect of TSRQ on behavioral engagement.

We found no evidence of an effect of reading or math achievement on any of the mediators. We did, however, find a reciprocal negative effect of behavioral engagement on conflict. When teachers rate students as less engaged in the classroom, students are more likely to view subsequent relationships with teachers as higher in conflict. A reciprocal negative relationship between child perceived relationship conflict and teacher-perceived engagement may contribute to trajectories of stable or increasing conflict for subsets of students (Spilt et al., in press).

Reading versus Math—Although indirect effects for conflict and warmth were found for both reading and math, the effects were more consistent for math than for reading. This finding may be due to shifts in the amount of time spent in math versus literacy after 2nd grade. Although there are large variations across U.S. classrooms, in general, much more time is spent in literacy instruction than in math instruction in kindergarten through second grade. From grade 3 to 5, the amount of time spent in literacy activities decreases and the time spent in math increases (Pianta, Belsky, et al., 2008; Sonnenschein et al, 2010). As more time is spent in math, the relational context of instruction in math may become more important.

Developmental changes

From 3rd to 5th grade, students perceive stable levels of teacher conflict but decreasing levels of teacher warmth. This pattern was similar for boys and girls and for children of differing ethnic and racial groups. A decline in student perceived teacher warmth at the transition to middle school is well documented (Eccles, Wigfield, Midgley, & Reuman, 1993). However, at the beginning of year 3 of the current study, the average age of students was 10.58 years, and the large majority of students had not yet made the transition to middle school. Thus the decline in perceptions of teacher warmth occurs prior to the onset of puberty, and prior to the transition to middle school. During the span of the three years of the current study, the effect of children's perceptions of teacher warmth on teacher-rated engagement and perceived math competence was unvarying. Taken together, these findings suggest that late elementary grade students continue to benefit from perceived warm relationships with teachers, despite the decreasing perceived availability of such relationships. The current study is not able to identify the reasons for decreased perceptions of warmth over this developmental period. Perhaps upper elementary school teachers, relative to primary grade teachers, place a greater focus on their instructional roles versus their relationships roles. In the upper elementary grades, less time is spent in small-group instructional settings and more in whole-class instruction and independent seatwork (Brophy & Evertson, 1981). Thus students may have fewer interactions with teachers in the upper elementary grades. Or perhaps students rely less on teachers for emotional support as they progress through the elementary grades (Bokhorst et al., 2010). Regardless of the reasons, the provision of a warm and supportive relationship with one's teacher is an important contextual resource for learning throughout the elementary grades.

Gender differences

Gender differences in warmth and conflict were found at each wave: girls tended to report significantly higher warmth and lower conflict than boys. These gender mean level differences are consistent with results of studies using teacher reports (Saft & Pianta, 2001; Hughes et al., 2008; Ladd et al., 1999) and child reports (Blankemeyer, Flannery, &

Vazsonyi, 2002; Furrer & Skinner, 2003) of relationship quality. However, to our knowledge, the current study is the first to investigate gender differences in the cross-year changes in child perceptions of teacher support and conflict. The patterns of stable conflict and declining warmth across the later elementary grades were similar for boys and girls.

We found no evidence of gender moderation of the indirect effects of child perceived teacher conflict and warmth on changes in achievement via changes in engagement and perceived competence. Although higher levels of child perceived warmth and lower levels of perceived conflict are less common for boys than for girls; the effect of such a relationship on motivation and achievement is similar for boys and girls. These findings suggest that gender differences in mean levels of perceived teacher conflict and warmth that persist across the elementary grades may contribute to gender differences in academic achievement. The findings are inconsistent with gender socialization theory, which suggests a more powerful effect of teacher warmth on girls than boys, and with the vulnerability hypothesis, which suggests boys are more susceptible to the effect of social risks at school. Failure to find support for the vulnerability hypothesis may be due to the fact that the current sample was at risk for academic failure, based on low literacy skills in first grade, and included a large percentage of ethnic minority and poor children. The additional risk of being a boy among a high risk sample may not increase one's susceptibility to the perceived quality of one's relationship with teachers.

Ethnicity differences

African American children reported higher levels of warmth and conflict, relative to Caucasian and Hispanic students. The finding for conflict is consistent with research on teacher-reports of conflict (Meehan et al., 2003; Hughes & Kwok, 2007; Saft & Pianta, 2001) as well as with results from studies with young children's perceptions of teacher-student conflict (Murray et al., 2008). However, the finding that African American children also report higher teacher provision of warmth than do Caucasian and Hispanic students was unexpected and may be explained by the greater subjectivity of items on the warmth scale, relative to the conflict scale. Items on the conflict scale often refer to observable behaviors (e.g., How much do you and your teacher disagree or quarrel? How much does your teacher punish you?), whereas items on the warmth scale often refer to one's subjective experience of the relationship (e.g., "How happy are you with the way things are between you and your teachers? How much does your teacher like or love you?). Thus perceptions of warmth may depend more than perceptions of conflict on a child's generalized expectations for relationships or response biases. Evidence for racial and ethnic group differences in the tendency to perceive relationship as positive comes from studies investigating racial and ethnic differences in perceptions of social competence. Compared to Euro-American students, African American students' self-ratings of how much peers like them are more positive than the ratings of liking they received from others (Dunkel, Kistner, & David-Ferdon, 2009, Zakriski & Coie, 1996). African American children's readiness to perceive teachers and peers as emotionally supportive may reflect greater valuing of or reliance on relationship supports at school (Ellison, Boykin, Tyler, & Dillihunt, 2005). Importantly, ethnicity did not moderate the indirect effects of child perceived conflict or warmth on achievement. Thus a child's view of teacher-student relationship as low in conflict and high in warmth is as strongly predictive of achievement (via improved engagement or perceived academic competence) for African American children as for Caucasian or Hispanic students. Taken together, these findings suggest that African American children might benefit from classrooms that emphasize relationship-based and cooperative learning contexts (Boykin & Cunningham, 2001; Hurley, Boykin, & Allen, 2005; Slavin & Madden, 2006). A communal orientation is marked by a priority placed on social bonds, group identity formation, and a sense of shared responsibility. Using an experimental design, Hurley et al. found that

African American students achieve more in classrooms that employ a communal versus a more individualistic learning environment .

Study limitations and suggestions for future research

An important caveat to interpreting study findings is that the data are correlational and were not obtained in the context of an experimental manipulation. Even though recommended steps were taken to reduce the probability that the observed relationships were due to unmeasured variables, one cannot rule out such a possibility.

Although the Woodcock Johnson Tests of Achievement is a nationally standardized measure that has demonstrated excellent psychometric properties, it may provide an underestimate of the hypothesized effects because it is not aligned with the curriculum in the classroom. Grades or scores on a curriculum-aligned measure might better estimate the effect of TSRQ on students' classroom adjustment and achievement (Hughes, Chen, Thoemmes, & Kwok, 2010).

The current study spanned three academic years (grades 3–5 for most study participants). Three years may provide too narrow a window to detect developmental changes in the effects of child perceived TSRQ on engagement, perceptions of academic competence, and achievement. For example, perceptions of teacher warmth may be more predictive of growth in reading in grades kindergarten to 2nd, when reading instruction consumes a greater amount of time than it does in grades 3–5 (Sonnenschein et al., 2010). Future studies should investigate developmental shifts in the effects of students' perceptions of TSRQ across a wider developmental period, from early elementary grades into middle school.

Participants in the current study were selected on the basis of scoring below their school district's median on a test of literacy administered in kindergarten or first grade. Thus, these findings may not generalize to samples of students who begin school with above-average literacy. Indeed, students at risk due to family adversity or child characteristics are more affected by the quality of social supports at school than are students with few or no risks (Baker, 2006; Hughes et al., 1999; Pianta & Hamre, 2005). It is also important to note that the hypothesized effects were of small magnitude. Findings are nevertheless noteworthy given the stability of academic trajectories beyond 3rd grade. For example, in a longitudinal study of achievement trajectories across elementary school, Pianta, Belsky et al. (2008) found that 98% of the change in reading achievement scores that would occur in elementary school was completed by third grade and virtually all of the change in math scores was completed by third grade.

The present study examined a limited aspect of the classroom context-i.e., students' perceptions of teacher support and conflict. Other aspects of the teacher-student relationship and the classroom context, including teacher instructional practices such as those measured by the Classroom Assessment Scoring System (Pianta, La Paro, & Hamre, 2008) influence students' achievement. Combining objective measures of teacher classroom practices with measures of students' perceptions of relatedness, competence, and autonomy would permit a more nuanced understanding of the dynamics of classroom contexts, student motivation, and achievement.

Conclusion and implications for practice

Multi-tiered problem-solving models, often referred to as Response to Intervention (RTI), are widely viewed as necessary to the prevention of school failure (Sugai & Horner, 2009). These models provide evidence-based instruction and intervention to meet the needs of all students across academic, behavioral, and social-emotional domains. These models include a first, or universal, tier focused on high quality instruction and support for appropriate student

behavior and school-wide screening for academic and behavioral difficulties (Fletcher & Vaughan, 2009). Opportunities for all students to experience supportive adult relationships at school are a critical element of tier 1 interventions. Yet such opportunities are least available in schools serving higher needs students (Pianta et al., 2007). Achieving the goal of reducing achievement disparities between income and racial and ethnic groups requires interventions to even the playing field in terms of a supportive learning context. In recent years, a number of teacher professional development programs have shown a positive impact on teacher-student relationships (Driscoll & Pianta, 2010; Pianta Mashburn, Downer, Hamre, & Justice, 2008; Raver et al., 2008). Classroom-wide interventions such as Responsive Classroom (Rimm-Kaufman, Fan, Chiu, & You, 2007) have been shown to improve supportive teacher-student interactions and student achievement. Training and support for teachers in implementing such interventions is likely to have a beneficial effect on students' learning, especially students at-risk for school failure due to low achievement. Moreover, schools interested in improving the social-emotional climate of classrooms should consider the inclusion of student-report measures of teacher-student relationships. Student reports of TSRQ might serve both as an indicator of the need for such evidence-based interventions as noted above and as an index of intervention effectiveness.

These findings also suggest the value of assessing students' perceptions of their relationships with their teachers when students experience academic problems. Although a lack of student motivation is frequently thought to underlie poor academic performance, rarely are the potential contributors to poor motivation assessed. In addition to classroom wide (Tier 1) interventions to enhance the classroom level of teacher support, interventions designed to enhance specific teacher-student relationships, (i.e., Tier 2 interventions) may be needed. Banking Time (Pianta, Mashburn, et al., 2008,) and Teacher-Child Interaction Training (Lyon et al., 2009) are examples of evidence-based, teacher-focused interventions that may be appropriate when low achieving students perceive high conflict and low warmth in their relationships with teachers.

Students who struggle academically in the early grades may be more dependent on relational supports than are students who do not struggle, as suggested by the stress-diathesis model (Monroe & Simons, 1991). Consistent with attachment and self determination theory theories, our findings suggest that academically at risk learners' perceptions of teachers as supportive have a beneficial effect on their academic effort in the classroom and confidence in their academic abilities, which contribute to higher achievement. The study adds to an increasing body of literature on the motivational processes that explain the effect of teacher-student relationship quality on students' achievement. Although previous studies have drawn from attachment and self determination theories in explaining an effect of TSRQ on engagement and achievement, few of these studies have tested whether students' perceptions of TSRQ have implications for their psychological and behavioral engagement and subsequent achievement. Thus these findings provide more direct support for the putative self-system processes responsible for an effect of TSRQ on children's achievement than provided in studies relying only on teacher report of TSRQ.

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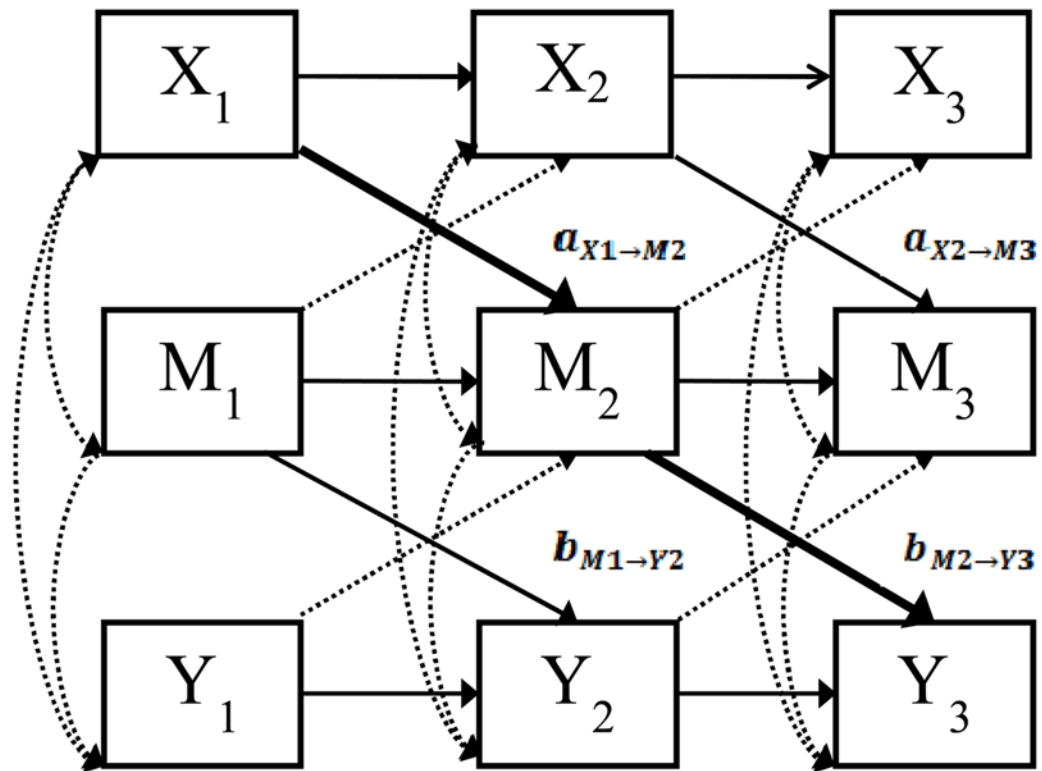
Figure 1.
Hypothesized longitudinal mediation model. Subscripts denote the time point t (i.e. t wave; t=1, 2, or 3) at which a given measure was observed. The bold lines indicate the target time-specific indirect effect ($ab_{X1 \to M2 \to Y3}$). The dash lines are examined in the analyses.
X_t represents the predictor, which can be either child-rated teacher-student relationship warmth or conflict;
M_t represents the mediators, which are the teacher-rated behavioral engagement and the child-rated academic competencies (reading or math competence);
Y_t represents the outcome, which can be either student's WJ-III reading or math achievement score.
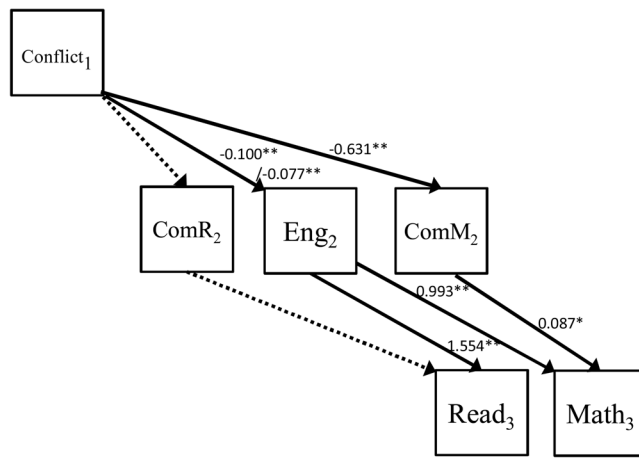
Figure 2a
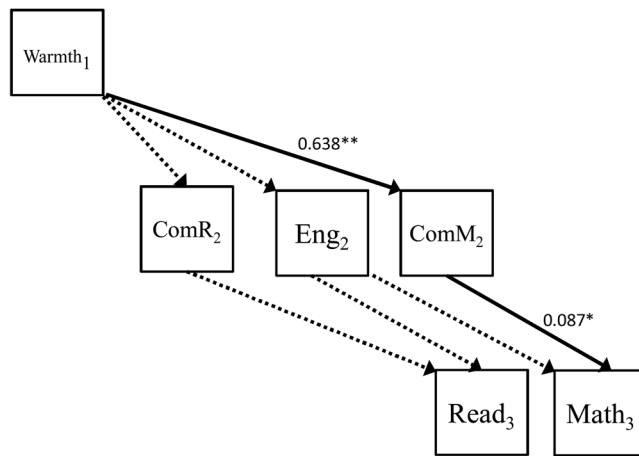
Figure 2b

Figure 2.
Illustration of longitudinal mediation model. Solid lines represents significant paths; dotted lines represent nonsignificant paths. For Time 1 Conflict 1 → Time 2 Engagement, two path coefficients are presented; the first coefficient is from the reading model and the second coefficient is from the math model. Tables 4 and 5 report all direct paths in the full tested models (i.e., Time 2 warmth/conflict →Time 3 mediators and Time 1 mediators → Time 2 read/math).

Table 1

Within- and cross-wave zero order correlations for study variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1 Conflict3	----																				
2 Warmth3	**-.18**	----																			
3 Eng3	**-.34**	**.14**	----																		
4 ComR3	-.08	**.21**	.05	--																	
5 ComM3	-.04	**.15**	**.15**	**.28**	--																
6 Read3	**-.19**	-.04	**.27**	**.28**	.08	--															
7 Math3	**-.09**	-.07	**.33**	.08	**.27**	**.61**	--														
8 Conflict2	**.45**	**-.10**	**-.30**	-.07	**-.11**	**-.14**	**-.15**	--													
9 Warmth2	-.04	**.40**	.06	**.09**	.07	-.05	**-.09**	**-.09**	--												
10 Eng2	**-.24**	.07	**.54**	.10	**.20**	**.26**	**.34**	**-.33**	**.13**	--											
11 ComR2	-.06	**.14**	.02	**.37**	.06	**.28**	**.12**	-.07	**.27**	.07	----										
12 ComM2	-.03	**.10**	.06	**.09**	**.41**	.00	**.19**	**-.10**	**.20**	**.14**	**.30**	----									
13 Read2	**-.18**	-.01	**.28**	**.24**	.06	**.90**	**.58**	**-.16**	-.04	**.23**	**.28**	-.02	--								
14 Math2	**-.10**	-.04	**.27**	.06	**.24**	**.59**	**.83**	**-.13**	-.07	**.29**	.08	**.17**	**.58**	--							
15 Conflict1	**.40**	**-.09**	**-.32**	-.06	-.06	**-.21**	**-.25**	**.48**	-.08	**-.28**	-.07	-.08	**-.22**	**-.24**	--						
16 Warmth1	-.08	**.33**	**.09**	.07	**.09**	-.04	-.06	-.04	**.36**	.01	**.14**	**.20**	-.01	-.02	**-.14**	--					
17 Eng1	**-.24**	**.09**	**.55**	.04	**.12**	**.24**	**.30**	**-.25**	**.13**	**.52**	**.12**	**.13**	**.26**	**.25**	**-.29**	**.11**	--				
18 ComR1	-.01	**.09**	-.03	**.31**	.00	**.19**	.03	-.01	**.11**	.05	**.41**	.03	**.20**	.06	-.07	**.19**	.09	--			
19 ComM1	.07	.07	.02	.05	**.25**	.03	**.15**	.00	**.10**	.06	**.17**	**.35**	.03	**.17**	**-.09**	**.16**	**.09**	**.28**	--		
20 Read1	**-.17**	-.01	**.25**	**.21**	.04	**.84**	**.54**	**-.11**	-.03	**.20**	**.23**	-.02	**.88**	**.55**	**-.18**	-.01	**.23**	**.19**	.06	--	
21 Math1	**-.10**	-.07	**.18**	.05	**.20**	**.51**	**.74**	**-.10**	**-.10**	**.25**	.05	**.13**	**.49**	**.82**	**-.22**	-.04	**.25**	.05	**.17**	**.51**	--
Mean	1.8	3.4	2.8	21.3	22.2	498.8	504.4	1.8	3.5	2.8	21.4	22.3	488.4	496.3	1.8	3.6	2.8	22.2	22.6	477.3	486.6
SD	.74	.93	.70	5.55	5.85	18.80	1.60	.71	.92	.68	5.90	6.06	18.70	1.80	.77	.87	.69	6.26	6.32	19.43	11.02

Note. Conflict: Child-rated TSRQ conflict; Warmth: Child-rated TSRQ Warmth; Eng: Teacher-rated behavioral engagement; ComR: Child-rated reading competence; ComM: Child-rated math competence; Reading: WJ III reading achievement score; Math: WJ III math achievement score;

[a]Bold numbers indicate significant correlations at .05 level.

[b]The number following the variable name indicates the year of assessment (e.g., Conflict1 is the baseline measure of child-rated TSRQ conflict at year 1) .

Table 2

Gender and ethnic group mean difference for Child-reported Warmth and Conflict scores

	Gender				
	Girl	**Boy**	**t**	**p**	**ES**
Warmth1	3.82(.83)	3.41(.85)	6.21	<.01	0.49
Conflict1.	1.58(.65)	1.93(.84)	−5.84	<.01	−0.47
Warmth2	3.59(.86)	3.33(.95)	3.71	<.01	0.28
Conflict2.	1.57(.56)	1.94(.78)	−6.78	<.01	−0.54
Warmth3	3.62(.91)	3.26(.91)	4.81	<.01	0.38
Conflict3	1.66(.66)	1.94(.78)	−4.82	<.01	−0.38

	Ethnicity					
	AA	**HIS**	**CAU**	**F**	**p**	**ES(η^2)**
Warmth1	3.73(.89) [a]	3.64(.85) [b]	3.47(.87) [b]	4.54	=.01	1.4%
Conflict1.	2.01(.92) [a]	1.70(.71) [b]	1.71(.78) [b]	8.96	<.01	2.7%
Warmth2	3.70(.95) [a]	3.40(.88) [b]	3.34(.92) [b]	7.07	<.01	2.3%
Conflict2.	1.91(.81) [a]	1.71(.68) [b]	1.76(.66) [b]	3.62	=.02	1.2%
Warmth3	3.70(.92) [a]	3.37(.92) [a]	3.35(.91) [a]	7.58	<.01	2.5%
Conflict3	1.98(.82) [a]	1.73(.69) [b]	1.82(.73) [b]	5.43	<.01	1.8%

Note. Conflict: Child-rated TSRQ conflict; Warmth: Child-rated TSRQ Warmth; ES (*d*): Cohen's *d* between the means of the measures. ES(η^2): η^2 = SS$_{effect}$ / SS$_{total}$. Measurement means in the same row that do not share subscripts (e.g., a and b) differ at p < .05 in using the Fisher least Significant Difference Test procedure.

[a] The number in the parentheses indicates the standard deviation of measurements.

[b] The number following the variable name indicates the year of assessment (e.g., Conflict1 is the baseline measure of child-rated TSRQ conflict a

Table 3

Model comparison results between Freely estimated model and Constrained model.

	Step1: Freely estimated model				Step2: Constrained model				
	χ^2 (df)	CFI	RMSEA	SRMR	χ^2 (df)**	CFI	RMSEA	SRMR	$\Delta\chi^2$ (Δdf)
Model 1: Conflict → Eng&ComR → Reading	141.05 (34)**	.94	.08	.05	144.89 (38)**	.94	.07	.05	.77 (4)†
Gender moderation	177.41 (66)**				189.07 (78)**				.85 (12)†
Ethnicity moderation	245.01 (99)**				255.52 (119)**				.80 (20)†
Model 2: Conflict → Eng&ComM → Math	134.85 (34)**	.95	.07	.04	152.65 (38)**	.94	.07	.05	2.31 (4)†
Gender moderation	165.02 (66)**				191.39 (78)**				2.25 (12)†
Ethnicity moderation	240.52 (99)**				266.04 (119)**				1.58 (20)†
Model 3: Warmth → Eng&ComR → → Reading	149.83(34)**	.94	.07	.05	159.65 (38)**	.94	.07	.05	1.76 (4)†
Gender moderation	173.81(66)**				195.82 (78)**				1.52 (12)†
Ethnicity moderation	200.21 (99)**				222.57 (119)**				.96 (20)†
Model 4: Warmth → Eng&ComM → Math	120.56(34)**	.95	.07	.05	140.21 (38)**	.94	.07	.05	5.20 (4)†
Gender moderation	163.14(66)**				194.45 (78)**				2.63 (12)†
Ethnicity moderation	219.91 (99)**				250.39 (119)**				1.75 (20)†

Note. Step1: Freely estimated model: $aX1 \rightarrow M2$ $aX2 \rightarrow M3$ & $bM1 \rightarrow Y2$ $bM2 \rightarrow Y3$; Step2: Constrained model : $aX1 \rightarrow M2 = aX2 \rightarrow M3 = a$ & $bM1 \rightarrow Y2 = bM2 \rightarrow Y3 = b$; χ^2 = overall model scaled Chi-Square test statistics with degrees of freedom (*df*); CFI = Comparative Fit Index; RMSEA = Root-Mean-Square of Error Approximation; SRMR = Standardized Root Mean Square Residual.

$\Delta\chi^2$ test: The Satorra-Bentler scaled differential chi-square test statistic with scaled differential degrees of freedom (Δ*df*). Conflict: Child-rated TSRQ conflict; Warmth: Child-rated TSRQ Warmth; Eng: Teacher-rated behavioral engagement; ComM: Child-rated math competence; ComR: Child-rated reading competence; Reading: WJ III reading achievement score; Math: WJ III math achievement score.

†
p>.05,

**
p .01

Table 4

Direct and Indirect path estimates of Child-rated Conflict to Achievement.

| | Step1: Freely estimated model | | Step2: Constrained model | | | |
| | Direct effect | | Direct effect | | Indirect effect | |
	UnStand.	Stand.	UnStand.	Stand.	UnStand.	E.S.
Model 1 A: Conflict → Eng → Reading						
$a_{X1→M2}$	−.085 **	−.097 **	−.100 **	−.107 **	−.155 **	4.9%
$a_{X2→M3}$	−.119 **	−.118 **		−.094 **		
$b_{M1→Y2}$	1.132 **	.043 **	1.554 **	.056 **		
$b_{M2→Y3}$	1.979 **	.073 **		.053 **		
Model 1 B: Conflict → ComR → Reading						
$a_{X1→M2}$	−.106	−.014	−.430	−.024	−.049	1.1%
$a_{X2→M3}$	−.815 *	−.100 *		−.023		
$b_{M1→Y2}$	.118 *	.041 *	.113 **	.049 **		
$b_{M2→Y3}$	.110 *	.035 *		.045 **		
Model 2 A: Conflict → Eng → Math						
$a_{X1→M2}$	−.065 **	−.074 **	−.077 **	−.088 **	−.077 **	3.0%
$a_{X2→M3}$	−.091 **	−.091 **		−.078 **		
$b_{M1→Y2}$	.336	.022	.993 **	.066 **		
$b_{M2→Y3}$	1.782 **	.121 **		.067 **		
Model 2 B: Conflict → ComM → Math						
$a_{X1→M2}$	−.571	−.076	−.631 **	−.084 **	−.055 *	1.9%
$a_{X2→M3}$	−.755 *	−.087 *		−.073 **		
$b_{M1→Y2}$	.084 *	.052 *	.087 *	.054 *		
$b_{M2→Y3}$	.093 *	.054 *		.051 *		

Note. Step1: Freely estimated model: $a_{X1→M2}$, $a_{X2→M3}$ & $b_{M1→Y2}$, $b_{M2→Y3}$; Step2: Constrained model: $a_{X1→M2} = a_{X2→M3} = a$ & $b_{M1→Y2} = b_{M2→Y3} = b$; $ab_{X1→M2→Y3}$: Time-specific indirect effect. UnStand: Unstandardized path estimate; Stand: Standardized path estimate; E.S.: Effect size, the proportion of the unexplained variance in reading and math (after controlling the stability and covariates) at time 5 was explained by the time-specific indirect effect. Conflict: Child-rated TSRQ conflict; Eng: Teacher-rated behavioral engagement; ComR: Child-rated reading competence; ComM: Child-rated math competence; Reading: WJ III reading achievement score; Math: WJ III math achievement score.

*
p .05.

**
p .01

Table 5

Direct and Indirect path estimates of Child-rated Warmth to Achievement.

| | Step1: Freely estimated model | | Step2: Constrained model | | | |
| | Direct effect | | Direct effect | | Indirect effect | |
	UnStand.	Stand.	UnStand.	Stand.	UnStand.	E.S.
Model 3A: Warmth → Eng → Reading						
$a_{X1 \to M2}$	−.104 **	−.133 **	−.046 *	−.059 *	−.070	1.5%
$a_{X2 \to M3}$	.004	.006		−.060 *		
$b_{M1 \to Y2}$	1.123 **	.042 **	1.525 **	.057 **		
$b_{M2 \to Y3}$	1.893 **	.069 **		.056 **		
Model 3B: Warmth → ComR → Reading						
$a_{X1 \to M2}$	.503 *	.074 *	.286	.042	.033	1.1%
$a_{X2 \to M3}$	.084	.014		.048		
$b_{M1 \to Y2}$	.118 *	.041 *	.114 **	.040 **		
$b_{M2 \to Y3}$	.110 *	.035 *		.036 **		
Model 4A: Warmth → Eng → Math						
$a_{X1 \to M2}$	−.112 **	−.142 **	−.044 *	−.056 *	−.055	1.5%
$a_{X2 \to M3}$	.009	−.012		−.058 *		
$b_{M1 \to Y2}$	.333	.022	.988 **	.065 **		
$b_{M2 \to Y3}$	1.810 **	.124 **		.067 **		
Model 4B: Warmth → ComM → Math						
$a_{X1 \to M2}$	1.272 **	.190 **	.638 **	.096 **	.056 *	1.9%
$a_{X2 \to M3}$	.035	.005		.099 **		
$b_{M1 \to Y2}$	.084 *	.052 *	.087 *	.054 *		
$b_{M2 \to Y3}$	.095 *	.055 *		.050 *		

Note. Step1: Freely estimated model: $a_{X1 \to M2}$ $a_{X2 \to M3}$ & $b_{M1 \to Y2}$ $b_{M2 \to Y3}$; Step2: Constrained model: $a_{X1 \to M2} = a_{X2 \to M3} = a$ & $b_{M1 \to Y2} = b_{M2 \to Y3} = b$; $ab_{X1 \to M2 \to Y3}$: Time-specific indirect effect. UnStand: Unstandardized path estimate; Stand: Standardized path estimate; E.S.: Effect size, the proportion of the unexplained variance in reading and math (after controlling the stability and covariates) at time 5 was explained by the time-specific indirect effect. Conflict: Child-rated TSRQ conflict; Eng: Teacher-rated behavioral engagement; ComR: Child-rated reading competence; ComM: Child-rated math competence; Reading: WJ III reading achievement score; Math: WJ III math achievement score.

*
p .05.

**
p .01